American Nuclear Society

REAFFIRMED

April 18, 2016

ANSI/ANS-2.21-2012; R2016

criteria for assessing atmospheric effects on the ultimate heat sink

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reviewed and reaffirmed with the recognition that it may reference other standards and documents that may have been superseded or withdrawn.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.

ANSI/ANS-2.21-2012

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

ANSI/ANS-2.21-2012

American National Standard Criteria for Assessing Atmospheric Effects on the Ultimate Heat Sink

Secretariat
American Nuclear Society

Prepared by the
American Nuclear Society
Standards Committee
Working Group ANS-2.21

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

Approved June 5, 2012
by the
American National Standards Institute, Inc.

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

Printed in the United States of America

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 "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 Standards Administrator.

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: Standards Administrator
555 N. Kensington Avenue
La Grange Park, IL 60526

or standards@ans.org

Foreword

(This Foreword is not a part of American National Standard "Criteria for Assessing Atmospheric Effects on the Ultimate Heat Sink," ANSI/ANS-2.21-2012.)

Code of Federal Regulations, Title 10, "Energy," Part 50, "Domestic Licensing of Production and Utilization Facilities" (10 CFR 50), Appendix A, "General Design Criteria for Nuclear Power Plants," Criterion 44, "Cooling Water," requires suitable redundancy in the cooling water system features of nuclear power plants to ensure that its safety function is accomplished. 10 CFR 50, Appendix A, Criterion 2, "Design Bases for Protection Against Natural Phenomena," requires that systems, structures, and components important to safety be designed to withstand the effects of natural phenomena without loss of capability to perform its safety function. The redundancy features of the cooling water system of nuclear power plants are referred to as the ultimate heat sink. The ultimate heat sink is the complex of water sources, including necessary retaining structures (e.g., a pond or river with its dam), and the canals or conduits connecting the sources with, but not including, the cooling water system intake structures for a nuclear power unit. The sink constitutes the source of essential service water supply necessary to safely operate, shut down, and cool down a nuclear plant.

There is a need to provide consistency to calculations of atmospheric effects to ultimate heat sinks at nuclear facilities. Existing regulatory guidance (i.e., Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants") is dated (1970s vintage) and does not provide guidance on how to calculate effects to ultimate heat sinks using atmospheric parameters.

This standard establishes criteria for use of meteorological data collected at nuclear facilities to evaluate the atmospheric effects from meteorological parameters [e.g., dry-bulb temperature/wet-bulb temperature differential, precipitation, wind speed, short wave radiation, incoming solar (i.e., short wave) radiation, surface water temperature, and atmospheric pressure] on ultimate heat sinks.

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.

The ANS-2.21 Working Group of the American Nuclear Society Standards Committee had the following membership:

S. A. Vigeant, Chair, *Shaw Environmental & Infrastructure, Inc.*

A. Garrett, *Savannah River National Laboratory*
C. Cook, *U.S. Nuclear Regulatory Commission*
R. Kannor, *Bechtel Power Corporation*
M. J. Parker, *Savannah River National Laboratory*
R. B. Harvey, *U.S. Nuclear Regulatory Commission*
S. Gardocki, *U.S. Nuclear Regulatory Commission*

Subcommittee ANS-25, Site Characteristics, had the following membership at the time it approved the standard:

K. R. Bryson (Chair), *Shaw Environmental, Inc.*
C. A. Mazzola (Vice Chair), *Shaw Environmental & Infrastructure, Inc.*

J. S. Bollinger, *Savannah River National Laboratory*
C. J. Costantino, *Individual*
A. N. Findikakis, *Bechtel Power Corporation*
C. J. Guggino, *Bechtel Power Corporation*
D. F. Hang, *Individual*
K. L. Hanson, *AMEC-Geomatrix Consultants*
J. J. Litehiser, *Bechtel Power Corporation*
T. C. Rasmussen, *University of Georgia*

J. D. Stevenson, *Individual*
L. W. Vail, *Pacific Northwest National Laboratory*
S. A. Vigeant, *Shaw Environmental & Infrastructure, Inc.*

The Nuclear Facility Standards Committee (NFSC) had the following membership at the time of its approval of this standard:

C. A. Mazzola (Chair), *Shaw Environmental & Infrastructure, Inc.*
R. M. Ruby (Vice Chair), *Individual*

J. A. August, *CORE, Inc.*
W. H. Bell, *South Carolina Electric & Gas Company*
J. R. Brault, *Shaw MOX Project*
C. K. Brown, *Southern Nuclear Operating Company*
K. R. Bryson, *Individual*
C. E. Carpenter, *U.S. Nuclear Regulatory Commission*
D. R. Eggett, *Automated Engineering Services Corporation*
R. W. Englehart, *Individual*
P. K. Guha, *U.S. Department of Energy*
P. S. Hastings, *Babcock & Wilcox*
R. A. Hill, *ERIN Engineering and Research, Inc.*
N. P. Kadambi, *Individual*
M. A. Linn, *Oak Ridge National Laboratory*
E. M. Lloyd, *Exitech Corporation*
S. A. Lott, *Los Alamos National Laboratory*
R. H. McFetridge, *Westinghouse Electric Company, LLC*
T. K. Meneely, *Westinghouse Electric Company, LLC*
C. H. Moseley, *ASME NQA Liaison*
D. G. Newton, *AREVA NP*
W. B. Reuland, *Individual*
J. C. Saldarini, *Bechtel Power Corporation*
D. J. Spellman, *Oak Ridge National Laboratory (NFSC Liaison to Institute of Electrical and Electronics Engineers Nuclear Power Engineering Committee)*
S. L. Stamm, *Individual*
J. D. Stevenson, *Individual*
J. A. Werenberg, *Southern Company Services*
M. J. Wright, *Entergy Operations, Inc.*
L. Zull, *Defense Nuclear Facilities Safety Board*

NFSC Liaison:

G. Hutcherson, *Institute of Nuclear Power Operations*
J. Riley, *Nuclear Energy Institute*

Contents

Criteria for Assessing Atmospheric Effects on the Ultimate Heat Sink

1 Scope

This standard describes atmospheric effects for consideration when designing ultimate heat sinks for safety-related systems at nuclear power units. Required analyses are provided for a meteorological assessment of the ultimate heat sink to ensure that design temperatures and cooling capacity requirements for the facility are met. The standard is intended to apply to new nuclear units or the redesign of the cooling systems at existing nuclear units. The discussion primarily applies to cooling lakes, spray ponds, rivers, mechanical draft cooling towers, and natural draft cooling towers, which are the heat dissipation systems most commonly used for nuclear power plants. However, the same principles apply to seawater cooling and spray ponds. This standard does not apply to designs that do not rely on external water sources as the ultimate heat sink or to nonmeteorological elements of ultimate heat sink design.

2 Definitions

critical time period: The time frame over which relevant meteorological data are evaluated to determine that a particular type of ultimate heat sink design (e.g., cooling lakes, rivers, spray ponds, mechanical draft cooling towers, and natural draft cooling towers) will be able to perform its critical function.

drift loss: The emission of small water droplets entrained in the cooling tower air flow. The droplets contain the dissolved solids found in the circulating water.

dry-bulb temperature: The temperature registered by the dry-bulb thermometer of a psychrometer or simply the temperature of the air.

frazil ice: Ice crystals that form in supercooled water that is too turbulent to permit coagulation into sheet ice.

shall, should, and may: The word "shall" is used to denote a requirement; the word "should" is used to denote a recommendation; and the word "may" is used to denote permission, neither a requirement nor a recommendation.

ultimate heat sink: The complex of water sources, including necessary retaining structures (e.g., a pond or river with its dam), and the canals or conduits connecting the sources with, but not including, the cooling water system intake structures for a nuclear power unit. The sink constitutes the source of service water supply necessary to safely operate, shut down, or cool down a plant following a design-basis accident.

wet-bulb temperature: The temperature of a wet-bulb thermometer when the heat leaving the wet bulb from evaporative cooling is equal to the heat transferred to the wet bulb by convective heat transfer from the surrounding air.

3 Ultimate heat sink function

The ultimate heat sink function is to ensure that design-basis temperatures of the plant's safety-related equipment are not exceeded. Ultimate heat sinks shall be designed to have the cooling capacity to provide sufficient cooling water at the maximum allowable inlet temperature under the most adverse meteorological conditions expected for the power plant climatic regime.

Ultimate heat sink design shall be based on development of numerical models of a cooling lake or cooling tower using meteorological data representative of the site taken at or near the power plant. The numerical models shall be validated using data taken at locations with climates similar to the climate of the site of the proposed power plant. NUREG-0693 [1][1)] and NUREG-0733 [2] give detailed instructions on

[1)]Numbers in brackets refer to corresponding numbers in Sec. 8, "References."