ASME AG-1–2017
(Revision of ASME AG-1–2015)

# Code on Nuclear Air and Gas Treatment

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

ASME AG-1–2017
(Revision of ASME AG-1–2015)

# Code on Nuclear Air and Gas Treatment

AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

Date of Issuance: February 9, 2018

The next edition of this Code is scheduled for publication in 2020.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Code. Periodically certain actions of the ASME Committee on Nuclear Air and Gas Treatment may 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.

Errata to codes and standards may be posted on the ASME Web site under the Committee Pages to provide corrections to incorrectly published items, or to correct typographical or grammatical errors in codes and standards. Such errata shall be used on the date posted.

The Committee Pages can be found at http://cstools.asme.org/. There is an option available to automatically receive an e-mail notification when errata are posted to a particular code or standard. This option can be found on the appropriate Committee Page after selecting “Errata” in the “Publication Information” section.

ASME is the registered trademark of The American Society of Mechanical Engineers.

This code or standard was developed under procedures accredited as meeting the criteria for American National Standards. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not “approve,” “rate,” or “endorse” any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.

No part of this document may be reproduced in any form,
in an electronic retrieval system or otherwise,
without the prior written permission of the publisher.

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

Copyright © 2018 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved
Printed in U.S.A.

# CONTENTS

**Figures**

**Tables**

**Forms**

# FOREWORD

In 1971, the ANSI N45.8 Committee was organized to develop standards for high reliability air cleaning equipment for nuclear facilities and corresponding tests to confirm performance of the equipment. Two standards, ASME N509 and ASME N510, were published in 1975 and 1976.

In 1976, under the accredited organization rules, the Committee was reorganized as the ASME Committee on Nuclear Air and Gas Treatment. The scope of responsibility increased to include the development of codes and standards for design, fabrication, inspection, and testing of air cleaning and conditioning components and appurtenances used in safety-related systems in nuclear facilities. ASME AG-1 was the new Code resulting from the increased scope.

This Code contains mandatory requirements, specific prohibitions, and nonmandatory guidance for construction activities. Construction, as used in this Foreword, is an all-inclusive term relating to material, design, fabrication, inspection, testing, and certification. The Code does not address all aspects of these activities and those not specifically addressed may be considered. The Code is neither a handbook nor a replacement for education, experience, and the use of engineering judgment. The phrase "engineering judgment" refers to technical judgments made by knowledgeable designers experienced in the application of the Code. Engineering judgments must be consistent with Code philosophy and such judgments shall never be used to overrule mandatory requirements or specific prohibitions of the Code. The user is cautioned to carefully review these Code requirements for suitability to specific applications other than nuclear power and nuclear fuel cycle facilities.

The Code requirements established by the Committee shall not be interpreted as approving, recommending, or endorsing any proprietary design.

The Committee on Nuclear Air and Gas Treatment meets regularly to consider revisions of the Code requirements, new Code requirements as dictated by technological development, Code Cases, and requests for interpretations. Only the Committee on Nuclear Air and Gas Treatment has the authority to provide official interpretations of this Code. Requests for revisions, new Code requirements, Code Cases, or interpretations shall be addressed to the Secretary in writing and shall give full particulars in order to receive consideration and action. (See the Correspondence With the Committee page.)

The first edition of this Code was approved by the American National Standards Institute (ANSI) on April 30, 1985, and issued on February 28, 1986. This edition was approved by ANSI on May 22, 2017.

# ASME COMMITTEE
# ON NUCLEAR AIR AND GAS TREATMENT

(The following is the roster of the Committee at the time of approval of this Code.)

## STANDARDS COMMITTEE

**R. R. Bellamy,** *Chair,* Camfil USA, Inc.
**E. M. Banks,** *Vice Chair,* NUCON International, Inc.
**H. A. Mearns,** *Vice Chair,* Department of Homeland Security, Science and Technology, Chemical Security Analysis Center
**O. Martinez,** *Secretary,* The American Society of Mechanical Engineers
**K. Verderber,** *Secretary,* The American Society of Mechanical Engineers
**D. J. Adamson,** Savannah River National Laboratory
**R. K. Aggarwal,** Sargent & Lundy, LLC
**T. B. Axley, Jr.,** Consultant
**J. O. Bettle,** U.S. Nuclear Regulatory Commission
**M. A. Doersam,** Ellis & Watts Global Industries, Inc.
**M. J. Fox,** ECU Corp.
**B. Franklin**
**D. Ghosh,** Southern Nuclear
**C. E. Graves,** NUCON International, Inc.
**M. R. Hahn,** U.S. Department of Energy
**M. R. Hargan,** Hargan Engineering
**J. R. Hunt,** NCS Corp.
**R. T. Jubin,** Oak Ridge National Laboratory
**A. M. Kouvolo,** Consultant
**G. G. Pyle,** Knolls Atomic Power Laboratory
**C. I. Ricketts,** New Mexico State University
**J. B. Roberts,** National Security Technologies, LLC
**J. C. Royer,** Sargent & Lundy, LLC
**A. Stillo,** Camfil USA, Inc.
**T. J. Vogan,** Consultant
**C. A. Waggoner,** Mississippi State University — Institute for Clean Energy Technology
**N. S. Zaremba,** Newport News Shipbuilding
**N. J. Cocklin,** *Delegate,* Cavendish Nuclear
**A. Soma,** *Contributing Member,* Camfil USA, Inc.
**R. R. Sommer II,** *Contributing Member,* NUCON International, Inc.

## EXECUTIVE COMMITTEE

**E. M. Banks,** *Chair,* NUCON International, Inc.
**H. A. Mearns,** *Chair,* Department of Homeland Security, Science and Technology, Chemical Security Analysis Center
**R. R. Bellamy,** *Vice Chair,* Camfil USA, Inc.
**O. Martinez,** *Secretary,* The American Society of Mechanical Engineers
**K. Verderber,** *Secretary,* The American Society of Mechanical Engineers
**M. A. Doersam,** Ellis & Watts Global Industries, Inc.
**D. Ghosh,** Southern Nuclear
**R. T. Jubin,** Oak Ridge National Laboratory
**J. C. Royer,** Sargent & Lundy, LLC
**A. Soma,** Camfil USA, Inc.
**T. J. Vogan,** Consultant
**N. S. Zaremba,** Newport News Shipbuilding

## CONAGT HONORARY MEMBERS

**J. R. Edwards,** Consultant
**M. W. First,** Harvard School of Public Health Air Cleaning Laboratory
**J. L. Kovach,** NUCON International, Inc.
**R. Porco,** RDP Consulting Services
**D. J. Gladden**
**C. Golden,** Whirlpool Corp.
**L. J. Klaes,** Consultant
**W. H. Miller, Jr.**
**S. C. Ornberg,** Consultant
**R. R. Weidler,** Consultant

## SUBCOMMITTEE ON ADSORPTION

**E. M. Banks,** *Chair,* NUCON International, Inc.
**A. Soma,** *Vice Chair,* Camfil USA, Inc.
**R. K. Aggarwal,** Sargent & Lundy, LLC
**R. R. Bellamy,** Camfil USA, Inc.
**R. Blose,** SSM Industries, Inc.
**N. J. Cockin,** Cavendish Nuclear
**M. A. Doersam,** Ellis & Watts Global Industries, Inc.
**W. P. Freeman,** Jacobi
**C. E. Graves,** NUCON International, Inc.
**R. T. Jubin,** Oak Ridge National Laboratory
**C. B. Summers,** NUCON International, Inc.
**D. Gibbs,** *Contributing Member,* Camfil USA, Inc.

## SUBCOMMITTEE ON COMMON EQUIPMENT

**M. A. Doersam,** *Chair,* Ellis & Watts Global Industries, Inc.
**L. Krooswyk,** *Vice Chair,* Burns & McDonnell
**J. M. Apablaza-Lorca,** Washington River Protection Solutions, LLC
**T. B. Axley, Jr.,** Consultant
**R. Flye,** Washington River Protection Solutions, LLC
**D. Gibbs,** Camfil USA, Inc.
**N. Handschke,** American Air Filter
**Z. Hostetler,** SSM Industries
**S. Khabir,** Washington River Protection Solutions/Hanford
**W. H. Lampkin,** Greenheck Fan Corp.
**D. S. Maletich,** The New York Blower Co.
**C. Massar,** Ruskin Co.
**J. B. Roberts,** National Security Technologies, LLC
**J. C. Royer,** Sargent & Lundy, LLC
**A. Soma,** Camfil USA, Inc.
**M. T. Sorna,** Puget Sound Naval Shipyard
**M. G. Wiltfong,** Ruskin Co.
**D. Schoepflin,** *Contributing Member,* Washington River Protection Solutions
**G. D. Singleton,** *Contributing Member,* AAF International

## SUBCOMMITTEE ON FILTRATION

**H. A. Mearns,** *Chair,* Department of Homeland Security, Science and Technology, Chemical Security Analysis Center
**A. Stillo,** *Vice Chair,* Camfil USA, Inc.
**D. J. Adamson,** Savannah River National Laboratory
**W. Bergman,** Aerosol Science
**S. Dinakaran,** Flanders Filters
**D. M. Dykes,** Consultant
**G. Garcia,** Bechtel National, Inc.
**M. R. Hahn,** U.S. Department of Energy
**C. A. Hart,** Air Techniques International Test Laboratory
**S. Jaganathan,** Hollingsworth and Vose
**J. Levinson,** Newport News Shipbuilding
**L. E. Major,** Lydall
**M. A. Mitchell,** Lawrence Livermore National Laboratory
**G. W. Moore,** Camfil USA, Inc.
**D. P. Nguyen,** U.S. Army Edgewood Chemical Biological Center
**G. G. Pyle,** Knolls Atomic Power Laboratory
**C. I. Ricketts,** New Mexico State University
**K. L. Rubow,** Mott Corp.
**S. R. Salisbury,** Los Alamos National Laboratory
**J. W. Slawski,** Federal Aviation Administration
**J. A. Stormo,** Mississippi State University — Institute for Clean Energy Technology
**C. A. Waggoner,** Mississippi State University — Institute for Clean Energy Technology
**M. S. Win,** U.S. Army Edgewood Chemical Biological Center
**N. S. Zaremba,** Newport News Shipbuilding
**J. S. MacMurray,** *Contributing Member,* Savannah River National Laboratory
**D. Schoepflin,** *Contributing Member,* Washington River Protection Solutions
**S. K. Sen,** *Contributing Member,* U.S. Department of Energy
**L. D. Weber,** *Contributing Member,* Stony Brook University

## SUBCOMMITTEE ON GAS PROCESS TREATMENT EQUIPMENT

**R. T. Jubin,** *Chair,* Oak Ridge National Laboratory
**M. R. Hargan,** *Vice Chair,* Hargan Engineering
**T. B. Axley, Jr.,** Consultant
**M. Bauer,** Westinghouse Electric Germany Gmbh
**S. Brink,** Australian Nuclear Science and Technology Organisation
**M. J. Fox,** ECU Corp.
**D. Ghosh,** Southern Nuclear
**D. Klein,** AREVA NP, Inc.
**J. R. Kriskovich,** Kurion, Inc.
**D. Ryland,** Canadian Nuclear Laboratories
**M. Sulva,** Fluor Corp.
**B. K. Austin,** *Contributing Member,* URS Corp.
**C. A. Curtis,** *Contributing Member,* West Valley Nuclear
**W. P. Drosjack,** *Contributing Member,* Consultant
**I. Kutuzov,** *Contributing Member,* Alfa Laval, Inc. (Canada)

## SUBCOMMITTEE ON GENERAL SUPPORT SERVICES

**J. C. Royer,** *Chair,* Sargent & Lundy, LLC
**R. K. Aggarwal,** *Vice Chair,* Sargent & Lundy, LLC
**J. O. Bettle,** U.S. Nuclear Regulatory Commission
**M. A. Doersam,** Ellis & Watts Global Industries, Inc.
**R. Flye,** Washington River Protection Solutions, LLC
**B. Franklin**
**D. J. Grover,** Defense Nuclear Facilities Safety Board
**S. Khabir,** Washington River Protection Solutions/Hanford
**M. Kmetz,** Bechtel
**K. G. Nelson,** Porvair Filtration Group, Inc.
**G. Roca,** Westinghouse Electric Spain
**T. J. Schaefer,** Sargent & Lundy, LLC
**M. Sulva,** Fluor Corp.
**T. J. Vogan,** Consultant
**W. F. Williams, Jr.,** AREVA NP, Inc.
**R. Blose,** *Contributing Member,* SSM Industries, Inc.

## SUBCOMMITTEE ON TECHNOLOGY

**A. Soma,** *Chair,* Camfil USA, Inc.
**N. S. Zaremba,** *Vice Chair,* Newport News Shipbuilding
**R. K. Aggarwal,** Sargent & Lundy, LLC
**T. B. Axley, Jr.,** Consultant
**E. M. Banks,** NUCON International, Inc.
**D. Ghosh,** Southern Nuclear

**C. E. Graves,** NUCON International, Inc.
**J. R. Kriskovich,** Kurion, Inc.
**J. C. Medley,** National Security Technologies, LLC
**D. P. Nguyen,** U.S. Army Edgewood Chemical Biological Center
**J. C. Royer,** Sargent & Lundy, LLC
**R. R. Sommer II,** NUCON International, Inc.
**C. B. Summers,** NUCON International, Inc.
**T. J. Vogan,** Consultant
**C. A. Waggoner,** Institute for Clean Energy Technology

## SUBCOMMITTEE ON TESTING AND INSPECTION

**N. S. Zaremba,** *Chair,* Newport News Shipbuilding
**J. C. Medley,** *Vice Chair,* National Security Technologies, LLC
**E. M. Banks,** NUCON International, Inc.
**S. Barnette,** U.S. Department of Energy
**K. S. Eng,** U.S. Army Research, Development and Engineering Command
**R. Flye,** Washington River Protection Solutions, LLC
**M. R. Hahn,** U.S. Department of Energy
**J. Hunt,** NCS Corp.
**S. Khabir,** Washington River Protection Solutions/Hanford
**J. Levinson,** Newport News Shipbuilding
**J. S. MacMurray,** Savannah River National Laboratory
**G. G. Pyle,** Knolls Atomic Power Laboratory
**D. Scheopflin,** Washington River Protection Solutions, LLC
**R. R. Sommer II,** NUCON International, Inc.
**M. T. Sorna,** Puget Sound Naval Shipyard
**G. L. Laws,** *Contributing Member,* Washington State Department of Health — Radiation Protection
**D. P. Nguyen,** *Contributing Member,* U.S. Army Edgewood Chemical Biological Center
**G. D. Singleton,** *Contributing Member,* AAF International

## SUBCOMMITTEE ON VENTILATION AIR CONDITIONING EQUIPMENT

**D. Ghosh,** *Chair,* Southern Nuclear
**M. J. Fox,** *Vice Chair,* ECU Corp.
**T. B. Axley, Jr.,** Consultant
**B. C. Elliott,** Super Radiator Coils
**M. R. Hargan,** Hargan Engineering
**R. Kim,** Finetec Century America, Inc.
**T. J. Schafer,** Sargent & Lundy, LLC
**C. Wojcik,** PMT Nuclear
**W. P. Drosjack,** *Contributing Member,* Consultant
**R. N. Knoche,** *Contributing Member,* Consultant
**I. Kutuzov,** Alfa Laval, Inc. (Canada)
**T. A. Meisner,** *Contributing Member,* Consultant
**G. Roca,** *Contributing Member,* Westinghouse Electric Spain

# CORRESPONDENCE WITH THE COMMITTEE ON NUCLEAR AIR AND GAS TREATMENT

**General.** ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Code may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, Standards Committee on Nuclear Air and Gas Treatment
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

**Proposing Revisions.** Revisions are made periodically to the Code to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Code. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Code. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

**Proposing a Case.** Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee Web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Code and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Code to which the proposed Case applies.

**Interpretations.** Upon request, the Standards Committee on Nuclear Air and Gas Treatment (CONAGT) will render an interpretation of any requirement of the Code. Interpretations can only be rendered in response to a written request sent to the Secretary of CONAGT.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may mail the request to the Secretary of CONAGT at the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

| | |
|---|---|
| Subject: | Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words. |
| Edition: | Cite the applicable edition of the Code for which the interpretation is being requested. |
| Question: | Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a "yes" or "no" reply is acceptable. |
| Proposed Reply(ies): | Provide a proposed reply(ies) in the form of "Yes" or "No," with explanation as needed. If entering replies to more than one question, please number the questions and replies. |
| Background Information: | Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information. |

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

Moreover, ASME does not act as a consultant for specific engineering problems or for the general application or understanding of the Code requirements. If, based on the inquiry information submitted, it is the opinion of the Committee that the Inquirer should seek assistance, the inquiry will be returned with the recommendation that such assistance be obtained.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

**Attending Committee Meetings.** CONAGT regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of CONAGT.

# ORGANIZATION OF ASME AG-1

**1. GENERAL** The ASME Code on Nuclear Air and Gas Treatment consists of Divisions I through IV. All divisions are broken down into sections designated by two capital letters. Each division is made up as follows:

Division I: General Requirements
- Section AA: Common Articles

Division II: Ventilation Air Cleaning and Ventilation Air Conditioning
- Section BA: Fans and Blowers
- Section DA: Dampers and Louvers
- Section SA: Ductwork
- Section HA: Housings
- Section RA: Refrigeration Equipment
- Section CA: Conditioning Equipment
- Section FA: Moisture Separators
- Section FB: Medium Efficiency Filters
- Section FC: HEPA Filters
- Section FD: Type II Adsorber Cells
- Section FE: Type III Adsorbers
- Section FF: Adsorbent Media
- Section FG: Mounting Frames for Air-Cleaning Equipment
- Section FH: Other Adsorbers
- Section FI: Metal Media Filters
- Section FJ: Low Efficiency Filters
- Section FK: Special HEPA Filters
- Section FL: Deep Bed Sand Filters
- Section FM: High-Strength HEPA Filters
- Section IA: Instrumentation and Controls

Division III: Process Gas Treatment
- Section GA: Heat Exchangers
- Section GB: Noble Gas Hold-Up Equipment
- Section GC: Gas Compressors and Exhausters
- Section GD: Other Radionuclide Equipment
- Section GE: Hydrogen Recombiners and Igniters
- Section GF: Gas Sampling
- Section GG: Scrubbers
- Section GH: Cyclones
- Section GI: Membranes
- Section GJ: Filters
- Section GK: Mist Eliminators
- Section GL: Elastomeric Precipitators
- Section GM: Noble Gas Hold-Up Media

Division IV: Testing Procedures
- Section TA: Field Testing of Air Treatment Systems
- Section TB: Field Testing of Gas-Processing Systems

**2. SECTIONS** Sections are divided into articles, subarticles, paragraphs, and, where necessary, subparagraphs and subsubparagraphs.

**3. ARTICLES** Articles are designated by the application letters indicated above for the sections, followed by Arabic numbers in units of 1000, such as BA-1000 or RA-2000. Where possible, articles dealing with the same topics are given the same number in each section in accordance with the following:

| Article Number | Title |
|---|---|
| 1000 | Introduction |
| 2000 | Referenced Documents |
| 3000 | Materials |
| 4000 | Structural Design |
| 5000 | Inspection and Testing |
| 6000 | Fabrication, Joining, Welding, Brazing, Protective Coating, and Installation |
| 7000 | Packaging, Shipping, Receiving, Storage, and Handling |
| 8000 | Quality Assurance |
| 9000 | Nameplates and Stamping |

The numbering of articles and the material contained in the articles may not, however, be consecutive. Because the complete outline may cover phases not applicable to a particular section or article, the rules have been prepared with some gaps in the numbering.

**4. SUBARTICLES** Subarticles are numbered in units of 100, such as BA-1100 or RA-1200.

**5. SUBSUBARTICLES** Subsubarticles are numbered in units of 10, such as BA-2130, and generally have no text. When a number such as BA-1110 is followed by text, it is considered a paragraph.

**6. PARAGRAPHS** Paragraphs are numbered in units of 1, such as BA-2131 or RA-2132.

**7. SUBPARAGRAPHS** Subparagraphs, when they are major subdivisions of a paragraph, are designated by adding a decimal followed by one or more digits to the paragraph number, such as BA-1111.1 or RA-1111.2. When they are minor subdivisions of a paragraph, subparagraphs may be designated by lowercase letters in parentheses, such as BA-1111(a) or RA-1111(b).

**8. SUBSUBPARAGRAPHS** Subsubparagraphs are designated by adding lowercase letters in parentheses to major subparagraph numbers, such as BA-1111.1(a)