American Nuclear Society

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airborne release fractions at non-reactor nuclear facilities

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an American National Standard

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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.

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American National Standard for Airborne Release Fractions at Non-Reactor Nuclear Facilities

Secretariat
American Nuclear Society

Prepared by the
**American Nuclear Society
Standards Committee
Working Group ANS-5.10**

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American National Standard

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Foreword

(This Foreword is not a part of American National Standard for Airborne Release Fractions at Non-Reactor Nuclear Facilities, ANSI/ANS-5.10-1998.)

Techniques for assessing potential downwind impacts of radionuclides released from nuclear facilities have evolved since the inception of the nuclear industry. The techniques have become more rigorous as well as more numerous. The many techniques applied in safety analyses have often resulted in divergent estimates of the downwind impacts from identical or very similar postulated events. Guidance toward more standard techniques for radionuclide release analysis is needed so that estimates can be compared in a meaningful fashion.

One technique used in evaluating the potential downwind impacts is the selection of an Airborne Release Fraction (ARF), which is the amount of the radioactive or hazardous material-of-concern made airborne through specific postulated accident stresses. This standard provides guidance for a consistent selection and application of ARFs in accident analyses.

The complexity of any actual situation precludes an analytical determination of the ARF. Thus, estimates from experimental data generally have been identified for specific materials (such as plutonium and uranium) or for physically similar materials (such as liquids, powders, or contaminated combustibles) under accident-induced types and levels of stress. ARFs derived from data are used to estimate the amount of a material-of-concern made airborne by thermal, aerodynamic, or mechanical stress over time periods ranging from seconds for explosively generated ARFs, hours for a fire, or potentially very long periods of time for aerodynamic stress. The applicability of experimentally derived ARFs is limited to the range covered in the experimental study. Experimental data are limited for some of the initiator-response sequences and values are also inferred from other experimental studies that appear to impose the same type and level of stress upon similar materials. As the need arises, additional data and information may be generated to improve or revise the ARFs.

Actual accidents are unique events that cannot be accurately defined, and it would be misleading to leave the impression that estimates of the potential impacts based upon analyses can be very accurate. Therefore, ARFs must be viewed as tools to provide estimates of airborne release but, due to the lack of accuracy in defining the response and behavior of other components, highly accurate ARFs do not assure highly accurate estimates of airborne release.

This standard was prepared by Working Group ANS-5.10 of the Standards Committee of the American Nuclear Society. Continuing efforts will be required to augment or modify the criteria in this standard and to implement additional information and experimental studies as they become available.

Working Group ANS-5.10 had the following membership at the time it developed this standard:

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F. Baumdad, *Defense Nuclear Facilities Safety Board*; A. Conklin, *Washington State Department of Health*; Y. Faraz, *U.S. Nuclear Regulatory Commission*; L. Fischer, *Lawrence Livermore National Laboratory*; A. Godwin, *Arizona Radiation Control Regulatory Agency* (representing the Council of Radiation Control Directors); W.B. House, *Chem-Nuclear Systems, Inc.*; N. Kent, *Westinghouse Electric Company*; P. Lee, *U.S. Department of Energy/Rocky Flats*; J. Roarty, *Defense Nuclear Facilities Safety Board*; R. Wooley, *U.S. Enrichment Corporation.*

The American Nuclear Society's Nuclear Power Plant Standards Committee (NUPPSCO) had the following membership at the time of approval of this standard:

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Contents

Airborne Release Fractions at Non-Reactor Nuclear Facilities

1. Scope and Purpose

1.1 Scope. This standard provides criteria for defining Airborne Release Fractions (ARFs) for radioactive materials under accident conditions (excluding nuclear criticalities) at non-reactor nuclear facilities. The criteria in this standard provide requirements for selecting ARFs based on the calculated or assumed forms of radioactive material released. This standard may be applied to determine the ARFs for certain applicable reactor plant events for which alternative methodologies are not mandated by regulatory requirements. Because the predominant physical forms of radioactive materials in non-reactor facilities are solids and liquids, the standard focuses on these forms. Criteria are also provided for gases and materials that can be converted into the form of a vapor.

1.2 Purpose. This standard addresses criteria for selecting appropriate ARFs to estimate the airborne release from accident phenomena that can subdivide and suspend radioactive materials from various initiating events. The purpose of this standard is to provide a uniform approach for the selection of ARFs used in consequence assessments based upon the degree of definition of the relevant parameters (i.e., the type and level of the suspension mechanism applied to the material-at-risk and the behavior of other materials and equipment that may affect the airborne release) and the complexity of the initiating event.

The criteria for selecting ARFs are presented in Section 3. Section 4 discusses the limitations of the standard. Background information on the analytical process commonly employed to calculate source terms is necessary to understand fully all aspects of the ARF selection process; sample problems illustrating the application of ARFs to some accident scenario analysis are also helpful.[1]

2. Definitions

aerodynamic entrainment. The suspension and transport of particulate materials, initially at rest, by the flow of gas.

aerodynamic equivalent diameter (AED). The diameter of a sphere with a density of 1 g/cm^3 that exhibits the same terminal velocity as the particle of concern.

airborne release fraction (ARF). The fraction of affected material that can be suspended in air and become available for airborne transport.

airborne release rate (ARR). The fractional rate of affected material that is suspended into air and becomes available for transport as a function of time.

brittle solids. Solids that will fragment into particles upon impact or crush forces that exceed the tensile/compressive strength of the material.

energetic event. An event that generates a sufficient amount of energy over a brief period (such as less than one minute) to result in the airborne suspension of the material-at-risk, and damages equipment and systems that might result in loss of confinement.

free-fall spill. An elevated release of powder or liquid as a slug of material that falls without obstruction and impacts a hard, essentially unyielding surface.

material-at-risk (MAR). The amount of radioactive material available to be acted upon by the physical stresses generated by the accident conditions.

peer review. The review and concurrence of the basis and findings of a document or paper by more than one individual recognized as knowledgeable in the specific technical area.

respirable fraction (RF). The fraction of material made airborne, present in particulate form, that could be transported through the air, inhaled, and be deposited in the deep lung.

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 a permission, neither a requirement nor a recommendation.

[1] Information on this topic is provided in Appendix B.