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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, Section 70.23(a)(3), of the *Code of Federal Regulations* (10 CFR 70.23(a)(3)) (Ref. 1), and 10 CFR 70.23(a)(4) on 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, "Definitions,") must satisfy the provisions of 10 CFR 70.23, "Requirements for the Approval of Applications." The regulations at 10 CFR 70.23(a)(3) and 10 CFR 70.23(a)(4) require that the applicant's proposed equipment, facility, and procedures be adequate to protect health and minimize danger to life or property.

The NRC issues regulatory guides to describe and make available to the public methods that the NRC staff considers acceptable for use in implementing specific parts of the agency's regulations, techniques that the staff uses in evaluating specific problems or postulated accidents, and data that the staff needs in reviewing applications for permits and licenses. Regulatory guides are not substitutes for regulations, and compliance with them is not required. Methods and solutions that differ from those set forth in regulatory guides will be deemed acceptable if they provide a basis for the findings required for the issuance or continuance of a permit or license by the Commission.

This guide was issued after consideration of comments received from the public.

Regulatory guides are issued in 10 broad divisions: 1, Power Reactors; 2, Research and Test Reactors; 3, Fuels and Materials Facilities; 4, Environmental and Siting; 5, Materials and Plant Protection; 6, Products; 7, Transportation; 8, Occupational Health; 9, Antitrust and Financial Review; and 10, General.

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This regulatory guide contains information collection requirements covered by 10 CFR Part 70, and 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. The NRC has determined that this Regulatory Guide is not a major rule as designated by the Congressional Review Act and has verified this determination with the OMB.

B. DISCUSSION

Ventilation systems for a plutonium processing and fuel fabrication plant may comprise 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. A portion of the ventilation air in occupied areas may be recycled to the air supply system through the recirculating air system.

Ventilation systems are important to safety and are 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. They may also be subject to the effects of natural phenomena such as seismic motion, floods, tornadoes, hurricanes and other tropical storms, missiles, fires, explosions, and other accidents.

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 criteria in 10 CFR Part 20, “Standards for Protection against Radiation” (Ref. 2).

The continuity of necessary ventilation can 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 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

Subpart H, “Additional Requirements for Certain Licensees Authorized To Possess a Critical Mass of Special Nuclear Material,” of 10 CFR Part 70, “Domestic Licensing of Special Nuclear Material,” requires the applicant to conduct an integrated safety analysis (ISA). Based on the ISA, 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 in accordance with 10 CFR Part 20.

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 dispersible 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 to provide 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 for contamination to zones of greater potential for contamination (i.e., from the environment 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, fire-resistant construction materials, fire-resistant filters, heat and smoke detectors, alarms, heat removal devices, and fire suppression equipment. The design of the fire protection systems should include provisions to protect against adverse effects in the event of the 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 should be designed to protect systems that are shut down 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 that occur within or outside the system. Such ventilation system components should meet the requirements in American Society of Mechanical Engineers (ASME) AG-1, "Code on Nuclear Air and Gas Treatment," issued 2003 (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 are not degraded during fires. Spark and flame arresters and isolation valves or dampers may be necessary to protect final HEPA filters from contact with hot particles and excessive soot loading beyond their 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 in 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 the continuous monitoring of such materials with suitable monitoring systems that can function 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 the loss of confinement capability because of mechanical damage to the system or components or because of reduced ambient pressure at the intake and exhaust openings. Protection against missiles generated by tornadoes 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 the loss of confinement or system function to prevent an uncontrolled release of radioactive materials to the environment.

2. Ventilation Systems in Occupied Areas

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

b. Air in the secondary and tertiary confinement zones may be recirculated. Based on the results of the ISA, the ventilation system design should consider the need for HEPA filtration and removal of radioactive and chemical contaminants in recirculated air streams before the air is returned to secondary and tertiary confinement zones. The design should also consider the 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, the supply air and inert gases to gloveboxes and process equipment may require conditioning to control temperature and humidity. Humidity control may also be necessary for criticality safety. Supply air should be provided consistent with the recommendations in Regulatory Position 2.a of this 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 the 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 an inward airflow of at least 125 linear feet per minute through the maximum credible breach.

d. Based on the results of the ISA, the exhaust flow 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. Based on the results of the ISA, if exhaust air or inert gases from gloveboxes and process equipment are recirculated, ventilation system designs should provide for HEPA filtration and the removal of chemical contaminants in recirculated air streams before the air is returned to the gloveboxes and process equipment. The design should also consider the 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

a. Based on the results of the ISA, 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. Based on the results of the ISA, fans designated as IROFS should be provided with alarms to indicate fan malfunctions.

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

d. Based on the results of the ISA, emergency power supplies may be needed for the 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 that are selected based on their strength to withstand accident conditions, corrosion resistance, fire resistance, and ease of decommissioning.

b. Based on the results of the ISA, ventilation systems designated as IROFS should be designed and constructed in accordance with ASME AG-1.

6. Ventilation System Inspection, Testing, and Monitoring

a. Based on the results of the ISA, ventilation systems and components designated as IROFS should be designed so that they can be initially and periodically inspected and tested to ensure that they will be available and will perform reliably when they are needed to perform their functions. Based on the results of the ISA, 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. Based on the results of the ISA, 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. Designation of the CAMS as an IROFS should be based on the results of the ISA. 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

a. Based on the results of the ISA, gloveboxes designated as IROFS should be designed, fabricated, tested, installed, operated, and inspected in accordance with American Glovebox Society (AGS)-G001, "Guideline for Gloveboxes," issued 2007 (Ref. 4).

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

c. Based on the results of the ISA, 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. Based on the results of the ISA, gloveboxes and process enclosures designated as IROFS should be tested for leaks, containment integrity, and ventilation flow in accordance with the provisions in 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 filtration systems with removal efficiencies equivalent to HEPA filters may also be used.

c. If credit is taken for HEPA filters in the ISA, those HEPA filters should be tested in place in accordance with ASME AG-1 initially when placed 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 dioctylphthalate penetrant that has a light-scattering mean diameter of approximately 0.7 microns. Penetrants equivalent to polydisperse dioctylphthalate 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, the quality assurance requirements in 10 CFR 70.22(f) and the requirements in Subpart H of 10 CFR Part 70.

D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees may use this guide and information regarding the NRC's plans for using this Regulatory Guide. In addition, it describes how the NRC staff has complied with the Backfit Rule in 10 CFR 70.76.

Applicant and Licensees' Use

Applicants and licensees may (i.e., voluntarily) use the information in this regulatory guide to develop applications for initial licenses, amendments to licenses, or other requests for NRC regulatory approval (e.g., exemptions). Licensees may use the information in this regulatory guide for actions which do not require prior NRC review and approval. Licensees may use the information in this Regulatory Guide or applicable parts to resolve regulatory or inspection issues (e.g., by committing to comply with provisions in the regulatory guide).

Current licensees may continue to use the guidance that was found acceptable for complying with specific portions of the regulations as part of their license approval process, which may be a previous version of this Regulatory Guide.

A licensee who believes that the NRC staff is inappropriately imposing this Regulatory Guide as part of a request for a license amendment or request for a change to a previously issued NRC regulatory approval may file a backfitting appeal with the NRC in accordance with applicable procedures.

NRC Staff Use

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this Regulatory Guide. The staff does not expect any existing licensee to use or commit to using the guidance in this Regulatory Guide in the absence of a licensee-initiated change to its licensing basis. The NRC staff does not expect or plan to request licensees to voluntarily adopt this Regulatory Guide to resolve a generic regulatory issue. The NRC staff does not expect or plan to initiate NRC regulatory action which would require the use of this regulatory guide without further back-fit consideration.

During inspections of specific facilities, the staff may suggest or recommend that licensees consider various actions consistent with staff positions in this regulatory guide. Such suggestions and recommendations would not ordinarily be considered backfitting even if prior versions of this Regulatory Guide are part of the licensing basis of the facility with respect to the subject matter of the inspection. However, the staff may not represent to the licensee that: (i) the licensee's failure to comply with the positions in this Regulatory Guide constitutes a violation; (ii) the licensee may avoid the violation by

agreeing to comply with this Regulatory Guide; or (iii) the only acceptable way for the licensee to address the NRC-identified non-compliance or violation is to commit to this Regulatory Guide (i.e., including this Regulatory Guide in the facility's licensing basis).

If an existing licensee seeks a license amendment or change to an existing regulatory approval, and the staff's consideration of the request involves a regulatory issue which is directly relevant to this Regulatory Guide and the specific subject matter of the new or revised guidance is an essential consideration in the NRC staff's determination of the acceptability of the licensee's request, the staff may require the licensee to use this Regulatory Guide or its equivalent as a prerequisite for NRC approval. This is not considered backfitting as defined in 70.76(a)(1).

Conclusion

This regulatory guide is not being imposed upon current licensees and may be voluntarily used by existing licensees. In addition, this Regulatory Guide is issued in conformance with all applicable internal NRC policies and procedures governing backfitting. Accordingly, the NRC's staff issuance of this regulatory guide is not considered backfitting, as defined in 70.76(a)(1).

REFERENCES[1]

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

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

3. ASME AG-1, "Code on Nuclear Air and Gas Treatment," American Society of Mechanical Engineers, New York, NY, 2003, and applicable addenda.[2]

4. AGS-G001, "Guideline for Gloveboxes," American Glovebox Society, Santa Rosa, CA, 2007.

[1] Publicly available NRC published documents are available electronically through the Electronic Reading Room on the NRC's public Web site at: http://www.nrc.gov/reading-rm/doc-collections/. The documents can also be viewed online or printed for a fee in 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.resource@nrc.gov.

[2] 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/.