7.0 FIRE PROTECTION

7.1 PURPOSE OF REVIEW

The purpose of this review is to establish that there is reasonable assurance that the applicant designed a facility that provides for "adequate protection against fires and explosions" (§ 70.64(a)(3)) and that is based on defense-in-depth practices (§ 70.64(b)). This review should also establish that radiological consequences from fires are considered in determining how the facility will meet the performance requirements of § 70.61.

7.2 RESPONSIBILITY FOR REVIEW

Primary: Fire Protection Engineer

Secondary: Project Manager

Supporting: Chemical Safety Reviewer

Nuclear Criticality Safety Reviewer

Quality Assurance Reviewer

Physical Security Reviewer

7.3 AREAS OF REVIEW

The review should address the adequacy of the following areas of fire protection:

A. Organization and Conduct of Operations: Organization and conduct of operations includes organization and management, training and qualifications, fire prevention, engineering review of design changes, quality assurance (QA), and documentation and recordkeeping.

B. Fire Protection Features and Systems: Plant fire protection features and systems include construction features; passive fire-rated barriers; process and operational features; fire detection and alarm systems; fire suppression systems and equipment; design bases documents; and inspection, maintenance, and testing of fire protection features and systems.

C. Manual Fire Fighting Capability: A baseline needs assessment should establish the minimum required capabilities of site fire fighting forces. This assessment should include minimum staffing, organization and coordination of onsite and offsite fire fighting resources, personal protective and fire fighting equipment, training, and prefire emergency planning.

D. Fire Hazards Analysis (FHA): The FHA consists of a systematic analysis of the fire hazards, an identification of specific areas and systems important to plant fire safety, the development of design basis fire scenarios, an evaluation of anticipated consequences,

and a determination of the adequacy of plant fire safety. FHA requirements are listed separately in Appendix D of this Standard Review Plan (SRP)

7.4 ACCEPTANCE CRITERIA

7.4.1 Regulatory Requirements

The regulations in 10 CFR 70.64(a) has a baseline design criterion for "fire protection" and requirements regarding defense-in-depth practices. In addition, § 70.61 contains performance requirements for the facility. The sections of 10 CFR Part 70 require that there be reasonable assurance of public health and safety and of the environment from the fire and explosion hazards of processing licensed material during normal operations, anticipated operational occurrences, and accidents.

7.4.2 Regulatory Guidance

The guidance in this SRP establishes the criteria for the staff in its review of the fire protection program provided by an applicant for authorization to construct and license to possess and use special nuclear material (SNM) at a mixed oxide (MOX) facility. The program must establish the fire protection policy for the protection of structures, systems, and components relied on for safety at the plant and the procedures, equipment, and personnel required to implement the program at the plant site.

While providing specific guidance in selected areas of fire safety, the staff's position as presented in this SRP also references a National Fire Protection Association, Inc. (NFPA) code that can provide information on standard practices that may be applied for MOX facilities in other areas of fire safety.[1] Significant guidance from Department of Energy DOE–STD–1066–97, "Fire Protection Design Criteria," has also been incorporated into this SRP. Guidance in regard to accident analysis may be found in Nuclear Regulatory Commission (NRC) NUREG/CR–6410, "Nuclear Fuel Cycle Facility Accident Analysis Handbook."

Additional industry documents that may provide useful background information for consideration in the design of MOX fuel fabrication facilities are listed in Section 7.7.

7.4.3 Regulatory Acceptance Criteria

The NRC reviewers should find that the applicant's fire protection is acceptable if it provides reasonable assurance that the regulatory acceptance criteria below are adequately addressed and satisfied. Some of the information may be referenced to other sections of the SRP, or incorporated by reference, provided an adequate summary is provided and a single reference essentially contains all the information.

Where specific NFPA or other standards are referenced, the intent of the SRP is to refer the user to the latest standard. Because these standards may have been retitled or renumbered since the publication of this SRP, specific dates are not listed in the reference list. If the applicant references an NFPA or other industry standard, it should be dated (as the code of

[1] National Fire Protection Associations, Inc. (NFPA) Standard 801, "Standards for Facilities Handling Radioactive Material, " provides additional overall guidance on fire protection for fuel cycle facilities.

record) so that its criteria can be applied in the review of the applicant's submittal. Specified standards will normally be considered as acceptable means of meeting the review criteria. Alternative means, as well as deviations from specific sections of the standards, will also be considered but may require justification through analysis. Also, depending on the application, standards other than those referenced may be more appropriate for the fire protection required. In addition, hazards may exist or occur at the facility that are not specifically addressed in this SRP chapter. In its license application, the applicant is expected to select and reference the most applicable standards for all known hazards and fire protection measures at its facility beyond those identified in this SRP Chapter.

7.4.3.1 Organization and Conduct of Operations

The following organizational and operational guidance is appropriate for the MOX facility because of the significantly increased potential for fire-induced high radiological consequences over that for other types of fuel cycle facilities:[2]

A. Fire Protection Program

A fire protection program should be established at each MOX facility. The program should establish the fire protection policy for the protection of items relied on for safety (IROFS) at the plant and the procedures, equipment, and personnel required to implement the program at the plant site. The fire protection program should be acceptable if:

i. The fire protection program extends the concept of defense-in-depth to fire protection in fire areas that may affect IROFS, with the following objectives:

   a. To prevent fires from starting;

   b. To detect rapidly, control, and extinguish promptly those fires that do occur; and

   c. To provide protection for IROFS so that a fire that is not promptly extinguished by the fire suppression activities will not result in uncontrolled release of radioactive materials.

ii. Responsibility for the overall fire protection program is assigned to a person who has management control over all organizations involved in fire protection activities. Formulation and assurance of program implementation may be delegated to a staff composed of personnel prepared by training and experience in fire protection and MOX process safety to provide a balanced approach in directing the fire protection program for the MOX plant. The staff is responsible for:

   a. Fire protection program requirements, including consideration of potential hazards associated with postulated fires, with knowledge of building layout and systems design;

[2] Memorandum to the Commission on the Office of Nuclear Material Safety and Safeguards Fire Protection Plan, August 26, 1977, Attachment A.

b. Post-fire safety considerations;

c. Design, maintenance, surveillance, and QA of all fire protection features (e.g., detection systems, suppression systems, barriers, dampers, doors, penetration seals, and fire brigade equipment);

d. Fire prevention activities (administrative controls and training);

e. Fire brigade organization and training; and

f. Prefire planning.

iii. The organizational responsibilities and lines of communication pertaining to fire protection is defined between the various positions through the use of organizational charts and functional descriptions of the responsibilities of each position. The positions/organizations listed below are specifically designated; however, positions and responsibilities may be combined as appropriate depending on the scope of the responsibilities:

a. The upper level offsite or onsite management position that has management responsibility for the formulation, implementation, and assessment of the effectiveness of the MOX facility fire protection program;

b. The offsite or onsite management position(s) directly responsible for formulating, implementing, and periodically assessing the effectiveness of the fire protection program for the applicant's MOX plant, including fire drills and training conducted by the fire brigade and plant personnel and reporting the results of these assessments to the upper level manager responsible for fire protection, with recommendations for improvements or corrective actions as deemed necessary; and

c. The onsite management position responsible for the overall administration of the plant operations and emergency plans that include the fire protection and prevention program and that provide a single point of control and contact for all contingencies.

d. The onsite position(s) that:

(1) Implements periodic inspections to: minimize the amount of combustibles in areas with IROFS; determine the effectiveness of housekeeping practices; assure the availability and acceptable condition of all fire protection systems and equipment, fire stops, penetration seals, and fire-retardant coatings (if any); and assure that prompt and effective corrective actions are taken to correct conditions adverse to fire protection and preclude their recurrence;

(2) Is responsible for the fire fighting training for production plant personnel and the plant’s fire brigade; design and selection of equipment; periodic inspection and testing of fire protection systems and equipment in accordance with

established procedures; and evaluation of test results and determination of the acceptability of the systems under test;

(3) Assists in the critique of all fire drills to determine how well the training objectives have been met;

(4) Reviews and evaluates proposed work activities to identify potential transient fire loads;

(5) Implements a program for indoctrination of all plant contractor personnel in appropriate administrative procedures that implement the fire protection program and the emergency procedures relative to fire protection; and

(6) Implements a program for instruction of personnel on the proper handling of accidental events, such as leaks or spills of flammable materials, that are related to fire protection.

e. The onsite position responsible for fire protection QA. This position is responsible for assuring the effective implementation of the fire protection program by planned inspections, scheduled audits, and verification that the results of these inspections or audits identifying significant adverse conditions are promptly reported to cognizant management personnel.

f. The positions that are part of the plant fire brigade:

(1) The plant fire brigade positions are responsible for fighting fires. The authority and responsibility of each fire brigade position relative to fire protection is clearly defined.

(2) The responsibilities of each fire brigade position corresponds with the actions required by the fire fighting procedures.

(3) The responsibilities of the fire brigade members under normal plant conditions do not conflict with their responsibilities during a fire emergency.

g. Personnel qualifications

(1) The position responsible for formulation and implementation of the fire protection program has within its organization (or as a consultant) a manager selected on the basis of education, experience, and advancement as an industrial fire protection engineer.

(2) The qualifications for members of the fire brigade include satisfactory completion of a physical examination for performing strenuous activity.

(3) The personnel responsible for the maintenance and testing of the fire protection systems are qualified by training or experience for such work.

(4) The personnel responsible for training the fire brigade are qualified by training and experience for such work.

(5) During operation and construction or major modification of the MOX facility, the superintendent (or equivalent position) of the MOX facility has the lead responsibility for all site fire protection.

B. Administrative Controls

Administrative controls should be used to maintain the performance of the fire protection system and personnel. These controls should establish procedures to:

i. Govern bulk storage of combustible materials inside or adjacent to buildings or systems having IROFS during operation or maintenance periods.

ii. Govern the handling and limitation of the use of ordinary combustible materials, combustible and flammable gases and liquids, combustible high efficiency particulate air (HEPA) and charcoal filters, dry ion exchange resins, or other combustible supplies in areas containing IROFS.

iii. Govern the handling of and limit transient fire loads such as combustible and flammable liquids, wood and plastic products, or other combustible materials in buildings containing IROFS during all phases of operation, and especially during maintenance or modification operations. Use of wood products is permitted only when noncombustible products are not practical from a process consideration. If wood or wood products are required, the wood is pressure treated with a flame retardant. Equipment or supplies shipped in untreated combustible packing or containers may be unpacked inside the plant production areas if required for valid operating reasons. However, all combustible materials are to be removed from the area immediately following unpacking. Such transient combustible material, unless stored in approved containers, is not to be left unattended during lunch breaks, shift changes, or other similar periods. Loose combustible packing material such as wood or paper excelsior or polyethylene sheeting is placed in metal containers with tight-fitting, self-closing metal covers.

iv. Govern the use of ignition sources by use of a hot work permit system to control welding, flame cutting, brazing, or soldering operations. A separate permit is issued for each area where work is to be done. If work continues over more than one shift, the permit is valid for not more than 24 hours when the facility is operating or for the duration of a particular job during plant shutdown.

v. Control the removal of work-generated combustible waste from the work activity immediately following completion of the activity, or at the end of each work shift, whichever comes first.

vi. Prohibit the use of open flames or combustion-generated smoke for leak testing.

vii. Maintain periodic housekeeping inspections to ensure continued compliance with these administrative controls.

viii. Control disarming of fire detection or fire suppression systems by a permit system. Fire watches should be established in areas where systems are so disarmed.

ix. Test and maintain the fire protection equipment and the emergency lighting and communication. A test plan that lists the responsible personnel positions in connection with routine tests and inspections of the fire detection and protection systems is developed. The test plan contains the types, frequency, and detailed procedures for testing. Procedures also contain instructions on maintaining fire protection during those periods when the fire protection system is impaired or during periods of plant maintenance, such as, fire watches or temporary hose connections to water systems.

x. Control actions to be taken by an individual discovering a fire, for example, notification of control room, attempt to extinguish fire, and actuation of the local fire suppression system(s).

xi Control actions to be taken by a designated operator to determine the need for fire brigade assistance upon report of a fire or receipt of alarm on control room annunciator panel; for example, announcing the location of fire over public address system, sounding fire alarms, and notifying the shift supervisor (or equivalent position) and the fire brigade leader of the type, size, and location of the fire.

xii. Define the strategies for fighting fires in all areas containing IROFS and areas presenting a hazard to IROFS. These strategies, which are reflected in the prefire plans, designate:

a. Fire hazards in each area covered by the specific prefire plans.

b. Fire extinguishants best suited for controlling the fires associated with the fire hazards in that area and the nearest location of these extinguishants.

c. Most favorable direction from which to attack a fire in each area in view of the ventilation direction, access hallways, stairs, and doors that are most likely to be free of fire, and best station or elevation for fighting the fire. All access and egress routes that involve locked doors are specifically identified in the procedure, with the appropriate precautions and methods for access specified.

d. Management of plant systems to reduce the damage potential during a local fire and the location of local and remote controls for such management (e.g., any hydraulic or electrical systems in the area or zone covered by the specific fire fighting procedure that could increase the hazards in the area because of overpressurization and/or electrical hazards).

e. Vital heat-sensitive system components that need to be kept cool while fighting a local fire, particularly hazardous combustibles that need cooling.

f. Organization of fire fighting brigades and the assignment of special duties according to job title so that all fire fighting functions are covered by any complete shift personnel complement. These duties include having command

control of the brigade, transporting fire suppression and support equipment to the fire scenes, applying the extinguishant to the fire, communicating with the control room, and coordinating with outside fire departments.

g. Potential radiological and toxic hazards in fire areas or zones.

h. Operations requiring control room and designated management coordination or authorization.

i. Instructions for plant operators and general plant personnel during fires.

xiii. Establish and implement a penetration seal tracking program to record pertinent information regarding the emplacement and modification of fire barrier penetration seals that are defined in the Integrated Safety Analysis (ISA) Summary or FHA as IROFS.

7.4.3.2 Fire Protection Features and Systems

The facility fire protection features and systems should be considered acceptable if the following conditions are met:

A. Buildings containing IROFS are designed to qualify as Type I construction as defined by NFPA Standard 220, "Standard on Types of Building Construction." This includes structural building components such as walls, floors, roofs, columns, and beams as well as interior building features. The process layout separates and isolates, as much as practical, operations presenting fire hazards. This can be accomplished by distance, or compartmentalizing using fire barriers, or both. In addition, adequate fire safety criteria for adjoining process facilities, or facilities close to each other, or near bulk hazardous material storage is defined in NFPA Standard 80A, "Recommended Practice for Protection of Buildings from Exterior Fire Exposures."

B. The structural shell (and its supporting members) surrounding any area handling plutonium, where the plutonium could be accidently dispersed and cause exposure to either operating personnel or the public, is designed with sufficient fire resistance that it will remain standing and continue to act as a confinement structure during any credible accident conditions resulting from fires. The fire resistance rating of this shell is at least 2 hours and is attained by integral parts of this structure (concrete slabs, walls beams, columns and ceilings/roofs). Penetrations in the shell incorporate equivalent protection.

C. Special facilities such as SNM storage, radioactive waste, or other facilities with a potential for significant releases of radioactivity are designed and constructed using building components of fire-resistant and noncombustible material, particularly in locations vital to the functioning of confinement systems. The fire resistance rating of SNM storage facilities is at least 2 hours and is attained by integral parts of this structure (concrete slabs, walls, beams, columns, and ceiling/roofs). Combustible materials are not used in the construction of confinement systems.

D. Exposed interior walls or ceilings (including ceilings formed by the underside of roofs) and any factory-installed facing material have an Underwriters Laboratories Inc. (UL)

listed/Factory Mutual Research Corporation approved flame spread rating of 25 or less and a smoke developed rating of 50 or less, per the American Society for Testing and Materials (ASTM) ASTM–E–84, "Standard Test Method for Surface Burning Characteristics of Building Materials."

E. The use of carpets and rugs is minimized to the extent practicable in buildings containing SNM. If determined to be necessary, carpets and rugs are tested in accordance with NFPA Standard 253 (ASTM–E–648, "Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source") when applying the floor finish requirements of The Life Safety Code (NFPA Standard 101) to MOX facilities. Carpets and rugs used in storage or industrial occupancies (no criteria in NFPA Standard 101) have a critical radiant flux not less than 0.45 watts per square cm (0.40 BTU per second per square ft) in areas unprotected by an automatic fire suppression system and 0.22 watts per square cm (0.20 BTU per second per square ft) in protected areas.

F. Storage racks in SNM (oxides, pellets, or fuel rods) storage facilities are noncombustible and designed to securely hold storage containers in place, ensure proper separation of storage containers, and maintain structural integrity during a fire. No combustible material is stored in the SNM storage facilities in a location that would endanger the storage facility or stored material if a fire should occur.

G. Electrical wiring for MOX facilities is designed and provisions exist to maintain such wiring in accordance with the applicable provisions of the National Electric Code (NFPA Standard 70).

H. Lightning protection for plant buildings determined to be IROFS is designed in accordance with the applicable provisions of NFPA Standard 780, "Lightning Protection Code."

I. Ventilation systems in areas containing IROFS are designed to minimize the spread of fire, smoke, hot gases, and products of combustion from the area of fire origin and prevent explosions in accordance with the applicable provisions of NFPA Standard 69, " Standard on Explosion Prevention Systems," and Standard 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Where ventilation systems are designed to prevent the release of radioactive materials, HEPA filters of these systems will satisfy the requirements of UL Standard 586, "High Efficience Air Filtration Units." Further fire protection guidance for nuclear filter plenums is contained in Appendix E of this SRP.

J. Where fire barriers are penetrated by the confinement system’s ventilation ducting, fire dampers are appropriately used to maintain the barrier integrity. However, the closure of such dampers does not compromise the functions of the confinement system where the loss of confinement might pose a greater threat than the spread of fire. In such cases, alternative fire protection means (e.g., duct wrapping, duct enclosure, or rerouting) are used as a substitute for fire barrier closure. Sprinkler systems, such as those designed as a "water curtain," are not considered a fire barrier substitute.

K. Building layout provides a safe means of egress for plant personnel in the event of fire in accordance with the applicable provisions of The Life Safety Code (NFPA Standard 101). Physical security of nuclear facilities, by design, may inadvertently institute controls that

delay worker egress and firefighter access during fire events. Provisions are made to minimize these delays. Emergency lighting for the purpose of personnel egress is in accordance with NFPA Standard 101. The design basis for emergency lighting (location, intensity, and duration) required to perform any functions relied on for safety during a loss of power is determined from engineering evaluations and the ISA.

L. The design of openings in passive fire-rated barriers incorporates suitable automatic or fixed closure devices or components, such as fire doors, fire dampers, and fire-rated penetration seals. Manual activation of fire closure devices may be used where other safety considerations may preclude the use of automatic closure devices as determined by the ISA or FHA (see Appendix E, Section 2.4). Fire doors are designed and installed in accordance with the applicable provisions of NFPA Standard 80, "Standard for Fire Doors and Fire Windows." Fire dampers are designed and installed in accordance with the applicable provisions of UL Standard 555, "Standard for Fire Dampers and Ceiling Dampers."

M. Plant areas with the potential for large spills of flammable or combustible liquids are identified and means of containing, such as, dikes, and disposing of such spills are provided for in the facility design. The design of containment and drainage systems considers the rate of water discharge from fixed suppression systems and/or hose lines and is capable of preventing the spread of combustible liquids from pits or confining areas. Flammable and combustible liquids are stored, handled, and used in accordance with the applicable provisions in NFPA Standard 30, "Flammable and Combustible Liquids Code," and/or other industry standards.

N. Plant areas are identified where credible risk of creation of a flammable mixture with hydrogen or other flammable or oxidizing gases exists. Preventive measures in accordance with NFPA Standard 50, "Standard for Bulk Oxygen Systems at Consumer Sites;" Standard 50A, "Standard for Gaseous Hydrogen Systems at Consumer Sites;" Standard 50B, "Standard for Liquified Hydrogen at Consumer Sites;" Standard 51, "Standard for Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes;" Standard 55, "Standard for Compressed and Liquified Gases in Portable Cylinders;" Standard 58, "Standard for Storage and Handling of Liquified Petroleum Gases;" Standard 69, "Standard on Explosion Prevention Systems;" and/or other industry standards are provided.

O. Flammable gas is not introduced into SNM-processing buildings except when specifically required for process reasons. Where hydrogen is necessary for processes:

    i. Hydrogen lines introduced into plutonium processing buildings are either designed to maintain functionality when subjected to an earthquake, or sleeved such that the outer pipe is directly vented to the outside, or are equipped with excess flow valves so that the hydrogen concentration in the affected areas will not exceed 2% in case of a line break. Shutoff valves are installed as close as possible to the reducing furnaces, or other using devices, but the shutoff valves are located so that they are not likely to be involved in a fire involving the using device.

ii. Bulk storage of hydrogen is outside of all process buildings. Cryogenic storage is located so that the possibility and consequences of a catastrophic spill are minimized. High pressure tube trailers are located so that the long axis of the tube cylinders are parallel and not perpendicular to the process buildings. Master shutoff valves are installed at the bulk storage tank or manifold.

iii. Entry of air into a furnace operating with reducing gas is precluded by the use of inert-gas-purged locks or other suitable means at the furnace entry and exit. Furnace gas is exhausted through an enclosed, noncombustible construction, filtered off-gas system.

iv. Process furnaces are provided with a system for automatically shutting off the furnace gas and purging with inert gas in the event of a power failure, loss of coolant water, loss of exhaust fan, overtemperature, low flow pressure and/or high flow in gas line, or detection of hydrogen in the vicinity of the furnace.

P. The facility design incorporates a fire alarm system, designed in accordance with the applicable provisions of NFPA Standard 72, "National Fire Alarm Code," provided throughout areas as determined to be relied on for safety by the ISA/FHA. The system incorporates features such as local and remote annunciation, primary and secondary power supplies, and audible and visual alarm devices. The alarm system also includes supervisory devices for all critical fire protection functions.

Q. The facility design incorporates an adequate and reliable water supply system, designed in accordance with NFPA standards for fire protection use. The system consists of the water source, dedicated storage facilities, fire pumps, a distribution-piping network, sectional isolation valves, and fire hydrants and standpipes, as applicable to the facility. The design of the fire pumps, where provided, is in accordance with the applicable provisions of NFPA Standard 20, "Standard for Installation of Centrifugal Fire Pumps." If pumps are required to meet system pressure or flow requirements, a sufficient number of pumps are provided to ensure that 100% capacity will be available assuming failure of the largest pump or loss of offsite power (e.g., three 50% pumps or two 100% pumps). This can be accomplished, for example, by providing either: electric motor-driven fire and diesel engine-driven pump(s); or two or more electric motor-driven fire pumps connected to emergency power buses and designed to maintain functionality when subjected to an earthquake. Common tanks are permitted for fire and sanitary or service water storage. When this is done, however, minimum fire water storage requirements are dedicated by passive means, for example, use of a vertical standpipe for other water services. Administrative controls, including locks for tank outlet valves, are unacceptable as the only means to ensure minimum water volume reserved for fire service needs. Note that if standpipes are used for other water services, they should be arranged so that a leak or other malfunction will not be able to drain off the water reserved for the fire service needs. Designs of the distribution piping, valves, and fire hydrants are in accordance with the applicable provisions of NFPA Standard 24, "Standard for the Installation of Private Service Mains and their Appurtenances." Water supply requirements in terms of stored volume and/or supply rates are determined in the FHA. Standpipe and hose systems are

in accordance with the applicable provisions of NFPA Standard 14, "Standard for the Installation of Standpipes and Hose Systems."

R. Automatic fire suppression is incorporated in areas of significant, or potentially significant, fire loading to protect IROFS. Manual activation of fire suppression systems may be used where other safety considerations may preclude the use of automatic suppression as determined by the ISA or FHA. The design and installation of fire suppression systems and equipment is in accordance with the applicable provisions of appropriate NFPA standards. Commonly applied NFPA Standards include NFPA Standard 10, "Standard for Portable Fire Extinguishers;" Standard 11, "Standard for Low Expansion Foam;" Standard 11A, "Standard for Medium- and High- Expansion Foam Systems;" Standard 12, "Standard on Carbon Dioxide Extinguishing Systems;" Standard 13, "Standard for the Installation of Sprinkler Systems;" Standard 15, "Standard for Water Spray Fixed Systems for Fire Protection;" Standard 16, "Standard for the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems;" Standard 16A, "Standard for the Installation of Closed-Head Foam Water Sprinkler Systems;" and Standard 2001, "Standard on Clean Agent Extinguishing Systems." In addition, total reliance is not placed on a single fire suppression system. Appropriate backup fire suppression capability is provided. A single active failure or a crack in a moderate-energy line (pipe) in the fire suppression system does not impair both the primary and backup fire suppression capability. For example, neither the failure of a fire pump, its power supply or controls, nor a crack in a moderate-energy line in the fire suppression system should result in loss of function of both sprinkler and hose standpipe systems in an area protected by such primary and backup systems. Also, as a minimum, there should be capability for manual fire suppression in areas containing IROFS following the most severe earthquake expected in the geological area where the facility is located. The required water quantities, flow, and pressure would be determined from the FHA. The need for fire detection and/or suppression following an earthquake may be determined from the ISA/FHA.

S. The applicant commits to providing a program of regular inspection, testing, and maintenance of fire protection equipment in accordance with the provisions of appropriate NFPA or other industry standards. A commonly applied standard for water-based systems is NFPA Standard 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems."

T. Safety controls and interlocks for combustible liquids, flammable liquids, and flammable gases and their associated delivery systems are tested periodically and after maintenance operations.

U. Combustible and pyrophoric metals are stored and handled in accordance with the applicable codes and/or industry standards. Additional information on storage and handling of combustible and pyrophoric metals may be found in DOE Handbook–1081–9, "Primer on Spontaneous Heating and Pyrophorocity," December 1994, and DOE–STD–3013–99, "Stabilization, Packaging, and Storage of Plutonium-Bearing Materials," November 1999.

V. Operating controls and limits for the handling of pyrophoric materials are established. An adequate supply of the appropriate extinguishing agent should be available where combustible and pyrophoric metals are present.

W. Provisions are made to construct gloveboxes and windows of noncombustible materials. A means of fire detection is provided if pyrophoric materials, oxidizers, or organic liquids are handled. Fire suppression or a fixed inerting system is provided if combustible materials are present, or could be present, in quantities sufficient to cause a breach of integrity. If a fixed suppression system is utilized, the internal pressurization is calculated to prevent gloves from falling or being blown off. If an inerting system is used to reduce fire risk to IROFS, the oxygen concentration is continually monitored to assure that the oxygen concentration does not exceed 25% of the level required for combustion by means of an alarm and other measures (such as shutdown of operations and electric power to the glovebox) as warranted by the FHA/ISA.

X. Glovebox ventilation ducting is provided with separation/isolation dampers or doors to minimize fire propagation. Fire barriers are also provided between individual or groups of gloveboxes or within glove lines where warranted by the FHA. If closure of the separation/isolation dampers or doors does not compromise the functions of the confinement system, the separation/isolation mechanism is shut by a fusible device or upon activation of the glovebox automatic fire suppression or detection system. In the case of fire detection systems, precautions such as heat detectors or dual-zone smoke detectors should be used to avoid inadvertent damper operation and shutdown of the glovebox ventilation system.

Y. Glovebox primary exhaust openings are provided with prefilters and fire screens to reduce vapor mist and fire propagation. The fire screens are stainless steel screens (8–16 mesh) or a perforated stainless steel plate using the same opening sizes. Glovebox exhaust ventilation lines are also designed so that each box has its own exhaust port so that flame or hot fire gases will not travel from one glovebox to another through a common header or interconnection arrangement. Single exhaust manifolds that connect an entire glovebox line shall not be used. Exceptions may be made where necessary for confinement considerations if compensation for fire risk is provided, if necessary.

Z. Where flammable or combustible solvents are used, they are stored and handled in accordance with the guidance of NFPA Standard 30, "Flammable and Combustible Liquids Code." Approved operating controls and limits for the use of flammable or combustible solvents are established. An approved fixed fire suppression system is installed or the process carried out in an inert atmosphere such as nitrogen. The FHA should identify the specific hazards and the best fire protection method.

AA. Inert gas purge and vent systems are used for SNM-bearing solution tanks to minimize potential accumulation of a flammable mixture of hydrogen gas, including a means of venting hydrogen gas from process piping. If inert gas is not used to purge the system, the ventilation system must be capable of maintaining hydrogen concentrations below 25% of the lower flammable limit under all expected process conditions.

BB. Incinerators, boilers, and furnaces are located in separate fire areas with automatic suppression and installed and maintained in accordance with NFPA Standard 31, "Standard for Installation of Oil Burning Equipment;" Standard 54, "National Fuel Gas Code;" and Standard 8501, "Standard for Single Burner Oil Operation;" and/or other applicable industry standards.

CC. Facility laboratories using chemicals or nuclear materials are operated in accordance with the safety criteria in NFPA Standard 45, "Standard for Fire Protection for Laboratories Using Chemicals," and/or NFPA Standard 801, "Standards for Facilities Handling Radioactive Material," as applicable.

DD. Provisions for the drainage and holdup of contaminated fire water following a fire are incorporated into the design.

7.4.3.3 Manual Fire Fighting Capability

The following manual fire fighting guidance for the MOX facility, because of the significantly increased potential for fire-induced high radiological consequences over that for other types of fuel cycle facilities, is closely related to the guidance provided for light water power reactors. The manual fire fighting capability should be acceptable if:

A. The recommendations for organization, training, and equipment specified in, "Standard on Industrial Fire Brigades," (NFPA Standard 600), are considered appropriate criteria for organizing, training, and operating a plant fire brigade.

B. A site fire brigade trained and equipped for fire fighting is established to ensure adequate manual fire fighting capability for all areas of the plant containing IROFS. The minimum fire brigade members to be available on each shift is determined from the baseline needs assessment (the minimum required for commercial reactor facilities is five). The brigade leader and at least two brigade members have sufficient training in or knowledge of plant safety and process systems to understand the effects of fire and fire suppression activities on the ability to control release of radioactive materials. The qualification of fire brigade members is in accordance with the guidance in NFPA Standard 600 for the type of duties to be performed. The shift supervisor or equivalent position is not a member of the fire brigade. The brigade leader is competent to assess the potential safety consequences of a fire and to advise control room personnel.

C. The minimum equipment provided for the brigade consists of personal protective equipment such as turnout coats, boots, gloves, hard hats, emergency communications equipment, portable lights, portable ventilation equipment, and portable extinguishers. Self-contained breathing apparatus using full-face positive-pressure masks approved by the National Institute for Occupational Safety and Health is provided for fire brigade, damage control, and control room personnel. An extra mask is available for each of the required fire brigade personnel. Control room personnel may be furnished breathing air by a manifold system piped from a storage reservoir if practical. Service or rated operating life is a minimum of one-half hour for the self-contained units.

D. At least two extra air bottles are located onsite for each self-contained breathing unit. In addition, an onsite 6-hour supply of reserve air is provided and arranged to permit quick and complete replenishment of exhausted supply air bottles as they are returned. If compressors are used as a source of breathing air, only units approved for breathing air are used and compressors are operable assuming a loss of offsite power. Special care is taken to locate the compressor in areas free from dust and contaminants.

E. The fire brigade training program ensures that the capability to fight potential fires is established and maintained. The program consists of an initial classroom instruction program followed by periodic classroom instruction, fire fighting practice, and fire drills.

i. The initial classroom instruction includes:

a. Indoctrination of the plant fire fighting plan with specific identification of responsibilities for each individual;

b. Identification of the type and location of fire hazards and associated types of fires that could occur in the plant;

c. The toxic and corrosive characteristics of expected products of combustion;

d. Identification of the location of fire fighting equipment for each fire area and familiarization with the layout of the plant, including access and egress routes to each area;

e. The proper use of available fire fighting equipment and the correct method of fighting each type of fire; types of fires covered include fires in energized electrical equipment, fires in cables and cable trays, hydrogen fires, fires involving flammable and combustible liquids or hazardous process chemicals, fires involving uranium and/or plutonium metal, fires resulting from construction or maintenance activities, and record file fires;

f. The proper use of communication, lighting, ventilation, and emergency breathing equipment;

g. The proper method for fighting fires inside buildings and confined spaces;

h. The direction and coordination of the fire fighting activities (fire brigade leaders only);

i. Detailed review of fire fighting strategies and procedures;

j. Review of the latest plant modifications and corresponding changes in fire fighting plans;

k. The plant fire brigade training is coordinated with the responsible fire department so that responsibilities and duties are delineated in advance. This coordination is part of the training course and is included in the training of the responsible fire department staff as appropriate.

l. The responsible fire departments are provided training in operational precautions when fighting fires on MOX facility sites and are made aware of the need for radiological protection of personnel and the special hazards associated with a MOX facility site.

Note: Items (i) and (j) may be deleted from the training of no more than two of the nonoperations personnel who may be assigned to the fire brigade.

ii. The instruction is provided by qualified individuals who are knowledgeable, experienced, and suitably trained in fighting the types of fires that could occur in the plant and in using the types of equipment available in a MOX plant.

iii. Instruction is provided to all fire brigade members and fire brigade leaders.

iv. Regularly planned meetings are held at least every 3 months for all brigade members to review changes in the fire protection program and other subjects as necessary.

v. Periodic refresher training sessions are held to repeat the classroom instruction program for all brigade members over a 2-year period. These sessions may be concurrent with the regularly planned meetings.

vi. Practice

a. Practice sessions are held for each shift fire brigade on the proper method of fighting the various types of fires that could occur in a MOX facility. These sessions should provide brigade members with experience in actual fire extinguishment and the use of emergency breathing apparatus under strenuous conditions encountered in fire fighting.

b. Practice sessions are provided at least once per year for each fire brigade member.

vii. Drills

a. Fire brigade drills are performed in the plant so that the fire brigade can practice as a team.

b. Drills are performed at regular intervals not to exceed 3 months for each shift fire brigade. Each fire brigade member should participate in each drill, but as a minimum in at least two drills per year. A sufficient number of these drills, but not less than one for each shift fire brigade per year, are unannounced to determine the fire fighting readiness of the plant fire brigade, brigade leader, and fire protection systems and equipment. Persons planning and authorizing an unannounced drill ensure that the responding shift fire brigade members are not aware that a drill is being planned until it starts. Unannounced drills are not scheduled closer than 4 weeks. At least one drill per year is performed on a "back shift" for each shift fire brigade.

c. Drills are preplanned to establish the training objectives of the drill and are critiqued to determine how well the training objectives have been met. Unannounced drills

are planned and critiqued by members of the management staff responsible for plant safety and fire protection. Performance deficiencies of a fire brigade or of individual fire brigade members are remedied by scheduling additional training for the brigade or members. Unsatisfactory drill performance is followed by a repeat drill within 30 days.

d. These drills provide for responsible fire department participation at least annually.

e. At 3-year intervals, a randomly selected unannounced drill is critiqued by qualified individuals independent of the MOX plant staff. A copy of the written report from such individuals is available for NRC review.

f. Drills include, at a minimum:

(1) Assessment of fire alarm effectiveness, time required to notify and assemble the fire brigade, and selection, placement, and use of equipment and fire fighting strategies.

(2) Assessment of the knowledge of each brigade member concerning his or her role in the fire fighting strategy for the area assumed to contain the fire. Assessment of the conformance of each brigade member with established plant fire fighting procedures and use of fire fighting equipment, including self-contained emergency breathing apparatus, communication equipment, and ventilation equipment, to the extent practical.

(3) The simulated use of fire fighting equipment required to cope with the situation and type of fire selected for the drill. The area and type of fire chosen for the drill should differ from those used in the previous drills so that brigade members are trained in fighting fires in various plant areas. The situation selected should simulate the size and arrangement of a fire that could reasonably occur in the area selected, allowing for fire development due to the time required to respond, to obtain equipment, and to organize for the fire, assuming loss of automatic suppression capability.

(4) Assessment of the brigade leader's direction of the fire fighting effort as to thoroughness, accuracy, and effectiveness

viii. Records

Individual records of training provided to each fire brigade member, including drill critiques, are maintained for at least 3 years to ensure that each member receives training in all parts of the training program. These training records are available for NRC review. Retraining or broadened training for fire fighting within buildings is scheduled for all those brigade members whose performance records show deficiencies.

7.4.3.4 Fire Hazards Analysis

The FHA should be considered acceptable if it reflects current conditions throughout the facility and the applicant commits to reviewing and updating the FHA as necessary at defined, regular intervals to document that fire protection measures are adequate to ensure plant fire safety. In addition, the FHA should be revised to incorporate significant changes and modifications to the

facility, processes, or inventories, as needed. (The level of detail provided in the FHA should reflect the complexity of the facility and the anticipated consequences from fire events. A more detailed description of the requirements for an FHA is provided in Appendix D of this SRP.)

7.5 REVIEW PROCEDURES

7.5.1 Acceptance Review

The primary reviewer should perform an acceptance review to determine if the application adequately addresses the items in Section 7.3, "Areas of Review," for either the construction approval review or the review for a license to possess and use SNM.

Guidance specific to the construction approval review and the review for a license to possess and use SNM is provided below.

A. Construction Approval

Specifically, the application material should adequately addresses commitments related to Sections 7.3(A), 7.3(C), and 7.3(D), and the fire protection features and systems identified in Section 7.3(B).

B. License To Possess and Use SNM

Specifically, the application material should address the areas described in Sections 7.3(A), 7.3(C), and 7.3(D) in full and update the information described in Section 7.3(B) to reflect any changes in fire protection features and design

If the primary reviewer verifies that fire protection is adequately addressed for the construction approval review or the review for the license to possess and use SNM, the primary reviewer should accept the application for the safety evaluation in Section 7.5.2. If the primary reviewer identifies significant deficiencies in the material provided, the primary reviewer should request that the applicant submit additional information prior to the start of the safety evaluation.

7.5.2 Safety Evaluation

After determining that the application is acceptable for review in accordance with either Section 7.5.1(A) (construction) or Section 7.5.1(B) (license), the primary reviewer should perform a safety evaluation against the acceptance criteria described in Section 7.4. On the basis of its review, the staff may request that the applicant provide additional information or modify the application to meet those acceptance criteria.

Guidance specific to the construction approval review and the review for a license to possess and use SNM is provided below.

A. Construction Approval

The primary reviewer should verify that the applicant's commitments and goals as they relate to fire protection are adequate to meet or exceed the regulatory acceptance criteria in Section 7.4.3. The primary reviewer should focus on Section 7.4.3.2, "Fire

Protection Features and Systems," with emphasis on building construction, water supply and distribution systems, ventilation systems fire protection, major combustible liquid storage areas, and facility fire suppression and detection systems. Fire protection aspects of process areas and gloveboxes should be described to the extent possible, considering the present stage of the applicant's design process.

B. License To Possess and Use SNM

The primary reviewer should focus on Section 7.4.3.1, "Organization and Conduct of Operations," Section 7.4.3.3, "Manual Fire Fighting Capability," and Section 7.4.3.4, "Fire Hazards Analysis," with a re-review of Section 7.4.3.2 if any significant changes have been made or information added.

The primary reviewer should also review sections of the ISA Summary that address fire protection to ensure that those sections are consistent with the fire protection portion of the application. The primary reviewer should also assure that the requirements for placement and reliability of fire protection measures are consistent with the ISA Summary.

The secondary reviewer should confirm that descriptions in the fire protection section are consistent with descriptions in other sections of the application that may interface with fire safety. The secondary reviewer may also request support from other technical reviewers as required.

Supporting reviewers should confirm that provisions made in the applicant's fire protection section are in accordance with other SRP sections within their areas of responsibility. For example, the nuclear criticality safety reviewer, as a supporting reviewer of fire protection, should establish that the program described by the applicant provides reasonable assurance that a water-based suppression system will not adversely affect criticality safety. The physical security reviewer should assist in the review of access and egress requirements.

When the safety evaluation is complete, the primary reviewer, with assistance from the other reviewers, should prepare the fire protection input for the Safety Evaluation Report (SER), as described in Section 7.6 using the acceptance criteria from Section 7.4. The primary reviewer should coordinate the fire protection input with the balance of the reviews and the SER.

7.6 Evaluation Findings

The primary reviewer should document the safety evaluation by preparing material suitable for inclusion in the SER. The primary reviewer should describe the review, explain the basis for the findings, and state the conclusions.

The staff could document the safety evaluation for the construction approval review as follows:

The staff reviewed the application material for construction approval for [insert facility name] according to Chapter 7.0 of NUREG–1718. The staff evaluated [state what was evaluated] and found [state what was found]. The applicant provided fire protection

features and systems consistent with the level of design it provided in the license application's material for construction approval. In addition to the fire hazards analysis, the applicant also made commitments related to the fire safety organization and conduct of operation; fire protection features and systems; and manual fire fighting capability.

The staff concluded that the applicant's proposed equipment, facilities, and commitments provide a reasonable level of assurance that the applicant's design bases will provide adequate fire protection to meet the safety performance requirements and the baseline design criteria for construction approval in accordance with 10 CFR Part 70.

The staff could document the safety evaluation for the review for the license to possess and use SNM as follows:

The staff reviewed the license application for a license to possess and use special nuclear material for [insert facility name] according to Chapter 7.0 of NUREG–1718. The staff evaluated [state what was evaluated] and found [state what was found]. The applicant updated a fire hazards analysis that documents all significant facility fire hazards, fire protection features designed to control those hazards, and the overall adequacy of facility fire safety. In addition to the fire hazards analysis, the applicant also provided the following information in the license application on the fire safety organization and conduct of operation; the fire protection features and systems; and the manual fire fighting capability.

The staff concluded 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 items determined to be relied upon for safety to meet the safety performance requirements and the baseline design criteria of 10 CFR Part 70.

7.7 REFERENCES

American Society for Testing and Materials (ASTM). ASTM–E–84, "Standard Test Method for Surface Burning Characteristics of Building Materials."

Department of Energy (U.S.) (DOE). DOE–STD–1066–97, "Fire Protection Design Criteria." DOE: Washington, DC. March 1997.

Department of Energy (U.S.) (DOE). Draft DOE–STD–5XXX–99, "Stabilization, Packaging, and Storage of Plutonium-Bearing Materials." DOE: Washington, DC. March 1999.

Factory Mutual Research Corporation. "Factory Mutual System Approval Guide−Equipment, Materials, Services, and Conservation of Property."

Institute of Electrical and Electronics Engineers, Inc. (IEEE). Standard 690, "IEEE Standard for the Design and Installation of Cable Systems for Class 1E Circuits in Nuclear Power Generating Stations."

National Fire Protection Association, Inc. (NFPA). Standard 10, "Standard for Portable Fire Extinguishers."

Standard 11, "Standard for Low Expansion Foam."

Standard 11A, "Standard for Medium- and High-Expansion Foam Systems."

Standard 12, "Standard on Carbon Dioxide Extinguishing Systems."

Standard 13, "Standard for the Installation of Sprinkler Systems."

Standard 14, "Standard for the Installation of Standpipes and Hose Systems."

Standard 15, "Standard for Water Spray Fixed Systems for Fire Protection."

Standard 16, "Standard for the Installation of Deluge Foam-Water Sprinkler and Foam-Water Spray Systems."

Standard 16A, "Standard for the Installation of Closed-Head Foam Water Sprinkler Systems."

Standard 20, "Standard for the Installation of Centrifugal Fire Pumps."

Standard 24, "Standard for the Installation of Private Service Mains and their Appurtenances."

Standard 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems."

Standard 30, "Flammable and Combustible Liquids Code."

Standard 31, "Standards for Installation of Oil Burning Equipment."

Standard 45, "Standard for Fire Protection for Laboratories Using Chemicals."

Standard 50, "Standard for Bulk Oxygen Systems at Consumer Sites."

Standard 50A, "Standard for Gaseous Hydrogen Systems at Consumer Sites."

Standard 50B, "Standard for Liquified Hydrogen Systems at Consumer Sites."

Standard 51, "Standard for Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes."

Standard 54, "National Fuel Gas Code."

Standard 55, "Standard for Compressed and Liquified Gases in Portable Cylinders."

Standard 58, "Standard for Storage and Handling of Liquified Petroleum Gases."

Standard 69, "Standard on Explosion Prevention Systems."

Standard 70, "National Electric Code."

Standard 72, "National Fire Alarm Code."

Standard 80, "Standard for Fire Doors and Fire Windows."

Standard 80A, "Recommended Practice for Protection of Buildings from Exterior Fire Exposures."

Standard 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

Standard 101, "Life Safety Code."

Standard 220, "Standard on Types of Building Construction."

Standard 251, "Standard Methods of Tests of Fire Endurance of Building Construction and Materials."

Standard 253 (ASTM E–648, "Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source").

Standard 600, "Standard on Industrial Fire Brigades."

Standard 780, "Lightning Protection Code."

Standard 801, "Standards for Facilities Handling Radioactive Material."

Standard 803, "Standard for Fire Protection for Light Water Nuclear Power Plants."

Standard 2001, "Standard on Clean Agent Extinguishing Systems."

Standard 8501, "Standard for Single Burner Oil Operation."

Nuclear Regulatory Commission (U.S.) (NRC). "Domestic Licensing of Special Nuclear Material (10 CFR Part 70)," Federal Register: Vol. 64, No. 146. pp. 41338–41357. July 30, 1999.

Underwriters Laboratories, Inc. "Underwriters Laboratories Building Materials Directory."

"Underwriters Laboratories Fire Protection Equipment Directory."

Standard 555, "Standard for Fire Dampers and Ceiling Dampers."

Standard 586, "High Efficiency Air Filtration Units."

7.8 DEFINITIONS

combustible: A material, in the form and condition in which it is used, that will ignite and burn.

combustible liquid: A liquid having a flash point at or above 37.8 °C (100 °F).

fire area: A location bounded by fire-rated construction, having a minimum fire resistance rating of 2 hours.

fire barrier: A continuous membrane such as a wall, floor, or roof that is constructed to limit fire spread and the movement of smoke. Fire barriers have fire resistance ratings and may have protected openings.

fire brigade: Facility personnel trained in plant fire fighting operations.

fire door: A fire-rated door assembly.

Fire Hazards Analysis (FHA): A comprehensive assessment of potential fires to ensure mitigative features are in place to limit damage from fires to an acceptable level.

fire prevention: Measures directed toward avoiding the inception of fires.

fire protection: Methods of providing for fire control or fire extinguishment.

fire resistance rating: Time, in minutes or hours, that a material or assembly withstood a fire exposure as specified in NFPA Standard 251, "Standard Methods of Tests of Fire Endurance of Building Construction and Materials."

flammable liquid: Liquid with a flash point below 37.8 °C (100 °F) and a vapor pressure not exceeding 40 psia at 37.8 °C (100 °F).

flammable gas: A gas that will burn in the normal concentration of oxygen in the air.

gas: Any substance that in a liquid state exerts a vapor pressure greater than 40 psia at 37.8 °C (100 °F).

limited-combustible: A building construction material that, in the form in which it is used, has a potential heat value not exceeding 8,141 KJ/kg (3,500 BTU/lb) and has either a structural base of noncombustible material with a surfacing not to exceed 3.2 mm (1/8 in) that has a flame spread rating not greater than 50, or other material having neither a flame spread rating greater than 25 nor evidence of continual progressive combustion, even on surfaces exposed by cutting through the material on any plane.

noncombustible: A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat. Materials passing ASTM–E–136, "Standard Test Method for Behavior of Materials in Vertical Tube Furnace at 750 °F," should be considered noncombustible.

pyrophoric material: A material with an auto ignition temperature in air at or below 54.4 °C (130 °F) and 50% relative humidity.

oxidizing gases: Gases that support combustion.

reactive gases: Gases that will either react with other materials or within themselves by a chemical reaction other than combustion under reasonably anticipated initiating conditions.

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