This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

ANS

Determining Meteorological Information at Nuclear Facilities

REAFFIRMED

May 21, 2020

ANSI/ANS-3.11-2015 (R2020)

ANSI/ANS-3.11-2015

An American National Standard

This standard has been reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn. The requirements of this document will be met by using the version of the standards and documents referenced herein. It is the responsibility of the user to review each of the references and to determine whether the use of the original references or more recent versions is appropriate for the facility. Variations from the standards and documents referenced in this standard should be evaluated and documented.
This standard does not necessarily reflect recent industry initiatives for risk informed decision-making or a graded approach to quality assurance. Users should consider the use of these industry initiatives in the application of this standard.

Published by the
American Nuclear Society
555 N. Kensington Ave
La Grange Park, IL 60526

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

ANSI/ANS-3.11-2015

American National Standard Determining Meteorological Information at Nuclear Facilities

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-3.11

Published by the
American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

Approved August 20, 2015
by the
American National Standards Institute, Inc.

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

American National Standard

Designation of this document as an American National Standard attests that the principles of openness and due process have been followed in the approval procedure and that a consensus of those directly and materially affected by the standard has been achieved.

This standard was developed under the procedures of the Standards Committee of the American Nuclear Society; these procedures are accredited by the American National Standards Institute, Inc., as meeting the criteria for American National Standards. The consensus committee that approved the standard was balanced to ensure that competent, concerned, and varied interests have had an opportunity to participate.

An American National Standard is intended to aid industry, consumers, governmental agencies, and general interest groups. Its use is entirely voluntary. The existence of an American National Standard, in and of itself, does not preclude anyone from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard.

By publication of this standard, the American Nuclear Society does not insure anyone utilizing the standard against liability allegedly arising from or after its use. The content of this standard reflects acceptable practice at the time of its approval and publication. Changes, if any, occurring through developments in the state of the art, may be considered at the time that the standard is subjected to periodic review. It may be reaffirmed, revised, or withdrawn at any time in accordance with established procedures. Users of this standard are cautioned to determine the validity of copies in their possession and to establish that they are of the latest issue.

The American Nuclear Society accepts no responsibility for interpretations of this standard made by any individual or by any ad hoc group of individuals. Responses to inquiries about requirements, recommendations, and/or permissive statements (i.e., "shall," "should," and "may," respectively) should be sent to the Standards Department at Society Headquarters. Action will be taken to provide appropriate response in accordance with established procedures that ensure consensus.

Comments on this standard are encouraged and should be sent to Society Headquarters.

Published by

American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA

This document is copyright protected.
Copyright © 2015 by American Nuclear Society. All rights reserved.

Any part of this standard may be quoted. Credit lines should read "Extracted from American National Standard ANSI/ANS-3.11-2015 with permission of the publisher, the American Nuclear Society." Reproduction prohibited under copyright convention unless written permission is granted by the American Nuclear Society.

Printed in the United States of America

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

Inquiry Requests

The American Nuclear Society (ANS) Standards Committee will provide responses to inquiries about requirements, recommendations, and/or permissive statements (i.e., "shall," "should," and/or "may," respectively) in American National Standards that are developed and approved by ANS. Responses to inquiries will be provided according to the Policy Manual for the ANS Standards Committee. Nonrelevant inquiries or those concerning unrelated subjects will be returned with appropriate explanation. ANS does not develop case interpretations of requirements in a standard that are applicable to a specific design, operation, facility, or other unique situation only, and therefore is not intended for generic application.

Responses to inquiries on standards are published in ANS's magazine, *Nuclear News*, and are available publicly on the ANS Web site or by contacting the ANS Scientific Publications and Standards Department.

Inquiry Format

Inquiry requests must include the following:

(1) the name, company name if applicable, mailing address, and telephone number of the inquirer;

(2) reference to the applicable standard edition, section, paragraph, figure, and/or table;

(3) the purposes of the inquiry;

(4) the inquiry stated in a clear, concise manner;

(5) a proposed reply, if the inquirer is in a position to offer one.

Inquiries should be addressed to:

American Nuclear Society
ATTN: Scientific Publications and Standards Department
555 N. Kensington Avenue
La Grange Park, IL 60526

or standards@ans.org

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

Foreword

(This foreword is not a part of American National Standard, "Determining Meteorological Information at Nuclear Facilities," ANSI/ANS-3.11-2015.)

Meteorological data collected at nuclear facilities play an important role in determining the effects of radiological and toxic chemical effluents on workers, facilities, the public, and the environment; and these data have many other useful applications, such as determining the effects of non-radiological/non-toxic water vapor releases (e.g., cooling tower plumes) and implementing emergency response plan Emergency Action Levels (e.g., in instances of high winds). Accordingly, meteorological program design should be based on the needs and objectives of the facility and the guiding principles for making accurate and valid meteorological measurements. ANSI/ANS-2.5-1984 (R1990) (withdrawn), "Determining Meteorological Information at Nuclear Power Sites," was issued in 1984 to address nuclear power facility meteorological data acquisition programs. ANSI/ANS-2.5-1984 (R1990) (withdrawn) was referenced by second proposed Revision 1 to Regulatory Guide 1.23, "Meteorological Measurement Program for Nuclear Power Plants." ANSI/ANS-2.5-1984 (R1990) (withdrawn) was, however, narrowly focused on commercial nuclear power plant siting considerations and did not provide adequate guidance on meteorological data application from startup to operations to decommissioning (i.e., life cycle).

In 1996, the Nuclear Utility Meteorological Data Users Group and the U.S. Department of Energy (DOE) Meteorological Coordinating Council jointly undertook comprehensive reviews of the applicability of ANSI/ANS-2.5-1984 (R1990) (withdrawn) and recommended major refinements in the following areas:

(1) operational data applications (especially emergency preparedness) in addition to siting applications;

(2) availability of guidance for both public and private sector entities;

(3) life cycle considerations of meteorological monitoring systems;

(4) the need to monitor multiple locations to acquire sufficient data for models to characterize three-dimensional flows in regions of complex terrain;

(5) inclusion of state-of-the-art meteorological monitoring equipment, including remote sensing instrumentation.

The meteorological data that are acquired, according to ANSI/ANS-2.5-1984 (R1990) (withdrawn) principles, are primarily used in supporting licensing applications of commercial nuclear power plants. More common operational applications to support protection of the health and safety of site personnel and the public, such as emergency preparedness consequence assessments and environmental compliance analyses, were not addressed because these programs had not fully matured at that time. Meteorological data required to support consequence assessments associated with emergency response differ significantly from the archived data used for climate characterization, environmental impact assessment, and compliance analysis purposes in that data must be available in real time. Real-time meteorological data availability may require significant upgrades to existing monitoring systems to limit data loss and to focus attention on the diurnal and seasonal effects that complex terrain, if present, have on the meteorological wind fields (and therefore plume trajectory) in the region of transport.

Nuclear facilities in the public sector and non-regulatory domains of the DOE and the U.S. Department of Defense were not represented in ANSI/ANS-2.5-1984 (R1990) (withdrawn). Government agencies resorted to issuing their own technical guidance (such as "Environmental Radiological Effluent Monitoring and Environmental Surveillance Handbook," DOE-HDBK-1216-2015, in which Chapter 5 addressed meteorological measurements). The need to develop a standard that was also applicable to the public sector

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

was enhanced by the recent DOE initiative, through its Technical Standards Program, which set a goal of operating DOE facilities under voluntary standards by 2000, in compliance with the Federal guidance contained in the Office of Management and Budget's circular OMB-119A, "Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities."

Meteorological data monitored at public sector nuclear facilities are used for

(1) routine radiological and chemical release consequence analyses;

(2) operating procedures, with respect to severe weather;

(3) operations and maintenance considerations for heat sinks (e.g., cooling towers, ponds);

(4) real-time consequence assessments of accidental releases of radiological and chemical species;

(5) potential environmental and control room habitability impacts resulting from design-basis accidents from projected new facilities or from modifications to existing facilities.

The use of meteorological data can also play an important role in various types of environmental, decontamination and decommissioning, air quality, wind loading, and engineering studies. Other uses of meteorological data include assessments of environmental remediation activities, industrial hygiene, construction, and waste management. Ideally, meteorological data needed to design or evaluate nuclear facilities complying with the requirements of ANSI/ANS-2.3-2011, "Estimating Tornado, Hurricane and Extreme Straight Line Wind Characteristics at Nuclear Facilities," and other applicable standards should be collected and analyzed in accordance with this standard. A comprehensive meteorological monitoring system requires instrumentation that will meet the programmatic purposes for which it is intended.

Meteorological measurements are most commonly taken with in situ sensors that are mounted on towers and are directly in contact with the atmosphere. Additionally, atmospheric properties can be inferred with "remote" sensors, which emit or propagate electromagnetic or acoustic waves into the atmosphere. The criteria for upgrading a sensor include improved accuracy, durability, and/or dependability, or a decrease in required maintenance that would increase the level of data recovery and cost-effectiveness of the measurement system while maintaining or improving appropriate measurement capabilities. When it becomes necessary to replace, upgrade, or supplement the meteorological monitoring system equipment, the most effective technology available that is appropriate to meet the objectives is normally employed. In the case where a new type of sensor replaces an existing sensor, a demonstration of the effectiveness of the new sensor is necessary before the replacement is completed (see ASTM D4430-96, "Standard Practice for Determining the Operational Comparability of Meteorological Measurements"). The following document provided useful information related to the subject of this standard: "National Technology Transfer and Advancement Act," PL 104-113; accessible online at http://gsi.nist.gov/global/docs/pubs/NISTIR_5967.pdf.

ANSI/ANS-3.11-2000 was developed to address life cycle issues associated with meteorological monitoring programs at nuclear facilities. This standard was also developed to address technological advances for in situ and remote sensing instrumentation to monitor meteorological parameters (e.g., sonic anemometers, lidar, Doppler sodar, radar wind profilers, etc.), modifications in analytical requirements, and other considerations. The aforementioned remote sensing systems provide the nuclear facility meteorologist

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

or meteorological program manager with additional means to acquire sufficient data to characterize the three-dimensional wind field in the vicinity of the facility and within the region of transport. ANSI/ANS-3.11-2000 also provides additional information on instrument siting and measurement issues, based on the results of wind tunnel studies, which have given insight into the aerodynamic effects of obstacles on a local wind field.

ANSI/ANS-3.11-2000 was designed with sufficient depth and breadth to address the needs of the entire meteorological monitoring community associated with all nuclear facilities nationwide, including commercial electric generating stations and nuclear installations at federal sites, ranges, and reservations. It does not attempt to define the exact monitoring criteria for every possible type of facility or site environment. It does identify the minimum information that comprises a successful monitoring program and requires that the details of such programs be delegated to subject matter expert meteorologists who analyze each particular site and application in order to arrive at an acceptable program for that particular application.

The ANS-3.11 Working Group was reconstituted in February 2003 to evaluate the currency of the three-year-old standard and to determine whether it should be simply reaffirmed on its February 18, 2005, sunset or it needed to be updated to account for new reference standards, advances in ex situ and in situ instrumentation, advances in data management equipment and techniques, advances in meteorological program management, integration with facility programs (e.g., configuration management), and other considerations. The Working Group unanimously determined to update the standard, and ANSI/ANS-3.11-2005 is a result of this work. In 2008, the ANS-3.11 Working Group again reevaluated the actions to be taken on the standard prior to its five-year sunset in December 2010. The Working Group unanimously determined to reaffirm the standard, and ANSI/ANS-3.11-2005 (R2010) is a result of this work.

The ANS-3.11 Working Group was reconstituted in August 2012 to revise ANSI/ANS-3.11-2005 (R2010). The revision is needed to account for new reference standards, advances in ex situ and in situ instrumentation, advances in data management equipment and techniques, advances in meteorological program management, improvements in integration with facility programs (e.g., configuration management), cyber security, software quality assurance, and other programmatic considerations. The appendices provide supplemental information needed for the design and implementation of a meteorological monitoring program.

This standard does not incorporate the concepts of generating risk-informed insights, performance-based requirements, or a graded approach to quality assurance. The user is advised that one or more of these techniques could enhance the application of this standard.

This standard might reference documents and other standards that have been superseded or withdrawn at the time the standard is applied. A statement has been included in the references section that provides guidance on the use of references.

This standard was prepared by the ANS-3.11 Working Group of the American Nuclear Society. The following members contributed to this standard:

T. Bellinger (Cochair), *Y-12 National Security Complex*
J. Call (Cochair), *OASYS, Inc.*

M. Abrams, *ABS Consulting, Inc.*
R. Baskett, *Lawrence Livermore National Laboratory*
K. Birdwell, *Oak Ridge National Laboratory*
P. Brennan, *Meteorological Evaluation Services Incorporated*

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

M. Carroll, *Murray and Trettel, Inc.*
J. Ciolek, *AlphaTRAC, Inc.*
K. Clawson, *Air Resources Laboratory, Field Research Division*
T. Coulter, *Coulter Air Quality Services*
P. Fransioli, *Individual*
C. Glantz, *Pacific Northwest National Laboratory*
R. Harvey, *U.S. Nuclear Regulatory Commission*
F. Hickey, *Susquehanna Pennsylvania Power & Light*
J. Holian, *Holian Environmental, LLC*
C. Hunter, *Savannah River National Laboratory*
J. Irwin, *John S. Irwin & Associates*
R. Ishaya, *BRYZA Wind Laboratory*
D. Katz, *Climatronics Corporation*
M. Kinley, *Duke Energy*
S. Lanham, *Duke Energy*
S. Marsh, *Southern California Edison*
M. Mazaika, *U.S. Nuclear Regulatory Commission*
C. Mazzola, *CB & I Federal Services Inc.*
E. McCarthy, *Individual*
M. Parker, *Savannah River National Laboratory*
D. Pittman, *Individual*
K. Quinlan, *U.S. Nuclear Regulatory Commission*
W. Schalk, *Air Resources Laboratory, Special Operations & Research Division*
A. Smith, *Tennessee Valley Authority*
P. Wan, *Individual*
K. Wastrack, *Tennessee Valley Authority*

Subcommittee Siting: General and Monitoring had the following membership at the time of its approval of this standard:

L. Parks (Chair), *U.S. Nuclear Regulatory Commission*

T. Bellinger, *Y-12 National Security Complex*
J. Call, *OASYS, Inc.*
D. Kosson, *Vanderbilt University*

The Environmental and Siting Consensus Committee had the following membership at the time of its approval of this standard:

C. A. Mazzola (Chair), *CB & I Federal Services*
Y. Gao (Vice Chair), *Westinghouse Electric Company, LLC*

T. Bellinger, *Y-12 National Security Complex*
K. Bryson, *Individual*
J. Call, *OASYS, Inc.*
R. Carpenter, *U.S. Nuclear Regulatory Commission*
Q. Hossain, *Lawrence Livermore National Laboratory*
R. J. Hunt, *Y-12 National Security Complex*
J. O'Brien, *U.S. Department of Energy*
L. Parks, *U.S. Nuclear Regulatory Commission*
T. Rasmussen, *University of Georgia*
J. Savy, *Individual*
S. A. Vigeant, *CB & I Federal Services*
J. Xu, *U.S. Nuclear Regulatory Commission*

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

Contents

Section **Page**

1 Scope ... 1

2 Acronyms and definitions ... 1
- 2.1 Acronyms ... 1
- 2.2 Shall, should, and may ... 2
- 2.3 Definitions ... 2

3 Meteorological monitoring system ... 4
- 3.1 Basic meteorological measurements ... 4
  - 3.1.1 Horizontal wind speed ... 4
  - 3.1.2 Horizontal wind direction ... 6
  - 3.1.3 Air temperature ... 6
  - 3.1.4 Precipitation ... 6
- 3.2 Meteorological monitoring for atmospheric turbulence ... 7
  - 3.2.1 Direct measurement of turbulence using three-dimensional ultrasonic anemometers ... 7
  - 3.2.2 Turbulence (stability) typing methods ... 7
  - 3.2.3 Additional considerations ... 8
- 3.3 Supplemental meteorological measurements (site-specific) ... 9
  - 3.3.1 Atmospheric moisture ... 9
  - 3.3.2 Solar and net radiation ... 9
  - 3.3.3 Barometric pressure ... 9
  - 3.3.4 Mixing height ... 9
  - 3.3.5 Vertical wind speed ... 10
  - 3.3.6 Vertical wind direction ... 10
  - 3.3.7 Soil temperature ... 10
  - 3.3.8 Soil moisture ... 11
- 3.4 Remote sensing ... 11
- 3.5 Sources of other surface observations ... 11
- 3.6 Meteorological observation towers ... 11
  - 3.6.1 Fixed meteorological tower ... 11
  - 3.6.2 Lightning protection ... 12
  - 3.6.3 Extreme natural phenomena ... 12

4 Siting of meteorological observation instruments ... 12
- 4.1 Overview ... 12
- 4.2 Topographic effects ... 13
  - 4.2.1 Flat terrain sites ... 13
  - 4.2.2 Complex terrain sites ... 13
- 4.3 Instrument orientation ... 14
  - 4.3.1 Aerodynamic effects of obstacles ... 14
  - 4.3.2 Diabatic effects ... 15
  - 4.3.3 Impacts of non-meteorological systems ... 15
- 4.4 Optional site selection techniques ... 15
- 4.5 Other considerations for monitoring sites ... 15

5 Data acquisition ... 16
- 5.1 Recording mechanisms ... 16
- 5.2 Sampling frequencies ... 16
- 5.3 Data processing ... 16

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

5.3.1 Wind data applications 17
5.3.2 Other meteorological variables 17

6 Database management 17
6.1 Representative site database(s) 17
6.2 Data validation 18
6.3 Data substitution 19
6.4 Data recovery 19
6.5 Data archiving 20
6.6 Data reporting 20

7 System performance 20
7.1 System accuracy 20
7.2 System calibrations 20
7.3 System protection, maintenance, and service 23
7.4 Cyber security for meteorological systems 24
7.5 Quality assurance program and documentation 24

8 Programmatic considerations 25

9 References 26

Tables

Table 1 Minimum system accuracy and resolution requirements 5
Table 2 Joint frequency distribution of wind direction, wind speed, and atmospheric turbulence 21

Exhibit

Exhibit 1 Method for calculating system accuracy 22

Appendices

Appendix A Supplemental Meteorological Measurements 30
Appendix B Meteorological Tower Siting Considerations in Complex Terrain 34
Appendix C Optional Site Selection Techniques 35
Appendix D Guidelines for Performing Wind Computations 37
Appendix E Recommended Calibration Practices 41
Appendix F Measurement Uncertainty 45

This is a preview of "ANSI/ANS-3.11-2015 (...". Click here to purchase the full version from the ANSI store.

Determining Meteorological Information at Nuclear Facilities

1 Scope

This consensus standard provides criteria for gathering, assembling, processing, storing, and disseminating meteorological information at commercial nuclear electric generating stations, U.S. Department of Energy / National Nuclear Security Administration nuclear facilities, and other national or international nuclear facilities. While well-established monitoring and analysis methods are adequately addressed, this revision provides information on newer systems, both hardware and software, and more modern methods to keep up with the state of the science.

Meteorological data collected, processed, stored, and disseminated through implementation of this standard are utilized to support the full life cycle (i.e., siting, construction, operation, and decommissioning) of nuclear facilities. The meteorological data are employed in a large number of applications associated with determining environmental impacts, enabling consequence assessments in routine release and design-basis accident evaluations, supporting emergency preparedness and response programs, and other important applications, such as evaluating beyond design-basis events.

2 Acronyms and definitions

2.1 Acronyms

ABL:	atmospheric boundary layer
QA:	quality assurance
DQOs:	data quality objectives
FAA:	Federal Aviation Administration
HVAC:	heating, ventilating, and air conditioning
lidar:	light detection and ranging
MADIS:	Meteorological Assimilation Data Ingest System
NIST:	National Institute of Standards and Technology
NOAA:	National Oceanic and Atmospheric Administration
NEXRAD:	next-generation weather radar
NWS:	National Weather Service
radar:	radio detection and ranging
RASS:	radio acoustic sounding system
SA:	system accuracy
sodar:	sound detection and ranging
SRDT:	solar radiation/delta-T
TIBL:	thermal internal boundary layer
TKE:	turbulence kinetic energy