U.S. NUCLEAR REGULATORY COMMISSION

Revision 2
June 2001

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.140

(Draft was issued as DG-1103)

DESIGN, INSPECTION, AND TESTING CRITERIA FOR AIR FILTRATION AND ADSORPTION UNITS OF NORMAL ATMOSPHERE CLEANUP SYSTEMS IN LIGHT-WATER-COOLED NUCLEAR POWER PLANTS

A. INTRODUCTION

This guide provides guidance and criteria acceptable to the NRC staff for meeting the NRC's regulations with regard to the design, inspection, and testing of air filtration and adsorption units installed in the normal atmosphere cleanup systems of light-water-cooled nuclear power plants. This guide applies only to atmosphere cleanup systems designed to collect airborne radioactive materials during normal plant operation, including anticipated operational occurrences. Therefore, in this guide these systems are referred to as normal atmosphere cleanup systems. These normal atmosphere cleanup systems may consist of heaters and/or cooling coils, prefilters, high-efficiency particulate air (HEPA) filters, iodine adsorption units, fans, associated ductwork, dampers, and instrumentation. The instrumentation covered by this guide is that used to measure air flow and differential pressure.

In Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” General Design Criteria 60 and 61 require that the nuclear power plant design include means to suitably control the release of radioactive materials in gaseous effluents during normal reactor operation, including anticipated operational occurrences and fuel storage and handling operations. In addition, 10 CFR 50.34a, "Design Objectives for Equipment To Control Releases of Radioactive Material in Effluents -- Nuclear Power Reactors," and 10 CFR 50.36a, "Technical Specifications on Effluents from Nuclear Power Reactors," of 10 CFR Part 50 require that means be employed to ensure that release of radioactive material to unrestricted areas during normal reactor operation, including during expected operational occurrences, is kept as low as is reasonably achievable.

Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation To Meet the Criterion ‘As Low As Is Reasonably Achievable’ for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50 provides guidance and numerical values for design objectives to help applicants for, and holders of, licenses for nuclear power plants meet the requirements of 10 CFR 50.34a and 50.36a. Appendix I requires that each light-water-cooled nuclear power reactor unit not exceed an annual dose design objective of 15 mrem to any organ of any individual in an unrestricted area via all exposure pathways from airborne radioactive iodine and particulate releases. Appendix I also requires that additional radwaste equipment be provided if the equipment has reasonably demonstrated technology and the cost-benefit ratio is favorable.

This guide does not apply to post-accident engineered-safety-feature (ESF) atmosphere cleanup systems that are designed to mitigate the consequences of postulated accidents. Regulatory Guide 1.52, "Design, Inspection, and Testing Criteria for Air Filtration and Adsorption Units of Post-Accident Engineered-Safety-Feature Atmosphere Cleanup Systems in Light-Water-Cooled Nuclear Power Plants," provides guidance for these systems.

The guidance and criteria presented in this guide are not mandatory and licensees may choose not to change their licensing basis. Methods and solutions different from those set out in this guide will be acceptable when an applicant or licensee proposes an acceptable alternative method for complying with the specified portions of the NRC’s regulations.

The information collections contained in this regulatory guide are covered by the requirements of 10 CFR Part 50, which were approved by the Office of Management and Budget, approval number 3150-0011. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

B. DISCUSSION

Particulate filtration and radioiodine adsorption units are included in the design of the normal atmosphere cleanup systems of light-water-cooled nuclear power plants to reduce the quantities of radioactive materials in gaseous effluents released from building or containment atmospheres during normal operation, including anticipated operational occurrences. All such cleanup systems should be designed to operate continuously under normal environmental conditions.

In this guide, cleanup systems that should operate to meet the "as low as is reasonably achievable (ALARA)" guidelines of Appendix I to 10 CFR Part 50 inside the primary containment (recirculating units) are designated as "primary systems." Primary systems generally include a containment cleanup system (kidney filtration system). Systems that operate outside the primary containment are designated as "secondary systems." Secondary systems generally include normal atmosphere cleanup systems servicing the reactor building, turbine building, radwaste building, auxiliary building, mechanical vacuum pump, main condenser air ejector, and any other release points that may contain particulate and gaseous radioiodine species.

These normal atmosphere cleanup systems should be able to withstand normal environmental conditions such as inlet concentrations of radioactive iodine up to 10^{-6} µCi/cm^3, relative humidity of the influent stream up to 100%, temperatures of the influent stream up to 125°F (52°C), and normal atmospheric pressure. The system should be designed, inspected, and tested in such a manner that radiation levels of airborne radioactive material and radioiodine buildup on the adsorber do not degrade the performance of the filter system or any component.

Normal atmosphere cleanup system heaters are designed to heat the influent stream to reduce its relative humidity before it reaches the filters and adsorbers. HEPA filters are installed to remove particulate matter, which may be radioactive, and pass the air stream to the adsorber, which then removes gaseous iodine (elemental iodine and organic iodides) from the air stream. A HEPA filter or a medium efficiency postfilter (as defined in Section 5.3 of ASME N509-1989 (Ref. 1)) downstream from the adsorption units collects carbon fines and provides additional protection against particulate matter release in case of failure of the upstream HEPA filter bank. It is not necessary to perform in-place leak testing on postfilters or HEPA filters downstream from the carbon adsorbers. It is advantageous for the postfilters or HEPA filters downstream from the carbon adsorbers to be installed in separate housings or to be removed from the housing (for systems with a fan downstream from the housing) during in-place leak testing of the upstream HEPA filter. This will contribute to the accuracy of the test results for the upstream HEPA filter. The arrangement of the ductwork and the transitions between the separate housings can provide a torturous path that will aid in mixing the challenge agent. Removing the filters downstream from the carbon adsorbers will permit sampling downstream from the fan. The fan will provide the necessary mixing for an accurate test and the absences of the postfilters or HEPA filters downstream from the carbon adsorbers will prevent the challenge aerosol from being removed from the air stream. The fan is the final item in a normal atmosphere cleanup system. Consideration should be given to installing prefilters upstream from the HEPA filters to reduce the particulate load and extend their service life.

The environmental history of the facility will affect the performance of the normal atmosphere cleanup system. 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, weathering, and poisoning of these components, which may 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 warrants equal design consideration. The effects of these factors on the normal atmosphere cleanup system can be determined by a monitoring program.

All components of the normal atmosphere cleanup system need to be designed for reliable performance under the expected operating conditions. Initial testing and proper maintenance are primary factors in ensuring the reliability of the system. Consideration during the design phase of problems of system maintenance can contribute significantly to the reliability of the system by increasing the ease of such maintenance. A layout that provides accessibility and sufficient working space to safely and efficiently perform the required maintenance functions is of particular importance in the design. Periodic inspection and 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 system design.

Standards acceptable to the NRC staff for the design and testing of normal atmosphere cleanup systems include those portions of ASME N509-1989, "Nuclear Power Plant Air-Cleaning Units and Components" (Ref. 1), ASME N510-1989, "Testing of Nuclear Air-Treatment Systems" (Ref. 2), and ASME AG-1-1997, "Code on Nuclear Air and Gas Treatment" (Ref. 3) that are referenced in this guide and ASTM D3803-1989, "Standard Test Methods for Nuclear-Grade Activated Carbon" (Ref. 4).

If a referenced standard has been incorporated separately into the NRC's regulations, licensees and applicants must comply with that standard as set forth in the regulation. If the referenced standard has been endorsed in a regulatory guide, the standard constitutes a method acceptable to the NRC staff for meeting a regulatory requirement as described in the regulatory guide. If a referenced standard has been neither incorporated into the NRC's regulations nor endorsed in a regulatory guide, licensees and applicants may consider and use the information in the referenced standard if appropriately justified, consistent with current regulatory practice.

C. REGULATORY POSITION

1. GENERAL DESIGN AND TESTING CRITERIA

ASME AG-1-1997, "Code on Nuclear Air and Gas Treatment" (Ref. 3), and ASME N509-1989, "Nuclear Power Plant Air-Cleaning Units and Components" (Ref. 1) provide guidance that is acceptable to the NRC staff for the performance, design, construction, acceptance testing, and quality assurance of equipment used as components in nuclear safety-related or ESF air and gas treatment systems in nuclear power plants. Normal atmosphere cleanup systems designed to ASME N509-1989 (Ref. 1) (or its earlier versions) and tested to ASME N510-1989 (Ref. 2) (or its earlier versions) are considered adequate to protect public health and safety.

2. ENVIRONMENTAL DESIGN CRITERIA

2.1. The design of each normal atmosphere cleanup system should be based on the anticipated range of operating parameters of temperature, pressure, relative humidity, and radiation levels during normal plant operations, including anticipated operational occurrences.

2.2. If the normal atmosphere cleanup system is located in an area of high radiation during normal plant operation, adequate shielding of components and personnel from the radiation source should be provided.

2.3. The operation of any normal atmosphere cleanup system should not degrade the expected operation of any ESF system that is required to operate after a design basis accident.

2.4. The design of the normal atmosphere cleanup system should consider any significant contaminants such as dusts, chemicals, excessive moisture, or other particulate matter that could degrade the cleanup system's operation.

3. SYSTEM DESIGN CRITERIA

Normal atmosphere cleanup systems should be designed in accordance with Section 4.0 of ASME N509-1989 (Ref. 1) and ASME AG-1-1997 (Ref. 3) as modified and supplemented by the following:

3.1. Normal atmosphere cleanup systems need not be redundant nor designed to Seismic Category I classification, but they should consist of at least the following components: (1) HEPA filters before the adsorbers, (2) iodine adsorbers (impregnated activated carbon), (3) fans, and (4) interspersed ducts, dampers, and related instrumentation. To reduce the particulate load on the HEPA filters and extend their service life, the installation of prefilters upstream from the initial HEPA section is suggested. Consideration should also be given to the installation of a HEPA filter or medium efficiency postfilter (as defined in Section 5.3 of ASME N509-1989 (Ref. 1)) downstream from carbon adsorbers to retain carbon fines. Heaters or cooling coils or both may be used when the humidity is to be controlled before filtration. Whenever a normal atmosphere cleanup system is designed to remove only particulate matter, a component for iodine adsorption need not be included.

3.2. To ensure reliable in-place testing, the volumetric air-flow rate of a single cleanup unit should be limited to approximately 30,000 cubic feet per minute. If a total system air flow in excess of this rate is required, multiple units should be used.

3.3. Each normal atmosphere cleanup system should be instrumented to monitor and alarm pertinent pressure drops and flow rates in accordance with the recommendations of Section 5.6 of ERDA 76-21 (Ref. 5) and Section 4.9 of ASME N509-1989 (Ref. 1).

3.4. To maintain the radiation exposure to operating and maintenance personnel as low as is reasonably achievable (ALARA), normal atmosphere cleanup systems and components should be designed to control leakage and facilitate maintenance, inspection, and testing in accordance with the guidance in Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonable Achievable" (Ref. 6).

3.5. 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. The outdoor air intake openings should be located to minimize the effects of possible onsite plant contaminants, such as the diesel generator exhaust. 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, or is a salty environment near an ocean, the design of the system should consider these contaminants and prevent them from affecting the operation of any normal atmosphere cleanup system.

3.6. Normal atmosphere cleanup system housings and ductwork should be designed to exhibit, on test, a maximum total leakage rate as defined in Article SA-4500 of ASME AG-1-1997 (Ref. 3). Duct and housing leak tests should be performed in accordance with Section TA of ASME AG-1-1997.

4. COMPONENT DESIGN CRITERIA AND QUALIFICATION TESTING

Components of normal atmosphere cleanup systems should be designed, constructed, and tested in accordance with Division II of ASME AG-1-1997 (Ref. 3), as modified and supplemented by the following.

4.1. Prefilters that are used in the normal atmosphere cleanup system should be designed, constructed, and tested in accordance with Section FB of ASME AG-1-1997.

4.2. Air heaters should be designed, constructed, and tested in accordance with Section CA of ASME AG-1-1997.

4.3. The HEPA filters should be designed, constructed, and tested in accordance with Section FC of ASME AG-1-1997. Each HEPA filter should be tested for penetration of a challenge aerosol such as dioctyl phthalate (DOP) in accordance with Section TA of ASME AG-1-1997.

4.4. The HEPA filter and Type II adsorber cell mounting frames should be designed and constructed in accordance with Section FG of ASME AG-1-1997.

4.5. Filter and adsorber sections should be arranged in accordance with Section 4.4 of ERDA 76-21 (Ref. 5) and Section HA, "Housings," of ASME AG-1a-2000 (Ref. 7).

4.6. System filter housings, including floors and doors, and electrical conduits, drains, and piping installed inside filter housings should be designed and constructed in accordance with Section 5.6 of ASME N509-1989 (Ref. 1) and Section HA, ASME AG-1a-2000 (Ref. 7).

4.7. Adsorption units function efficiently at a relative humidity of 70% or less. If the relative humidity of the atmosphere entering the air cleanup system is expected to be greater than 70% during normal reactor operation, heaters or cooling coils should be designed to reduce the relative humidity of the atmosphere entering the adsorption unit to 70% or less. Heaters should be designed, constructed, and tested in accordance with Section CA of ASME AG-1-1997 (Ref. 3) exclusive of sizing criteria.

4.8. Adsorber cells should be designed, constructed, and tested in accordance with Section FD for Type II Adsorber cells or Section FE for Type III Adsorber cells of ASME AG-1-1997.

The design of the adsorber section should consider possible iodine desorption and adsorbent auto-ignition 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 section, or other cooling mechanisms.

When a water-based fire suppression or prevention (cooling) system is installed in the normal atmosphere cleanup system housing, the fire system should be manually actuated unless there is a reasonable probability that the iodine desorption and adsorbent auto-ignition could occur in the housing, in which case the fire system should have both automatic and manual actuation. The fire system should use open spray nozzles or devices of sufficient size, number, and location to provide complete coverage over the entire surface of the combustible filter media. The fire system should be hard piped and supplied with a reliable source of water at adequate pressure and volume. The location of the manual release (or valve) for the fire system should be remote from the cleanup system housing and should be consistent with the ALARA guidance in Regulatory Guide 8.8 (Ref. 6). Automatic fire systems should include a reliable means of detection to actuate the system. Detection can be accomplished by a mechanical or electrical device including, but not limited to, thermal, carbon monoxide, or smoke. Cross-zoning of detectors is acceptable. Manual fire systems should include a reliable means of internal monitoring for determining when to manually actuate the fire systems. The monitoring indication should be remote from the cleanup system housing in accordance with ALARA practices.

4.9. The adsorber section of the normal atmosphere cleanup system may contain any adsorbent material demonstrated to remove gaseous iodine (elemental iodine and organic iodides) from air at the required efficiency. However, since impregnated activated carbon[1] is used almost exclusively, only impregnated activated carbon is discussed in this guide.

Each original or replacement batch or lot of impregnated activated carbon used in the adsorber section should meet Section FF of ASME AG-1-1997 (Ref. 3).[2,3] A test performed as a "qualification test" should be interpreted to mean a test that establishes the suitability of a manufacturer's product for a generic application, normally a one-time test establishing typical performance of the product. Tests not specifically identified as being performed only for qualification purposes should be interpreted as "batch tests." Batch tests are tests to be made on each production batch of product to establish suitability for a specific application.

If impregnated activated carbon is used as the adsorbent, the adsorber system should be designed for an average atmosphere residence time of 0.25 seconds per two inches of adsorbent bed. Sections FD and FE of ASME AG-1-1997 should be used to determine the residence time.

If an adsorbent other than impregnated activated carbon is proposed or if the mesh size distribution or other physical properties of the impregnated activated carbon are different from the specifications above, the proposed adsorbent should have the capability to perform as well as or better than activated carbon that satisfies the specifications in Article FF of ASME AG-1-1997.

If sample canisters are used, they should be designed in accordance with Appendix A to ASME N509-1989 (Ref. 1).

4.10. Ductwork associated with the normal atmosphere cleanup system should be designed, constructed, and tested in accordance with Section SA of ASME AG-1-1997.

4.11. 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. Turning vanes or other air flow distribution devices should be installed where required to ensure representative air flow measurement and uniform flow distribution through cleanup components.

---

[1] Activated carbon is typically impregnated with a chemical compound or compounds to enhance radioiodine retention, particularly under conditions of high temperatures and humidity. Typical impregnants include iodides such as potassium iodide and triiodide, amines such as triethylenediamine (TEDA), and combinations thereof.

[2] A “batch of activated carbon” or a “batch of impregnated activated carbon” is a quantity of adsorbent, not to exceed 10 cubic meters (or 350 cubic feet), of the same grade or type that has been produced under the same manufacturer’s production designation using a consistent manufacturing procedure and equipment, and that has been homogenized to exhibit the same physical properties and performance characteristics throughout the mass. (See Article FF-1130 of ASME AG-1-1997).

[3] A "lot of activated carbon" or a "lot of impregnated activated carbon" is a quantity of adsorbent consisting of one or more batches of adsorbent that constitute and satisfy a purchase order. (See Article FF-1130 of ASME AG-1-1997).

4.12. Dampers should be designed, constructed, and tested in accordance with Section DA of ASME AG-1-1997.

4.13. The system fan and motor, mounting, and ductwork connections should be designed, constructed, and tested in accordance with ASME AG-1-1997 in Section BA for Blowers and Section SA for Ducts. The fan and motor used in the normal atmosphere cleanup system should be capable of operating under the environmental conditions postulated for its use.

5. MAINTAINABILITY CRITERIA

Provisions for maintaining normal atmosphere cleanup systems should be incorporated in the system design in accordance with Section 4.8 of ASME N509-1989 (Ref. 1) and Section HA of ASME AG-1a-2000 (Ref. 7) as supplemented by the following.

5.1. Accessibility of components and maintenance should be considered in the design of normal atmosphere cleanup systems in accordance with Section 2.3.8 of ERDA 76-21 (Ref. 5) and Section HA of ASME AG-1a-2000 (Ref. 7). For ease of inspection and maintenance, the system design should provide for a minimum of 3 feet from mounting frame to mounting frame between banks of components. If components are to be replaced, the dimensions to be provided should be the maximum length of the component plus a minimum of 3 feet.

5.2. The cleanup components (i.e., HEPA filters, prefilters, and adsorbers) that are used during construction of the ventilation systems should be replaced before the system is declared operable.

6. IN-PLACE TESTING CRITERIA

Initial in-place testing of normal atmosphere cleanup systems should be performed in accordance with Section TA of ASME AG-1-1997 (Ref. 3). Periodic, in-place testing of normal atmosphere cleanup systems and components should be performed in accordance with ASME N510-1989 (Ref. 2) as modified and supplemented by the following:

6.1. A visual inspection of the normal atmosphere cleanup system and all associated components should be performed in accordance with Section 5 of ASME N510-1989.

6.2. In-place aerosol leak tests for HEPA filters upstream from the carbon adsorbers in normal atmosphere cleanup systems should be performed (1) initially, (2) at least once each 24 months, (3) after each partial or complete replacement of a HEPA filter bank, (4) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of a normal atmosphere cleanup system that may have an adverse effect on the functional capability of the filters,[4] and (5) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the system.[5] The test should be performed in accordance with Section 10 of ASME N510-1989 (Ref. 2). The leak test should confirm a combined penetration and leakage (or bypass)[6] of the normal atmosphere cleanup system of less than 0.05% of the challenge aerosol at rated flow ±10%. A filtration system satisfying this condition can be considered to warrant a 99% removal efficiency for particulates.

HEPA filter sections in normal atmosphere cleanup systems that fail to satisfy the appropriate leak-test conditions should be examined to determine the location and cause of leaks. Repairs, such as alignment of filter frames and tightening of filter hold-down bolts, may be made; however, repair of defective, damaged, or torn filter media by patching or using caulking materials is not recommended in normal atmosphere cleanup systems, and such filters should be replaced and not repaired. HEPA filters that fail to satisfy test conditions should be replaced with filters qualified pursuant to Regulatory Position 4.3 of this guide. After repairs or filter replacement, the normal atmosphere cleanup system should be retested as described above in this Regulatory Position.

In accordance with ASME N510-1989 (Ref. 2) and Article TA-1000 of ASME AG-1-1997 (Ref. 3), the standard challenge aerosol used in the in-place leak testing of HEPA filters is polydisperse droplets of dioctyl phthalate (DOP), also known as di-2-ethylhexyl-phthalate (DEHP). The 0.3 micrometer monodisperse DOP aerosol is used for efficiency testing of individual HEPA filters by manufacturers. Alternative challenge agents[7] may be used to perform in-place leak testing of HEPA filters when their selection is based on the following.

1. The challenge aerosol has the approximate light scattering droplet size specified in Article TA-1130 of ASME AG-1-1997
2. The challenge aerosol has the same in-place leak test results as DOP.

---

[4] In 1998, the Department of Energy (DOE) presented the results of its HEPA filter deterioration research at the 25th DOE/NRC Nuclear Air Cleaning and Treatment Conference (Ref. 8). The results of this research demonstrated that wetting of the filter medium significantly reduces its tensile strength, which is not fully recovered after drying. In addition, further water exposures resulted in additional losses in filter media tensile strength. (See NRC Information Notice 99-01, Ref. 9).

[5] Painting, fire, or chemical release is “not communicating” with the HEPA filter or adsorber if the ESF atmosphere cleanup system is not in operation, the isolation dampers for the system are closed, and there is no pressure differential across the filter housing. This provides reasonable assurance that air is not passing through the filters and adsorbers. A program should be developed and consistently applied that defines the terms “painting,” “fire,” and “chemical release” in terms of the potential for degrading the HEPA filters and adsorbers. This program should be based on a well-documented, sound and conservative technical basis (i.e., the criteria should overestimate the potential damage to the filter and adsorber).

[6] In Section FD-1130 of ASME AG-1-1997 (Ref. 3), penetration is defined as the exit concentration of a given gas from an air cleaning device, expressed as a percentage of inlet concentration. In Section 3 of ASME N509-1989 (Ref. 1), bypass is defined as a pathway through which contaminated air can escape treatment by the installed HEPA or adsorber banks. Examples are leaks in filters and filter mounting frames, defective or inefficient isolation dampers that result in uncontrolled flow through adjacent plenums, and unsealed penetrations for electrical conduits, pipes, floor drains, etc.

[7] Care should be taken to ensure that the aerosol generator is compatible with the selected alternative challenge agent (see NRC Information Notice 99-34, Ref. 10).

3. The challenge aerosol has similar lower detection limit, sensitivity, and precision as DOP.
4. The challenge aerosol causes no degradation of the HEPA filter or the other normal air cleaning system components under test conditions.
5. The challenge aerosol is listed in the Environmental Protection Agency's "Toxic Substance Control Act" (TSCA) (Ref. 11) inventory for commercial use.

6.3. In-place leak testing for adsorbers should be performed (1) initially, (2) at least once each 24 months, (3) following removal of an adsorber sample for laboratory testing if the integrity of the adsorber section is affected, (4) after each partial or complete replacement of carbon adsorber in an adsorber section, (5) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of a normal atmosphere cleanup system that may have an adverse effect on the functional capability of the adsorbers, and (6) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the system.[5] The test should be performed in accordance with Section 11 of ASME N510-1989 (Ref. 2). The leak test should confirm a combined penetration and leakage (or bypass)[6] of the adsorber section of 0.05% or less of the challenge gas at rated flow±10%.

Adsorber sections that fail to satisfy the appropriate leak-test conditions should be examined to determine the location and cause of leaks. Repairs, such as alignment of adsorber cells, tightening of adsorber cell hold-down bolts, or tightening of test canister fixtures, may be made; however, the use of temporary patching material on adsorbers, filters, housings, mounting frames, or ducts should not be allowed. After repairs or adjustments have been made, the adsorber sections should be retested as described above in this Regulatory Position.

In accordance with ASME N510-1989 (Ref. 2) and Section TA of ASME AG-1-1997 (Ref. 3), the standard challenge gas used in the in-place leak testing of adsorbers is Refrigerant-11 (trichloromonofluoromethane). Alternative challenge gases may be used to perform in-place leak testing of adsorbers when their selection is based on meeting the characteristics specified in Appendix TA-C of ASME AG-1-1997.

6.4. If any welding repairs are necessary on, within, or adjacent to the ducts, housing, or mounting frames, the HEPA filters and adsorbers should be removed from the housing (or otherwise protected) prior to performing such repairs. The repairs should be completed prior to re-installation of filters and adsorbers; the system should then be visually inspected and leak tested as in Regulatory Positions 6.2, 6.3, and 6.4.

7. LABORATORY TESTING CRITERIA FOR ACTIVATED CARBON

7.1. The activated carbon adsorber section of the normal atmosphere cleanup system should be assigned the decontamination efficiencies given in Table 1 for radioiodine if the following conditions are met:

1. The adsorber section meets the conditions given in Regulatory Position 6.3 of this guide,

2. New activated carbon meets the physical property specifications given in Regulatory Position 4.9 of this guide, and

3. Representative samples of used activated carbon pass the laboratory tests given in Table 1 of this guide.

If the activated carbon fails to meet any of the above conditions, it should not be used in adsorption units.

7.2. 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 2 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 samples should be in accordance with Appendix A to ASME N509-1989 (Ref. 1). Where system activated carbon is greater than 2 inches deep, each representative sampling station should consist of enough 2-inch samples in series to equal the thickness of the system adsorbent. Once representative samples are removed for laboratory testing, their positions in the sampling array should be blocked off.

Sampling and analysis should be performed (1) initially, (2) at intervals of approximately 24 months, (3) following painting, fire, or chemical release in any ventilation zone communicating with the system that may have an adverse effect on the functional capability of the carbon media,[5] and (4) following detection of, or evidence of, penetration of water or other material into any portion of the filter system that may have an adverse effect on the functional capability of the carbon media.

Laboratory tests of representative samples should be conducted, as indicated in Table 1 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 given in Regulatory Position 4.9 of this guide if (1) testing in accordance with Table 1 results in a representative sample that fails to pass the acceptance criterion 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.

Except in those cases in which an applicant or licensee proposes an acceptable alternative method for complying with specified portions of the NRC's regulations, the methods described in this guide, which reflect public comments, will be used by the NRC staff in its evaluation of submittals in connection with the design, inspection, and testing of normal atmosphere cleanup systems for the following light-water-cooled nuclear power plants:

1. Plants for which the construction permit or license application is docketed after the issue date of this guide;

2. Plants for which the licensee voluntarily commits to the provisions of this guide.

Table 1: Laboratory Tests For Activated Carbon

Activated Carbon[a] Total Bed Depth[b]	Maximum Assigned Activated Carbon Decontamination Efficiencies		Methyl Iodide Penetration Acceptance Criterion for Representative Sample
2 inches	Elemental iodine	95%	Penetration #5% when tested in accordance with ASTM D-3803-1989 (Ref. 4)
	Organic iodide	95%	
4 inches or greater	Elemental iodine	99%	Penetration #1% when tested in accordance with ASTM D-3803-1989 (Ref. 4)
	Organic iodide	99%	

[a] The activated carbon, when new, should meet the specifications of Regulatory Position 4.9 of this guide.

[b] Multiple beds, e.g., two 2-inch beds in series, should be treated as a single bed of aggregate depth. It is advantageous when series beds are located in separate housings and individually in-place leak tested. This aids in mixing the challenge agent and contributes to the accuracy of the test results.

NOTES:

(1) Credited decontamination efficiencies (a portion of which includes bypass leakage) are based on 0.25 second residence time per 2-inch bed depth.

(2) Organic iodide and elemental iodine are the forms of iodine that are expected to be absorbed by activated carbon. Organic iodide is more difficult for activated carbon to adsorb than elemental iodine. Therefore, the laboratory test to determine the performance of the activated carbon adsorber is based on organic iodide. Methyl iodide is the organic form of iodine that is used in the laboratory test.

(3) This Table 1 provides acceptable decontamination efficiencies and methyl iodide test penetrations of used activated carbon samples for laboratory testing. Laboratory tests are conducted in accordance with ASTM D3803-1989 (Ref. 4). Tests are conducted at a temperature of 30°C and relative humidity of 95%, except a relative humidity of 70% is used when the air entering the carbon adsorber is maintained at less than or equal to 70% relative humidity.

(4) See Appendix A to ASME N509-1989 (Ref. 1) for the definition of a representative sample. Testing should be performed at the frequencies specified in Regulatory Position 7.2 of this guide. Testing should be performed in accordance with ASTM D3803-1989 (Ref. 4) at a temperature of 30°C and a relative humidity of 95% (or 70% with humidity control). Humidity control can be provided by heaters or an analysis that demonstrates that the air entering the carbon will be maintained less than or equal to 70% relative humidity.

REFERENCES

1. American Society of Mechanical Engineers, "Nuclear Power Plant Air-Cleaning Units and Components," ASME N509-1989. Reaffirmed 1996.

2. American Society of Mechanical Engineers, "Testing of Nuclear Air-Treatment Systems," ASME N510-1989. Reaffirmed 1995.

3. American Society of Mechanical Engineers, "Code on Nuclear Air and Gas Treatment," ASME/ANSI AG-1-1997.

4. American Society for Testing and Materials, "Standard Test Methods for Nuclear-Grade Activated Carbon," ASTM Standard D3803-1989. Reapproved 1995.

5. C. A. Burchsted, J. E. Kahn, and A. B. Fuller, "Nuclear Air Cleaning Handbook," Oak Ridge National Laboratory, ERDA 76-21, March 31, 1976.[1]

6. USNRC, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," Regulatory Guide 8.8, Revision 3, June 1978.[2]

7. American Society of Mechanical Engineers, Section HA, "Housings," of "Code on Nuclear Air and Gas Treatment," ASME AG-1a-2000, Addenda to ASME AG-1-1997, December 2000.

8. J.K. Fretthold, "HEPA Service Life Tests-Effects-Recommendations at Department of Energy Rocky Flats Environmental Technology Site," Proceedings of the 25th DOE/NRC Nuclear Air Cleaning and Treatment Conference, NUREG/CP-0167, April 1999.[3]

---

[1] Copies may be purchased from the National Technical Information Service by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161; telephone (703)487-4650; online <http://www.ntis.gov/ordernow>.

[2] Single copies of regulatory guides, both active and draft, may be obtained free of charge by writing the Reproduction and Distribution Services Section, OCIO, USNRC, Washington, DC 20555-0001, or by fax to (301)415-2289, or by email to <DISTRIBUTION@NRC.GOV>. Active guides may also be purchased from the National Technical Information Service on a standing order basis. Details on this service may be obtained by writing NTIS, 5285 Port Royal Road, Springfield, VA 22161; telephone (800)553-6847; online <http://www.ntis.gov/ordernow>. Copies of certain guides and many other NRC documents are available electronically on the internet at NRC's home page at <WWW.NRC.GOV> in the Reference Library. Documents are also available through the Electronic Reading Room (NRC's ADAMS document system, or PARS) at the same web site.

[3] Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328 (telephone (202)512-1800); or from the National Technical Information Service at 5285 Port Royal Road, Springfield, VA 22161; (telephone (800)553-6847; <http://www.ntis.gov/ordernow>). Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; email is PDR@NRC.GOV .

9. NRC Information Notice 99-01, "Deterioration of High-Efficiency Particulate Air Filters in a Pressurized Water Reactor Containment Fan Cooler Unit," January 20, 1999.[4]

10. NRC Information Notice 99-34, "Potential Fire Hazards in the Use of Polyalphaolefin in Testing of Air Filters," December 28, 1999.[4]

11. Environmental Protection Agency, "Toxic Substance Control Act" (TSCA), Inventory for Commercial Use.[5]

---

[4] Copies are available for inspection or copying for a fee from the NRC Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; e-mail <PDR@NRC.GOV>.

[5] Copies are available at current rates from the U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20402-9328 (telephone (202)512-1800); or from the National Technical Information Service 5285 Port Royal Road, Springfield, VA 22161; (telephone (800)553-6847; <http://www.ntis.gov/ordernow>.

VALUE/IMPACT STATEMENT

A value/impact statement was published with the draft of this guide when it was issued for public comment (Task DG-1103, October 2000). No changes were necessary, so a separate value/impact statement for this regulatory guide has not been prepared. This regulatory guide does not require a backfit analysis as described in 10 CFR 50.109(c) because it does not impose a new or amended provision in the NRC's rules and regulations. A copy of the value/impact statement (ADAMS Accession Number ML003756467) is available for inspection or copying for a fee in the NRC's Public Document Room at 11555 Rockville Pike, Rockville, MD; the PDR's mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or (800)397-4209; fax (301)415-3548; email is <PDR@NRC.GOV>.