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

October 2000
Division 1
Draft DG-1103

DRAFT REGULATORY GUIDE

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DRAFT REGULATORY GUIDE DG-1103

(Proposed Revision 2 to Regulatory Guide 1.140)

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

A. INTRODUCTION

This guide presents methods acceptable to the NRC staff for meeting the NRC's regulations with regard to the design, inspection, and testing criteria for air filtration and adsorption units installed in the normal ventilation exhaust 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. An atmosphere cleanup system installed in a normal ventilation exhaust system may consist of heaters or cooling coils used in conjunction with heaters, prefilters, high-efficiency particulate air (HEPA) filters, iodine adsorption units, fans, and 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 and 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. A proposed Revision 3 to Regulatory Guide 1.52, "Design, Testing, and Maintenance Criteria for Post-Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants" (DG-1102), is being developed to provide guidance for these systems.

The information collections contained in this draft 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 ventilation exhaust 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 cleanup systems installed in the ventilation exhaust systems for 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. In some instances, filtration equipment installed in a post-accident hydrogen purge exhaust system may be designed to the recommendations of this guide, e.g., when a removal efficiency of 90% or less for radioiodine species is sufficient for the hydrogen purge exhaust system when the sum of the calculated loss-of-coolant accident (LOCA) dose and the post-LOCA hydrogen purge dose is less than the guideline values of 10 CFR Part 100, "Reactor Site Criteria."

These 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.

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. HEPA filters downstream of the adsorber 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 system. Consideration should be given to installing prefilters upstream of 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 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 atmosphere cleanup system can be determined by scheduled testing.

All components of the atmosphere cleanup system installed in normal ventilation exhaust systems 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. Careful attention during the design phase to problems of 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 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 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). Other standards referenced in this guide include ASTM D3803-1989, "Standard Test Methods for Nuclear-Grade Activated Carbon" (Ref. 4), and ASTM D4069-81, "Impregnated Activated Carbon Used To Remove Gaseous Radioiodines from Gas Streams" (Ref. 5).

Other standards are available for the construction and testing of certain components of atmosphere cleanup systems. Not all the documents mentioned in this guide have been evaluated by the NRC staff as to their applicability or acceptability. When such standards have been evaluated by NRC staff and found acceptable, they are endorsed in this guide or referenced in other guides. If no suitable standard exists or the licensee has used standards not referenced in this guide, approaches are assessed by the staff on a case-by-case basis.

C. REGULATORY POSITION

1. GENERAL DESIGN AND TESTING CRITERIA

ASME AG-1-1997, “Code on Nuclear Air and Gas Treatment” (Ref. 3), provides 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. This code replaces the existing ASME N509-1989, “Nuclear Power Plant Air-Cleaning Units and Components” (Ref. 1). However, atmosphere cleanup systems designed to ASME N509-1989 and tested to earlier versions of ASME N510-1989 (Ref. 2) are considered adequate to protect public health and safety. Operating plants licensed under these earlier standards (or no standards at all) would not be required to revise their regulatory requirements under the current licensing bases (licensees are not required to adopt subsequent versions of this regulatory guide).

2. ENVIRONMENTAL DESIGN CRITERIA

2.1. The design of each atmosphere cleanup system installed in a normal ventilation exhaust system should be based on the anticipated range of operating parameters of temperature, pressure, relative humidity, and radiation levels.

2.2. If the 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 atmosphere cleanup system in a normal ventilation exhaust system should not degrade the expected operation of any ESF system that must operate after a design basis accident.

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

3. SYSTEM DESIGN CRITERIA

Atmosphere cleanup systems should be designed in accordance with the requirements of Section 4.7 of ASME N509-1989 (Ref. 1) and ASME AG-1-1997 (Ref. 3) as modified and supplemented by the following:

3.1. Atmosphere cleanup systems installed in normal ventilation exhaust systems need not be redundant nor designed to Seismic Category I classification, but they should consist of the following sequential 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 of the initial HEPA section is suggested. Consideration should also be given to the installation of a HEPA filter section downstream of carbon adsorbers to retain carbon fines. Heaters or cooling coils used in conjunction with heaters should be used when the humidity is to be controlled before filtration. Whenever an 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 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. 6).

3.4. To maintain the radiation exposure to operating and maintenance personnel as low as is reasonably achievable, 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. 7).

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. 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 salty environment near ocean, the design of the system should consider these contaminants and prevent them from affecting the operation of any atmosphere cleanup system.

3.6. 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 the provisions of 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 the requirements of ASME AG-1-1997, Division II (Ref. 3), as modified and supplemented by the following.

4.1. Prefilters that are used in the atmosphere cleanup system should be designed, constructed, and tested in accordance with the provisions of Section FB of ASME AG-1-1997 (Ref. 3).

4.2. Air heaters should be designed, constructed, and tested in accordance with the requirements of Section CA of ASME AG-1-1997 (Ref. 3).

4.3. The HEPA filters should be designed, constructed, and tested in accordance with the requirements of Section FC of ASME AG-1-1997 (Ref. 3). Each HEPA filter should be tested for penetration of a challenge aerosol such as dioctyl phthalate (DOP) in accordance with the provisions of Section TA of ASME AG-1-1997.

4.4. Filter and adsorber mounting frames should be designed and constructed in accordance with the provisions of Section FG of ASME AG-1-1997 (Ref. 3).

4.5. Filter and adsorber sections should be arranged in accordance with the recommendations of Section 4.4 of ERDA 76-21 (Ref. 6) and Section HA, “Housings,” of ASME AG-1a-2000 (Ref. 8).

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 the provisions of Section 5.6 of ASME N509-1989 (Ref. 1) and Section HA, ASME AG-1a-2000 (Ref. 8).

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 used in conjunction with heaters should be designed to reduce the relative humidity of the adsorption unit entering atmosphere to 70% or less. Heaters should be designed, constructed, and tested in accordance with the requirements of 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 the requirements of Section FD for Type II Adsorber cells and Section FE for Type III Adsorber cells, ASME AG-1-1997 (Ref. 3).

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 the requirements for adsorbent contained in Section FF of ASME AG-1-1997 (Ref. 3), and in Section 16 of ASTM D4069-81 (Ref. 5).[2, 3] In ASTM D4069-81, a test performed "only for qualification purposes" 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. Section FD and FE of ASME AG-1-1997 (Ref. 3) should be used to determine the residence time.

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[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, ASME AG-1-1997, Ref. 3).

[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 comprise and satisfy a purchase order. (See Article FF-1130, ASME AG-1-1997, Ref. 3).

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 satisfying the specifications in Article FF of ASME AG-1-1997 (Ref. 3).

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 atmosphere cleanup system should be designed, constructed, and tested in accordance with the provisions of Section SA of ASME AG-1-1997 (Ref. 3).

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.

4.12. Dampers should be designed, constructed, and tested in accordance with the provisions of Section DA of ASME AG-1-1997 (Ref. 3).

4.13. The system fan and motor, mounting, and ductwork connections should be designed, constructed, and tested in accordance with the requirements of Section BA for Blowers and Section SA for Ducts, ASME AG-1-1997 (Ref. 3). The fan and motor used in the atmosphere cleanup system should be capable of operating under the environmental conditions postulated for its use.

5. MAINTAINABILITY CRITERIA

Provisions for maintaining 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. 8) as supplemented by the following.

5.1. Accessibility of components and maintenance should be considered in the design of atmosphere cleanup systems in accordance with the provisions of Section 2.3.8 of ERDA 76-21 (Ref. 6) and Section HA of ASME AG-1a-2000 (Ref. 8). For ease of inspection and maintenance with minimum danger of damage to the system, its design should provide for a minimum of three feet of clear access space in each compartment after allowing for the component dimension itself and the maximum length of the component during changeout.

5.2. The system design should provide for permanent test probes or ports with external connections in accordance with the provisions of Section HA of ASME AG-1a-2000 (Ref. 8).

5.3. The cleanup components (e.g., HEPA filters and adsorbers) should be installed after construction is completed.

6. IN-PLACE TESTING CRITERIA

In-place testing of 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 atmosphere cleanup system and all associated components should be made before each in-place airflow distribution test, DOP (dioctyl phthalate) test, or activated carbon adsorber section leak test in accordance with the provisions of Section TA of ASME AG-1-1997 (Ref. 3).

6.2. The airflow distribution to the HEPA filters and iodine adsorbers should be tested in place for uniformity both initially and after maintenance affecting the flow distribution. The distribution should be within ±20% of the average flow per unit when tested in accordance with the provisions of Section TA of ASME AG-1-1997 (Ref. 3).

6.3. In-place aerosol leak test for HEPA filters of normal atmosphere cleanup systems should be performed: (1) initially, (2) at least once per 24 months or once per refueling outage, whichever comes first, (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 foreign material into any portion of a normal atmosphere cleanup system,[4] and (5) following painting, fire, or chemical release in any ventilation zone communicating with 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. 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 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 4.4 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

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[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. 9). 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. 10.)

[5] Painting, fire, or chemical release is "not communicating" with the HEPA filter or adsorber only if the atmosphere cleanup system is not in operation and the isolation dampers for the system are closed and leak tight, thereby preventing air from 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 filters and adsorbers).

[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.

(DEHP). The 0.3 micrometer monodisperse DOP aerosol is used for efficiency testing of individual HEPA filters by manufacturers and Filter Test Stations. Alternative challenges[7] may be used to perform in-place leak testing of HEPA filters when their selection is based on the following.

(a) The challenge aerosol has the approximate light scattering droplet size specified in Article TA-1130 of ASME AG-1-1997 (Ref. 3).
(b) The challenge aerosol has the same in-place leak test results as DOP.
(c) The challenge aerosol has similar lower detection limit, sensitivity, and precision as DOP.
(d) The challenge aerosol causes no degradation of the HEPA filter or the other normal air cleaning system components under test conditions.
(e) The challenge aerosol is listed in the Environmental Protection Agency's “Toxic Substance Control Act” (TSCA) (Ref. 12) inventory for commercial use.

6.4. In-place adsorber leak testing should be conducted (1) initially, (2) at least once per 24 months or during each refueling outage, whichever comes first, (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 foreign material into any portion of a normal atmosphere cleanup system, and (6) following painting, fire, or chemical release in any ventilation zone communicating with 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) of the adsorber section of 0.05% or less of the challenge gas at rated flow.

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 (Ref. 3).

6.5. 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 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

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[7] Care must be taken to ensure that the aerosol generator is compatible with the selected alternative challenge aerosol (see NRC Information Notice 99-34, Ref. 11).

7.1. The activated carbon adsorber section of the 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 6.4 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 samplers should be in accordance with the provisions of Appendix A to ASME N509-1989 (Ref. 1). Where 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 or during each refueling outage, whichever comes first, (3) following painting, fire, or chemical release in any ventilation zone communicating with the system,[5] and (4) following detection of, or evidence of, penetration of water or other foreign material into any portion of the filter system.

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 failing 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.

This proposed revision has been released to encourage public participation in its development. Except in those cases in which an applicant proposes an acceptable alternative method for complying with specified portions of the NRC's regulations, the guidance to be described in the active guide reflecting public comments will be used by the NRC staff in its evaluation of the design, testing, and maintenance of air filtration and adsorption units in normal exhaust systems for the following light-water-cooled nuclear power plants:

1. Plants for which the construction permit application is docketed after the issue date of the final guide;
2. Plants for which the operating license application is docketed 6 months after the issue date of the final guide;
3. Plants for which the licensee voluntarily commits to the provisions of this guide.

TABLE 1: Laboratory tests and assigned decontamination efficiencies for new and used activated carbon samples for normal ventilation system atmosphere cleanup system units. 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.

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

NOTES:

1. Decontamination efficiencies 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 charcoal filters are designed to adsorb. Organic iodide is more difficult for charcoal to adsorb than elemental iodine. Therefore, the laboratory test to determine the performance of the charcoal adsorber is based on organic iodide. Methyl iodide is the organic form of iodine that is used in the laboratory test.

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[a] The activated carbon, when new, should meet the specifications of Regulatory Position 4.7 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 Appendix A to ASME N509-1989 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 charcoal 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. American Society for Testing and Materials, "Impregnated Activated Carbon Used To Remove Gaseous Radioiodines from Gas Streams," ASME D4069-81. Reapproved 1998.

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

7. 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.[1]

8. American Society of Mechanical Engineers, Section HA, “Housings,” of "Code on Nuclear Air and Gas Treatment," ASME AG-1a-2000.[2]

10. 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] Single copies of regulatory guides, both active and draft, and draft NUREG documents 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 (703)487-4650; 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.

[2] ASME expects to publish this Addendum, AG-1a-2000, in the near future. A prepublication copy may be obtained from ASME by email to <infocentral@asme.org> .

[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 (703)487-4650; <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.

10. 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]

11. NRC Information Notice 99-34, “Potential Fire Hazards in the Use of Polyalphaolefin in Testing of Air Filters,” December 28, 1999.[3]

12. Environmental Protection Agency's “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 (first floor), Rockville, MD; the PDR’s mailing address is USNRC PDR, Washington, DC 20555; telephone (301)415-4737 or 1-(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 (703)487-4650; <http://www.ntis.gov/ordernow>.

VALUE/IMPACT STATEMENT

1. PROPOSED ACTION

1.1 Description

Revision 1 of Regulatory Guide 1.140 was issued in October 1979 to provide guidance to applicants and licensees on design, inspection, and testing for normal atmosphere cleanup systems for light-water-cooled nuclear power plants. This proposed action is to issue a Revision 2 to Regulatory Guide 1.140 to update its guidance.

1.2 Need

At present, Revision 1 of Regulatory Guide 1.140 is the basic document used in commercial nuclear power plants for testing normal air-cleaning systems. Revision 1, issued in October 1979, is considered to be significantly outdated and in error in many significant technical areas. This proposed Revision 2 would update guidance on testing and maintenance of normal air cleaning systems to be consistent with present policies and recent revisions in ASME AG-1 and ASME N510.

1.3 Value/Impact

1.3.1 NRC

The primary effect of the proposed action on the NRC staff would be to facilitate implementation of current NRC positions with regard to normal filter system design, inspection, and testing. It would improve the basis for communication between the NRC staff and licensees and would reduce staff effort that might otherwise be spent answering questions about acceptable means for testing filter systems.

1.3.2 Other Government Agencies

The principal effect on other government agencies would be to inform them of NRC's policies on filter system inspection and testing.

1.3.3 Industry

The guide will be useful to industry because it will advise of changes in normal ventilation system testing and inspection provisions and will thus promote understanding of current NRC positions and prevent any unnecessary costs being applied to meet provisions no longer recommended by the NRC staff. None of the changes is expected to impose significant additional burdens on applicants or licensees. Some of the changes may relax certain guide positions but without compromise to safety, thereby reducing cost and effort. There will be no costs associated with the revised positions related to testing and inspection of new and used charcoal, because the revised positions are in accordance with current regulatory requirements. Also, the adoption of this regulatory guide is voluntary.

1.3.4 Public

The proposed action would increase public confidence and enhance the protection of the public health and safety by providing that normal ventilation systems would be tested and inspected in accordance with up-to-date technical information, NRC positions, and NRC generic communications.

2. TECHNICAL APPROACH

Major technical questions related to normal ventilation system design, inspection, and testing were considered in developing the previous versions of Regulatory Guide 1.140. Revision 2 would address adoption of the recommendations in GL 99-02, “Laboratory Testing of Nuclear-Grade Activated Charcoal” (June 3, 1999); endorsement of ASME AG-1-1997, “Code on Nuclear Air and Gas Treatment”; ASME N509-1989, "Nuclear Power Plant Air-Cleaning Units and Components"; ASME N510-1989, "Testing of Nuclear Air-Treatment Systems"; the use of an alternative to DOP and Refrigerent-11 for in-place leak testing of HEPA filters and adsorbers; update the testing of new charcoal; and provide clarification.

3. PROCEDURAL APPROACH

3.1 Procedural Alternatives

NRC procedures that may be used for making this information available include:

* Regulation
* NUREG-series report
* Branch position paper
* Regulatory guide

A regulation is not suitable for incorporating the degree of detail presented in this guide. As regulatory positions are stated, it would be inappropriate to publish this material as a NUREG-series report. Branch technical positions (BTP) are sometimes prepared for specific guidance, however, it would be most appropriate to update Regulatory Guide 1.140 and prepare clear regulatory guidance for licensees and applicants in a generic format.

3.2 Decision on Procedural Approach

A revision to Regulatory Guide 1.140 should be prepared.

4. STATUTORY CONSIDERATIONS

4.1 NRC Authority

Authority for the proposed action is derived from the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974, as amended, and implemented through the Commission's regulations.

4.2 Need for NEPA Assessment

Issuance or amendment of guides for the implementation of regulations in Title 10, Chapter I, of the Code of Federal Regulations is a categorical exclusion under paragraph 51.22(c)(16) of 10 CFR Part 51. Thus, an environmental impact statement or assessment is not required for this action.

5. RELATIONSHIP TO OTHER EXISTING OR PROPOSED REGULATIONS OR POLICIES

General Design Criteria 60 and 61 of 10 CFR Part 50 Appendix A, "Domestic Licensing of Production and Utilization Facilities," require that filtering systems be included in the nuclear power unit design 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," require 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 is reasonably achievable.

6. CONCLUSIONS

Revision 2 of Regulatory Guide 1.140 should be issued to update the current staff positions and to inform its users of the current staff positions.