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DRAFT REGULATORY GUIDE

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(Proposed Revision 1 of Regulatory Guide 3.12, dated August 1973)

GENERAL DESIGN GUIDE FOR VENTILATION SYSTEMS OF PLUTONIUM PROCESSING AND FUEL FABRICATION PLANTS

A. INTRODUCTION

This guide describes a method that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable for use in complying with Title 10, Sections 70.23(a)(3) and 70.23(a)(4), of the *Code of Federal Regulations* (10 CFR 70.23(a)(3) and 10 CFR 70.23(a)(4)) (Ref. 1) with respect to the design of ventilation systems for plutonium processing and fuel fabrication plants. At plutonium processing and fuel fabrication plants, a principal risk to health and safety is the release and dispersal of radioactive materials. The prevention of such release and dispersal is an important function of the ventilation systems. To meet these objectives, this guide provides recommendations for achieving defense in depth and for minimizing the release of radioactive materials to the environment.

Each applicant for a license to possess and use special nuclear material in a plutonium processing and fuel fabrication plant, as defined in 10 CFR 70.4, "Special Nuclear Material," must satisfy the provisions of 10 CFR 70.23, "Requirements for the Approval of Applications." As required by 10 CFR 70.23(a)(3) and 10 CFR 70.23(a)(4), the applicant's proposed equipment, facility, and procedures must be adequate to protect health and minimize danger to life or property.

The NRC issues regulatory guides to describe to the public methods that the staff considers acceptable for use in implementing specific parts of the agency's regulations, to explain techniques that the staff uses in evaluating specific problems or postulated accidents, and to provide guidance to applicants. Regulatory guides are not substitutes for regulations and compliance with them is not required.

This regulatory guide contains information collection requirements covered by 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," that the Office of Management and Budget (OMB) approved under OMB control number 3150-0009. The NRC may neither conduct nor sponsor, and a person is not required to respond to, an information collection request or requirement unless the requesting document displays a currently valid OMB control number.

B. DISCUSSION

Ventilation systems for a plutonium processing and fuel fabrication plant may consist of the air supply, recirculating air, process ventilation, and exhaust air systems together with associated air filters, fans, dampers, ducts, and control instrumentation. The air supply system draws in and conditions fresh air and distributes it throughout the plant. A portion of the supply air enters the process ventilation system through gloveboxes, hoods, and other components and is removed together with other plant air through the exhaust ventilation system, which discharges through a stack to the environment. Part of the occupied-area ventilation air may be recycled to the air supply system through the recirculating air system.

Ventilation systems are important to safety and crucial to protect workers, the public, and the environment because they serve as principal confinement barriers in a multiple confinement barrier system that guards against the release of radioactive or other potentially dangerous materials during normal or abnormal conditions. Ventilation systems will be subject to variations in operating temperatures and pressures and to environmental conditions associated with normal operation, maintenance, plant shutdown, and testing. Natural phenomena, such as seismic motion, floods, tornadoes, hurricanes and other tropical storms, missiles, fire and explosion, and other accidents may also affect them.

The systems may be required to continue to perform their safety functions effectively under all conditions by confining radioactive or other potentially dangerous materials. The systems also contribute to meeting the as low as reasonably achievable criterion in 10 CFR Part 20, "Standards for Protection against Radiation" (Ref. 2).

Means such as standby equipment and fail-safe control systems can ensure the continuity of necessary ventilation. The ability of the systems to perform their safety functions effectively can be ensured by periodic testing of safety-related components during normal operation of the systems to demonstrate their ability to perform at the assumed efficiency and to verify their availability and reliability for emergencies.

C. REGULATORY POSITION

Based on the applicant's Integrated Safety Analysis (ISA), required by 10 CFR Part 70 Subpart H, "Additional Requirements for Certain Licensees Authorized to Possess a Critical Mass of Special Nuclear Material," the ventilation system may be designated as an item relied on for safety (IROFS) needed to ensure the confinement of hazardous materials during normal and abnormal conditions, including natural phenomena, fires, and explosions. In addition, the release of radioactive material to the environment, or to areas occupied by facility workers, must meet the requirements of 10 CFR Part 20 and should be reduced to levels as low as reasonably achievable.

1. General Safety

a. Consistent with the applicant's ISA, the ventilation systems should have the general safety attributes described in this section.

b. The ventilation systems should confine radioactive materials within the process areas as close to the point of origin as practicable.

c. Confinement of radioactive materials should be provided by multiple zones. Each zone should be bounded by barriers such as vessel and glovebox walls, building walls, and internal room walls. The primary confinement zone should be the process ventilation system for gloveboxes, conveyors, transfer boxes, and other spaces that may contain plutonium or other radioactive materials during normal operations. A secondary confinement zone should be the operating and other potentially contaminated areas surrounding the process equipment and gloveboxes. A tertiary confinement zone should be provided in areas outside the secondary confinement zone providing defense in depth between potentially contaminated areas and the environment.

d. Pressure differentials should be maintained between building confinement zones and also between the building confinement zones and the outside atmosphere to ensure that airflow is from zones of lesser potential contamination to zones of greater potential for contamination (i.e., from the environs into the building, to tertiary, secondary, and primary confinement zones). Devices should be provided to control and indicate pressure differentials between confinement zones. Alarms should be provided to indicate when pressure differentials are not maintained in a prescribed range.

e. Based on the results of the ISA, ventilation systems may be designated as IROFS and require that the failure of any one component (equipment or control device) will not affect the continuous operation of the ventilation system. Ventilation systems and components designated as IROFS may require fail-safe features with provision for alarm indication.

f. Based on the results of the ISA, one or more onsite emergency power supply systems may be needed to operate the ventilation systems designated as IROFS.

g. Based on the results of the ISA, ventilation systems designated as IROFS may need to be designed to withstand the effects of fires and to maintain confinement during these events. Such ventilation systems should have fire protection features, such as fire doors and dampers or other proven devices to restrict the spread of fires (e.g., fire-resistant materials of construction, fire-resistant filters, heat and smoke detectors, alarms, heat removal devices, and fire-suppression equipment). The design of the fire protection systems should protect against adverse effects in the event of inadvertent operation or failure of the fire suppression system.

h. Based on the results of the ISA, air supply systems designated as IROFS may need to remain operational during fires. Such systems should have the capability to shut off air supply to involved fire areas and be designed to protect shutdown systems from backflow.

i. Based on the results of the ISA, components in ventilation systems designated as IROFS should be fire resistant to protect against fires occurring within or outside the system. Such ventilation system components should meet the requirements of American Society of Mechanical Engineers (ASME) AG-1, "Code on Nuclear Air and Gas Treatment" (Ref. 3).

j. Based on the results of the ISA, ventilation systems designated as IROFS should have fire- and smoke-suppression equipment to ensure that the integrity of high-efficiency particulate air (HEPA) filters or filter systems is not degraded during fires. Spark and flame arresters and isolation valves or dampers may be needed to protect final HEPA filters from contact with hot particles and excessive soot loading beyond the filters' design capacity. (Final HEPA filters are those HEPA filter banks located immediately upstream of the discharge stack and represent the final stages of particulate removal for the ventilation system.) HEPA filters should meet the requirements of ASME AG-1.

k. Based on the results of the ISA, the design of ventilation systems designated as IROFS may need to consider combustible or explosive solvents, gases, or vapors. The applicant should consider continuous monitoring of such materials using suitable monitoring systems capable of functioning under normal and abnormal conditions as dictated by the ISA.

l. Based on the results of the ISA, ventilation systems designated as IROFS should be designed to withstand tornado, hurricane, and other tropical storm conditions without loss of confinement capability resulting from mechanical damage to the system or components or from reduced ambient pressure at the intake and exhaust openings. Protection against tornado missiles may also be needed at the intake and exhaust openings.

m. Based on the results of the ISA, ventilation systems designated as IROFS may need to be designed to withstand the effects of seismic conditions without loss of confinement or system function to prevent uncontrolled release of radioactive materials to the environment.

n. Based on the requirements of 10 CFR 20.1406 (a) and (b) applicants for licenses submitted after August 20, 1997, must describe in the application how facility design will minimize to the extent practicable, contamination of the facility and the environment and the generation of radioactive waste and facilitate decommissioning (Ref. 4).

2. Occupied-Area Ventilation Systems

a. Based on the results of the ISA, supply air systems designated as IROFS should be provided to ensure adequate control and proper functioning of each of the confinement zones. Supply air should be conditioned to maintain control parameters of temperature and humidity. Supply air systems should be provided with filters to remove incoming particulate matter for contamination control within confinement zones and for reducing the dust loading on filters in the final filtration assemblies.

b. Air in secondary and tertiary confinement zones may be recirculated. Based on the results of the ISA, the ventilation system designs should consider the need for HEPA filtration and removal of radioactive and chemical contaminants in recirculated air streams before it is returned to secondary and tertiary confinement zones. The design should also consider continuous monitoring of recirculated air streams and the capability to exhaust the recirculated air directly to the final filtration assemblies in the event that contaminant levels exceed safe occupational levels.

3. Process Ventilation Systems

a. Based on the results of the ISA and process control specifications, supply air and inert gases to gloveboxes and process equipment may need to be conditioned to control temperature and humidity. Humidity control may also be needed for criticality safety. Supply air should be provided consistent with the recommendations in Section C.2.a of this regulatory guide.

b. Based on the results of the ISA, supply air and inert gases may need to be introduced into primary confinement zones through at least one HEPA filter and be discharged through at least one HEPA filter to the exhaust duct leading to the final filtration assemblies. (Final filtration assemblies are those filter assemblies located immediately upstream of the discharge stack and represent the final stages of contaminant removal for the ventilation system.) The inlet HEPA filters should be designed to prevent backflow of contaminants into supply ducts, and the outlet HEPA filters should provide contamination and criticality control in the exhaust ductwork.

c. Based on the results of the ISA, gloveboxes designated as IROFS should be designed to minimize contaminant releases in the event of credible breaches. Such designs should provide adequate capacity and controls to maintain inward airflow of at least 125 linear feet per minute through the maximum credible breach.

d. Based on the results of the ISA, exhaust flows from gloveboxes and process equipment, which are designated as IROFS and are associated with wet chemical operations, should be treated to protect exhaust ductwork and downstream filtration units from wetting and chemical attack.

e. If glovebox or process equipment exhaust air or inert gases are recirculated, based on the results of the ISA, ventilation system designs should provide for HEPA filtration and removal of chemical contaminants in recirculated air streams before the air is returned to gloveboxes and process equipment. The design should also consider continuous monitoring of recirculated air and inert gas streams and the capability to exhaust the recirculated air and inert gases directly to the final filtration assemblies in the event that contaminant levels exceed process and contamination control objectives.

4. Fans

Based on the results of the ISA:

a. Ventilation systems designated as IROFS should have redundant fans and isolation dampers for the supply and exhaust air systems. (Supply air systems include filters and fans that supply fresh outside air into the facility. Exhaust air systems include filters and fans that discharge ventilation air and process gases from the facility.) Controls should be provided to automatically start redundant fans and automatically isolate idle fans with backflow dampers.

b. Fans designated as IROFS should be provided with alarms to indicate fan malfunctions.

c. Supply air fans designated as IROFS should be interlocked with exhaust fans to prevent supply air fan operations unless the exhaust fans are in operation. This will prevent pressurization of confinement zones in the event that exhaust fans fail.

d. Emergency power supplies may be needed for operation of fans that are designated as IROFS.

5. Ventilation System Construction and Layout

a. Based on the results of the ISA, ventilation systems designated as IROFS should use construction materials based on strength to withstand accident conditions, corrosion resistance, fire resistance, and ease of decommissioning.

b. Ventilation systems designated as IROFS should be designed and constructed in accordance with ASME AG-1.

6. Ventilation System Inspection, Testing, and Monitoring

Based on the results of the ISA:

a. Ventilation systems and components designated as IROFS should be designed so that they can be initially and periodically inspected and tested to ensure that the system will be available and will perform its function reliably when needed. Ventilation systems and components, including the ductwork and pressure boundaries, should be inspected and tested in accordance with the applicable provisions of ASME AG-1.

b. Ventilations systems designated as IROFS should have a continuous air monitoring system (CAMS) to continuously obtain representative samples and monitor effluent releases. The CAMS should have alarms at appropriate control rooms or areas. Air monitoring and sampling systems should also be provided in occupied areas to alert workers of hazardous concentrations of radioactive or chemical materials.

7. Gloveboxes and Other Process Enclosures

Based on the results of the ISA:

a. Gloveboxes designated as IROFS should be designed, fabricated, tested, installed, operated, and inspected in accordance with American Glovebox Society (AGS)-G001, “Guideline for Gloveboxes” (Ref. 5).

b. Gloveboxes and process enclosures designated as IROFS should use materials that are selected based on strength to withstand accident conditions, corrosion resistance, fire resistance, and ease of decommissioning. This equipment should employ fire detectors, combustible gas and vapor detection, pressure relief devices, and fire suppression based on the materials and processes used within the gloveboxes and enclosures. Downdraft ventilation should be considered to minimize the spread of fires.

c. Gloveboxes and process enclosures designated as IROFS should have differential pressure sensors and alarms to ensure that pressure differentials between confinement zones are maintained.

d. Gloveboxes and process enclosures designated as IROFS should be leak tested and tested for containment integrity and ventilation flow in accordance with the provisions of AGS-G001.

8. Filtration Systems

a. Based on the results of the ISA, filter components and assemblies designated as IROFS should be designed, fabricated, inspected, tested, stored, handled, packaged, shipped, and received in accordance with ASME AG-1.

b. Based on the results of the ISA, filter assemblies designated as IROFS should have at least two banks of HEPA filtration. In addition, filter assemblies should have prefilters and roughing filters to reduce HEPA filter dust loadings and to protect HEPA filters from hot particles. Other filter systems with removal efficiencies equivalent to HEPA filters may also be used.

c. If the ISA takes credit for HEPA filters, those HEPA filters should be tested in place, in accordance with ASME AG-1, initially upon placement into service and periodically thereafter to ensure that they will be available and reliable to perform their intended function. HEPA filter banks should demonstrate an efficiency of at least 99.95 percent using a polydisperse dioctyl phalate (DOP) penetrant having a light-scattering mean diameter of approximately 0.7 microns. Penetrants equivalent to DOP may also be used.

9. Management Measures

Management measures should be established for the design, fabrication, installation, testing, inspection, operation, and maintenance of ventilation systems designated as IROFS consistent with the results of the ISA and the requirements in 10 CFR 70.22(f) and Subpart H of 10 CFR Part 70.

10. Procedures for Operation

Procedures for operation should contain provisions to meet the objectives of 10 CFR 20.1406 with regard to minimization of contamination and facilitation of decommissioning. Compliance can be demonstrated through a combination of procedures which anticipate the failure of preventive measures contained in the design and provide for prompt detection of leaks outside of controlled systems and appropriate action to correct such leaks and clean-up residual contamination.

D. IMPLEMENTATION

The purpose of this section is to provide information to applicants and licensees regarding the NRC's plans for using this draft regulatory guide. The NRC does not intend or approve any imposition or backfit in connection with its issuance.

The NRC has issued this draft guide to encourage public participation in its development. The NRC will consider all public comments received in development of the final guidance document. In some cases, applicants or licensees may propose an alternative or use a previously established acceptable alternative method for complying with specified portions of the NRC's regulations. Otherwise, the methods described in this guide will be used in evaluating compliance with the applicable regulations for license applications, license amendment applications, and exemption requests.

REGULATORY ANALYSIS

1. Statement of the Problem

Regulatory Guide 3.12 was first issued in August 1973 to provide guidance for facilities processing plutonium. Since that time, there have been few commercial facility applications for plutonium processing and fuel fabrication. At this time, the NRC is in the process of considering whether to authorize the operation of a mixed oxide fuel fabrication facility for use in processing surplus weapons materials, and it is expected that, in the future, additional plutonium processing and fuel fabrication facilities may be proposed for licensing. These future facilities may be either commercial facilities or facilities licensed through the U.S. Department of Energy's Global Nuclear Energy Partnership.

In 2000, the NRC made significant regulatory changes to 10 CFR Part 70 that require applicants to prepare ISAs, which are systematic evaluations of nuclear facility hazards using risk-informed approaches. In addition, new industry consensus standards are available that update previous guidance reflecting new experiences and state-of-the-art equipment. Therefore, revision of this regulatory guidance is necessary to reflect the new regulatory requirements and the most current industry standards.

2. Objective

The objective of this regulatory action is to provide current guidance for the design of ventilation systems for use in plutonium processing and fuel fabrication facilities.

3. Alternative Approaches

The NRC staff considered the following alternative approaches:

- Do not revise Regulatory Guide 3.12.
- Update Regulatory Guide 3.12.

3.1 Alternative 1: Do Not Revise Regulatory Guide 3.12

Under this alternative, the NRC would not revise this guidance, and the original version of this regulatory guide would continue to be used. This alternative is considered the baseline or "no action" alternative and, as such, involves no value/impact considerations. However, this alternative would not address the changes in regulatory requirements, and would likely result in inefficiencies in preparing and reviewing applications for applicants and staff.

3.2 Alternative 2: Update Regulatory Guide 3.12

Under this alternative, the NRC would update Regulatory Guide 3.12, taking into consideration the new regulatory requirements and the most current industry consensus standards.

One benefit of this action is that it would enhance plutonium processing and fuel fabrication facility safety by incorporating a risk-informed approach through the use of ISAs, which systematically evaluate all safety hazards relating to the use of nuclear materials at a facility and provide a technical basis for focusing resources on the most hazardous operations.

The costs to the NRC would be the one-time cost of issuing the revised regulatory guide (which is expected to be relatively small) and applicants would incur little or no cost.

4. Conclusion

Based on this regulatory analysis, the staff recommends that the NRC revise Regulatory Guide 3.12. The staff concludes that the proposed action will enhance plutonium processing and fuel fabrication facility safety by taking into consideration new regulatory requirements and the most current industry consensus standards. The proposed action could also lead to cost savings for the industry, especially with regard to applications of a risk-informed approach to facility design and operation.

REFERENCES

1. 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material," U.S. Nuclear Regulatory Commission, Washington, DC.[1]

2. 10 CFR Part 20, "Standard for Protection against Radiation," U.S. Nuclear Regulatory Commission, Washington, DC.[2]

3. ASME AG-1, American Society of Mechanical Engineers, ASME Standard AG-1, "Code on Nuclear Air and Gas Treatment," American Society of Mechanical Engineers, New York, NY, 2003 and applicable addenda.[3]

4. Regulatory Guide 4.21 "Minimization of Cntamination and Radioactive Waste Generation: Life-Cycle Planning".[4]

5. AGS G001, "Guideline for Gloveboxes," American Glovebox Society, Santa Rosa, CA, 2007.[5]

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[1] All NRC regulations listed herein are available electronically through the Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/cfr/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail PDR@nrc.gov.

[2] All NRC regulations listed herein are available electronically through the Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/cfr/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail PDR@nrc.gov.

[3] Copies of American Society of Mechanical Engineers (ASME) standards may be purchased from ASME, Three Park Avenue, New York, NY 10016-5990; telephone (800) 843-2763. Purchase information is available through the ASME Web-based store at http://www.asme.org/Codes/Publications/.

[4] The NRC regulatory guide listed herein is available electronically through the Electronic Reading Room on the NRC's public Web site, at http://www.nrc.gov/reading-rm/doc-collections/cfr/. Copies are also available for inspection or copying for a fee from the NRC's Public Document Room (PDR) at 11555 Rockville Pike, Rockville, MD; the mailing address is USNRC PDR, Washington, DC 20555; telephone (301) 415-4737 or (800) 397-4209; fax (301) 415-3548; and e-mail PDR@nrc.gov.

[5] Copies of American Glovebox Society (AGS) standards may be purchased from AGS, P.O. Box 9099, Santa Rosa, CA, 95405; telephone (800) 530-1022. Purchase information is available through the AGS Web-based store at http://www.gloveboxsociety.org/.