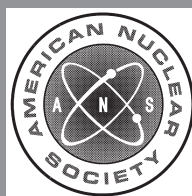


American Nuclear Society

**method for calculating the
fractional release of
volatile fission products from oxide fuel**

an American National Standard



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

**American National Standard
Method for Calculating the
Fractional Release of
Volatile Fission Products from Oxide Fuel**

Secretariat
American Nuclear Society

Prepared by the
**American Nuclear Society
Standards Committee
Working Group ANS-5.4**

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Foreword

(This Foreword is not a part of American National Standard “Method for Calculating the Fractional Release of Volatile Fission Products from Oxide Fuel,” ANSI/ANS-5.4-2011.)

This standard provides a methodology for determining the radioactive fission product releases from UO_2 fuel for use in assessing radiological consequences of postulated accidents that do not involve significant abrupt power transients such as in a reactivity-initiated accident (RIA). When used with isotopic yields, this method will give the so-called “gap activity,” which is the inventory of volatile fission products that could be available for release from the fuel rod if the cladding were breached. The standard as developed applies to steady-state conditions and, therefore, should not be applied to accidents where abrupt temperature increases are experienced resulting in what is sometimes referred to as “burst release.” The standard can be applied to Condition 1 and 2 transients that do not result in large fuel temperature increases, i.e., ≥ 300 K temperature increase, where significant burst release is possible. The standard does not consider escape-rate coefficients or other transport of fission products from the fuel rod void space to the reactor coolant or other medium; the standard applies only to available fission products in the fuel rod void space available for release if failure is experienced. The standard assumes that no significant fuel oxidation will be present during the accident because fuel oxidation can significantly enhance the release. Therefore, the standard does not apply to accidents where significant fuel oxidation is present.

The volatile and gaseous fission products of primary significance are krypton, xenon, iodine, and cesium. The radioactive nuclide that contributes the largest to equivalent dose to individuals is generally ^{131}I for accidents during in-reactor operation or shortly after reactor operation (e.g., a fuel-handling accident) because of its dose to the thyroid. These radioactive gaseous and volatile fission products can be divided into two categories: (a) short-lived radioactive nuclides (half-life < 1 yr) and (b) long-lived radioactive nuclides (half-life > 1 yr). This division is significant because the most important release mechanism involves thermally activated migration (diffusion) processes that proceed slowly such that the short-lived nuclides decay appreciably before they are released from the pellet. Consequently, release calculations for short-lived nuclides must include their decay rate, whereas for long-lived nuclides, decay does not have to be considered. The revised new standard is only applicable to the short-lived nuclides with half-lives < 1 yr.

The ANS-5.4 standard was first implemented in 1982 with Dr. Stan Turner as chairman of the ANS-5.4 Working Group. The original methodology was based on the use of the Booth diffusion model [A. H. Booth, CRDC-721 and DCI-17, Atomic Energy of Canada (1957); A. H. Booth and G. T. Rymer, CRDC-720, Atomic Energy of Canada (1958); S. D. Beck, BMI-1433, Battelle Columbus (1960)]. The coefficients to the model were determined from the measured release data of stable nuclides of xenon and krypton. The coefficients were derived using the stable nuclide release data because very few release data were available for the radioactive nuclides. Also, because of the lack of data from the radioactive ^{131}I , the diffusion of this nuclide was assumed to be a factor of 7 higher than for the xenon and krypton nuclides. The 1982 standard was not reaffirmed in 1992 because newer data were demonstrating that the assumptions used in the earlier standard were overly conservative. Many of the original working group members were not available to revise the standard at that time; therefore, a new ANS-5.4 Working Group was formed in 2000 to revise the standard. In the past this standard had primarily been used to estimate the dose to operators in the control room due to a fuel-handling accident but could be used