U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REGULATORY RESEARCH

June 2012
Division 1

# DRAFT REGULATORY GUIDE

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## DRAFT REGULATORY GUIDE DG-1280

*(Proposed Revision 3 of Regulatory Guide 1.140, dated June 2001)*

## 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 describes a method that the staff of the U.S. Nuclear Regulatory Commission (NRC) considers acceptable to implement regulatory requirements with regard to the design, inspection, and testing of normal atmosphere cleanup systems for controlling releases of airborne radioactive materials to the environment during normal operations, including anticipated operational occurrences. This guide applies to all types of nuclear power plants that use water as the primary means of cooling.

Title 10, of the *Code of Federal Regulations*, Part 50, "Domestic Licensing of Production and Utilization Facilities" (10 CFR Part 50) (Ref. 1), Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 60, "Control of Releases of Radioactive Materials to the Environment," requires, in part, that a facility's design include the means to control the release of radioactive materials in gaseous effluents. GDC 61, "Fuel Storage and Handling and Radioactivity Control," requires, in part, that fuel storage and handling, radioactive waste, and other systems which may contain radioactivity be designed with appropriate containment, confinement, and filtering systems. 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," require, in part, that means be employed to ensure that the release of radioactive material to unrestricted areas during normal reactor operation, including during expected operational occurrences, is kept as low as reasonably achievable.

10 CFR 50.34a and 50.36a provide guidance and numerical values for design objectives to help applicants for new reactors and nuclear power plant license holders meet the requirements of 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

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This regulatory guide is being issued in draft form to involve the public in the early stages of the development of a regulatory position in this area. It has not received final staff review or approval and does not represent an official NRC final staff position. Public comments are being solicited on this draft guide (including any implementation schedule) and its associated regulatory analysis or value/impact statement. Comments should be accompanied by appropriate supporting data. Written comments may be submitted to the Rules, Announcements, and Directives Branch, Office of Administration, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; submitted through the NRC's interactive rulemaking Web page at http://www.nrc.gov; or faxed to (301) 492-3446. Copies of comments received may be examined at the NRC's Public Document Room, 11555 Rockville Pike, Rockville, MD. Comments will be most helpful if received by August 27, 2012.

Electronic copies of this draft regulatory guide are available through the NRC's interactive rulemaking Web page (see above); the NRC's public Web site under Draft Regulatory Guides in the Regulatory Guides document collection of the Electronic Reading Room at http://www.nrc.gov/reading-rm/doc-collections/; and the NRC's Agencywide Documents Access and Management System (ADAMS) at http://www.nrc.gov/reading-rm/adams.html, under Accession No. ML11273A057. The regulatory analysis may be found in ADAMS under Accession No. ML11273A060.

Reactor Effluents."  In addition to complying with the design objectives and ALARA provisions, Section II.D of Appendix I requires that additional radwaste equipment be installed if the equipment, as reasonably demonstrated technology, would result in a reduction of population doses within a 50-mile (80-km) radius from the power plant when added to the system in order of diminishing favorable cost-benefit return. The requirements of this paragraph D need not be complied with by persons who have filed applications for construction permits which were docketed on or after January 2, 1971, and prior to June 4, 1976, if the radwaste systems and equipment described in the preliminary or final safety analysis report and amendments there to satisfy the Guides on Design Objectives for Light-Water-Cooled Nuclear Power Reactors proposed in the Concluding Statement of Position of the Regulatory Staff in Docket-RM-50-2 dated February 20, 1974, pp. 25-30, reproduced in the Annex to this Appendix I.

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" (Ref. 2), provides guidance for the engineered safety feature (ESF) systems.

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

This regulatory guide contains information collection requirements covered by 10 CFR Part 50 that the Office of Management and Budget (OMB) approved under OMB control number 3150-0011. 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.  This regulatory guide is a rule as designated in the Congressional Review Act (5 U.S.C. 801-808).  However, OMB has not found it to be a major rule as designated in the Congressional Review Act.

The International Atomic Energy Agency (IAEA) has established a series of safety guides and standards constituting a high level of safety for protecting people and the environment.  IAEA safety guides present international good practices and increasingly reflects best practices to help users striving to achieve high levels of safety.  Pertinent to this regulatory guide, IAEA Safety Guide NS-G-1.10, "Design of Reactor Containment Systems for Nuclear Power Plants" (Ref. 3), addresses the requirements of management of radionuclides leaking through a containment of Nuclear Power Plants.  Additionally, IAEA Safety Guide NS-G-2.7, "Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants" (Ref. 4), provides recommendations as to how to develop radiation protection programs.  IAEA Safety Standard NS-R-1, "Safety of Nuclear Power Plants: Design" (Ref. 5), addresses controlling the release of radioactive gases into the environment.  The NRC has an interest in facilitating the harmonization of standards used domestically and internationally.  This regulatory guide is consistent with the recommendations and guidance in the IAEA Safety Guides NS-G-1.10, NG-G-2.7 and NS-R-1.

## B.  DISCUSSION

The design of the normal atmosphere cleanup systems of light-water-cooled nuclear power plants includes particulate filtration and radioiodine adsorption units to reduce the quantities of radioactive materials in gaseous effluents released from primary containment or auxiliary building atmospheres during normal operations, including anticipated operational occurrences.  These systems operate to meet the "as low as reasonably achievable" requirements of 10 CFR 50.34a and 10 CFR 50.36a.  Auxiliary buildings can include those referred to as the secondary containment building, turbine building, radwaste building, and fuel handling building.

Normal atmospheric cleanup systems are generally designed to operate continuously under normal environmental conditions, such as inlet radioiodine activity levels up to 37 millibecquerels per cubic centimeter (16.4 picocuries per cubic inch), relative humidity up to 100 percent, temperatures up to 52 degrees Celsius (125 degrees Fahrenheit), and normal atmospheric pressure. System design, inspection, and testing anticipates the buildup of radioactive particulates and radioiodine and minimizes consequential degradation of system performance. The ambient environment both within and surrounding the facility may affect the performance of the normal atmosphere cleanup systems. Industrial contaminants and pollutants, as well as temperature and relative humidity, contribute to the aging and weathering of filters and adsorbers and reduce their reliability.

Components of the normal atmosphere cleanup systems need to be designed for reliable performance under the expected operating conditions. Initial and inservice testing and proper maintenance are also primary factors in ensuring system reliability. Component and system design should support and facilitate testing, inspection, and maintenance through built-in layout and accessibility features.

This regulatory guide only discusses impregnated activated carbon since it is the adsorber media used almost exclusively. Section FF of American Society of Mechanical Engineers (ASME) AG-1b-2009, "Code on Nuclear Air and Gas Treatment"(Ref. 6), provides the terminology and describes the characteristics of adsorbent media.

Previous revisions of this regulatory guide endorsed industry standards. This revision endorses updated industry standards.

In addition to filtration systems used to treat exhausts from containment and auxiliary building atmospheres, cleanup systems are also used to treat process streams from power cycle waste offgas systems. These systems treat radioactive process and effluent streams characterized by the presence of noble gases, radioiodines, and mixtures of hydrogen and oxygen gases. These systems also operate to meet the "as low as reasonably achievable" requirements of 10 CFR 50.34a and 10 CFR 50.36a. The design of treatment systems used in power cycle waste offgas systems are characterized by the presence of hydrogen recombiners, compressors, delay tanks or vessels either empty or containing large amounts of activated carbon (e.g., hundreds of kilograms or thousands of pounds in PWRs or tens of thousands of kilograms/pounds in BWRs). The ASME Committee on Nuclear Air and Gas Treatment (CONAGT) has indicated their intention for future editions of the ASME AG-1 code to detail requirements for power cycle waste offgas systems. Staff positions now include power cycle waste offgas systems in anticipation that future revisions of this guide will address the ASME AG-1 code.

## C. STAFF REGULATORY GUIDANCE

1. General Design and Testing Criteria

ASME AG-1-2009, including 2010 Addenda 1a and 2011 Addenda 1b (i.e., ASME AG-1b-2009), and ASME N511-2007, "Inservice Testing of Nuclear Air Treatment, Heating, Ventilating, and Air-Conditioning Systems" (Ref. 7), provide guidance that is acceptable to the NRC staff for the design, construction, acceptance testing, quality assurance, and inservice testing of normal atmosphere cleanup systems and components. Normal atmosphere cleanup systems designed to ASME N509-2002 (Reaffirmed 2008), "Nuclear Power Plant Air Cleaning Units and Components" (Ref. 8) (or its earlier versions), and tested to ASME N510-2007, "Testing of Nuclear Air-Treatment Systems" (Ref. 9) (or its earlier versions), are also considered adequate to protect public health and safety.

2. Environmental Design Criteria

a. Design of normal atmosphere cleanup systems 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.

b. Normal atmosphere cleanup system operation should not degrade the operation or capability of any safety system required to operate after a design-basis accident.

c. Design of normal atmosphere cleanup systems should consider any reasonably expected significant contaminants, such as chemicals, dusts, or other particulate matter that could degrade the systems operation or capability.

d. For power cycle waste offgas systems relying on activated carbon delay tanks or beds, the above environmental design criteria are deemed applicable, but should be evaluated and applied taking into consideration the system's specific design features.

3. System Design Criteria

Normal atmospheric cleanup systems should be designed in accordance with ASME AG-1b-2009 as modified and supplemented by the following:

a. Normal atmosphere cleanup systems need not be redundant or designed to seismic Category I requirements, but they should consist of at least the following components:

(1) high-efficiency particulate air (HEPA) filters upstream of adsorbers,
(2) iodine adsorbers (typically impregnated activated carbon), if iodine removal from the airstream is anticipated,
(3) fans,
(4) interspersed ducts, dampers, and instrumentation,
(5) prefilters upstream of HEPA filters, if needed to reduce particulate loading of the HEPA filters and achieve an acceptable service life,
(6) postfilters downstream of adsorbers, if needed to retain carbon fines, and
(7) heating elements or cooling coils, or both, if necessary to control humidity before filtration.

b. The volumetric airflow rate of a single filtration unit should be limited to 850 cubic meters (30,000 cubic feet) per minute unless reliable in-place testing can be assured. If a higher flow capacity is needed, consider a system design with multiple, parallel units.

c. Normal atmosphere cleanup systems should be provided with instrumentation recommended in Section IA of ASME AG-1b-2009 for monitoring and alarming pertinent airflow rates and pressure drops.

d. Normal atmosphere cleanup systems design should limit personnel radiation exposure by incorporation of features that facilitate inspection, testing, and maintenance consistent with the guidance of Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is

Reasonably Achievable" (Ref. 10).

e. Outdoor air intake openings should be equipped with louvers, grills, screens, or similar protective devices to minimize the adverse effects of high winds, rain, snow, ice, and other debris on system operation. Outdoor air intake openings should be located to minimize the effects of onsite sources of contaminants, such as diesel generator exhaust. System design should consider potential airborne contaminants from offsite sources, such as nearby industrial facility discharges of dusts, combustion particulates and gases, dust storms, or salt spray particulate from nearby oceans or bays.

f. Normal atmosphere cleanup system housings and ductwork should be designed to limit system total leakage rate, as defined in Article SA-4500 of ASME AG-1b-2009. Duct and housing leak tests should be performed consistent with Section TA of ASME AG-1b-2009.

g. For power cycle waste offgas systems relying on activated carbon delay tanks or beds, the above system design criteria are deemed applicable, but should be evaluated and applied taking into consideration the system's specific design features.

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-1b-2009, as modified and supplemented by the following:

a. Prefilters should be designed, constructed, and tested consistent with Sections FB or FJ of ASME AG-1b-2009.

b. Air heaters should be designed, constructed, and tested consistent with Section CA of ASME AG-1b-2009.

c. HEPA filters should be designed, constructed, and tested consistent with Sections FC of ASME AG-1b-2009. HEPA filters should be compatible with the chemical and physical composition and physical conditions of the air stream. Each HEPA filter should be tested for penetration of a challenge aerosol, such as dioctyl phthalate or 4-centistoke poly-alpha olephin, in accordance with Section TA of ASME AG-1b-2009.

d. HEPA and Type II adsorber cell mounting frames should be designed and constructed in accordance with Section FG of ASME AG-1b-2009.

e. Filter and adsorber sections should be arranged in accordance with Section HA of ASME AG-1b-2009.

f. Filter housings, including floors and doors, and electrical conduits, drains, and other piping installed inside filter housings should be designed and constructed in accordance with Section HA of ASME AG-1b-2009.

g. If the relative humidity of the atmosphere entering the air cleanup system can be expected to exceed 70 percent during normal operation, the design should include heaters or cooling coils, or both, to maintain relative humidity at or below 70 percent to ensure adsorption unit efficiency. Heaters should be designed, constructed, and tested in accordance with Section CA of ASME AG-1b-2009.

h. Adsorber cells should be designed, constructed, and tested in accordance with Section FD for Type II or Section FE for Type III or Section FH of ASME AG-1b-2009 for Type IV adsorber cells.

(1) Design of an adsorber section should consider possible iodine desorption and adsorbent autoignition that may result from radioactivity-induced heat in the adsorbent and concomitant temperature rise. If needed, prevention and mitigation features could include low-flow air or inert gas bleed, cooling coils, cleanup unit isolation, or water sprays.

(2) If a water-based fire suppression or prevention (cooling) system is installed in a normal atmosphere cleanup system housing, it should be designed for manual actuation unless a reasonable possibility exists that iodine desorption and adsorbent autoignition could occur in the housing. If autoignition is a reasonable possibility, the fire suppression system should have both manual and automatic actuation. The fire suppression system should use open spray nozzles of sufficient size, number, and location to provide complete coverage over the entire surface of the combustible filter/adsorber media. The fire system should be hard piped and supplied with a reliable source of water of adequate pressure and flow. Location of the water supply manual actuation device should be remote from the cleanup system housing and consistent with the guidance of Regulatory Guide 8.8 (Ref. 10). Reliable mechanical or electrical detection devices sensing temperature, smoke, carbon monoxide, or other indications of fire ignition should be included in the system for manual and automatic actuation methods. Monitoring indicators for these detector outputs should be remote from the system housings and consistent with the guidance of Regulatory Guide 8.8 and support the manual actuation capability. Cross-zoning of detectors may be used for automatic actuation.

(3) For portions of atmospheric clean up systems and power cycle off gas systems (such as filter housings, delay tanks or beds, and low-points in ductwork), the design should consider features to collect and drain accumulated water from various sources. The presence and accumulation of water within portions of these systems may be attributed to condensation and from water-based fire suppression systems, when triggered. The design should provide the means to collect and route water to the appropriate radioactive waste management system given that the water would entrain radioactive materials present in such systems.

The design of water collection systems and drains should consider the requirements of 10 CFR 20.1406 in minimizing the contamination of plant facilities and the environment. NRC guidance is presented in RG 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures and Components Installed in Light-Water-Cooled Nuclear Reactor Power Plants" (Ref. 13). RG 1.143 describes systems handling of radioactive materials in liquids, gaseous and solid collection systems that include construction of structures. Further, RG 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life Cycle Planning" (Ref. 14) gives guidance for Design of facilities to minimize contamination, the environment and generation of waste. NUREG-0800 "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (Ref. 15) and associated Interim Staff Guidance gives NRC review criteria. Nuclear Energy Institute (NEI) technical report NEI 08-08A “Guidance for Life Cycle Minimization of Contamination,” (ADAMS Accession Number ML093220530, ML092720253) (Ref. 16) provides a method for licensees to describe operational policies and operational programs to meet the programmatic requirements of 10 CFR Part 20.1406(a) and (b) for life cycle minimization of contamination. Meeting these requirements is achieved pa, in part, by addressing the applicable regulatory position elements of Regulatory Guide 4.21. The main objective of the regulations and NRC guidance is to avoid unmonitored and uncontrolled releases of radioactive materials on the site and in uncontrolled areas, and provide information that can be used to assess potential radiological hazards.

i. 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 with the required efficiency or better.

(1) Each original or replacement batch or lot of impregnated activated carbon media used in an adsorber section should be prepared, inspected, and tested consistent with Section FF of ASME AG-1b-2009.

(2) If impregnated activated carbon media is used, the adsorber section design should provide for a minimum atmosphere residence time of 0.05 seconds per centimeter (0.125 seconds per inch) of adsorbent media bed depth at rated flow.

(3) Sections FD, FE, and FH of ASME AG-1b-2009 should be used to determine residence time.

(4) If sample (inservice test) canisters are used, their design should be consistent with Section FE of ASME AG-1b-2009 or Appendix I to ASME N509-2002.

j. Ductwork should be designed, constructed, and tested consistent with Section SA of ASME AG-1b-2009.

k. Duct and housing layout designs should minimize ledges, protrusions, and crevices that could collect dust and moisture and impede personnel work performance or create avoidable industrial safety hazards. Turning vanes or other airflow distribution devices should be installed where needed to achieve acceptably uniform flow profiles and support representative airflow measurements.

l. Dampers should be designed, constructed, and tested consistent with Section DA of ASME AG-1b-2009.

m. Fan/blower and motor, mounting, and ductwork connections should be designed, constructed, and tested consistent with Section BA for fans/blowers and Section SA of ASME AG-1b-2009 for ducts.

n. For power cycle waste offgas systems relying on activated carbon delay tanks or beds, the above component design criteria and qualification testing are deemed applicable, but should be evaluated and applied taking into consideration the system’s specific design features.

5. Maintainability Criteria

Cleanup system design should incorporate provisions for maintenance consistent with Section HA of ASME AG-1b-2009 as modified and supplemented by the following:

a. System design should support accessibility for inspection and maintenance. Filtration unit enclosures should provide a minimum of 0.92 meters (3 feet) from mounting frame to mounting frame between banks of components. Where components within a bank are designed for replacement, the spacing between banks should be the length of the component plus at least 0.92 meters (3 feet).

b. Cleanup system components (i.e., HEPA filters, prefilters, and adsorbers) that are used during system construction should be replaced before the system is declared fully functional.

c. Duct access for inspection and maintenance should be provided consistent with the guidance of Section 4.3.4 of National Fire Protection Association (NFPA) 90A, "Standard for the Installation of Air Conditioning and Ventilation Systems" (Ref. 11).

d. For power cycle waste offgas systems relying on activated carbon delay tanks or beds, the above maintainability criteria are deemed applicable, but should be evaluated and applied taking into consideration the system's specific design features.

6. In-Place Testing Criteria

Initial in-place testing of normal atmosphere cleanup systems should be performed consistent with Section TA of ASME AG-1b-2009. Periodic in-place testing of the cleanup systems and components should be performed consistent with ASME N511-2007 as modified and supplemented by the following:

a. A visual inspection of the normal atmosphere cleanup system and all associated components should be performed consistent with Appendix I to ASME N511-2007.

b. In-place aerosol leak tests for HEPA filters upstream from the carbon adsorbers should be performed (1) consistent with and at the frequency intervals shown in Section 5.7 and Appendix III to ASME N511-2007 , (2) after each partial or complete replacement of a HEPA filter bank, (3) following detection of, or evidence of, penetration or intrusion of water or other material into any portion of a cleanup system that may have an adverse effect on the functional capability of the filters, and (4) 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. The leak test should confirm a combined penetration and leakage (or bypass) of the normal atmosphere cleanup system of less than 0.05 percent of the challenge aerosol at a system-rated flow ±10 percent to warrant a 99-percent removal efficiency for particulates.

c. HEPA filter sections that fail to satisfy appropriate leak test criteria should be examined to determine location and cause of leaks. Adjustments, such as alignment of filter cases and tightening of filter holddown fasteners, may be made. Defective, damaged, or torn filter media should not be repaired by patching and caulking; filters should be replaced and not repaired. After adjustments or filter replacement, the cleanup system should be retested.

d. Cleanup system adsorbers should be in-place leak tested (1) consistent with and at the frequency intervals shown in Section 5.8 and Appendix IV to ASME N511-2007,

(2) following removal of an adsorber sample for laboratory testing if the integrity of the adsorber section is affected, (3) after each partial or complete replacement of carbon adsorber in an adsorber section, (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 adsorbers, 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. The leak test should confirm a combined penetration and leakage (or bypass) of the adsorber section of 0.05 percent or less of the challenge gas at a system-rated flow ±10 percent.

e. Adsorber sections that fail to satisfy the appropriate leak test conditions should be examined to determine the location and cause of leaks. Adjustments, such as alignment of adsorber cells, tightening of adsorber cell holddown fasteners, or tightening of test canister fixtures, may be made. Defective or damaged adsorber cells, mounting frames, or housings should not be temporarily repaired with patching material or caulking. After adjustments or adsorber cell replacement, the cleanup system should be retested.

f. Painting, fire, or chemical release is "not communicating" with the HEPA filter or adsorber if the cleanup system is not in operation, the isolation dampers 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. Conservative, well-documented administrative controls should be implemented that define the terms "painting," "fire," and "chemical release" with respect to the potential for degrading cleanup system HEPA filters and adsorbers.

g. If welding repairs are performed on, within, or adjacent to the cleanup system ducts, housing, or mounting frames, the HEPA filters and adsorbers should first be removed from the housing (or otherwise protected). When repairs are completed and filters and adsorbers reinstalled, the cleanup system should be visually inspected and leak tested as described in Regulatory Positions 6.a, 6.b, and 6.d of this guide.

h. For power cycle waste offgas systems relying on activated carbon delay tanks or beds, the above in place testing criteria are deemed applicable, but should be evaluated and applied taking into consideration the system's specific design features.

7. Laboratory Testing Criteria for Activated Carbon

a. Activated carbon adsorber sections of the 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.d of this guide.
(2) New activated carbon meets the physical property specifications given in Regulatory Position 4.i of this guide.
(3) Representative samples of used activated carbon pass the laboratory tests given in Table 1 of this guide.

b. Efficiency of an activated carbon adsorber section should be determined by laboratory testing of representative samples of the activated carbon experiencing the same service conditions and the same exposure to all contaminants as the entire adsorber section. Each representative sample should be 5.1 centimeters (2 inches) or more in both length and diameter, and each sample should have the same qualification and batch test characteristics as the system adsorbent. A sufficient number of representative samples should be located in parallel with the adsorber section to allow periodic determination of system adsorbent penetration throughout its service life. Where system activated carbon adsorber is greater than 5.1 centimeters (2 inches) deep, each representative sampling should consist of an equivalent depth. Once representative samples are removed for laboratory testing, the positions they occupied should be blocked off to maintain adsorber section capability.

c. Sampling and analysis of adsorbent should be performed (1) consistent with and at the frequency intervals shown in Sections 7 and 5.9 of ASME N511-2007, (2) 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, and (3) 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 adsorber media.

d. Laboratory tests of representative samples of adsorbent should be conducted as indicated in Table 1 of this guide, with the test gas flow in the same direction as normal cleanup system flow. Similar laboratory tests should be performed on a sample before loading media into the adsorber section to establish a baseline for comparison with future sample test results. The contents of an activated carbon adsorber section should be replaced with new, unused activated carbon adsorbent meeting the physical properties identified in Regulatory Position 4.i of this guide if (1) testing in accordance with Table 1 of this guide results in a representative sample failing an acceptance criterion or (2) no representative sample is available for testing.

e. For power cycle waste offgas systems relying on activated carbon delay tanks or beds, the above laboratory testing criteria for activated carbon are deemed applicable, but should be evaluated and applied taking into consideration the system's specific design features.

**Table 1. Inservice Adsorber Laboratory Tests for Activated Carbon**

| Activated Carbon Total Bed Depth | Maximum Assigned Activated Carbon Decontamination Efficiencies | | Methyl Iodide Penetration Acceptance Criterion for Representative Sample |
|---|---|---|---|
| 2 inches | Elemental iodine<br><br>Organic iodide | 95%<br><br>95% | Penetration ≤5% when tested in accordance with ASTM D3803-1991 (Ref. 12) |
| 4 inches or greater (in-series beds are treated as a single bed of aggregate depth) | Elemental iodine<br><br>Organic iodide | 99%<br><br>99% | Penetration ≤1% when tested in accordance with ASTM D3803-1991 (Ref. 12) |
| Activated carbon in delay tanks or beds | Elemental iodine<br><br>Organic iodide | 99%<br><br>99% | Penetration ≤1% when tested in accordance with ASTM D3803-1991 (Ref. 12) |

**Table 1 Notes:**

(1) See Appendix I to ASME N509-2002 for the definition of a representative sample.

(2) Credited decontamination efficiencies (a portion of which includes bypass leakage) are based on a 0.25-second residence time per 5.1 centimeter (2-inch bed depth).

(3) The activated carbon, when new, should meet the specifications of Regulatory Position 4.i of this guide. Table 1 provides acceptable decontamination efficiencies and methyl iodide test penetrations of used activated carbon samples for laboratory testing. Testing should be performed at the frequencies specified in Regulatory Position 7.c of this guide. Testing should be performed in accordance with American Society for Testing and Materials (ASTM) D3803-1991 (Reaffirmed 2009), "Standard Test Methods for Nuclear-Grade Activated Carbon" (Ref. 12), with an entering air temperature of 30 degrees Celsius (86 degrees Fahrenheit) and a relative humidity of 95 percent (or 70 percent with humidity control). Humidity control can be provided by heaters, cooling coils, or an analysis that demonstrates that the air entering the installed adsorber section would be maintained less than or equal to a 70-percent relative humidity level.

(4) 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.

(5) For power cycle waste offgas systems relying on activated carbon delay tanks or beds, the inservice adsorber laboratory tests should confirm that the proper types of activated carbon (nuclear grade and defined mesh size) are tested for representative batches of activated carbon over the entire design inventory of the waste offgas treatment system, given the design capacity and number of delay tanks or beds.

# D. IMPLEMENTATION

The purpose of this section is to provide information on how applicants and licensees[1] may use this guide and information regarding the NRC's plans for using this regulatory guide. In addition, it describes how the NRC staff complies with the Backfit Rule (10 CFR 50.109) and any applicable finality provisions in 10 CFR Part 52.

**Use by Applicants and Licensees**

Applicants and licensees may voluntarily[2] use the guidance in this document to demonstrate compliance with the underlying NRC regulations. Methods or solutions that differ from those described in this regulatory guide may be deemed acceptable if they provide sufficient basis and information for the NRC staff to verify that the proposed alternative demonstrates compliance with the appropriate NRC regulations. Current licensees may continue to use guidance the NRC found acceptable for complying with the identified regulations as long as their current licensing basis remains unchanged.

Licensees may use the information in this regulatory guide for actions which do not require NRC review and approval such as changes to a facility design under 10 CFR 50.59. Licensees may use the information in this regulatory guide or applicable parts to resolve regulatory or inspection issues.

**Use by NRC Staff**

During regulatory discussions on plant specific operational issues, the staff may discuss with licensees various actions consistent with staff positions in this regulatory guide, as one acceptable means of meeting the underlying NRC regulatory requirement. Such discussions would not ordinarily be considered backfitting even if prior versions of this regulatory guide are part of the licensing basis of the facility. However, unless this regulatory guide is part of the licensing basis for a facility, the staff may not represent to the licensee that the licensee's failure to comply with the positions in this regulatory guide constitutes a violation.

If an existing licensee voluntarily seeks a license amendment or change and (1) the NRC staff's consideration of the request involves a regulatory issue directly relevant to this new or revised regulatory guide and (2) the specific subject matter of this regulatory guide is an essential consideration in the staff's determination of the acceptability of the licensee's request, then the staff may request that the licensee either follow the guidance in this regulatory guide or provide an equivalent alternative process that demonstrates compliance with the underlying NRC regulatory requirements. This is not considered backfitting as defined in 10 CFR 50.109(a)(1) or a violation of any of the issue finality provisions in 10 CFR Part 52.

The NRC staff does not intend or approve any imposition or backfitting of the guidance in this regulatory guide. The NRC staff does not expect any existing licensee to use or commit to using the guidance in this regulatory guide, unless the licensee makes a 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. Examples of such unplanned NRC regulatory actions

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1 In this section, "licensees" refers to licensees of nuclear power plants under 10 CFR Parts 50 and 52; and the term "applicants," refers to applicants for licenses and permits for (or relating to) nuclear power plants under 10 CFR Parts 50 and 52, and applicants for standard design approvals and standard design certifications under 10 CFR Part 52.

2 In this section, "voluntary" and "voluntarily" means that the licensee is seeking the action of its own accord, without the force of a legally binding requirement or an NRC representation of further licensing or enforcement action.

include issuance of an order requiring the use of the regulatory guide, requests for information under 10 CFR 50.54(f) as to whether a licensee intends to commit to use of this regulatory guide, generic communication, or promulgation of a rule requiring the use of this regulatory guide without further backfit consideration.

Additionally, an existing applicant may be required to adhere to new rules, orders, or guidance if 10 CFR 50.109(a)(3) applies.

**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 staff issuance of this regulatory guide is not considered backfitting, as defined in 10 CFR 50.109(a)(1), nor is it deemed to be in conflict with any of the issue finality provisions in 10 CFR Part 52.

If a licensee believes that the NRC is either using this regulatory guide or requesting or requiring the licensee to implement the methods or processes in this regulatory guide in a manner inconsistent with the discussion in this Implementation section, then the licensee may file a backfit appeal with the NRC in accordance with the guidance in NUREG-1409, "Backfitting Guidelines" and NRC Management Directive 8.4, "Management of Facility-specific Backfitting and Information Collection."

# REFERENCES[3]


1. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," U.S. Nuclear Regulatory Commission, Washington DC.

2. 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," U.S. Nuclear Regulatory Commission, Washington, DC.

3. NS-G-1.10, "Design of Reactor Containment Systems of Nuclear Power Plants," International Atomic Energy Agency, Vienna, Austria. [4]

4. NS-G-2.7, "Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants," International Atomic Energy Agency, Vienna, Austria. [4]

5. NS-R-1, "Safety of Nuclear Power Plants: Design," International Atomic Energy Agency, Vienna, Austria. [4]

6. ASME AG-1b-2009, American Society of Mechanical Engineers, ASME Standard AG-1, "Code on Nuclear Air and Gas Treatment," 2009, including 2010 Addenda 1a and 2011 Addenda 1b (ASME AG-1b-2009), American Society of Mechanical Engineers, New York, NY.[5]

7. ASME N511-2007, American Society of Mechanical Engineers, ASME Standard N511, "Inservice Testing of Nuclear Air Treatment, Heating, Ventilating, and Air-Conditioning Systems," American Society of Mechanical Engineers, New York, NY.

8. ASME N509-2002 (Reaffirmed 2008), American Society of Mechanical Engineers, ASME Standard N509, "Nuclear Power Plant Air-Cleaning Units and Components," American Society of Mechanical Engineers, New York, NY.

9. ASME N510-2007, American Society of Mechanical Engineers, ASME Standard N510, "Testing of Nuclear Air-Treatment Systems," American Society of Mechanical Engineers, New York, NY.

10. Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," U.S. Nuclear Regulatory Commission, Washington, DC.


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[3] Publicly available NRC published documents are available electronically through the NRC Library on the NRC's public Web site at: http://www.nrc.gov/reading-rm/doc-collections/. The documents can also be viewed on-line 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.

[4] Copies of International Atomic Energy Agency (IAEA) standards may be requested from IAEA, P.O. Box, A-1400, Vienna, Austria; telephone (+431) 2600-0. Standards are also available on the IAEA website at http://www.iaea.org/

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

11. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilation Systems," National Fire Protection Association (NFPA), National Fire Codes, 2002, Quincy, MA.[6]

12. ASTM D3803-1991 (Reaffirmed 2009), "Standard Test Methods for Nuclear-Grade Activated Carbon," ASTM International, West Conshohocken, PA.[7]

13. Regulatory Guide 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures and Components Installed in Light-Water-Cooled Nuclear Reactor Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC.

14. Regulatory Guide 4.21, "Minimization of Contamination and Radioactive Waste Generation: Life Cycle Planning," U.S. Nuclear Regulatory Commission, Washington, DC.

15. NUREG-0800 "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition"

16. Nuclear Energy Institute (NEI) technical report NEI 08-08A "Guidance for Life Cycle Minimization of Contamination," (ADAMS Accession Number ML093220530, ML092720253)

6 Copies of the National Fire Protection Association (NFPA) may be purchased from the NFPA, 1 Batterymarch Park, Quincy, Massachusetts; telephone (800) 344-3555. Purchase information is available through the NFPA Web-based store at http://www.nfpa.org/Catalog/.

7 Copies of American Society for Testing and Materials (ASTM) standards may be purchased from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, Pennsylvania 19428-2959; telephone (610) 832-9585. Purchase information is available through the ASTM Web site at http://www.astm.org.