U.S. NUCLEAR REGULATORY COMMISSION

June 1976

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 3.38

GENERAL FIRE PROTECTION GUIDE FOR FUEL REPROCESSING PLANTS

A. INTRODUCTION

Section 50.34, "Contents of Applications; Technical Information," of 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires, among other things, that each application for a construction permit for a production or utilization facility, including a fuel reprocessing plant, include the principal design criteria for the facility.

A potential risk to the health and safety of the general public and plant personnel at a fuel reprocessing plant is the release and dispersal of radioactive materials due to a fire or explosion. Fire protection programs for these plants should be designed to prevent, detect, extinguish, limit, or control fires and explosions and their concomitant hazards and damaging effects. Many acceptable bases and criteria for fire protection programs are available and have been used. This guide describes bases and criteria for fire protection programs in the design and construction of fuel reprocessing facilities that should be considered by applicants in their submittals for construction permit applications for such facilities.

B. DISCUSSION

The principal purpose of a fire protection program for a fuel reprocessing plant is fire protection of the general public, plant personnel, and the environment from adverse radiological consequences due to fire.

Structures, systems, and components important to safety should be designed and located so they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions. Heat-resistant and noncombustible materials should be used wherever practical throughout the facility, particularly in locations vital (a) to the functioning of confinement barriers and systems, (b) to methods of controlling radioactive materials within the facility, and (c) to the maintenance of safety control functions. The adverse effects of fires and explosions on structures, systems, and components important to safety can be minimized by providing systems with sufficient capacity and capability for detecting and suppressing explosions and fires and for transmitting alarms to one or more central control areas. Adverse effects may result from normal operation, malfunction, or failure of a fire suppression system. It is important to recognize these potential adverse effects and eliminate or mitigate them by proper design and installation.

Accomplishment of these overall objectives entails an evaluation of such factors as the expected maximum amount of combustible material in each area of the plant; severity, intensity, and duration of credible fires; assurance of confinement of radioactive and other potentially dangerous contaminants; effects of exposure of construction and processing materials to high-radiation fields and/or corrosive atmospheres; arrangements and structural design features of buildings for control of smoke, heat, flame, and combustible and explosive gases; and systems for fire detection, confinement, control, and suppression.

Selected areas of the plant having particular occupancy requirements, such as control rooms or control areas, should be designed to allow occupancy (1) for the safe operation of the plant under normal conditions and (2) for maintaining the plant in a safe condition under accident or other abnormal conditions. Consideration should be given to the selection of systems for fire detection, confinement, control, and suppression suitable for use in these areas.

Water should be the principal fire suppressor. Special consideration should be given to selection of water sources, water distribution systems, fire pumps, and automatic and manual fire extinguishing systems to control and extinguish a credible fire in any area. Automatic sprinkler or equivalent coverage should be provided throughout the facility with provisions for special hazard fire control measures where particular hazards exist, such as in processing operations involving considerable amounts of flammable, oxidizing, and corrosive liquids and in areas where the presence of large quantities of highly radioactive materials requires massive shielding and remote controls for personnel safety.

Incipient fires may be controlled by portable fire extinguishers. This phase of fire control is particularly important even though automatic sprinklers have been provided. Consideration should be given to the selection of portable fire extinguishers suitable for use on specific hazards that may be encountered.

The need for fire detection devices and the type most desirable should be related to combinations of hazards involved, extinguishing controls available, and availability of public and private fire department services. Various fire detection devices operating on different principles are available. These include devices where fire detection is based on fixed temperature, rate of temperature rise, presence of combustion and pyrolysis products, or various combinations of these principles.

Fire protection systems may be subject to effects of natural phenomena such as seismic motion and floods, missiles, fire and explosion, and other accidents. These systems should remain functional to the extent that sufficient protective and suppressive capabilities are maintained to prevent uncontrolled release of radioactive materials as a result of fire. Where possible, continuity of fire protection systems should be ensured by such means as standby equipment and fail-safe control systems.

The ability of the systems to perform their safety functions effectively can be ensured by periodic testing of safety-related components to demonstrate their ability to perform at design efficiency and to verify their availability for emergencies.

An important aspect of a fire protection program is the training of a firefighting organization and maintaining its competence with periodic drills.

The fire protection program should provide for the use of appliances, equipment, and materials listed by such testing organizations as the Underwriters' Laboratories, Inc. (UL) and the Factory Mutual Research Corp. (FM) as meeting their standards.

Fire protection programs should conform to the provisions of the following codes and standards, as applicable:

1. National Fire Codes of the National Fire Protection Association (NFPA),

2. Fire Prevention Code of the American Insurance Association (AIA),

3. Fire Protection Standards and Bulletins of the Factory Insurance Association (FIA),

4. Standards of the American Petroleum Institute (API),

5. One of the four model building codes–

a. National Building Code of the AIA,

b. Uniform Building Code of the International Conference of Building Officials (ICBO),

c. Southern Standard Building Code of the Southern Building Code Congress,

d. Basic Building Code of the Building Officials Conference of America.

C. REGULATORY POSITION

Fuel reprocessing plants should be designed to ensure the confinement of hazardous materials during normal or abnormal conditions including fires and explosions.

1. General Features

a. Fire protection systems for fuel reprocessing plants should be designed to ensure that any credible fire or explosion will not prevent the operation or use of structures, systems, equipment, and components (hereinafter referred to as "essential items") whose continued integrity and/or operability are essential to ensure confinement of radioactive materials.

b. Where possible, each fire protection system should be designed so that the failure of any one component (equipment or control device) will not disable the entire fire protection system. Fire protection systems and components should have fail-safe features and audible and visual alarms for both operation and trouble.

c. Onsite emergency power supply systems should be provided to operate fire protection systems and components as well as other systems and components important to safety. Fire protection systems should be capable of operating during normal power outage. The

onsite emergency power sources and the electrical distribution circuits should have independence and testability to ensure performance of their safety functions assuming any single failure.

d. The design of the facility should include provisions to protect against adverse effects that might result from operation or failure of the fire suppression system. For example, collection systems should be provided for runoff water from the normal or abnormal flow of an automatic sprinkler system.

e. The fire protection systems should be designed to withstand tornado conditions and the effects of earthquakes and remain functional to the extent that sufficient protective and suppressive capabilities are maintained to prevent uncontrolled release of radioactive materials as a result of fire.

f. Criteria for fire protection equipment, systems, components, and programs should comply with the intent of applicable provisions of the National Fire Codes of the NFPA (Ref. 1). Fire protection appliances, equipment, and materials that have been examined by and meet the standards of such nationally recognized testing organizations as UL and FM should be used.

2. Building Construction and Facilities

a. The fuel reprocessing plant should be designed and constructed using building components of heat-resistant and noncombustible material wherever practicable, particularly in locations vital to the functioning of confinement barriers and systems.

b. Where practicable, materials and equipment designed for minimum fire potential should be selected. Structural members including walls, partitions, columns, beams, floors, and roofs should be of noncombustible, fire-resistive construction with fire-resistance ratings sufficient for protection against credible fire exposures.

c. Assuming failure of any fire suppression system that is not designed as an essential item, the structural shell (and its supporting members) surrounding any area handling radioactive material, where the radioactive material could be accidentally dispersed and cause exposure to either operating personnel or the public, should be designed with sufficient fire resistance for it to remain standing and continue to act as a confinement structure during any credible accident conditions resulting from fires. Penetrations in this shell should incorporate, as a minimum, equivalent protection against credible fire exposures.

d. Suspended ceilings and their supports should be of noncombustible construction as listed by UL (Ref. 2) or FM (Ref. 3). Insulation for pipes and ducts, sound attenuating materials, and the adhesives used for each should also be noncombustible. Concealed spaces should be devoid of combustibles. Materials used should have a rating of 25 or less with respect to flame spread, fuel contribution, and smoke development (Ref. 4).

e. Exits should be strategically located to ensure that radiation exposure of personnel will be minimal during evacuation through a confinement barrier in the event of a breach of processing equipment confinement resulting from fires and explosions. Such a barrier would be a partition separating two different air zones (Ref. 5). The airflow through the barrier should be opposite to the direction of exit travel.

f. Electrical wiring systems and their supporting members (i.e., conduits, trays, troughs, raceways, and distribution frames) servicing essential items should be protected against fire. Cable enclosures, fire stops at fire barrier walls, floors, and ceilings, and non-flame-propagating electrical insulation should be used in the design of electrical wiring systems to minimize the spread of fire.

g. Structures, systems, equipment, and components in processing areas requiring hydraulic, lubricating, cooling, insulating, and processing fluids should be protected from fire and its spread by use of minimum volumes of such fluids, by use of fire-resistant fluids, by fire barrier isolation, by provision for automatic fire suppression, and by installation of curbs, catch basins, or other confinement designs that minimize the spread of fluid leakage.

h. Provision should be made for protection of the plant against lightning damage.

i. Protective barriers should be provided around high-pressure or other potentially dangerous systems.

3. Ventilation Systems

The ventilation systems should be designed to withstand any credible fire and explosion and continue to act as confinement barriers. Fire protection for ventilation systems is discussed in Regulatory Guide 3.32 (Ref. 6).

4. Hot Cells, Glove Boxes, Hoods, and Other Process Enclosures

a. Combustible materials should not be used in the construction of hot cells. Hot cells should contain the minimum amount of combustibles consistent with operational requirements. Construction and processing materials should be selected that will not be degraded by exposure to high-radiation fields or corrosive atmospheres to the point where they will present a fire hazard. Materials and equipment in a hot cell should not

be arranged in such a way as to contribute to the ignition or the spread of a fire or hinder the detection or suppression of a fire.

b. Glove boxes and process enclosures should be provided with fire stops in connecting tunnels to prevent the spread of fire. The fire stops between enclosures should normally be closed. Where operations require that the fire stops be in the open position, they should be designed to close automatically upon operation of the fire detection system. Provision should also be made for manual operation of fire stops. Combustible materials that are an integral part of a glove box should be held to a minimum.

c. The design of enclosures should be based on downdraft ventilation flow to minimize the spread of fire. Heat detectors and combustible gas and vapor detection meters should be provided on glove boxes or enclosures where fire or explosion hazards exist. Automatic fire suppression equipment should be provided in these boxes or enclosures. When automatic systems are not required, fire detectors should be installed and provisions made for manual fire suppression.

d. Chemical fume or particulate exhaust hoods should be equipped with full-closing sashes and provided with fire detectors. Provisions should be made for manual fire suppression where fire or explosion hazards exist.

5. Sprinkler Systems

a. Automatic water sprinkler coverage using components listed by UL (Ref. 7) or FM (Ref. 3) should be provided throughout the facility except in areas where nuclear criticality or other hazards specifically preclude its use. Nonaqueous systems using components listed by UL (Ref. 7) or FM (Ref. 3) should be used in areas not protected by automatic water sprinklers or for other special applications (see regulatory position 6).

b. Automatic water-type extinguishing systems include wet-pipe, preaction sprinkler, open head deluge, water spray, and systems utilizing automatic "on-off" flow control. Selection of a specific type of system should take into account system characteristics such as speed of operation, ambient temperature, and required volume and optimum use of water.

c. Wet-pipe conventional automatic sprinklers should be used in nonprocess areas of the facility.

d. Where used in process areas, the sprinkler system selected should minimize the quantity of water used, the unintentional operation of sprinkler heads, the spread of contamination by water, the extent of cleanup operations, and the possibility of criticality.

6. Special Automatic Extinguishing Systems

a. Areas not protected by automatic water sprinklers should be protected by some other fire suppression agents such as inert gas, carbon dioxide, high-expansion foam, or halogenated organic compounds.

b. Selection of a carbon dioxide extinguishing system should take into account such considerations as type of fire hazard, protection of personnel, and process enclosure pressurization.

c. Selection of a halogenated extinguishing system should take into account such considerations as process enclosure pressurization, protection of personnel, type of fire hazard, adverse reaction with pyrophoric metals, and corrosive thermal decomposition products.

d. For other special applications, consideration should be given to inert gas, dry chemical, high-expansion foam, and "wet water" fire extinguishing systems. When dry chemical systems are used, consideration must be given to protect filters against fouling.

7. Fire Protection Water Systems

a. Potable and process water systems should be arranged so they can be shut down without affecting the water supply to the fire systems. Fire protection water supply and distribution systems required for essential item protection should be designed and constructed so that continuity of protection in the event of any credible accident conditions is ensured.

b. The water supply for the permanent fire protection installation should have a minimum of two reliable, independent sources and sufficient capacity (based on the maximum water demand) for firefighting until other sources of water become available. Water supplies containing salt or other materials deleterious to the fire protection systems should be avoided wherever possible.

c. Water for firefighting and fire suppression systems should be furnished to the site by a loop distribution system encircling the site buildings. Hydrants served by this system should be strategically located around the loop. Valves or valve assemblies listed by UL (Ref. 7) or FM (Ref. 3) should be provided for proper sectional control of the loop.

d. Fire water pumps should be equipped with automatic starting features and listed by UL (Ref. 7) or FM (Ref. 3) for fire service. Where water supply pressure is provided by pumps only, there should be a minimum of two pumps, at least one of which should be driven by nonelectrical means, preferably diesel engine. Emergency power should be supplied to an electric-driven fire pump

in the event of failure of the normal power supply (see regulatory position 1.c). Multiple fire water pumps should be selected so that the maximum water demand for firefighting will be supplied with the largest pump out of service.

Audible alarms for pump startup and operation and for power failure should be provided for the pump system and arranged to sound in a constantly attended location. A small pressurizing pump should be provided to automatically maintain the desired static pressure on the fire protection water supply system and minimize unnecessary operation of the fire water pumps.

e. Water should be supplied to each water spray extinguishing system from the water main loop around the facility. A water spray system may be used for heat removal for the high-efficiency filtration system serving as a final means of effluent cleaning for the ventilation systems. This water spray system should have a dedicated water supply, in addition to the normal water supply, sized to operate the system during a credible fire or explosion even if all other water supplies fail.

f. Collection systems should be provided for runoff water from firefighting activities or water breaks or leaks in process areas. Nuclear criticality, confinement, sampling, volume determination, and retrievability of liquids and solids should be considered in the design of collection systems. The size of the collection system for firefighting water should be based on the maximum amount of water that could be used in fighting a credible fire.

8. Manual Firefighting Equipment

a. Provision should be made for portable fire extinguishers listed by UL (Ref. 7) or FM (Ref. 3) and suitable for use on specific hazards that may be encountered. The number of fire extinguishers required should be determined considering the area and arrangement of the plant or occupancy, the severity of the hazards, the anticipated classes of fires, and the distances to be traveled to reach extinguishers.

b. Standpipe and hose systems using components listed by UL (Ref. 7) or FM (Ref. 3) should be provided and installed in both process and nonprocess areas. Standpipes should be so located that they are protected against mechanical and fire damage. Hose outlets should be easily accessible.

9. Fire Detection, Signal, and Alarm Systems

a. Provision should be made for fire detection and alarm systems using components listed by UL (Ref. 7) or FM (Ref. 3). These systems should consist of fire detectors, signaling devices, and audible and visual indicators in a constantly attended location, as well as in appropriate locations about the plant. A means should be provided to monitor the status and functioning of the fire detection, signal, and alarm systems as well as other fire protection system components located throughout the plant. Provision should be made for periodic testing and checkout of these systems.

b. A plant-wide public address and two-way communication system should be provided.

c. Manual fire alarm stations should be installed throughout the facility at readily accessible locations. These stations should be connected to the plant-wide alarm system.

d. Fires should be indicated audibly by alarms that are set off by fire suppression and detection systems. Each sprinkler system should be equipped with a flow alarm on the plant-wide alarm system.

e. Glove boxes and enclosures should be equipped with fire and/or smoke detectors to provide both a local alarm and a zone and location signal on the plant-wide alarm system.

f. The inlet duct to a multistage high-efficiency filter plenum serving as a final means of effluent cleaning for the ventilation systems should be provided with heat and smoke detectors that actuate a local alarm and an automatic fire alarm station on the plant-wide alarm system.

10. Flammable Materials

a. Special control should be exercised over the handling of flammable, toxic, and explosive gases, chemicals, and materials admitted to or produced in process areas. Solvents and other flammable liquids, other than small quantities in use, should be stored in a separate building or unexposed storage area. Safety cans listed by UL (Ref. 8) or FM (Ref. 3) should be used for flammable liquids. Covered noncombustible containers listed by UL (Ref. 8) or FM (Ref. 3) should be provided for combustible wastes.

b. Provisions should be made for isolation between incompatible chemicals, materials, and processes such as solvent extraction.

c. Flammable and combustible materials should not be stored in finished product storage areas or shipping areas.

11. Quality Assurance Program

A quality assurance program should be established for the design, construction, testing, operation, and maintenance of all structures, systems, equipment, and components of fire protection systems in accordance

with the criteria in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," of 10 CFR Part 50. Regulatory Guides 3.3 (Ref. 9) and 3.21 (Ref. 10) describe, respectively, methods of complying with this regulation with regard to overall program requirements and requirements for protective coatings.

12. Procedures, Organization, and Training

a. Fire emergency procedures should be established for plant personnel. A plant fire protection organization should be trained and equipped to deal effectively with fire or explosion emergencies. Selected personnel should be specifically trained in firefighting techniques. Operating personnel and new employees should be periodically instructed in the proper use of plant firefighting equipment and emergency fire procedures. Decontamination procedures should be covered in training programs. Drills should be held periodically.

b. Arrangements should be made with offsite fire departments for providing assistance to the plant fire protection organization in the event of an onsite fire. Offsite fire departments should be familiarized with plant emergency fire procedures, fire protection organization, layout, and unusual hazards. Drills should be held periodically.

c. An approved recorded watchman service, central station supervisory service, or constant occupancy of all important areas should be provided to maintain a satisfactory degree of surveillance of the property at all times.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants regarding the NRC staff's plans for using this regulatory guide.

Except in those cases in which the applicant proposes to use an acceptable alternative method for complying with specific portions of the Commission's regulations, the methods described herein will be used in the evaluation of submittals for construction permit applications docketed after March 1, 1977. If an applicant wishes to use this regulatory guide in developing submittals for an application docketed prior to March 1, 1977, the pertinent portions of the application will be evaluated on the basis of this guide.

REFERENCES

1. National Fire Codes, National Fire Protection Association. Copies may be obtained from National Fire Protection Association International, 470 Atlantic Avenue, Boston, Mass. 02210.

2. Underwriters' Laboratories Building Materials List (latest edition). Copies may be obtained from Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, Ill. 60611.

3. Factory Mutual Approval Guide (latest edition). Copies may be obtained from Factory Mutual Research Corporation, 1151 Boston-Providence Turnpike, Norwood, Mass. 02062.

4. ASTM E84-70, "Method of Test for Surface Burning Characteristics of Building Materials," American Society for Testing and Materials. Copies may be obtained from American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

5. Regulatory Guide 3.18, "Confinement Barriers and Systems for Fuel Reprocessing Plants," U.S. Nuclear Regulatory Commission, Washington, D.C.

6. Regulatory Guide 3.32, "General Design Guide for Ventilation Systems for Fuel Reprocessing Plants," U.S. Nuclear Regulatory Commission, Washington, D.C.

7. Underwriters' Laboratories Fire Protection Equipment List (latest edition). Copies may be obtained from Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, Ill. 60611.

8. Underwriters' Laboratories Gas and Oil Equipment List (latest edition). Copies may be obtained from Underwriters' Laboratories, Inc., 207 East Ohio Street, Chicago, Ill. 60611.

9. Regulatory Guide 3.3, "Quality Assurance Program Requirements for Fuel Reprocessing Plants and for Plutonium Processing and Fuel Fabrication Plants," U.S. Nuclear Regulatory Commission, Washington, D.C.

10. Regulatory Guide 3.21, "Quality Assurance Requirements for Protective Coatings Applied to Fuel Reprocessing and to Plutonium Processing and Fuel Fabrication Plants," U.S. Nuclear Regulatory Commission, Washington, D.C.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
U.S. NUCLEAR REGULATORY
COMMISSION