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American National Standard for Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites

Secretariat
American Nuclear Society

Prepared by the
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Standards Committee
Working Group ANS-2.17

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Foreword

(This Foreword is not a part of American National Standard for Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites, ANSI/ANS-2.17-1980.)

The purpose of this document is to specify standards for determining the concentrations of radionuclides in the ground water resulting from both potential accidental and routine releases from nuclear power plants. This standard was prepared by Working Group ANS-2.17 of ANS-2 Subcommittee, Site Evaluation, of the American Nuclear Society Standards Committee.

The initial meeting of the working group was held in October, 1974. At that meeting, the working group was designated as ANS-2.9, Standards for Evaluating Water Supply and Waterborne Radionuclide Transport for Nuclear Power Sites. This working group was subdivided into surface water and ground water subgroups, and, the working group was formally subdivided at the March, 1975 meeting of the ANS-2 subcommittee into ANS-2.9, Standards for Evaluating Water Supply and Waterborne Radionuclide Transport for Power Reactor Sites: Ground Water, and ANS-2.13, Standards for Evaluating Water Supply and Waterborne Radionuclide Transport for Power Reactor Sites: Surface Water.

The draft standard, ANS-2.9, was balloted on May 31, 1977, by the ANS-2 Subcommittee with 12 approved, 10 approved with comments, 2 disapproved, 1 not voting, and 2 unreturned ballots. As a result of comments received during this balloting, the draft standard was further sub-divided into ANS-2.9, American National Standard for Evaluation of Ground Water Supply for Nuclear Power Sites, and ANS-2.17, American National Standard for Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites. These draft standards, dated January, 1978, were transmitted to the ANS-2 Subcommittee in June, 1978, for information and informal comments. The draft standards were revised to incorporate these informal comments. As a result of these revisions, the two disapproved ballots were changed to approved with comments.

This standard covers parts of the material that meet the requirements of Section 2.4, Hydrologic Engineering, and Section 11.2, Liquid Waste Management Systems, of the "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," Regulatory Guide 1.70, issued by the Nuclear Regulatory Commission (NRC).

Before preparing the Safety Analysis Report (SAR) Sections 2.4 and 11.2, for the licensing of nuclear power plants, the applicant should be aware of hydrologic work which has been done by others in the area of interest. Almost invariably, much work can be saved by utilizing all or parts of studies of local, state, and federal agencies. Such information as historical ground water levels, pumping tests, well logs, withdrawal and recharge rates, geologic data, hydraulic parameters of underlying formations, location and extent of aquifers, and water quality can be obtained from such sources.

Federal agencies which have useful data are the U.S. Geological Survey, Corps of Engineers, Bureau of Reclamation, Soil Conservation Service, Forest Service, Tennessee Valley Authority, Environmental Protection Agency, and the Nuclear Regulatory Commission. Most states have one or more agencies which are concerned with various aspects of water resources. Various local and interstate agencies, including soil and water conservation districts, irrigation districts, and river basin commissions, can be sources of information. SAR's for other nuclear facilities in the region can provide data.

It is also profitable to discuss the specific site in detail with the hydrology staff of the NRC prior to starting preparation of Section 2.4. In such discussions the scope of work can often be reduced, and methodologies and procedures can be agreed upon, which will save many man-hours and dollars, both for the applicant and for the NRC staff.

Working Group 2.17 of the Standards Committee of the American Nuclear Society had the following membership:

David L. Siefken, Chairman, *Sargent & Lundy*
Y. C. Chang, *Stone & Webster Engineering Corporation*
Stanley N. Davis, *University of Arizona*
James O. Duguid, *Battelle Memorial Institute*
I. Wendell Marine, *E. I. DuPont de Nemours & Company*
John A. McLaughlin, *Pacific Gas and Electric Company*
William M. McMaster, *Tennessee Valley Authority*
Thomas Nicholson, *Nuclear Regulatory Commission*

The chairman of the working group prior to the preparation of Draft 4, dated December, 1978 was Patrick J. Ryan, Bechtel, Inc. Prior to his retirement, Donald L. Milliken represented the Nuclear Regulatory Commission.

Subcommittee ANS-2, Site Evaluation, of the American Nuclear Society Standards Committee had the following members at the time of its approval of this standard:

R. V. Bettinger, Chairman, *Pacific Gas and Electric Company*
Luis E. Escalante, *Los Angeles Department of Water and Power*
J. A. Fischer, *Dames & Moore*
Walter W. Hays, *U.S. Geological Survey*
G. E. Heim, *Sargent & Lundy*
G. F. Hoveke, *Sargent & Lundy*
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E. J. Keith, *EDS Nuclear Inc.*
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George Nicholas, *Dames & Moore*
R. Noble, *Dames & Moore*
T. Pickel, *Oak Ridge National Laboratory*
Craig Roberts, *U.S. Nuclear Regulatory Commission*
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Earl Ivan White, *General Atomic Company*
Karl Wiedner, *Bechtel Power Corporation*

The members of American Nuclear Society's Nuclear Power Plant Standards Committee (NUPPSCO) at the time it balloted this standard in July 1979 were:

J. F. Mallay, Chairman
M. D. Weber, Secretary

Name of Representative	*Organizations*
G. A. Arlotto	*U.S. Nuclear Regulatory Commission*
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R. G. Benham	*General Atomic Company*
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R. V. Bettinger	*Pacific Gas & Electric Company*
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G. L. Wessman	*General Atomic Company*
J. E. Windhorst	*Southern Company Services*
	(for the American Society of Mechanical Engineers)
E. R. Wiot	*NUS Corporation*

Contents

Evaluation of Radionuclide Transport in Ground Water for Nuclear Power Sites

1. Scope and Purpose

This standard presents guidelines for the determination of the concentration of radionuclides in the ground water resulting from both postulated accidental and routine releases from nuclear power plants.

1.1 Coverage. This standard presents the methods to evaluate potential radionuclide transport in ground water for use in evaluation of nuclear power plant sites. This standard contains mandatory requirements as designated by the use of the word "shall".

1.2 Exclusions. This standard does not discuss the release of non-radioactive waste to ground water, nor the radioactive source terms for the ground water evaluation studies.

2. Definitions

In general, ground water terms are used in accordance with definitions as described by Lohman and others.[1][1] Definitions are given below for terms which can have more than one meaning to ground water hydrologists.

anisotropic. The properties at any point within a medium are different in different directions.

dispersion coefficient (L^2T^{-1}) A measure of the spreading of a flowing substance due to the nature of the porous medium, with its interconnected channels distributed at random in all directions.

dispersivity (L). A geometric property of a porous medium which determines the dispersion characteristics of the medium by relating the components of pore velocity to the dispersion coefficient.

distribution coefficient ($M^{-1}L^3$). The quantity of the radionuclide sorbed by the solid per unit weight of solid divided by the quantity of radionuclide dissolved in the water per unit volume of water.

[1]Numbers in brackets refer to corresponding numbers in Section 7, References.

exchange capacity (ion exchange capacity). The amount of exchangeable ions measured in milligram equivalents per gram of solid material at a given pH.

flux (specific discharge, darcy velocity) (LT^{-1}). The volume of discharge from a given cross-sectional area per unit time divided by the area of the cross section.

heterogeneity. The properties or conditions of isotropy or anisotropy vary from point to point in the medium.

homogeneity. The properties or conditions of isotropy or anisotropy are constant from point to point in the medium.

hydraulic conductivity (LT^{-1}). "A medium has a hydraulic conductivity of unit length per unit time if it will transmit in unit time a unit volume of ground water at the prevailing viscosity through a cross section of unit area, measured at right angles to the direction of flow, under a hydraulic gradient of unit change in head through unit length of flow."[2] The term "hydraulic conductivity" has been called permeability, coefficient of permeability, field coefficient of permeability, and conductivity.

hydrogeologic unit. Any soil or rock unit or zone which by virtue of its porosity or permeability, or lack therof, has a distinct influence on the storage or movement of ground water.

infiltration. The process of downward movement of water from the surface into underlying materials.

intrinsic permeability (L^2). The measure of the ability of a rock or soil to transmit fluid under a fluid potential gradient (see definition of hydraulic conductivity).

isotropic. The properties at any point within a medium are the same in all directions.

pore velocity, seepage velocity (LT^{-1}). The average rate of flow in the pores of a given medium. This is approximated by dividing the flux by the effective porosity.

porosity. The property of containing interstices. Total porosity is expressed as the ratio of the volume of interstices to total volume. Effective porosity refers to the porosity through which flow occurs.[2]