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DESIGN, TESTING, AND MAINTENANCE CRITERIA FOR POSTACCIDENT ENGINEERED-SAFETY-FEATURE ATMOSPHERE CLEANUP SYSTEM AIR FILTRATION AND ADSORPTION UNITS OF LIGHT-WATER-COOLED NUCLEAR POWER PLANTS

A. INTRODUCTION

General Design Criteria 41, 42, and 43 of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," require that containment atmosphere cleanup systems be provided as necessary to reduce the amount of radioactive material released to the environment following a postulated design basis accident (DBA). They also require that these systems be designed to permit appropriate periodic inspection and testing to ensure their integrity, capability, and operability.

General Design Criterion 61 of Appendix A to Part 50 requires that fuel storage and handling systems, radioactive waste systems, and other systems that may contain radioactivity be designed to ensure adequate safety under normal and postulated accident conditions and that they be designed with appropriate containment, confinement, and filtering systems. General Design Criterion 19 requires that adequate radiation protection be provided to permit access to and occupancy of the control room under accident conditions and for the duration of the accident without personnel radiation exposures in excess of 5 rems to the whole body.

This guide presents methods acceptable to the NRC staff for implementing the Commission's regulations in Appendix A to 10 CFR Part 50 with regard to design, testing, and maintenance criteria for air filtration and adsorption units of engineered-safety-feature (ESF) atmosphere cleanup systems in light-water-cooled nuclear power plants. This guide applies only to postaccident engineered-safety-feature atmosphere cleanup systems designed to mitigate the consequences of postulated accidents. It addresses the ESF atmosphere cleanup system, including the various components and ductwork, in the postulated DBA environment.

This guide does not apply to atmosphere cleanup systems designed to collect airborne radioactive materials during normal plant operation, including anticipated operational occurrences. Regulatory Guide 1.140, "Design, Testing, and Maintenance Criteria for Normal Ventilation Exhaust System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants," provides guidance for normal ventilation exhaust systems. *

The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

Atmosphere cleanup systems are included as engineered safety features in the design of light-water-cooled nuclear power plants to mitigate the consequences of postulated accidents by removing from the building or containment atmosphere radioactive material that may be released in the accident. All such cleanup systems should be designed to operate under the environmental conditions resulting from the accident.

In this guide, ESF atmosphere cleanup systems that must operate under postulated DBA conditions inside the primary containment (i.e., recirculating systems) are designated as "primary systems." ESF systems required to operate under conditions that are generally less severe (i.e., recirculating or once-through systems) are designated as "secondary systems." Secondary systems typically include the standby gas treatment system and the emergency air cleaning systems for the fuel handling building, control room, and shield building.

* Lines indicate substantive changes from the previous issue.

The DBA environmental conditions for a given ESF system should be determined for each plant. DBA environmental conditions for typical primary and secondary systems are shown in Table 1. In addition, primary systems should be designed to withstand the radiation dose from water and plateout sources in the containment and the corrosive effects of chemical sprays (if such sprays are included in the plant design).

An ESF atmosphere cleanup system consists of some or all of the following components: demisters, heaters, prefilters, high-efficiency particulate air (HEPA) filters, adsorption units, fans, and associated ductwork, valving, and instrumentation. The purpose of the demister is to remove entrained water droplets from the inlet stream, thereby protecting prefilters, HEPA filters, and adsorbers from water damage and plugging. Heaters, when used on secondary systems, normally follow the demisters in the cleanup train and are designed to heat the incoming stream to reduce the stream's relative humidity before it reaches the filters and adsorbers.

Prefilters and HEPA filters are installed to remove particulate matter, which may be radioactive. Prefilters remove the larger particles and prevent excessive loading of HEPA filters; to some extent demisters may also perform this function. The HEPA filters remove the fine discrete particulate matter and pass the air stream to the adsorber. The adsorber removes gaseous iodine (elemental iodine and organic iodides) from the air stream. HEPA filters downstream of the adsorption units collect carbon fines and provide redundant protection against particulate release in case of failure of the upstream HEPA filter bank. The fan is the final item in an atmosphere cleanup train.

The environmental conditions preceding a postulated DBA may affect the performance of the ESF atmosphere cleanup system. Such factors, for example, as industrial contaminants, pollutants, temperature, and relative humidity contribute to the aging and weathering of filters and adsorbers and reduce their capability to perform their intended functions. Therefore, aging and weathering of the filters and adsorbers, both of which vary from site to site, need to be considered during design and operation. Average temperature and relative humidity also vary from site to site, and the potential buildup of moisture in the adsorber should also be given design consideration. The effects of these environmental factors on the ESF atmosphere cleanup system can be determined by scheduled testing during operation.

All components of ESF atmosphere cleanup systems need to be designed for reliable performance under accident conditions. Initial testing and proper maintenance are primary factors in ensuring the reliability of the ESF system. Careful attention during the design phase to problems of ESF system maintenance can contribute significantly to the reliability of the system by increasing the ease of such maintenance. Of particular importance in the design is a layout that provides accessibility and sufficient working space so that the required functions can be performed safely. Periodic testing during operation to verify the efficiency of the components is another important means of ensuring reliability. Built-in features that will facilitate convenient in-place testing are important in ESF system design.

Standards for the design and testing of ESF atmosphere cleanup systems include ANSI N509-1976, "Nuclear Power Plant Air Cleaning Units and Components" (Ref. 1), and ANSI N510-1975, "Testing of Nuclear Air Cleaning Systems" (Ref. 2).

Other standards are available for the construction and testing of certain components of ESF systems. Where such standards are acceptable to the NRC staff, they are referenced in this guide. Where no suitable standard exists, acceptable approaches are presented in this guide. ERDA 76-21, "Nuclear Air Cleaning Handbook" (Ref. 3), provides a comprehensive review of air filtration systems. It is not a standard but a guide that discusses a number of acceptable design alternatives.

Not all of the documents mentioned in ANSI N509-1976 (Ref. 1), ANSI N510-1975 (Ref. 2), or other standards referenced in this guide have been the subject of an evaluation by the NRC staff as to their applicability or acceptability. It should be noted that ANSI N509-1976 and ANSI N510-1975 refer to ORNL-NSIC-65, "Design, Construction and Testing of High-Efficiency Air Filtration Systems for Nuclear Application" (Ref. 4), which has been replaced by ERDA 76-21 (Ref. 3).

C. REGULATORY POSITION

Section 2 of ANSI N509-1976 (Ref. 1) and Section 2 of ANSI N510-1975 (Ref. 2) list additional documents referred to in these standards. The specific applicability or acceptability of these listed documents, as well as documents listed in other standards referenced in this guide, has been or will be covered separately in other regulatory guides, where appropriate.

Where reference is made to ORNL-NSIC-65 (Ref. 4) in ANSI N509-1976 and in ANSI N510-1975, it should be interpreted to mean the corresponding portion of ERDA 76-21 (Ref. 3).

1. Environmental Design Criteria

a. The design of an engineered-safety-feature atmosphere cleanup system should be based on the maximum pressure differential, radiation dose rate, relative humidity, maximum and minimum temperature, and other conditions resulting from the postulated DBA and on the duration of such conditions.

b. The design of each ESF system should be based on the radiation dose to essential services in the vicinity of the adsorber section, integrated over the 30-day period following the postulated DBA. The radiation source term should be consistent with the assumptions found in Regulatory Guides 1.3 (Ref. 5), 1.4 (Ref. 6), and 1.25 (Ref. 7). Other engineered safety features, including pertinent components of essential services such as power, air, and control cables, should be adequately shielded from the ESF atmosphere cleanup systems.

c. The design of each adsorber should be based on the concentration and relative abundance of the iodine species (elemental, particulate, and organic), which should be consistent with the assumptions found in Regulatory Guides 1.3 (Ref. 5), 1.4 (Ref. 6), and 1.25 (Ref. 7).

d. The operation of any ESF atmosphere cleanup system should not deleteriously affect the operation of other engineered safety features such as a containment spray system, nor should the operation of other engineered safety features such as a containment spray system deleteriously affect the operation of any ESF atmosphere cleanup system.

e. Components of systems connected to compartments that are unheated during a postulated accident should be designed for postaccident effects of both the lowest and highest predicted temperatures.

2. System Design Criteria

a. ESF atmosphere cleanup systems designed and installed for the purpose of mitigating accident doses should be redundant. The systems should consist of the following sequential components: (1) demisters, (2) prefilters (demisters may serve this function), (3) HEPA filters before the adsorbers, (4) iodine adsorbers (impregnated activated carbon or equivalent adsorbent such as metal zeolites), (5) HEPA filters after the adsorbers, (6) ducts and valves, (7) fans, and (8) related instrumentation. Heaters or cooling coils used in conjunction with heaters should be used when the humidity is to be controlled before filtration.

b. The redundant ESF atmosphere cleanup systems should be physically separated so that damage to one system does not also cause damage to the second system. The generation of missiles from high-pressure equipment rupture, rotating machinery failure, or natural phenomena should be considered in the design for separation and protection.

c. All components of an engineered-safety-feature atmosphere cleanup system should be designated as Seismic Category I (see Regulatory Guide 1.29 (Ref. 8)) if failure of a component would lead to the release of significant quantities of fission products to the working or outdoor environments.

d. If the ESF atmosphere cleanup system is subject to pressure surges resulting from the postulated accident, the system should be protected from such surges. Each component should be protected with such devices as pressure relief valves so that the overall system will perform its intended function during and after the passage of the pressure surge.

e. In the mechanical design of the ESF system, the high radiation levels that may be associated with buildup of radioactive materials on the ESF system components should be given particular consideration. ESF system construction materials should effectively perform their intended function under the postulated radiation levels. The effects of radiation should be considered not only for the demisters, heaters, HEPA filters, adsorbers, and fans, but also for any electrical insulation, controls, joining compounds, dampers, gaskets, and other organic-containing materials that are necessary for operation during a postulated DBA.

f. The volumetric air flow rate of a single cleanup train should be limited to approximately 30,000 ft^3/min. If a total system air flow in excess of this rate is required, multiple trains should be used. For ease of maintenance, a filter layout three HEPA filters high and ten wide is preferred.

g. The ESF atmosphere cleanup system should be instrumented to signal, alarm, and record pertinent pressure drops and flow rates at the control room.

h. The power supply and electrical distribution system for the ESF atmosphere cleanup system described in Section C.2.a above should be designed in accordance with Regulatory Guide 1.32 (Ref. 9). All instrumentation and equipment controls should be designed to IEEE Standard 279 (Ref. 10). The ESF system should be qualified and tested under Regulatory Guide 1.89 (Ref. 11). To the extent applicable, Regulatory Guides 1.30 (Ref. 12), 1.100 (Ref. 13), and 1.118 (Ref. 14) and IEEE Standard 334 (Ref. 15) should be considered in the design.

i. Unless the applicable engineered-safety-feature atmosphere cleanup system operates continuously during all times that a DBA can be postulated to occur, the system should be automatically activated upon the occurrence of a DBA by (1) a redundant engineered-safety-feature signal (i.e., temperature, pressure) or (2) a signal from redundant Seismic Category I radiation monitors.

j. To maintain radiation exposures to operating personnel as low as is reasonably achievable during plant maintenance, ESF atmosphere cleanup systems should be designed to control leakage and facilitate maintenance in accordance with the guidelines of Regulatory Guide 8.8 (Ref. 16). The ESF atmosphere cleanup train should be totally enclosed. Each train should be designed and installed in a manner that permits replacement of the train as an intact unit or as a minimum number of segmented sections without removal of individual components.

k. Outdoor air intake openings should be equipped with louvers, grills, screens, or similar protective devices to minimize the effects of high winds, rain, snow, ice, trash, and other contaminants on the operation of the system. If the atmosphere surrounding the plant could contain significant environmental contaminants, such as dusts and residues from smoke cleanup systems from adjacent coal burning power plants or industry, the design of the system should consider these contaminants and prevent them from affecting the operation of any ESF atmosphere cleanup system.

l. ESF atmosphere cleanup system housings and ductwork should be designed to exhibit on test a maximum total leakage rate as defined in Section 4.12 of ANSI N509-1976 (Ref. 1). Duct and housing leak tests should be performed in accordance with the provisions of Section 6 of ANSI N510-1975 (Ref. 2).

3. Component Design Criteria and Qualification Testing

a. Demisters should be designed, constructed, and tested in accordance with the requirements of Section 5.4 of ANSI N509-1976 (Ref. 1). Demisters should meet Underwriters' Laboratories (UL) Class 1 (Ref. 17) requirements.

b. Air heaters should be designed, constructed, and tested in accordance with the requirements of Section 5.5 of ANSI N509-1976 (Ref. 1).

c. Materials used in the prefilters should withstand the radiation levels and environmental conditions prevalent during the postulated DBA. Prefilters should be designed, constructed, and tested in accordance with the provisions of Section 5.3 of ANSI N509-1976 (Ref. 1).

d. The HEPA filters should be designed, constructed, and tested in accordance with Section 5.1 of ANSI N509-1976 (Ref. 1).[1]

Each HEPA filter should be tested for penetration of dioctyl phthalate (DOP) in accordance with the provisions of MIL-F-51068 (Ref. 19) and MIL-STD-282 (Ref. 20).[2]

e. Filter and adsorber mounting frames should be constructed and designed in accordance with the provisions of Section 5.6.3 of ANSI N509-1976 (Ref. 1).

f. Filter and adsorber banks should be arranged in accordance with the recommendations of Section 4.4 of ERDA 76-21 (Ref. 3).

g. System filter housings, including floors and doors, should be constructed and designed in accordance with the provisions of Section 5.6 of ANSI N509-1976 (Ref. 1).

h. Water drains should be designed in accordance with the recommendations of Section 4.5.8 of ERDA 76-21 (Ref. 3).

i. The adsorber section of the ESF atmosphere cleanup system may contain any adsorbent material demonstrated to remove gaseous iodine (elemental iodine and organic iodides) from air at the required efficiency. Since impregnated activated carbon is commonly used, only this adsorbent is discussed in this guide.

Each original or replacement batch of impregnated activated carbon used in the adsorber section should meet the qualification and batch test results summarized in Table 5.1 of ANSI N509-1976 (Ref. 1). In this table, a "qualification test" should be interpreted to mean a test that establishes the suitability of a product for a general application, normally a one-time test reflecting historical typical performance of material. In this table, a "batch test" should be interpreted to mean a test made on a production batch of product to establish suitability for a specific application. A "batch of activated carbon" should be interpreted to mean a quantity of material of the same grade, type, and series that has been homogenized to exhibit, within reasonable tolerance, the same performance and physical characteristics and for which the manufacturer can demonstrate by acceptable tests and quality control practices such uniformity.

All material in the same batch should be activated, impregnated, and otherwise treated under the same process conditions and procedures in the same process equipment and should be produced under the same manufacturing release and instructions. Material produced in the same charge of batch equipment constitutes a batch; material produced in different charges of the same batch equipment should be included in the same batch only if it can be homogenized as above. The maximum batch size should be 350 ft^3 of activated carbon.

If an adsorbent other than impregnated activated carbon is proposed or if the mesh size distribution is different from the specifications in Table 5.1 of ANSI N509-1976 (Ref. 1), the proposed adsorbent should have demonstrated the capability to perform as well as or better than activated carbon in satisfying the specifications in Table 5.1 of ANSI N509-1976 (Ref. 1).

If impregnated activated carbon is used as the adsorbent, the adsorber system should be designed for an average atmosphere residence time of 0.25 sec per two inches of adsorbent bed. The adsorption unit should be designed for a maximum loading of 2.5 mg of total iodine (radioactive plus stable) per gram of activated carbon. No more than 5% of impregnant (50 mg of impregnant per gram of carbon) should be used. The radiation stability of the type of carbon specified should be demonstrated and certified (see Section C.1.b of this guide for the design source term).

j. Adsorber cells should be designed, constructed, and tested in accordance with the requirements of Section 5.2 of ANSI N509-1976 (Ref. 1).

k. The design of the adsorber section should consider possible iodine desorption and adsorbent autoignition that may result from radioactivity-induced heat in the adsorbent and concomitant temperature rise. Acceptable designs include a low-flow air bleed system, cooling coils, water sprays for the adsorber

[1] The pertinent quality assurance requirements of Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50 apply to all activities affecting the safety-related functions of HEPA filters.

[2] The U.S. Department of Energy (USDOE) operates a number of filter test facilities qualified to perform HEPA filter efficiency tests. These facilities are listed in the current USDOE Environmental Safety and Health Information Bulletin for Filter Unit Inspection and Testing Service (Ref. 18).

section, or other cooling mechanisms. Any cooling mechanism should satisfy the single-failure criterion. A low-flow air bleed system should satisfy the single-failure criterion for providing low-humidity (less than 70% relative humidity) cooling air flow.

l. The system fan, its mounting, and the ductwork connections should be designed, constructed, and tested in accordance with the requirements of Sections 5.7 and 5.8 of ANSI N509-1976 (Ref. 1).

m. The fan or blower used on the ESF atmosphere cleanup system should be capable of operating under the environmental conditions postulated, including radiation.

n. Ductwork should be designed, constructed, and tested in accordance with the provisions of Section 5.10 of ANSI N509-1976 (Ref. 1).

o. Ducts and housings should be laid out with a minimum of ledges, protrusions, and crevices that could collect dust and moisture and that could impede personnel or create a hazard to them in the performance of their work. Straightening vanes should be installed where required to ensure representative air flow measurement and uniform flow distribution through cleanup components.

p. Dampers should be designed, constructed, and tested in accordance with the provisions of Section 5.9 of ANSI N509-1976 (Ref. 1).

4. Maintenance

a. Accessibility of components and maintenance should be considered in the design of ESF atmosphere cleanup systems in accordance with the provisions of Section 2.3.8 of ERDA 76-21 (Ref. 3) and Section 4.7 of ANSI N509-1976 (Ref. 1).

b. For ease of maintenance, the system design should provide for a minimum of three feet from mounting frame to mounting frame between banks of components. If components are to be replaced, the dimension to be provided should be the maximum length of the component plus a minimum of three feet.

c. The system design should provide for permanent test probes with external connections in accordance with the provisions of Section 4.11 of ANSI N509-1976 (Ref. 1).

d. Each ESF atmosphere cleanup train should be operated at least 10 hours per month, with the heaters on (if so equipped), in order to reduce the buildup of moisture on the adsorbers and HEPA filters.

e. The cleanup components (i.e., HEPA filters, prefilters, and adsorbers) should not be installed while active construction is still in progress.

5. In-Place Testing Criteria

a. A visual inspection of the ESF atmosphere cleanup system and all associated components should be made before each in-place airflow distribution test, DOP test, or activated carbon adsorber section leak test in accordance with the provisions of Section 5 of ANSI N510-1975 (Ref. 2).

b. The airflow distribution to the HEPA filters and iodine adsorbers should be tested in place for uniformity initially and after maintenance affecting the flow distribution. The distribution should be within ±20% of the average flow per unit. The testing should be conducted in accordance with the provisions of Section 9 of "Industrial Ventilation" (Ref. 21) and Section 8 of ANSI N510-1975 (Ref. 2).

c. The in-place DOP test for HEPA filters should conform to Section 10 of ANSI N510-1975 (Ref. 2). HEPA filter sections should be tested in place (1) initially, (2) at least once per 18 months thereafter, and (3) following painting, fire, or chemical release in any ventilation zone communicating with the system to confirm a penetration of less than 0.05% at rated flow. An engineered-safety-feature air filtration system satisfying this condition can be considered to warrant a 99% removal efficiency for particulates in accident dose evaluations. HEPA filters that fail to satisfy this condition should be replaced with filters qualified pursuant to regulatory position C.3.d of this guide. If the HEPA filter bank is entirely or only partially replaced, an in-place DOP test should be conducted.

If any welding repairs are necessary on, within, or adjacent to the ducts, housing, or mounting frames, the filters and adsorbers should be removed from the housing during such repairs. The repairs should be completed prior to periodic testing, filter inspection, and in-place testing. The use of silicone sealants or any other temporary patching material on filters, housing, mounting frames, or ducts should not be allowed.

d. The activated carbon adsorber section should be leak tested with a gaseous halogenated hydrocarbon refrigerant in accordance with Section 12 of ANSI N510-1975 (Ref. 2) to ensure that bypass leakage through the adsorber section is less than 0.05%. After the test is completed, air flow through the unit should be maintained until the residual refrigerant gas in the effluent is less than 0.01 ppm. Adsorber leak testing should be conducted (1) initially, (2) at least once per 18 months thereafter, (3) following removal of an adsorber sample for laboratory testing if the integrity of the adsorber section is affected, and (4) following painting, fire, or chemical release in any ventilation zone communicating with the system.

6. Laboratory Testing Criteria for Activated Carbon

a. The activated carbon adsorber section of the ESF atmosphere cleanup system should be assigned the decontamination efficiencies given in Table 2 for elemental iodine and organic iodides if the following conditions are met:

(1) The adsorber section meets the conditions given in regulatory position C.5.d of this guide.

(2) New activated carbon meets the physical property specifications given in Table 5.1 of ANSI N509-1976 (Ref. 1), and

(3) Representative samples of used activated carbon pass the laboratory tests given in Table 2.

If the activated carbon fails to meet any of the above conditions, it should not be used in engineered-safety-feature adsorbers.

b. The efficiency of the activated carbon adsorber section should be determined by laboratory testing of representative samples of the activated carbon exposed simultaneously to the same service conditions as the adsorber section. Each representative sample should be not less than two inches in both length and diameter, and each sample should have the same qualification and batch test characteristics as the system adsorbent. There should be a sufficient number of representative samples located in parallel with the adsorber section to estimate the amount of penetration of the system adsorbent throughout its service life. The design of the samplers should be in accordance with the provisions of Appendix A of ANSI N509-1976 (Ref. 1). Where the system activated carbon is greater than two inches deep, each representative sampling station should consist of enough two-inch samples in series to equal the thickness of the system adsorbent. Once representative samples are removed for laboratory test, their positions in the sampling array should be blocked off.

Laboratory tests of representative samples should be conducted, as indicated in Table 2 of this guide, with the test gas flow in the same direction as the flow during service conditions. Similar laboratory tests should be performed on an adsorbent sample before loading into the adsorbers to establish an initial point for comparison of future test results. The activated carbon adsorber section should be replaced with new unused activated carbon meeting the physical property specifications of Table 5.1 of ANSI N509-1976 (Ref. 1) if (1) testing in accordance with the frequency specified in Footnote c of Table 2 results in a representative sample failing to pass the applicable test in Table 2 or (2) no representative sample is available for testing.

D. IMPLEMENTATION

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

This guide reflects current NRC staff practice. Therefore, except in those cases in which the applicant or licensee proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein is being and will continue to be used in the evaluation of submittals for operating license or construction permit applications until this guide is revised as a result of suggestions from the public or additional staff review.

TABLE 1

TYPICAL ACCIDENT CONDITIONS FOR ESF ATMOSPHERE CLEANUP SYSTEMS

Environmental Condition	Atmosphere Cleanup System	
	Primary	Secondary
Pressure surge	Result of initial blowdown	Generally less than primary
Maximum pressure	60 psig	~atmospheric
Maximum temperature of influent	280°F	180°F
Relative humidity of influent	100% plus condensing moisture	100%
Average radiation level		
For airborne radioactive materials	10^6 rads/hr[a]	10^5 rads/hr[a]
For iodine buildup on adsorber	10^9 rads[a]	10^9 rads[a]
Average airborne iodine concentration		
For elemental iodine	100 mg/m^3	10 mg/m^3
For methyl iodide and particulate iodine	10 mg/m^3	1 mg/m^3

[a] This value is based on the source term specified in Regulatory Guide 1.3 (Ref. 5) or 1.4 (Ref. 6), as applicable.

TABLE 2

LABORATORY TESTS FOR ACTIVATED CARBON

Activated Carbon[a] Bed Depth[b]	Assigned Activated Carbon Decontamination Efficiences		Laboratory Tests for Representative Sample[c]
2 inches. Air filtration system designed to operate inside primary containment.	Elemental iodine Organic iodide	90% 30%	Per Test 5.c[d] for a methyl iodide penetration of less than 10%.
2 inches. Air filtration system designed to operate outside the primary containment and relative humidity is controlled to 70%.	Elemental iodine Organic iodide	95% 95%	Per Test 5.b[d] at a relative humidity of 70% for a methyl iodide penetration of less than 1%.
4 inches or greater. Air filtration system designed to operate outside the primary containment and relative humidity is controlled to 70%.	Elemental iodine Organic iodide	99% 99%	Per Test 5.b[d] at a relative humidity of 70% for a methyl iodide penetration of less than 0.175%.

[a] The activated carbon, when new, should meet the specifications of regulatory position C.3.i of this guide.

[b] Multiple beds, e.g., two 2-inch beds in series, should be treated as a single bed of aggregate depth.

[c] See regulatory position C.6.b for definition of representative sample. Testing should be performed (1) initially, (2) at least once per 18 months thereafter for systems maintained in a standby status or after 720 hours of system operation, and (3) following painting, fire, or chemical release in any ventilation zone communicating with the system.

[d] See Table 5-1 of ANSI N509-1976 (Ref. 1).

REFERENCES

1. American National Standard ANSI/ASME N509-1976, "Nuclear Power Plant Air Cleaning Units and Components." Copies may be obtained from the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, N.Y. 10017.

2. American National Standard ANSI N510-1975, "Testing of Nuclear Air Cleaning Systems," American Society of Mechanical Engineers.

3. ERDA 76-21, "Nuclear Air Cleaning Handbook," Oak Ridge National Laboratory, C. A. Burchsted, J. E. Kahn, and A. B. Fuller, March 31, 1976. Copies may be obtained from the National Technical Information Service, Springfield, Va. 22161.

4. ORNL-NSIC-65, "Design, Construction, and Testing of High-Efficiency Air Filtration Systems for Nuclear Application," Oak Ridge National Laboratory, C.A. Burchsted and A.B. Fuller, January 1970. Copies may be obtained from the National Technical Information Service.

5. Regulatory Guide 1.3, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors," Office of Standards Development, U.S. Nuclear Regulatory Commission (USNRC).

6. Regulatory Guide 1.4, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors," Office of Standards Development, USNRC.

7. Regulatory Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors," Office of Standards Development, USNRC.

8. Regulatory Guide 1.29, "Seismic Design Classification," Office of Standards Development, USNRC.

9. Regulatory Guide 1.32, "Criteria for Safety-Related Electric Power Systems for Nuclear Power Plants," Office of Standards Development, USNRC.

10. IEEE Std 279, "Criteria for Protection Systems for Nuclear Power Generating Stations" (latest edition). Copies may be obtained from the Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, N.Y. 10017.

11. Regulatory Guide 1.89, "Qualification of Class 1E Equipment for Nuclear Power Plants," Office of Standards Development, USNRC.

12. Regulatory Guide 1.30, "Quality Assurance Requirements for the Installation, Inspection, and Testing of Instrumentation and Electric Equipment," Office of Standards Development, USNRC.

13. Regulatory Guide 1.100, "Seismic Qualification of Electric Equipment for Nuclear Power Plants," Office of Standards Development, USNRC.

14. Regulatory Guide 1.118, "Periodic Testing of Electric Power and Protection Systems," Office of Standards Development, USNRC.

15. IEEE Std 334-1974, "IEEE Standard for Type Tests of Continuous-Duty Class 1E Motors for Nuclear Power Generating Stations," Institute of Electrical and Electronics Engineers. Copies may be obtained from the address given in Reference 10.

16. Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be As Low As Is Reasonably Achievable," Office of Standards Development, USNRC.

17. Standard UL-900, "Air Filter Units," Underwriters' Laboratories (also designated ANSI B124.1-1971). Copies may be obtained from Underwriters' Laboratories Inc., 207 East Ohio Street, Chicago, Ill. 60611.

18. USDOE Environmental Safety and Health Information Bulletin, "Filter Unit Inspection and Testing Service," U.S. Department of Energy.

19. MIL-F-51068, "Filter, Particulate, High-Efficiency, Fire-Resistant" (latest edition), Military Specification. Copies may be obtained from the Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, Penn. 19120.

20. MIL-STD-282, "Filter Units, Protective Clothing Gas-Mask Components and Related Products: Performance-Test Methods," Military Standard, 28 May 1956. Copies may be obtained from the address given in Reference 19.

21. American Conference of Governmental Industrial Hygienists, "Industrial Ventilation," 14th Edition, 1976. Committee on Industrial Ventilation, P.O. Box 453, Lansing, Mich. 48902.

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