ASME N510-2007

(Revision of ASME N510-1989)

Testing of Nuclear Air Treatment Systems

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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Three Park Avenue • New York, NY 10016

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This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this document. Periodically certain actions of the ASME N510 Committee will be published as Cases. Cases and interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org as they are issued.

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

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FOREWORD

This Standard covers requirements for the field testing of ESF (Engineered Safety Feature) and other high-efficiency, air-cleaning systems designed to ASME N509 for nuclear power plants and other nuclear applications.

This Standard provides a basis for the development of test programs and detailed acceptance and surveillance test procedures and specifies minimum requirements for the reporting of test results.

This Standard was originally developed by the American National Standards Committee N45 on Reactor Plants. Following approval by the N45 Standards Committee, the first edition of the Standard was approved on June 19, 1975 by the American National Standards Institute, and designated ANSI N510-1975.

In 1975, the N45.8 Subcommittee was reorganized into the ASME Committee on Nuclear Air and Gas Treatment (CONAGT) and began operating under the ASME Procedures for Nuclear Projects, which received accreditation January 15, 1976. CONAGT was chartered to develop, review, maintain, and coordinate codes and standards for design, fabrication, installation, testing, and inspection of equipment for gas treatment for nuclear power plants.

Suggestions for improvement gained in the use of this Standard will be welcomed. They should be sent to the Secretary, Committee on Nuclear Air and Gas Treatment, The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016.

This Standard was approved by the ASME Committee on Nuclear Air and Gas Treatment and the ASME Board of Nuclear Codes and Standards and was subsequently approved as an American National Standard by the American National Standards Institute on September 24, 2007.

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TESTING OF NUCLEAR AIR TREATMENT SYSTEMS

1 SCOPE

This Standard covers in-service testing of ASME N509 high-efficiency air treatment systems for nuclear power plants.

1.1 Use of This Standard

This Standard provides a basis for the development of test programs and does not include acceptance criteria except where the results of one test influence the performance of other tests. Acceptance criteria shall be developed based on the design/function in accordance with ASME N509.

This Standard is arranged so that the user may select those portions (tests) that are relevant to their application. Tests should be performed in the sequence listed in Table 1. Table 1 also lists the recommended minimum frequency for performing these tests. The user must specify which tests shall be performed, and the acceptance criteria for those tests, in the test program.

1.2 Limitations of This Standard

This Standard covers the in-service (operational) testing of installed air treatment systems. This Standard shall be applied in its entirety to systems designed and built to ASME N509 specifications. Sections of this Standard may be used for technical guidance for testing air treatment systems designed to other criteria. ASME AG-1, Section TA covers the acceptance-testing program.

2 REFERENCES

The following references supplement this Standard and are part of it to the extent indicated in the text. The issue (date/revision) of the referenced document noted below shall be in effect. If no date is listed, then the issue of the referenced document in effect at the time of the purchase order shall apply. ASME AG-1 contains code requirements for nuclear air and gas treatment equipment. These code requirements may be substituted for the requirements listed herein.

Industrial Ventilation: A Manual of Recommended Practice (24th edition)

Publisher: American Conference of Governmental Industrial Hygienists (ACGIH), 1330 Kemper Meadow Drive, Cincinnati, OH 45240

ANS 3.1-1993, Selection, Qualification, and Training of Nuclear Power Plant Personnel

Publisher: American Nuclear Society (ANS), 555 North Kensington Avenue, LaGrange Park, IL 60526

ASME AG-1, Code on Nuclear Air and Gas Treatment

ASME N509, Nuclear Power Plant Air-Cleaning Units and Components

ASME N511, Standard for In-Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air Conditioning Systems

ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities

Publisher: The American Society of Mechanical Engineers (ASME), Three Park Avenue, New York, NY 10016-5990; Order Department: 22 Law Drive, P.O. Box 2300, Fairfield, NJ 07007-2300

ASTM D 3803-1991, Standard Test Method for Radioiodine Testing of Nuclear-Grade Gas Phase Adsorbents

Publisher: ASTM International (ASTM), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959

Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, 1998

Publisher: National Environmental Balancing Bureau (NEBB), 8575 Grovemont Circle, Gaithersburg, MD 20877

HVAC Systems Testing, Adjusting, and Balancing, 1993-2

Publisher: Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), 4201 Lafayette Center Drive, Chantilly, VA 20151-1209

3 DEFINITIONS

The definitions provided in this section supplement those listed in ASME AG-1, Section AA-1000.

activated carbon: an adsorbent of porous structure manufactured by carbonization of organic material and controlled oxidation to increase its microporosity, consisting mainly of elemental carbon in a porous structure.

adsorbent: any solid having the ability to concentrate other substances on its surface.

adsorber: a device or vessel containing adsorbent.

Table 1 Tests and Inspections With Recommended Frequencies

Test	Section of Standard	Recommended Frequency [Notes (1), (2)]
Visual inspection	5	Before each test series [Note (3)]
Duct leak test	6	Acceptance test [Note (4)]
Housing leak test	6	Acceptance test and at least once every 10 years [Note (4)]
Airflow capacity	7	Acceptance test [Note (4)] In-service test [Note (5)]
Air-aerosol mixing uniformity	8	Acceptance test [Note (4)]
In-service leak test, HEPA filters	9	In-service test, after each HEPA filter replacement and at least once each operating cycle [Notes (6), (7)]
In-service leak test, adsorbers	10	In-service test, after each adsorber filter replacement and at least once each operating cycle [Notes (6), (7)]
System bypass	11	In-service test, at least once each operating cycle [Note (6)]
Air heater performance	12	In-service test, at least once each operating cycle [Note (6)]
Laboratory tests of adsorbent	13	In-service test, at least once each operating cycle [Notes (8), (9)]

NOTES:
(1) Field testing of motors, valve and damper actuators, and fire protective systems are not covered by this Standard.
(2) Nonreactor facilities applying this Standard will need to develop other testing frequencies appropriate for their operational requirements. However, this Standard may be used for guidance for test frequencies of nonreactor facilities.
(3) Frequency of verifying loop seals and traps shall be evaluated by the owner to ensure integrity at all times.
(4) Acceptance tests to be performed after completion of initial construction, after any major system modification or repair, and as specified under Recommended Frequency in Table 1, in accordance with ASME N509.
(5) Airflow capacity for in-service testing is performed prior to any in-service leak tests per para. 7.5.
(6) Periodic in-service leak tests of systems located within reactor containments and used only for 100% recirculation are not necessary.
(7) Tests also to be performed immediately following inadvertent exposure to solvent, paints, other organic fumes, or water intrusion.
(8) Adsorbents shall be tested before installation or replacement to establish efficiency. Samples for laboratory testing should be taken before the routine in-place testing of the installed system to verify the condition of the adsorbent.
(9) Adsorbent is sampled and laboratory tests shall be made to confirm performance at intervals not exceeding 720 hr of system operation or for any system immediately following inadvertent exposure to solvent, paints, or other organic fumes or vapors which could degrade the performance of the adsorbent. The 720-hr requirement may be modified based on laboratory test history.

adsorber bank or filter bank: one or more filter or adsorber cells secured in a single mounting frame, or one or more side-by-side panels poured or packed air treatment media, confined within the perimeter of a duct, plenum, or vault cross section, sometimes referred to as a stage.

adsorber cell: a modular container for an adsorbent, with provision for sealing to a mounting frame, which can be used singularly or in multiples to build up a system of any airflow capacity.

aerosol: a stable suspension of particles, solid or liquid, in air.

aerosol detection instrument: an instrument capable of measuring challenge aerosol concentration with a linear range of at least 1 to 10^5.

challenge: to expose a filter, adsorber, or other air-cleaning device to an aerosol or gas of known characteristics, under specified conditions, for the purpose of testing.

challenge aerosol: the challenge aerosol used for in-place leak testing of installed HEPA filter systems.

challenge gas: a gas of known characteristics used for in-place testing of adsorbers.

dioctal phthalate (DOP): a chemical that, in aerosol form, is used to evaluate the efficiency of HEPA filters.

filter: a device that removes matter from a fluid, which passes through it.

halide gas detection instrument: an instrument capable of distinguishing halide challenge gas from background and detecting halide gas with a linear range of 1 to 10^5.

high-efficiency particulate air filter (HEPA filter): a disposable, extended media, dry type filter enclosed in a rigid casing that exhibits a minimum efficiency of 99.97% when tested with an essentially monodisperse 0.3 μm aerosol.

in-service leak test: a test to measure bypass leakage around or through a specified test boundary.

in-service test: a test to determine the operational readiness of a system or component.

operating cycle: a period of time, defined by the owner, not to exceed 24 months.

Refrigerant-11: challenge gas trichloromonofluoromethane (R-11).

Refrigerant-112: challenge gas tetrachlorodifluoromethane (R-112 or R-112A).

test boundary: the physical limit component, system, or device being subjected to a leakage test as defined in specific procedures.

test canister: a specially designed sample holder containing sufficient adsorbent for specific laboratory tests that can be removed from an adsorber bank, without disturbing the remainder of the adsorber, to provide representative samples for laboratory testing. A full-sized Type II adsorber tray may be removed and used to obtain material for specific laboratory tests provided that an in-place leak test is performed after replacement.

test program: a schedule that specifies tests and the sequence of tests to be made for the evaluation of a total air- or gas-cleaning system.

4 GENERAL

This Standard delineates the requirements for in-service testing of nuclear air-cleaning systems. Acceptance testing is covered in ASME AG-1. A list of the required in-service tests and the minimum performance frequency of these tests are shown in Table 1.

4.1 Test Procedure

Procedures shall be prepared for each required test, based upon the requirements of this Standard.

4.2 Personnel

Only persons who have demonstrated the competence to satisfactorily perform the specific tests in question as evidenced by experience and training shall perform tests. Personnel shall be certified in accordance with ASME NQA-1 or ANS 3.1 and with the owner's design specifications and quality assurance program.

4.3 Instrumentation: Permanent

Permanent instrumentation used in the performance of tests specified in this Standard shall meet the accuracy requirements specified in Table 2 and shall be calibrated in accordance with the owner's design specifications and quality assurance program.

4.4 Instrumentation: Portable

Portable instrumentation used in the performance of the tests specified in this Standard shall meet the accuracy requirements specified in Table 2 and shall be calibrated in accordance with the owner's design specifications and quality assurance program.

5 VISUAL INSPECTION

5.1 Purpose

A visual inspection of the air treatment system, as specified by the test program, shall be made in conjunction with each test series to identify visual deficiencies prior to commencing tests. In addition, this inspection may be used to verify that the system design and construction are in accordance with ASME N509.

5.2 Summary of Method

Visual inspection shall be performed under a combination of background light plus supplementary light that provides adequate illumination of the surface to be inspected.

5.3 Prerequisites

Construction, modification, and/or repairs shall be completed to the extent of supporting the test series.

5.4 Apparatus (Equipment)

Supplementary light providing adequate illumination of the surface to be inspected is required.

5.5 Procedure

Visual inspections shall be conducted in accordance with ASME N511. Whenever "unacceptable" is used, it is intended to mean any damage or condition that would impair the ability of the item to perform its function.

5.6 Acceptance Criteria

Inspection results are acceptable when there are no indications of improper installation, physical damage, structural distress, or degradation that would impair the ability of the system to perform its intended function.

5.7 Report

A written report shall be prepared in accordance with section 14. Items identified as unacceptable should be further documented in the comment section of the test report to assist the owner in preparation of corrective action.

6 DUCT AND HOUSING LEAK TEST

6.1 Purpose

These tests are used to verify the leak tightness of the housings and ducts.

6.2 Summary of Method

The ductwork or housing is pressurized to determine leak tightness. The leakage shall be determined using either the pressure decay or constant pressure method.

6.3 Prerequisites

Construction, modifications, and repairs affecting the test boundary shall be complete. All electrical, piping,

Table 2 Instrument Accuracy Requirements

Measurement	Range	Accuracy [Note (1)]
Pressure	From 1 in. wg to 1 psig [0.25 kPa to 7 kPa (gage)]	±2%
Pressure	From 0.1 in. wg to 1 in. wg [25 Pa to 250 Pa (gage)]	±0.01 in. wg (±2.5 Pa)
Temperature	Variable	±2°F (±1°C)
Temperature [Note (2)]	Variable	±0.5°F (±0.25°C)
Flow	Variable	±5%
Velocity (airflow)	Variable	±3%
Time	Variable	±1 sec
Electrical voltage	Variable	±1%
Electrical amperage	Variable	±1%
Electrical resistance	Variable	±1%
Challenge aerosol concentration [Note (3)]	1 to 10^5	±2%
Challenge gas concentration [Note (4)]	1 to 10^5	±2%

NOTES:
(1) References as percent of full scale unless otherwise noted.
(2) Required for pressure testing in section 6, Duct and Housing Leak Test.
(3) The challenge aerosol detection instrument shall have a linear range of at least 10^5 times the minimum detectable quantity.
(4) The challenge gas detection instrument shall have a linear range of at least 10^5 times the minimum detectable quantity of the instrument.

and instrument connections shall be complete and all permanent seals installed before the test is started.

6.4 Apparatus

(a) fan with flow control
(b) flow meter or totalizing gas meter (constant pressure method)
(c) temperature-indicating device
(d) pressure-indicating device
(e) covers to seal test boundaries
(f) clock or timer

6.5 Procedure

Duct and housing leak tests shall be performed in accordance with ASME N511.

6.6 Acceptance Criteria

Duct and housing leak test results are acceptable when there are no leaks in excess of the limits specified in ASME AG-1 or the owner's design specification.

6.7 Report

A written report shall be prepared in accordance with section 14.

7 AIRFLOW CAPACITY TEST

7.1 Purpose

The purpose of this test is to verify that the system is operating within the design airflow capacity range as specified in the owner's design specification.

7.2 Summary of Method

Measure the average velocity of the air stream in a duct, and calculate the volumetric flow rate.

7.3 Prerequisites

All construction, modifications, and repairs affecting the system shall be complete.

7.4 Apparatus

(a) Pitot tube or equivalent (length as required)
(b) pressure-indicating device (e.g., inclined or electronic manometer)
(c) rotating vane, heated wire, or heated thermocouple anemometer or other suitable measuring instrument

7.5 Procedure

Airflow capacity tests shall be performed in accordance with ASME N511.

7.6 Acceptance Criteria

Airflow capacity shall be within ±10% of the value specified in the test program or owner's design specifications. For systems with carbon adsorbers, the maximum velocity of air through the adsorbers shall be limited to that value (±10%) specified in the laboratory test section (section 13).

7.7 Report

A written report shall be prepared in accordance with section 14.

8 AIR-AEROSOL MIXING UNIFORMITY TEST

8.1 Purpose

This test verifies that challenge agent injection point or manifold is located to provide uniform mixing of the challenge agent upstream of the HEPA or adsorber stage to be tested with the system operating at its design flow rate (±10%). Uniform air-aerosol mixing ensures that all areas of the bank are challenged during in-place testing. These tests are normally performed during acceptance testing and are not required to be reperformed unless system modifications have been performed to invalidate previous testing or the injection point is being changed.

8.2 Summary of Method

The system is operated within the design flow range. Challenge aerosol or gas is injected through an injection port upstream of the bank. Challenge aerosol or gas concentration readings are taken at equal cross-sectional areas in front of the HEPA filter or adsorber bank. Each reading is compared with the average reading for the bank to qualify the injection point.

8.3 Prerequisites

All construction, modifications, and repair to the system shall be complete.

8.4 Apparatus

(a) challenge aerosol or gas (see paras. 9.4.1 and 10.4.1)
(b) challenge aerosol or gas generator
(c) challenge aerosol or gas-measuring instrument

8.5 Procedure

Air-aerosol mixing tests shall be performed in accordance with ASME N509.

8.6 Acceptance Criteria

No reading shall exceed ±20% of the calculated average.

8.7 Reporting

A written report shall be prepared in accordance with section 14.

9 HEPA FILTER BANK IN-SERVICE LEAK TEST

9.1 Purpose

This test is used for the leak testing of the installed HEPA filter bank.

NOTE: Challenge aerosol leak testing of other non-HEPA (pre-filters) is not required.

9.2 Summary of Method

The system is operated at the design flow rate (±10%). A challenge aerosol (e.g., DOP) is injected into the air stream upstream of the HEPA filter bank through the qualified injection port or manifold. Concentrations are measured upstream and downstream of the filter bank. The HEPA bank leak rate is determined from the ratio of the downstream to upstream concentrations.

9.3 Prerequisites

The injection and sample point shall be qualified per ASME N509.

9.4 Apparatus

(a) Challenge aerosol (e.g., DOP aerosol) for in-place leak testing of installed HEPA filter systems shall be a polydispersed liquid aerosol having an approximate light-scattering droplet size distribution as follows:
(1) 99% less than 3 μm diameter
(2) 50% less than 0.7 μm diameter
(3) 10% less than 0.4 μm diameter
(b) challenge aerosol generator
(c) challenge aerosol-measuring instrument

NOTE: Sample line length should be minimized to reduce sample response time, and the lengths of the lines shall be approximately equal.

9.5 Procedure

HEPA bank in-service leak tests shall be performed in accordance with ASME N511.

9.6 Acceptance Criteria

The leakage shall be within the criteria specified in the test program or owner's design specifications.

9.7 Report

A written report shall be prepared in accordance with section 14.

10 ADSORBER BANK IN-SERVICE LEAK TEST

10.1 Purpose

This test is used for the leak testing of the installed adsorber bank.

10.2 Summary of Method

The system is operated at the design flow rate (±10%). A challenge gas (e.g., R-11) is injected into the air stream upstream of the adsorber bank through the qualified injection port or manifold. Concentrations are measured upstream and downstream of the bank. The adsorber bank leak rate is determined from the ratio of downstream to upstream concentration.

10.3 Prerequisites

The injection and sample points shall be qualified per ASME N509.

10.4 Apparatus

(a) Challenge gas (e.g., R-11) is a halogenated hydrocarbon gas of known characteristics, under specified conditions, used for in-place testing of adsorbers. An acceptable substitute may be used. (For challenge gas substitution selection criteria, refer to ASME AG-1.)

(b) challenge gas-measuring instrument

(c) challenge gas generator

NOTES:

(1) Sample line lengths should be minimized to reduce sample response time and of approximately equal lengths to eliminate time delay errors.

(2) It may be necessary to operate the system for a period of time to purge residual challenge gas remaining from a prior test or reduce background concentrations to acceptable values.

10.5 Procedure

Adsorber bank in-service leak tests shall be performed in accordance with ASME N511.

10.6 Acceptance Criteria

The leakage shall be within the criteria specified in the test program or owner's design specifications.

10.7 Report

A written report shall be prepared in accordance with section 14.

11 SYSTEM BYPASS TEST

11.1 Purpose

This test is used to verify all potential HEPA filter bank and adsorber filter bank leakage paths, including housing bypass ducts and associated dampers, conduits, floor drains, and pipe penetrations are tested to ensure the total bank leak rate is within the owner's design specifications. If the performance of sections 9 and 10 can be documented to challenge all potential leak paths, the system bypass test requirements are satisfied.

11.2 Summary of Method

The challenge aerosol or gas method requires the injection and sample points be selected to disclose any potential leak paths. The test is then performed in the same manner as section 9 or 10.

For damper or valve testing, there are two equally appropriate methods, depending on the type of damper or valve to be leak tested. For low-leakage valves, a pressure decay test is usually the method of choice. For higher leakage devices (a few tenths of a percent of rated flow or greater), a challenge aerosol or gas test may be more convenient. If a challenge aerosol or gas test is specified, only one damper at a time is to be tested. The method shall be defined in the test program or owner's design specifications.

NOTE: The pressure decay method may not be adequate to identify bypass leakage if the duct leakage acceptance criterion allows a higher leak rate for the duct than the damper criterion. When the challenge aerosol test is used, the duct size and expected leakage range must be considered for the purpose of estimating aerosol transit time from the damper boundary to the downstream test port location.

11.3 Prerequisites

For a challenge aerosol or gas test, the injection and sample points shall be qualified per ASME AG-1.

11.4 Apparatus

11.4.1 For a challenge aerosol or gas leak test, the equipment shall be listed in section 9 or 10, respectively.

11.4.2 For a pressure decay leak test, the equipment shall be listed in section 6.

11.5 Procedure

11.5.1 For a challenge aerosol or gas leak test, the procedure shall be in accordance with section 9 or 10, respectively.

11.5.2 For a pressure decay leak test, the procedure shall be in accordance with section 6.

11.6 Acceptance Criteria

The leakage shall be within the criteria specified in the test program or owner's design specifications.

NOTE: The leakage value for bypass shall be added to the leak rate result measured in section 9 or 10, or both, if the bypass is not challenged when challenging the filter banks.

11.7 Report

A written report shall be prepared in accordance with section 14.

12 AIR HEATER PERFORMANCE TEST

12.1 Purpose

This test is used to verify that the nuclear air treatment system air heater performance, at the design flow rate (±10%), meets the test program or owner's design specifications.

12.2 Summary of Method

Power-on electrical (voltage and amperage measurements) and mechanical tests shall be performed to verify correct operation and condition of the air heater.

12.3 Prerequisites

Visual inspection of the heater shall be completed.

12.4 Apparatus

(a) clamp-on ammeter and voltmeter

(b) temperature-indicating device

12.5 Procedure

The air heater performance tests shall be performed in accordance with ASME N511.

12.6 Acceptance Criteria

Operating currents, voltages, and changes in temperature shall be within the limits of the test program or owner's design specifications.

12.7 Report

A written report shall be prepared in accordance with section 14.

13 LABORATORY TESTING OF ADSORBENT

13.1 Purpose

A laboratory test shall be performed to verify the acceptability of the adsorbent, in the adsorber bank, on periodically withdrawn samples.

13.2 Summary of Method

Adsorbent samples shall be tested in the laboratory to determine the overall efficiency of the entire bank for the retention of radioiodine.

13.3 Prerequisites

Refer to Table 1, Notes (6) and (7).

13.4 Apparatus

The laboratory apparatus required for the performance of this test is specified by reference in ASME N511.

13.5 Procedure

The adsorbent sample(s) shall be tested in accordance with ASME N511.

13.6 Acceptance Criteria

Adsorbent test criteria shall be as stated in the test program or owner's design specifications.

13.7 Report

A written report shall be prepared in accordance with section 14.

14 REPORTS

A written report shall be provided to document the in-service testing performed. The report shall conform to the facility's test program and contain, as a minimum, the following:

(a) the system name, test/inspection procedure(s) used, date of test, results, and the user's signature

(b) identification of the instruments, equipment, tools, and documents to the extent that they, or their equivalent, can be identified for future examinations

(c) observations and dimensional checks specified by the respective test data and any reports developed during the inspection and testing

(d) conclusions and recommendations by visual examinations and testing personnel

(e) reference to previous reports, if this report is for reinspection and testing

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