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ANS SHIELDING STANDARDS FOR LIGHT-WATER REACTORS

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ABSTRACT

The purpose of the American Nuclear Society Standards Subcommittee, ANS-6, Radiation Protection and Shielding, is to develop standards for radiation protection and shield design, to provide shielding information to other standards-writing groups, and to develop standard reference shielding data and test problems. A total of seven published ANS-6 standards are now current. Additional projects of the subcommittee, now composed of nine working groups, include: standard reference data for multigroup cross sections, gamma-ray absorption coefficients and buildup factors, additional benchwork problems for shielding problems and energy spectrum unfolding, power plant zoning design for normal and accident conditions, process radiation monitors, and design for postaccident radiological conditions.

INTRODUCTION

The American Nuclear Society (ANS) is a standards-writing organization member of the American National Standards Institute (ANSI). The ANS Standards Committee has a subcommittee denoted ANS-6, Radiation Protection and Shielding, whose charge is to develop standards for radiation protection and shield design, to provide shielding information to other standards-writing groups, and to develop standard reference shielding data and test problems. This paper is a progress report of this subcommittee. Significant progress has been made since the last comprehensive report.[1]

The purpose of a standard is to set forth acceptable practices, procedures, dimensions, material properties, specifications, etc. that have been agreed on by representatives of a broad segment of the subject activity. Ideally, because of the standardization process, a standard is a high-quality, highly-reliable, comprehensive summary of the state of the art.

The organization responsible for promulgating voluntary standards in the USA is ANSI. The Institute, a nonprofit corporation, is a federation of leading trade, technical and professional organizations, government agencies, and consumer groups. The principal functions of the ANSI are to coordinate standards development, minimize duplication and overlap, and provide a neutral forum to consider and identify standards needs.

The standards-writing organization of interest here is the ANS. Among its committees is one on standards composed of a steering committee and several subcommittees. The subcommittees, in turn, have established ad hoc working groups for preparation of individual standards.

The subcommittee on radiation protection and shielding standards, ANS-6, now composed of nine working groups, was established in 1964. The goals and accomplishments of the working groups are briefly described below.

ANS-6.1: Shielding Cross Section Standards

The first standard developed by the cross-section working group provides a reference set of neutron and gamma-ray flux-to-dose-rate factors for use by shielding design engineers.[2] This standard will be revised in the near future. Issues to be resolved are: the usefulness of the dose equivalent index, low-energy interpolation in the neutron dose equivalent table, and the relationship to other standards.

Current efforts of the working group are directed toward developing a standard to establish criteria for standard sets of multigroup cross sections to be used for radiation protection calculations. The group is also testing candidate data sets which appear to meet the criteria and therefore can be considered to be standard reference data. A draft standard has been approved by ANS-6 and is being submitted to ANSI Committee N17, Research Reactors, Reactor Physics, and Radiation Shielding.

ANS-6.2: Benchmark Problems

The primary objective of the benchmark problems effort is to compile in convenient form a limited number of well-documented problems in radiation transport which will be useful in testing computational methods used in shielding.

Four problem solutions were published in 1969 in loose-leaf form by the Radiation Shielding Information Center. Revisions were issued in 1970 and 1974. The work slowed for a period, but now additional problems are being developed, including several for typical reactor configurations. The group now is collecting and evaluating solutions to two problems specifying PWR shielding configurations and a problem which defines a radwaste configuration.

A second working group, ANS-6.2.2, is developing test procedures for neutron energy spectrum unfolding codes which treat the "many-channel" problem. This group is interested in both gamma-ray and neutron spectrum unfolding, but initial efforts have concentrated on tests of neutron unfolding codes using idealized, calculated response functions.[3]

ANS-6.3: Shield Performance Evaluation

The initial goal of this group was attained in 1972 with the publication of ANSI N18.9-1972. The group has developed a replacement standard which has now been published and is titled "Program for Testing Radiation Shields in Light Water Reactors."[4]

ANS-6.4: Shield Materials

The first major effort of this group resulted in a guide for the design of concrete shields for nuclear power plants and similar applications.[5] Plans are being made to update this standard in the near future.

The group is now developing a standard on compensatory shielding materials, i.e., special materials to be used in shield penetrations to compensate for the reduction in effectiveness of the bulk shield.

A more recent project, designated ANS-6.4.3, has been undertaken to develop standard reference absorption coefficient and buildup factor data for selected materials. A need for reliable low-energy data is especially recognized. These data are frequently used by design engineers in point kernel calculations, but no modern generally-recognized compilation of data exists.

ANS-6.5: Shielding Nomenclature

The group developed a glossary for use in radiation protection and shielding which was published in 1979.[6] The document also includes definitions of reactor physics terms, compiled by ANS-19.2, and a power reactor systems glossary compiled by ANS-50. The glossary was issued for trial use, and comments are desired by the group to use in developing succeeding drafts. Further work will be required to ensure that the most useful terms will be incorporated into the "Glossary of Terms in Nuclear Science and Technology," which continues development under ANS-9.

ANS-6.6: Calculation and Measurement of Direct and Scattered Radiation from Nuclear Power Plants

The group has developed a standard which defines calculational requirements and measurement techniques to estimate exposures near nuclear power plants due to direct and scattered radiation from contained sources on site.[7] Nitrogen-16 gamma-rays are a prime consideration.

ANS-6.7: Radiation Zoning for Design for Nuclear Power Plants

The proposed standard, "Radiation Zoning for Design of Nuclear Power Plants," has been sent to the Nuclear Power Plant Standards Committee (NUPPSCO) for approval as an ANSI standard. At the request of NUPPSCO,

the scope of the standard is being extended to cover the entire area of the plant in addition to the areas inside the main plant building.

A second group under 6.7 is organizing to begin the process of determining the scope of a project to establish zoning standards for design of shielding which takes account of possible reactor accident conditions.

ANS-6.8: Location and Range of Detection of Area and Process Fluid Radiation Monitoring Systems for Nuclear Steam Generating Plants

Organized in early 1975 as a joint project with the Health Physics Society Standards Committee, the group has developed a standard titled "Locations and Design Criteria for Radiation Monitoring Systems for Light Water Nuclear Reactors."[8] The standard was published in 1981.

The group is now working on a companion standard on continuous process and effluent radiation monitoring systems.

ANS-6.9: Designing for Postaccident Radiological Conditions

A new working group was organized in late 1981 to develop one or more standards to provide guidance in designing for postaccident radiological conditions which can arise at LWR power plants. This group will function in cooperation with groups under NUPPSCO sharing similar interests.

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