ANS Standards Development Process

The mission of the American Nuclear Society (ANS) Standards Committee is to develop voluntary consensus standards to be certified by the American National Standards Institute (ANSI) as American National Standards. The ANSI has served as administrator and coordinator of the United States private sector voluntary standardization system for more than 90 years. Founded in 1918 by five engineering societies and three government agencies, the Institute remains a private, nonprofit membership organization supported by a diverse constituency of private and public sector organizations. Its prescribed process is set forth in the ANS Standards Committee Rules and Procedures, and it is also illustrated in the following flow chart.

The National Technology Transfer and Advancement Act of 1995 (NTTAA) requires all federal agencies and departments to use technical standards that are developed or adopted by voluntary consensus standards bodies, unless such use is impractical or inconsistent with law. To implement the Act, the Office of Management and Budget issued Circular A-119, which provides guidance to promote consistent application of the Act across federal agencies and departments. The NTTAA is available at http://standards.gov/standards_gov/nttaa.cfm. OMB Circular A-119 can be found at http://www.whitehouse.gov/omb/circulars/a119/a119.html.

The process to produce an American National Standard requires much time, patience, most of all dedication. The birth of a standard begins with recognizing a need for a particular standard. Any individual or committee within the ANS Standards Committee may identify this need by completing a Project Initiation Notification System (PINS) form, which declares the purpose and need of the proposed standard. The document is reviewed, discussed, and most often approved by a select subcommittee (SC) and a consensus committee (CC) that will parent the standard. Last, the Standards Board (SB) will review the PINS form before it is submitted to ANSI.

Once the PINS form is approved and submitted to ANSI, a working group (WG) is assembled to commence the standard development process. Working Group members comprise a small number of individuals recognized for their expertise in the subject. Although there is no requirement for a balance of representation on a WG, as required for the CC and SB, WG membership should include those organizations having a significant interest in the project.

Subcommittees (SC) consist of members who have been appointed due to their expertise in one or more areas. They manage the development of several standards in closely related disciplines. Each SC member is expected to lend his/her special expertise in the development of standards. Subsequent to drafting the standard, a formal ballot process within the SC is not required, but SC approval is often achieved via internal committee discussion.

The SB has established four consensus committees, Nuclear Facilities Standards Committee (NFSC), Nuclear Criticality Safety (N16), Research Reactors, Reactor Physics, Radiation Shielding and Computational Methods (N17), and Risk Informed Standards Committee (RISC). Consensus committees (CC) comprise a diverse balance of interest. Each CC supervises the development of proposed standards within their assigned scopes, and they achieve consensus

approval of these projects. A formal ballot must be employed to ascertain each member's position on the standards brought before the committee.

The WG chair must respond to all "approved with comments" and "negative" comments received from the formal ballot period; the SC may assist in resolving comments. Balloters who ballot negative, must review the attempted resolution of his/her negative ballot vote. If the negative balloter finds the response unacceptable, then the balloter may maintain that decision by formally stating his/her reasons for doing so. Any outstanding negative positions must be circulated to all members of the CC for review. A member holding an affirmative position may change his/her vote if he/she wishes to support negative balloters.

Simultaneous to the CC ballot, public review (PR) is conducted through the auspices of ANSI. ANSI announces a 60-day public review period for the proposed standard in its publication, *Standards Action*. As with CC comments, all comments from PR must be considered and resolved promptly.

Upon completion of the consensus process, a Letter Ballot is created for the SB to review and certify that all ANS procedures have been implemented to finalize the standard. The SB Letter Ballot summarizes the CC ballot tallies and other details during the ballot period.

The final step in the development of a proposed standard is to gain approval by the ANSI Board of Standards Review (BSR). Once certification by the SB has been granted, the proposed standard is sent to the BSR with documentation of the ballot results to carefully scrutinize the case.

After ANSI notifies ANS of its approval, the proposed standard emerges as an American National Standard -- a remarkable achievement and a credit to all the volunteers who made it possible.

ANS Standards Committee

Scope:

The American Nuclear Society Standards Committee is responsible for the development and maintenance of standards that address the design, analysis, and operation of components, systems, and facilities related to the application of nuclear science and technology. The scope of the Standards Committee includes the development and maintenance of standards on the following subjects and closely related activities:

a. Nuclear criticality safety
b. Definitions of terminology used in nuclear science and technology
c. Facilities for handling radioactive isotopes, including the remote handling of radioactive materials
d. Research reactors and critical facilities
e. Reactor physics and radiation shielding
f. Ensuring the integrity of computer programs in the nuclear field
g. Siting requirements for nuclear facilities
h. Nuclear facility design, including safety criteria for the facility
i. Reactor operation, including operator training and selection
j. Fuel design, handling, and storage
k. Radioactive waste management
l. Remediation and restoration of sites used for nuclear facilities
m. Fission product behavior
n. Probabilistic risk assessment, risk management, and risk criteria

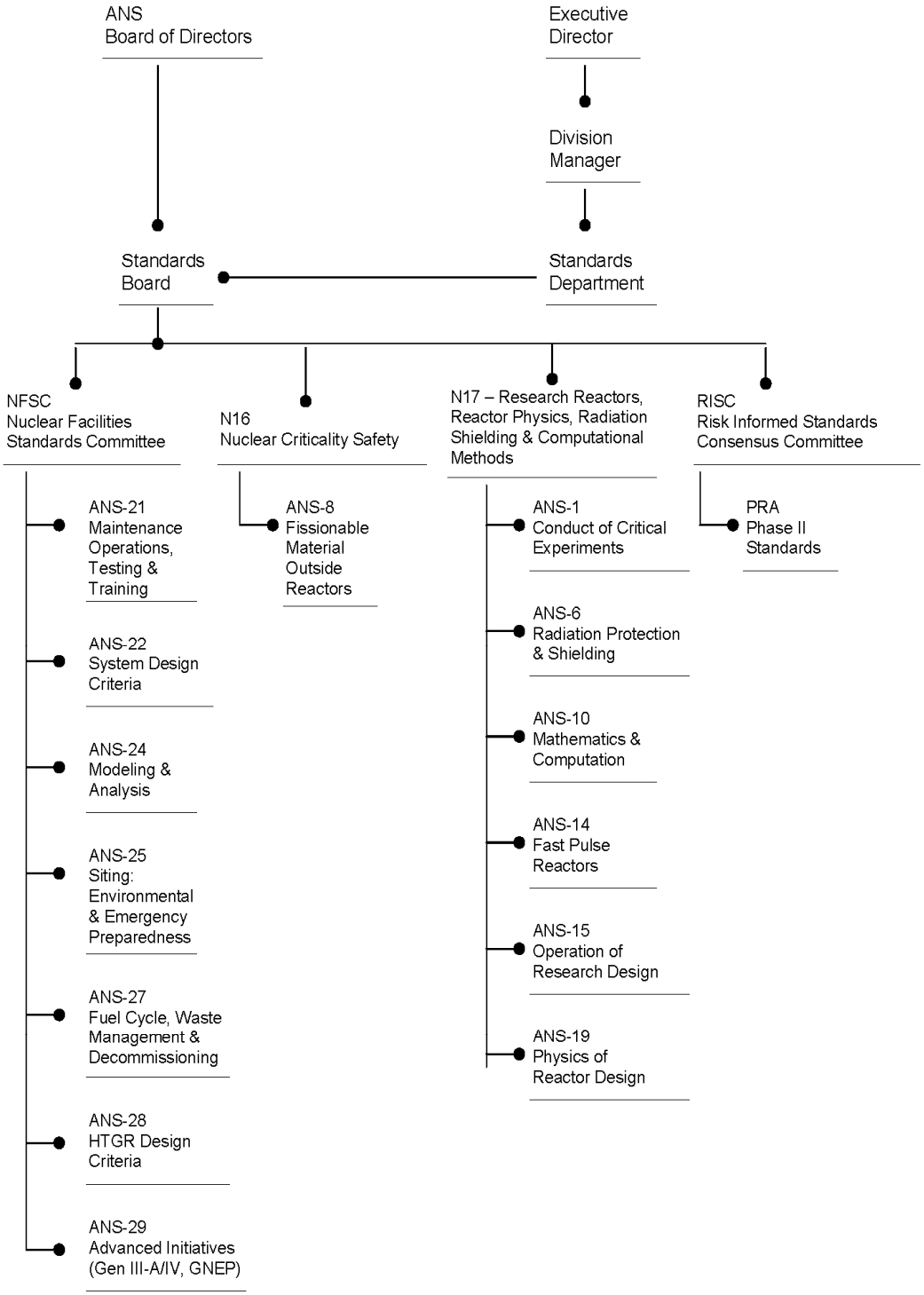
The Standards Committee does not develop standards for the application of radiation for medical purposes.

The Standards Committee reviews standards being developed or issued by other organizations on related topics to help ensure consistency and completeness and to avoid duplication.

Standards developed by the Standards Committee are intended to be issued as American National Standards.

The Standards Committee consists of consensus committees, subcommittees, and working groups, all of which are under the administrative control and policy direction of the ANS Standards Board (SB).

ANS Standards Committee: Organizational Chart



Consensus Committee 101: A Course in Standards Development

A constant in the standards development process at the American Nuclear Society has been the role of consensus committees. But, while the existence of consensus committees remains unchanged, their number and description has had some evolution over time.

Consensus committees, who are most notably recognized for their balloting responsibility in standard development, also have other jobs. The ANS standards development process is organized by hierarchies. Of course, the Standards Board (SB) sits at the top, but just below it are the consensus committees. These committees provide guidance and oversight to their various subcommittees and, in turn, report to the SB. This guidance to subcommittees includes the ballot of mature standard drafts, but also includes other activities like assistance in the identification of new projects, participation in the resolution of clarification inquiries and ballot comments, and oversight to insure the completion of projects. Some consensus committees also develop their own set of policies. Most consensus committees meet regularly and correspond via e-mail throughout the year.

Of course, consensus committees do have the responsibility of balloting proposed new, revised, and reaffirmed standards. This is the ballot tally that will be reported to the American National Standards Institute. A ballot requires a full review of the proposed standard, a timely vote response, and a complete set of comments to support the vote when necessary. Due to this important role, consensus committees must maintain a balance of interest groups on their committee. Each year their Chair attests to the balance of represented categories. No single category can hold more than one-third of the membership. Additionally, procedures restrict organizations with dual committee representation to a single vote unless there are extenuation circumstances.

Years ago when nuclear standards were just beginning, the various standards development organizations got together and divided up the pie of nuclear standards, so to speak. This is when consensus committees had their conception. Different standards development organizations are responsible for different consensus committees, and each consensus committee has a defined scope of responsibility. Currently ANS oversees four consensus committees. While the scope of ANS standards activity remains unchanged, consensus committees have been created and consolidated over time as necessary to reflect industry needs. ANS standards procedures give the SB the power to establish consensus committees as needed to cover the scope of standards activity, but specify that each consensus committee must have a prescribed scope.

The ANS Consensus Committee N16, Nuclear Criticality Safety, is a small and tight community that has been developing standards for a number of years. The committee works closely with Subcommittee ANS-8 in the development of timely standards for the control of criticality risks associated with processing fissionable materials outside reactors. Their scope is:

> To develop standards for determining the potential for nuclear criticality of fissile material outside reactors, for the prevention of accidental criticality, and for coping with accidents should they occur.

As a general practice, unanimous approval is expected to result from each ballot and a lack of unanimity is rare. This long term (over forty years) relationship has resulted in a body of 18 current

consensus standards, nearly all of which are accepted and endorsed by the Department of Energy and the Nuclear Regulatory Commission. These standards also enjoy broad acceptance worldwide.

N17, the ANS Consensus Committee covering Research Reactors, Reactor Physics, Radiation Shielding, and Computational Methods, has the following scope:

> To develop standards for the location, design, construction, operation, and maintenance of all nuclear reactors for training and research, both as mechanisms for investigating reactors per se and as sources of radiation, and excluding reactors designed for the production of electrical energy; standards for the location, design, construction, operation, and maintenance of critical facilities; standards for calculational methods and computer codes for use in nuclear-reactor and reactor-physics calculations, including shielding. Input into calculations and codes, such as nuclear cross sections, are included in this scope.
> This committee manages six subcommittees:
>
> - ANS-1, Conduct of Critical Experiments
> - ANS-6, Radiation Protection and Shielding
> - ANS-10, Mathematics and Computation
> - ANS-14, Fast Pulse Reactors
> - ANS-15, Operation of Research Reactors
> - ANS-19, Physics of Reactor Design

At present, this committee gives oversight to 25 current standards and an even larger number of working groups.

In 1998, the NUPPSCO (the Nuclear Power Plant Standards Committee) and N48 (the Radioactive Waste Management Committee) Consensus Committees were consolidated into the NFSC (Nuclear Facilities Standards Committee), and the scope was modified to reflect the broadened standards development activity:

> The Nuclear Facilities Standards Committee is responsible for the preparation and maintenance of standards associated with nuclear facilities, including radioactive waste management activities. The Committee's standards address siting, design, and operation of nuclear facilities as well as remediation and restoration of these sites. Excluded from this scope are standards for nuclear criticality safety, and training and research reactor facilities.

Recognizing that the consolidation would require more than merely lumping all the standards under one consensus committee umbrella, the NFSC tasked a small group of individuals with the job of suggesting a new organization structure for the projects under the NFSC. The current subcommittees include the following:

- ANS-21, Maintenance, Operations, Testing & Training
- ANS- 22, Systems Design Criteria
- ANS-24, Modeling & Analysis

- ANS-25, Siting: Environmental & Emergency Preparedness
- ANS-27, Fuel Cycle, Waste Management & Decommissioning
- ANS-28, HTGR Design Criteria
- ANS-29, Advanced Initiatives

ANS added the fourth consensus committee, the Risk Informed Standards Committee (RISC), in 1999. The primary purpose of this committee is to oversee the development of new risk-informed standards that the industry now seeks. Its scope is as follows:

> The American Nuclear Society Risk Informed Standards Committee is responsible for the development and maintenance of standards that establish safety and risk criteria and methods for probabilistic analysis, risk assessment and risk management. These criteria and methods are applicable to design, development, construction, operation, decontamination and decommissioning, waste management, and environmental restoration for nuclear facilities.

The RISC also reviews standards being developed or published by other organizations on related topics to help ensure consistency and needed corrections and to avoid duplication with other standards.

These four committees oversee the nearly 80 current standards and the countless additional standard projects. While each consensus committee handles a different niche of the industry, they all work together to cover the scope of the ANS standards activity. Their scopes and makeup may have changed over the years, but their organizational role in the standards development process remains as critical as it was at the very start.

For more information about activity on standards projects, check out the 2008 Standards Committee Report of Annual Activities at
http://www.ans.org/standards/resources/downloads/docs/comactivitiesreport2008.pdf

Why Should Companies Support Standards Development?

As professionals working in the nuclear energy industry, we are committed to the benefits that nuclear technology provides humankind. The future of nuclear energy depends on maintaining a strong safety record, economics, and effective waste management. So, how does the industry gather and maintain the information needed to meet these goals? It is done, in a large part, through the use of voluntary consensus standards.

Voluntary consensus standards represent the best knowledge of the field. They are written by groups of volunteers who are regarded as the technical experts in the nuclear energy industry. These standards have been in greater demand since 1998, when the Office of Management and Budget released Circular A-119. This document states that government agencies must use voluntary consensus standards instead of government-produced standards unless they happen to be "inconsistent with law or otherwise impractical." OMB Circular A-119 opens many possibilities for ANS and other standards-developing organizations by providing a stimulus for government agencies to help by providing support funding for standards development.

However, funding provided by government agencies is minimal such that volunteer participation remains essential to the development of all consensus standards. In recent years, the amount of participation has declined, largely due to tightened budgets, which reduce the support from the companies that employ the people who are critically needed as volunteers. In order for the industry to improve and implement safe practices, volunteers must be able to communicate their knowledge and the shared experience of tried and tested techniques, specifically because of their leadership in their specialized areas of work. Without these volunteers, consensus standards would not exist and the industry would lose the benefit of this huge storage bank of knowledge and development of safe practices.

With the resurgence of nuclear power about to occur, standards volunteers are going to be relied upon to provide that sound basis of technical information that is in current standards and, more importantly, in the creation of new standards. Companies engaged in nuclear-related work should think about their upcoming standards needs and canvass their personnel for experience and viewpoints, which could then be applied through the support of these employees' involvement in standards development.

What remains important in standards development is the quality that goes into the creation of standards and the groups of dedicated and talented volunteers who make it happen. This article is therefore a plea for nuclear energy companies to appreciate the importance of consensus standards, and the value that they bring to the industry. Companies, in their own best interest, should become more involved in standards development and support their employees' activities as volunteers. This is a very important challenge, and help is needed at ANS. Companies can make a difference by showing their commitment to the benefits that nuclear technology provides for a safer path forward for the industry.

American Nuclear Society Current and Active Standards Working Groups

American Nuclear Society

N16, Nuclear Criticality Safety

To develop standards for determining the potential for nuclear criticality of fissile material outside reactors, for the prevention of accidental criticality and for coping with accidents should they occur.

The N16 Consensus Committee works directly with ANS-8 Subcommittee, Fissionable Material Outside Reactors, sponsored by the Nuclear Criticality Safety Division.

The following projects are within the N16/ANS-8 management:

ANS-8.1, Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors

Scope: This standard is applicable to operations with fissionable materials outside nuclear reactors, except for the assembly of these materials under controlled conditions, such as in critical experiments. Generalized basic criteria are presented and limits are specified for some single fissionable units of simple shape containing 233U, 235U, or 239Pu, but not for multiunit arrays. Requirements are stated for establishing the validity and areas of applicability of any calculational method used in assessing nuclear criticality safety. This standard does not include the details of administrative controls, the design of processes or equipment, the description of instrumentation for process control, nor detailed criteria to be met in transporting fissionable materials.

ANS-8.3, Criticality Accident Alarm System

Scope: This standard is applicable to all operations involving fissionable materials in which inadvertent criticality can occur and cause personnel to receive unacceptable exposure to radiation. This standard is not applicable to detection of criticality events where no excessive exposure to personnel is credible, nor to nuclear reactors or critical experiments. This standard does not include details of administrative actions or of emergency response actions that occur after alarm activation.

ANS-8.5, Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material

Scope: This standard provides guidance for the use of borosilicate-glass Raschig rings as a neutron absorber for criticality control in ring-packed vessels containing solutions of 235U, 239Pu, or 233U. The chemical and physical environment, properties of the rings and packed vessels, maintenance inspection procedures, and operating guidelines are specified.

ANS-8.6, Safety in Conducting Subcritical Neutron-Multiplication Measurements in Situ

Scope: This standard provides safety guidance for conducting subcritical neutron-multiplication measurements where physical protection of personnel against the consequences of a criticality accident is not provided. The objectives of in situ measurements are either to confirm an adequate safety margin or to improve an estimate of such a margin. The first objective may constitute a test of the criticality safety of a design that is based on calculations. The second may effect improved operating conditions by reducing the uncertainty of safety margins and providing guidance to new designs.

ANS-8.7, Nuclear Criticality Safety in the Storage of Fissile Materials

Scope: This standard is applicable to the storage of fissile materials. Mass and spacing limits are tabulated for uranium containing greater than 30 wt-% 235U, for 233U, and for plutonium, as metals and oxides. Criteria for the range of application of these limits are provided.

ANS-8.10, Criteria for Nuclear Criticality Safety Controls in Operations with Shielding and Confinement

Scope: This standard provides criteria that may be used for operations outside of nuclear reactors with 235U, 233U, 239Pu, and other fissile and fissionable materials in which shielding and confinement are provided for protection of personnel and the public, except for the assembly of these materials under controlled conditions (e.g., critical experiments). The standard does not include details of administrative procedures for control (i.e., management prerogatives) nor details regarding design of processes and equipment or descriptions of instrumentation for process control.

ANS-8.12, Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors

Scope: This standard is applicable to operations with homogeneous mixtures of plutonium and uranium. The mixtures may be solutions, suspended solids, precipitates, or may have been formed mechanically. Basic criteria are presented for plutonium-uranium fuel mixtures containing no more than 30 wt% plutonium combined with uranium containing no more than 0.71 wt% 235U. This standard does not include the details of administrative controls, the design of processes or equipment, the description of instrumentation for process control, or detailed criteria to be met in transporting fissionable materials. The limits of this standard are not applicable to heterogeneous systems such as lattices of rods in water, mixtures in which particles are large enough to introduce lumping effects, or mixtures in which the concentrations of components are nonuniform. The limits are applicable, however, to homogeneous mixtures and slurries in which the particles constituting the mixture are uniformly distributed and have a diameter no larger than 127 mm (0.005 in.), i.e., are capable of being passed through a 120 mesh screen.

ANS-8.14, Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors

Scope: This standard provides guidance for the use of soluble neutron absorbers for criticality control. This standard addresses neutron absorber selection, system design and modifications, safety evaluations, and quality control programs.

ANS-8.15, Nuclear Criticality Control of Selected Actinide Nuclides

Scope: This Standard is applicable to operations with the following nuclides:
^{232}U, ^{234}U, ^{237}Np, ^{236}Pu, ^{238}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{242m}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{249}Cf, and ^{251}Cf.
Subcritical mass limits are presented for isolated units. The limits are not applicable to interacting units.

ANS-8.17, Criticality Safety Criteria for the Handling, Storage and Transportation of LWR Fuel Outside Reactors

Scope: This standard provides nuclear criticality safety criteria for the handling, storage, and transportation of LWR fuel rods and units outside reactor cores.

ANS-8.19, Administrative Practices for Nuclear Criticality Safety

Scope: This standard provides criteria for the administration of a nuclear criticality safety program for outside-of-reactor operations in which there exists a potential for criticality accidents. Responsibilities of management, supervision, and the nuclear criticality safety staff are addressed. Objectives and characteristics of operating and emergency procedures are included.

ANS-8.20, Nuclear Criticality Safety Training

Scope: This standard provides criteria for nuclear criticality safety training for personnel associated with operations outside reactors where a potential exists for criticality accidents. It is not sufficient for the training of nuclear criticality safety staff.

ANS-8.21, Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors

Scope: This standard provides guidance for the use of fixed neutron absorbers as an integral part of nuclear facilities and fissionable material process equipment outside reactors, where such absorbers provide criticality safety control.

ANS-8.22, Nuclear Criticality Safety Based on Limiting and Controlling Moderators

Scope: This standard applies to limiting and controlling moderators to achieve criticality safety in operations with fissile materials in a moderator control area. This standard does not apply to concentration control of fissile materials.

ANS-8.23, Nuclear Criticality Accident Emergency Planning and Response

Scope: This standard provides criteria for minimizing risks to personnel during emergency response to a nuclear criticality accident outside reactors. This standard applies to those facilities for which a criticality accident alarm system, as specified in American National Standard "Criticality Accident Alarm System", ANSI/ANS-8.3-1997 (R2003), is in use. This standard does not apply to nuclear power plant sites or to licensed research reactor facilities, which are addressed by other standards.

ANS-8.24, Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations

Scope: This standard provides requirements and recommendations for validation, including establishing applicability, of neutron transport calculational methods used in determining critical or subcritical conditions for nuclear criticality safety analyses.

ANS-8.25, Development of Nuclear Criticality Safety Related Postings

Scope: This standard provides a basic reference source to aid industry and governmental agencies in providing criteria and guidance on the proper development and placement of Nuclear Criticality Safety (NCS) limits and related postings for maximum effectiveness. The factors that may impinge on safety effectiveness must be considered in the final operational use of NCS limits and related postings.

ANS-8.26, Criticality Safety Engineer Training and Qualification Program

Scope: This standard presents the fundamental content elements of a training and qualification program for individuals with responsibilities for performing the various technical aspects of criticality safety engineering. The standard presents a flexible array of competencies for use by management to develop tailored training and qualification programs applicable to site-specific job functions, facilities and operations.

ANS-8.27, Burnup Credit for LWR Fuel

Scope: The standard provides criteria for processes and techniques used for criticality safety evaluations of irradiated light water reactor fuel assemblies in storage, transportation and disposal.

N17, Research Reactors, Reactor Physics, Radiation Shielding, and Computational Methods

To develop standards for the location, design, construction, operation, and maintenance of all nuclear reactors for training and research, both as mechanisms for investigating reactors per se and as sources of radiation, and excluding reactors designed for the production of electrical energy; standards for the location, design, construction, operation, and maintenance of critical facilities; standards for calculational methods and computer codes for use in nuclear-reactor and reactor-physics calculations, including shielding. Inputs into calculations and codes, such as nuclear cross sections, are included in this scope.

The N17 Consensus Committee supervises the work of six subcommittees.

ANS-1, Conduct of Critical Experiments

ANS-1, Conduct of Critical Experiments

Scope: This standard provides for the safe conduct of critical experiments. Such experiments study neutron behavior in a fission device where the energy produced is insufficient to require auxiliary cooling, and the power history is such that the inventory of long-lived fission products is insignificant.

ANS-6, Radiation Protection and Shielding

ANS-6.1.1, Neutron and Gamma-Ray Fluence-To-Dose Factors

Scope: This standard presents data recommended for computing the biologically relevant dosimetric quantity in neutron and gamma-ray radiation fields. Specifically, this standard is intended for use by shield designers to calculate effective dose equivalent. Values are given for effective dose equivalent per unit fluence for neutron energies from 1eV to 14 MeV and for gamma-ray energies from 0.01 to 12 MeV. Establishing maximum permissible exposure limits is outside the scope of this standard.

ANS-6.1.2, Neutron and Gamma-Ray Cross Sections for Nuclear Radiation Protection Calculations for Nuclear Power Plants

Scope: This standard provides information on acceptable evaluated nuclear data and group-averaged neutron and gamma-ray cross section libraries derived from these evaluated nuclear data based on the energy range and materials of importance in nuclear radiation protection and shielding calculations for nuclear power plants.

ANS-6.3.1, Program for Testing Radiation Shields in Light Water Reactors (LWR)

Scope: This standard describes a test program to be used in evaluating biological radiation shielding in nuclear reactor facilities under normal operating conditions including anticipated operational occurrences. The program encompasses examining and testing to be performed before startup, during startup, and testing subsequent to the startup phase. Post startup tests are required for the shielded components which do not contain sufficient radioactivity during the startup phase to allow valid testing. Shielding of these components is to be tested when radiation sources develop or are introduced into sufficient strength to allow meaningful measurements. Post startup shield tests are also required whenever radioactive or potentially radioactive equipment which could affect the adequacy of the installed shielding is introduced into the plant or relocated within the plant, or when previously tested shielding has been modified. One special category of post start-up testing is the testing of shielding during refueling operations.

ANS-6.4, Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants

Scope: The standard contains methods and data needed in design of concrete shielding required for protection of personnel and equipment against the effects of gamma rays and neutrons. Specific guidance is given regarding attenuation calculations, shielding design, and standards of documentation.

ANS-6.4.2, Specification for Radiation Shielding Materials

Scope: This standard sets forth physical and nuclear properties that shall be reported by the supplier as appropriate for a particular application in order to form the basis for the selection of radiation shielding materials.

ANS-6.6.1, Calculation and Measurement of Direct and Scattered Gamma Radiation from LWR Nuclear Power Plants

Scope: This standard defines calculational requirements and discusses measurement techniques for estimates of dose rates near light water reactor (LWR) nuclear power plants due to direct and scattered gamma-rays from contained sources onsite. Onsite locations outside plant buildings and locations in the offsite unrestricted area are considered. All sources that contribute significantly to dose rates are identified and methods for calculating the source strength of each are discussed. Particular emphasis is placed on 16N sources as they are significant sources of direct and scattered radiation for boiling water reactors (BWR). The standard specifically excludes radiation from gaseous and liquid effluents. The standard describes the considerations necessary to compute dose rates, including component self-shielding, shielding afforded by walls and structures, and scattered radiation. The requirements for measurements and data interpretation of measurements are given. The standard includes normal operation and shutdown conditions but does not address accident or normal operational transient conditions.

ANS-10, Mathematics and Computation

ANS-10.2, Portability of Scientific and Engineering Software

Scope: This standard provides recommended programming practices and requirements to facilitate the portability of computer programs prepared for scientific and engineering computations.

ANS-10.3, Documentation of Computer Software

Scope: This standard addresses the documentation of computer software prepared for scientific and engineering applications.

ANS-10.4, Verification and Validation of Scientific and Engineering Computer Programs for the Nuclear Industry

Scope: This standard provides guidelines for the verification and validation (V&V) of scientific and engineering computer programs developed for use by the nuclear industry.

ANS-10.5, Accommodating User Needs in Scientific and Engineering Computer Software Development

Scope: This standard presents criteria for accommodating user needs in the preparation of computer software for scientific and engineering applications.

ANS-10.7, Non-Real Time, High Integrity Software for the Nuclear Industry

Scope: This standard addresses rigorous, systematic development of high integrity, non-real time safety analysis, design, simulation software includes calculations or simulations that can have critical consequences if errors are not detected, but that are so complex that typical peer reviews are not likely to identify errors. This may include nuclear design and performance codes, codes used to assign safety classification levels to systems, structures and components at nuclear facilities, computational fluid dynamics or structural mechanics codes, complex Monte Carlo simulations, radiation dosimetry analysis codes, and nuclear medical physics analytical codes.

ANS-14, Fast Pulse Reactors

ANS-14.1, Operation of Fast Pulse Reactors

Scope: This standard is for those involved in the design, operation, and review of fast pulse reactors. It has been formulated in general terms to be applicable to all current fast pulse reactors. This standard does not apply to periodically pulsed reactors or booster assemblies.

ANS-15, Operation of Research Reactors

ANS-15.1, The Development of Technical Specifications for Research Reactors

Scope: This standard identifies and establishes the content of technical specifications (TS) for research and test reactors. Areas addressed are: Definitions, Safety Limits (SL), Limiting Safety System Settings (LSSS), Limiting Conditions for Operation (LCO), Surveillance Requirements, Design Features, and Administrative Controls. Sufficient detail is incorporated so that applicable specifications can be derived or extracted.

ANS-15.2, Quality Control for Plate-Type Uranium-Aluminum Fuel Elements

Scope: This standard sets forth general requirements for the establishment and execution of a program designed to verify that the qualify of plate-type uranium-aluminum fuel elements being purchased for research reactors conforms to the requirements of the contract and applicable technical documents, including specifications, standards, and drawings.

ANS-15.4, Selection and Training of Personnel for Research Reactors

Scope: This standard provides criteria for the selection and training of research reactor operating personnel. It addresses their qualifications, training, initial licensing, requalification, and relicensing. This standard is predicated on levels of responsibility rather than on a particular organizational concept.

ANS-15.8, Quality Assurance Program Requirements for Research Reactors

Scope: This standard provides criteria for quality assurance in the design, construction, operation, and decommissioning of research reactors.

ANS-15.10, Decommissioning of Research Reactors

Scope: This standard provides requirements and criteria for the decommissioning of research reactors and includes decommissioning alternatives, planning, radiation criteria, surveillance and maintenance, environmental impacts, quality assurance, and reports and documentation.

ANS-15.11, Radiation Protection at Research Reactors

Scope: This standard establishes the elements of a radiation protection program and the criteria necessary to provide an acceptable level of radiation protection for personnel at research reactor facilities and the public consistent with keeping exposures and releases as low as is reasonably achievable (ALARA).

ANS-15.16, Emergency Planning for Research Reactors

Scope: This standard identifies the elements of an emergency plan which describes the approach to coping with emergencies and minimizing the consequences of accidents at research reactor facilities. The emphasis given each of these elements shall be commensurate with the potential risk involved. The emergency plan shall be implemented by emergency procedures.

ANS-15.17, Fire Protection Program Criteria for Research Reactors

Scope: This standard provides criteria for a fire protection program for research reactor facilities and for the reactor safety-related systems included in those facilities. It stresses preservation of the capability to achieve and maintain safe shutdown of the reactor, and includes consideration of both direct fire hazards and indirect or consequential hazards.

ANS-15.19, Shipment and Receipt of Special Nuclear Material (SNM) by Research Reactor

Scope: This standard provides the necessary information for the shipping, receiving, and storing of fuel and other fabricated special nuclear material for research reactors. The areas addressed are data collection and analysis, packaging selection, preparation of the package or shipment, or both, safeguards, internal material control, records, and quality assurance for shipping.

ANS-15.20, Criteria for the Reactor Control and Safety Systems of Research Reactors

Scope: This standard sets forth the criteria from which design and review requirements can be established for the reactor control and safety system of a research reactor.

ANS-15.21, Format and Content for Safety Analysis Reports for Research Reactors

Scope: This standard provides the criteria for the format and content for safety analysis reports for research reactors.

ANS-19, Physics of Reactor Design

ANS-5.1, Decay Heat Power in Light Water Reactors

Scope: This standard sets forth values for the decay heat power from fission products and 239U and 239Np following shutdown of light water reactors (LWRs) containing 235U, 238U, and plutonium. The decay heat power from fission products is presented in tables and equivalent analytical representations. Methods are described that account for the reactor operating history, for the effect of neutron capture in fission products, and for assessing the uncertainty in the resultant decay heat power. Decay heat power from other actinides and activation products in structural materials, and fission power from delayed neutron-induced fission, are not included in this standard and shall be evaluated by the user and appropriately included in any analysis of shutdown power.

ANS-19.1, Nuclear Data Sets for Reactor Design Calculations

Scope: This standard identifies and describes the specifications for developing, preparing, and documenting nuclear data sets to be used in reactor design calculations. The specifications include (a) criteria for acceptance of evaluated nuclear data sets, (b) criteria for processing evaluated data and preparation of processed continuous data and averaged data sets (c) identification of specific evaluated, processed continuous and averaged data sets that meet these criteria for specific reactor types.

ANS-19.3, Determination of Steady-State Neutron Reaction-Rate Distributions and Reactivity of Nuclear Power Reactors

Scope: This standard provides guidance for performing and validating the sequence of steady state calculations leading to prediction, in all types of nuclear reactors, of: (1) Reaction rate spatial distributions (2) Reactivity (3) Change of isotopic compositions with time. The standard provides: (1) Guidance for the selection of computational methods. (2) Criteria for verification of calculational methods used by reactor core analysts (3) Criteria for evaluation of accuracy and range of applicability of data and methods (4) Requirements for documentation of the preceding. The scope of the standard is shown schematically in Figure 1.

ANS-19.3.4, The Determination of Thermal Energy Deposition Rates in Nuclear Reactors

Scope: It is the purpose of this standard to provide criteria for: (1) Determination of the energy allocation among the principal particles and photons produced in fission, both prompt and delayed; (2) Adoption of appropriate treatment of heavy charged particle and electron slowing down in matter; (3) Determination of the spatial energy deposition rates resulting from the interactions of neutrons; (4) Calculation of the spatial energy deposition rates resulting from the various interactions of photons with matter; and (5) Presentation of the results of such computations, including verification of accuracy and specification of uncertainty. This standard addresses the energy generation and deposition rates for all types of nuclear reactors where the neutron reaction rate distribution and photon and beta emitter distributions are known. Its scope is limited to the reactor core, including blanket zones, control elements and core internals, pressure vessel, and the thermal and biological shielding.

ANS-19.4, A Guide for Acquisition and Documentation of Reference Power Reactor Physics Measurements for Nuclear Analysis Verification

Scope: This Standard applies to measurements of reactor parameters in light water power reactors that are intended to serve as reference measurements to be used in evaluating reactor physics computational procedures. It includes: identification of the types of parameters of interest as reference measurements; a brief description of test conditions and experimental data required for such reference measurements; identification of problems and concerns which may affect the accuracy or interpretation of the data; and criteria to be used in documenting the results of reference measurements.

ANS-19.6.1, Reload Startup Physics Tests for Pressurized Water Reactors

Scope: This standard specifies the minimum acceptable startup reactor physics test program to determine if the operating characteristics of the core are consistent with the design predictions, which provides assurance that the core can be operated as designed.

ANS-19.8, Fission Product Yields for 235U, 238U, and 239P

Scope: This standard provides a reference set of fission yield data for thermal and fast neutron-induced fission of 233 U, 235U, 239Pu, and 241Pu; fast neutron-fission of 232Th, 238U, and 240PU; and spontaneous fission of 252CF. The data for these 12 fissioning systems are given as mass chain yields and their uncertainties and are presented in tabular form. Discussions are presented and references given concerning the application of the data. Concerns associated with the uncertainties in the mass chain yields are also discussed. A set of cumulative fission yields and uncertainties are included explicitly for a number of special purpose fission-product nuclides, particularly those important to dosimetry.

ANS-19.9, Delayed Neutron Parameters for Light Water Reactors

Scope: This standard provides energy-dependent delayed neutron yield and decay data for Light Water Reactor design and control. The standard addresses the identification and characterization of fission products leading to delayed neutron emission; the total delayed neutron yield as a function of energy for U-233, U-235, U-238 and Pu-239; and fractions associated with individual emitters, half-lives and spectra for the classical group representation of delayed neutron data

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ANS-19.10, Methods for Determining Neutron Fluence in BWR and PWR Pressure Vessel and Reactor Internals

Scope: This standard provides criteria for performing and validating the sequence of calculations required for the prediction of the fast neutron fluence t in the reactor vessel. Applicable to PWR and BWR plants the standard addresses flux attenuation from the core through the vessel to the cavity and provides criteria for generating cross sections, spectra, transport and comparisons with in- and ex-vessel measurements, validation, uncertainties and flux extrapolation to the inside vessel surface.

ANS-19.11, Calculation and Measurement of the Moderator Temperature Coefficient of Reactivity for Water Moderated Power Reactors

Scope: This standard provides guidance and specifies criteria for determining the MTC in water moderated power reactors. Measurement of the isothermal temperature coefficient of reactivity (ITC) at hot zero power (HZP) conditions is covered in American National Standard Reload Startup Physics Tests for Pressurized Water Reactors, ANSI/ANS-19.6.1-1997. This standard therefore addresses the calculation of the ITC at HZP and the calculation and measurement of the MTC at power. At present, this standard addresses the calculation and measurement of the MTC only in PWRs, because that is the only type of power reactor currently sited in the United States for which measurement of the MTC is required.

ANS-19.12, Nuclear Data for Isotope Production Calculations for Medical and Other Applications

Scope: This standard establishes criteria for developing evaluated neutron cross section and branching ratio data for isotope production pathways for fast and thermal reactor systems, providing the data needed to calculate production of the desired medical and other isotopes and associated impurities.

NFSC, Nuclear Facilities Standards Committee

The NFSC is responsible for the preparation and maintenance of standards associated with nuclear facilities. The Committee's standards address siting, design, operation, and waste management activities at these facilities, as well as remediation and restoration of formerly utilized sites. The NFSC supervises the work of seven subcommittees.

ANS-21, Maintenance, Operations, Testing & Training

ANS-2.10, Criteria for the Handling and Initial Evaluation of Records from Nuclear Power Plant Seismic Instrumentation

Scope: This standard provides criteria for the timely retrieval and the subsequent processing, handling, and storage of data obtained from seismic instrumentation specified in ANSI/ANS-2.2-2002. Also included are initial evaluation criteria to determine whether earthquake motion at the site has exceeded the plant's operating basis earthquake ground motion (OBE). This standard does not address procedures for plant walkdowns immediately (within 8 hours) after an earthquake, for ensuring a safe and orderly shutdown, for long term evaluations of the building and equipment response data, and for subsequently returning the plant to operation. These topics are addressed in ANS 2.23-2002.

ANS-2.23, Nuclear Plant Response to an Earthquake

Scope: This standard specifies actions that the owner of a nuclear power plant should take in the event of an earthquake. The requirements of this standard supplement those given in American National Standard Criteria for the Handling and Initial Evaluation of Records from Nuclear Power Plant Seismic Instrumentation, ANSI/ANS-2.10-2003. The application of these standards provides a complete evaluation of the need for postearthquake plant shutdown in a timely manner. This standard also provides guidelines that will enable the owner to develop plant-specific procedures for determining the condition of components, systems, and structures needed for shutdown and criteria for restart when a nuclear power plant is required to shut down following an earthquake. This standard does not cover those operator actions performed in connection with the operation and control of the nuclear power plant following an earthquake. These actions are specified in plant operating procedures, emergency operating procedures, and alarm response procedures.

ANS-3.1, Selection, Qualification, and Training of Personnel for Nuclear Power Plants

Scope: This standard provides criteria for the selection, qualification, and training of personnel for nuclear power plants. The qualifications of personnel in the operating organizations appropriate to safe and efficient operation of a nuclear power plant are addressed in terms of the minimum education, experience, and training requirements.

ANS-3.2, Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants

Scope: This standard provides requirements and recommendations for administrative controls and the owners' quality assurance program to help ensure that activities associated with nuclear power plant operation are carried out without undue risk to the health and safety of the public.

This standard provides requirements for implementing Quality Assurance programs consistent with requirements of Code of Federal Regulations, Title 10, Part 50, Appendix B.

ANS-3.4, Medical Certification and Monitoring of Personnel Requiring Operator Licenses for Nuclear Power Plants

Scope: This standard defines the medical and psychological requirements for licensing of nuclear power plant reactor operators and senior operators. It also addresses the content, extent, and methods of examination. This standard has been reviewed and reaffirmed by the ANS Nuclear Facilities Standards Committee (NFSC) with the recognition that it may reference other standards and documents that may have been superseded or withdrawn. The requirements of this document are 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 cited 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. The 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.

ANS-3.5, Nuclear Power Plant Simulators for Use in Operator Training and Examination

Scope: This standard establishes the functional requirements for full-scope nuclear power plant control room simulators for use in operator training and examination. The standard also establishes criteria for the scope of simulation, performance, and functional capabilities of simulators. This standard does not address simulators for reactors not subject to U.S. Nuclear Regulatory Commission licensing. This standard does not establish criteria for the use of simulators in training programs.

ANS-3.11, Determining Meteorological Information at Nuclear Facilities

Scope: This document provides criteria for gathering and assembling meteorological information at commercial nuclear electric generating stations, U.S. Department of Energy / National Nuclear Security Administration nuclear facilities, and other national or international nuclear facilities. Meteorological data collected, stored, and displayed through implementation of this standard are utilized to support the siting, operation, and decommissioning of nuclear facilities. The meteorological data are employed in determining environmental impacts, consequence assessments

supporting routine release and design-basis accident evaluations, emergency preparedness programs, and other applications.

ANS-3.12.3, Decommissioning of Nuclear Production and Utilization Facilities: Operator Training

Scope: This standard provides criteria for changes to Operator Qualification Training Requirements which will result from permanent shutdown and removal of fuel to the plant fuel pools or other locations, and from subsequent decommissioning actions. The hazards associated with a defueled, decommissioned facility are significantly less than those associated with an operating plant and the Operator Qualification and Training Requirements will be revised to reflect these reductions in risk.

ANS-56.8, Containment System Leakage Testing Requirements

Scope: This standard specifies acceptable primary containment leakage rate test requirements to assure valid testing. The scope includes (1) Leakage test requirements; (2) Test instrumentation; (3) Test procedures; (4) Test methods; (5) Acceptance criteria; (6) Data analysis; (7) Inspection and recording of test results.

ANS-58.6, Criteria for Remote Shutdown for Light Water Reactors

Scope: This standard provides design criteria for controls and monitoring instrumentation necessary to shut down a reactor and maintain it in a safe shutdown condition from outside the control room. The design criteria require that: (a) specific controls and monitoring instrumentation be provided; (b) these controls be installed at a location (or locations) that is physically separate from the control room and cable spreading areas; (c) simultaneous control from both locations be prevented by devices for transfer of control from the control room to the remote location(s); and (d) the remote controls be used as a defense-in-depth measure in addition to the control room shutdown controls and as a minimum provide for one complete channel of shutdown equipment.

ANS-22, System Design Criteria

ANS-2.26, Categorization of Nuclear Facility Structures, Systems, and Components For Seismic Design

Scope: This standard provides: (a) criteria for selecting the seismic design category (SDC) for nuclear facility structures, systems, and components (SSCs) to achieve earthquake safety and (b) criteria and guidelines for selecting Limit States for these SSCs to govern their seismic design. The Limit States are selected to ensure the desired safety performance in an earthquake.

ANS-51.10, Auxiliary Feedwater System for Pressurized Water Reactors

Scope: This standard sets forth the nuclear safety-related functional requirements, performance requirements, design criteria, design requirements for testing and maintenance, and interfaces for the nuclear safety-related portion of the auxiliary feedwater system (AFS) of pressurized water reactor (PWR) plants.

ANS-55.1, Solid Radioactive Waste Processing System for Light-Water-Cooled Reactor Plants

Scope: This standard sets forth the design, construction, and performance requirements for a solid radioactive waste processing system for light-water-cooled reactor plants. For the purposes of this standard, the solid radioactive waste processing system begins at the interface with the liquid radioactive waste processing system boundary and at the inlets to the spent resin, filter sludge, evaporator concentrate, and phase separator tanks. In addition, this standard pertains to dry active waste, mixed waste, and other solid radioactive waste forms that are generated as part of the operation and maintenance of light-water-cooled reactor plants. The system includes facilities for temporary (up to 30 days of anticipated normal waste generation) on-site storage of packaged waste but terminates at the point of loading the filled drums and other containers on a vehicle for shipping off-site to a licensed disposal site or transfer to interim (up to 5 yr.) on-site storage facilities. The solid radioactive waste processing system is not a safety-class system as defined by American National Standard Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, ANSI/ANS-51.1-1983 (R1988) or as defined in American National Standard Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants, ANSI/ANS-52.1-1983; R1988.

ANS-55.4, Gaseous Radioactive Waste Processing Systems for Light Water Reactor Plants

Scope: This standard sets forth minimum design, construction, and performance requirements, with due consideration for operation, for gaseous radioactive waste processing systems (GRWPS) for light water reactor (LWR) plants. It is applicable for routine operation, design basis fuel leakage, and other design basis occurrences.

ANS-55.6, Liquid Radioactive Waste Processing System for Light Water Reactor Plants

Scope: This standard sets forth minimum design, construction, and performance requirements, with due consideration for operation, of the Liquid Radioactive Waste Processing System (LRWPS) for light water reactor (LWR) plants for design basis inputs. It is applicable to routine operation, including design basis fuel leakage and other design basis occurrences.

ANS-58.3, Physical Protection for Nuclear Safety-Related Systems and Components

Scope: This standard sets forth physical protection criteria for nuclear safety-related systems and components in stations using light water reactors (LWRs). This standard includes an identification of potential hazards to nuclear safety-related systems and components and acceptable means of ensuring the protection of this equipment from these hazards.

ANS-58.8, Time Response Design Criteria for Safety-Related Operator Actions

Scope: This standard establishes time response design criteria for safety-related operator actions to be used in the design of light water reactor (LWR) nuclear power plants. The criteria are used to determine the minimum response time intervals for safety-related operator actions that are taken to mitigate design basis events (DBEs) which result in an automatic reactor trip. This standard specifies time requirements that are to be met to receive credit in the safety analysis for operator actions that initiate or control safety-related functions. Specifically, the criteria provide bases:(1) For establishing certain requirements for determining whether a particular action to initiate or control a safety-related system might be accomplished by operator action or must be accomplished by an automatic action.(2) For determining when design modifications can obviate the need for automatic actions that would otherwise be required.(3) For general guidance for hardware, such as instrumentation, controls, indicators, and annunciators necessary to support safety-related operator actions.

ANS-58.9, Single Failure Criteria for Light Water Reactor Safety-Related Fluid Systems

Scope: This standard provides criteria for the designer which interpret the requirements of Title 10, Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," Appendix A, "General Design Criteria for Nuclear Power Plants," with respect to design against single failures in safety-related Light Water Reactor (LWR) fluid systems. Means of treating both active and passive failures are addressed for safety-related fluid systems following various initiating events. Current acceptable practice is used as a basis for these criteria.

ANS-58.11, Design Criteria for Safe Shutdown Following Selected Design Basis Events in Light Water Reactors

Scope: This standard provides design criteria for systems that perform the safety-related functions necessary to shut down a reactor and maintain it in a safe shutdown condition for selected design basis events; i.e., any design basis events that do not require operation of engineered safety features. For design basis events that require operation of engineered safety features, this standard can be selectively applied because of plant features specifically designed for these conditions. For systems that serve multiple functions, the design criteria associated with the most limiting function shall be applied.

The following safety-related functions are required for safe shutdown and are addressed in this standard: 1) Reactor core reactivity control, 2) Reactor core heat removal, 3) Reactor coolant pressure boundary integrity provided by: a) Temperature control, b) Pressure control, and c) Inventory control.

ANS-58.14, Safety and Pressure Integrity Classification Criteria for Light Water Reactors

Scope: This standard specifies deterministic criteria for the safety classification of items (i.e., SSCs and parts (including consumables)) in a LWR NPP as either safety-related (Q), supplemented grade (S), or non-safety-related (N). Criteria provide and establish a procurement subclassification within Class Q, called commercial grade (C). In addition, pressure integrity classification criteria provide for the assignment of Classes 1 to 5 to the pressure-retaining portion of items.

ANS-58.16, Safety and Pressure Integrity Classification Loads and Behavior Criteria for Nuclear Facilities Other Than Large Nuclear Reactors

Scope: This standard provides guidance for the safety classification of items (structures, systems, components and parts (including consumables) in nuclear facilities other than nuclear power plants. In addition, pressure integrity classification criteria are provided for the assignment of safety design classes, SDC 1,2,3,4 or 5 to the nuclear safety related and pressure retaining portions of items and to include associated load criteria. Also identified are Limit States A, B, C, and D which provide allowable behavior criteria currently defined in ANS Standards for seismic loads.

ANS-59.3, Nuclear Safety Criteria for Control Air Systems

Scope: This standard provides criteria for the control air system that furnishes compressed air to nuclear safety-related components and other equipment that could affect any nuclear safety-related function in nuclear power plants.

This standard provides:
(1) the system nuclear safety design requirements and the non-nuclear safety design recommendations for equipment, piping, instruments, and controls that constitute the control air system; and
(2) the nuclear safety design requirements and the non-nuclear safety design recommendations to accommodate the testing and maintenance necessary to ensure adequate performance of the control air system.
This standard applies only to the control air system and does not apply to air-operated devices or the emergency diesel generator starting air system.

ANS-59.51, Fuel Oil Systems for Safety-Related Emergency Diesel Generators

Scope: This standard provides functional, performance, and initial design requirements for the fuel oil system for diesel generators that provide safety-related emergency onsite power for light water reactor nuclear power plants. This standard addresses the mechanical equipment associated with the fuel oil system, with the exception of the engine mounted components. These components, which are mounted directly to the engine structure itself, are excluded except to define interface requirements. It also includes the instrumentation and control functional requirements. The standard excludes motors, motor control centers, switchgear, cables, and other electrical equipment used in the operation of the fuel oil system, except to define interface requirements.

ANS-59.52, Lubricating Oil Systems for Safety-Related Emergency Diesel Generators

Scope: This standard provides functional, performance, and design requirements for lubricating oil systems for diesel generators that provide emergency onsite power for light water reactor nuclear power plants. The standard addresses all mechanical equipment associated with the lubricating oil system, with the exception of engine mounted components. These components, which are mounted directly to engine structure itself, are excluded, except to define interface requirements. This standard also includes the lubricating oil system instrumentation and control functional

requirements. It excludes motors, motor control centers, switchgear, cables, and other electrical equipment used in the operation of the lubricating oil system, except to define interface requirements.

ANS-24, Modeling and Analysis

ANS-2.15, Criteria for Modeling and Calculating Atmospheric Transport of Routine Releases from Nuclear Facilities

Scope: This standard establishes criteria for use of meteorological data collected at nuclear facilities to evaluate the atmospheric effects on routine radioactive releases, inclusive of dilution, dispersion, plume rise, plume meander, aerodynamic effects of buildings, dry, deposition, and wet deposition (e.g., precipitation scavenging).

ANS-2.16, Criteria for Modeling Design-Basis Accidental Releases from Nuclear Facilities

Scope: This standard established criteria for use of meteorological data collected at nuclear facilities to evaluate the atmospheric effects on accidental radioactive and chemical releases, inclusive on dilution, dispersion, plume rise, plume meander, aerodynamic effects of buildings, dry deposition, and wet deposition (e.g., precipitation scavenging). These criteria may also be useful in Department of Homeland Security (DHS) consequence assessments.

ANS-2.29, Probabilistic Seismic Hazard Analysis

Scope: This standard provides criteria to establish the probabilistic basis for various levels of natural phenomena hazards at nuclear materials facility sites

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ANS-3.8.5, Criteria for Emergency Radiological Field Monitoring, Sampling and Analysis

Scope: This standard provides criteria for the Emergency Radiological Field Monitoring Program, which establishes the approach to field monitoring, sampling, and analysis during and after an emergency. It addresses the issues relative to the field monitoring team: 1) organization, staffing, and training, 2) equipment and supplies, 3) procedures and techniques, 4) and sample analysis. This standard does not include either routine environmental monitoring programs used to establish baseline environmental conditions or dose assessment programs.

ANS-3.8.10, Criteria for Modeling Real-time Accidental Release Consequences at Nuclear Facilities

Scope: This standard establishes criteria for use of meteorological data collected at nuclear facilities or nearby stations to evaluate in real time the atmospheric effects on all anticipated accidental radioactive and hazardous chemical releases during emergencies, inclusive of atmospheric transport and dispersion

ANS-5.4, Method for Calculating the Fractional Release of Volatile Fission Products from Oxide Fuel

Scope: This standard provides an analytical method for calculating the release of volatile fission products from oxide fuel pellets during normal reactor operation. When used with nuclide 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 considers high-temperature (up to the melting point) and low-temperature (where temperature-independent processes dominate) releases and distinguishes between short-halflife (halflife less than one year) and long-halflife (halflife greater than one year) nuclides. This standard requires that releases for nuclides of interest be calculated with both the high-temperature and the low-temperature models, and the larger of the two calculated releases is to be taken as the result.

ANS-5.10, Airborne Release Fractions at Non-Reactor Nuclear Facilities

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.

ANS-16.1, Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure

Scope: This standard, ANSI/ANS-16.1-2003, provides a uniform procedure to measure and index the release of radionuclides from waste forms as a result of leaching in demineralized water for 5 days. The results of this procedure do not apply to any specific environmental situation except through correlative studies of actual disposal site conditions. The test presented in this standard has much in common with the original International Atomic Energy Agency proposal and has by now become familiar to those working in the radioactive waste-form development field. It contains the provisions published in the original version of this standard in 1986.

ANS-18.1, Radioactive Source Term for Normal Operation of Light Water Reactors

Scope: This standard provides a set of typical radionuclide concentrations for estimating the radioactivity in the principal fluid systems of light water reactors and for projecting the expected releases of radioactivity from nuclear plants. It is not Intended that the values be used as the sole basis for design, but be used in environmental reports and elsewhere where expected operating conditions over the life of the plant would be appropriate.

ANS-41.5, Verification and Validation of Radiological Data for Use in Waste Management and Environmental Remediation

Scope: This standard establishes criteria and processes for determining the validity of radioanalytical data for waste management and environmental remediation. These applications include site characterization, waste acceptance, waste certification, waste treatment design, process control, risk communication, litigation, and other applications as deemed necessary.

ANS-58.2, Design Basis for Protection of Light Water Nuclear Power Plants Against the Effects of Postulated Pipe Rupture

Scope: This standard addresses the design basis for the protection of light water reactor nuclear power plants from the potentially adverse effects of postulated pipe ruptures.

ANS-25, Siting: Environmental & Emergency Preparedness

ANS-2.2, Earthquake Instrumentation Criteria for Nuclear Power Plants

Scope: This standard specifies the required earthquake instrumentation for the site and structures of light water cooled, land based nuclear power plants. It may be used for guidance at other types of nuclear facilities. This standard does not address the following: (a) Instrumentation to automatically shut down a nuclear power plant at a predetermined ground acceleration. (b) Procedures for evaluating records obtained from seismic instrumentation and instructions for the treatment of data. These procedures and instructions are specified in American National Standard, "Criteria for the Handling and Initial Evaluation of Records from Nuclear Power Plant Seismic Instrumentation," ANSI/ANS 2.10-2003.

ANS-2.3, Determining Tornado and Other Extreme Wind Characteristics at Nuclear Facility Sites

Scope: The purpose of this standard is to specify guidelines to determine the wind velocity, atmospheric pressure change, missile type, size and velocity that result from tornadoes, hurricanes and other extreme winds to be used in nuclear facility design. The standard does not treat forces that result from these natural events.

ANS-2.6, Guidelines for Estimating Present and Forecasting Future Population Distributions Surrounding Power Reactor Sites

Scope: This standard provides guidance on suitable methodologies for developing estimates and forecasts of human population distribution around civilian and Federal nuclear facility sites. The standard is intended to provide applicants and DOE/NNSA professionals with methodologies that are generally acceptable in the demographic community and to facilitate the NRC review of site suitability relative to population considerations.

ANS-2.8, Determining Design Basis Flooding at Power Reactor Sites

Scope: This document presents criteria to establish design basis flooding for nuclear safety-related features at power reactor sites. Methodology is described to evaluate the flood having virtually no risk of exceedance that can be caused by precipitation and snowmelt and any resulting dam failures; seismically induced dam failures; surge or seiche and attendant wind-generated wave activity; or a reasonable combination of these events.

ANS-2.9, Evaluation of Ground Water Supply for Nuclear Facilities

Scope: This standard provides criteria for the determination of the availability of ground water supplies for nuclear facilities with respect to both safety and non-safety related aspects.

ANS-2.17, Evaluation of Radionuclide Transport in Ground Water for Nuclear Facilities

Scope: This standard provides criteria for the determination of the concentration of radionuclides in the ground water resulting from both postulated accidents and routine releases from nuclear facilities.

ANS-2.18, Standards for Evaluating Radionuclide Transport in Surface Water for Nuclear Power Sites

Scope: This standard presents guidelines for the determination of the transport of radionuclides in surface water resulting from both postulated accidental and routine releases from nuclear power plants and other nuclear facilities.

ANS-2.21, Criteria for Assessing Atmospheric Effects on the Ultimate Heat Sink

Scope: 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 (short wave) radiation, surface water temperature, and atmospheric pressure) on ultimate heat sinks.

ANS-2.22, Environmental Radiological Monitoring at Nuclear Facilities

Scope: This standard establishes criteria for use in developing and implementing an integrated radiological environmental monitoring program focusing on ambient air, surface water, and biota. It also provides criteria on the use of resultant environmental data collected near nuclear facilities to evaluate the impact of facility operations on the surrounding population and environment.

ANS-2.25, Surveys of Terrestrial Ecology Needed to License Thermal Power Plants

Scope: This standard discusses the need developers of thermal power plants and their associated facilities have for information on the terrestrial environment. Utilities and regulatory agencies must collect information to predict and assess real and potential environmental impacts, and to site and design generating plants that avoid or reduce adverse effects. Users of this standard will be guided through each stage of a survey with its corresponding requirements, the relationship of the terrestrial ecologist and other specialists in a major project, sources of information, and the governing laws and regulations.

ANS-2.27, Criteria for Investigations of Nuclear Facility Sites for Seismic Hazard Assessments

Scope: This standard provides requirements and recommended practices for conducting investigations and acquiring data sets needed to evaluate seismic source characterization for probabilistic seismic hazard analysis (PSHA), site response and soil structure interaction (SSI) effects, and liquefaction. These data also are used to evaluate fault rupture and associated secondary deformation, and other seismically-induced ground failure hazards (i.e., ground settlement, slope failure, and subsidence and collapse).

ANS-2.30, Assessing Capability for Surface Faulting at Nuclear Facilities

Scope: This standard provides criteria and guidelines for investigations to assess potential for surface and near-surface faulting and associated near-fault deformation at nuclear facilities, referencing considerable new experience. The standard is an up-to-date compilation of techniques to evaluate fault offset potential and a valuable resource for planning and conducting site characterization studies for future nuclear facilities. It supplements a group of standards (i.e., ANS-2.26, -2.27, -2.29, ASCE 43-05) whose focus is on vibratory ground motion rather than fault offset hazard.

ANS-3.7.1, Facilities and Medical Care for On-Site Nuclear Power Plant Radiological Emergencies

Scope: This standard provides criteria for developing plans, and for providing facilities and equipment, for the care and transportation of individuals exposed to unexpected radiation, or contaminated with radioactive materials either internally or externally, in nuclear power plants. The criteria address coordination of emergency response and first aid at the plant site; transportation to an offsite location, such as a local hospital; and care at the offsite location. Training of personnel in support of expected actions is also addressed.

ANS-3.8.1, Criteria for Radiological Emergency Response Functions and Organizations

Scope: This standard establishes criteria for developing an overall preplanned emergency response organization for commercial nuclear power plants. The criteria address: (1) basic emergency response functions (2) emergency response support functions to ensure that the basic functions are adequately implemented (3) emergency response organization (4) personnel responsibilities.

ANS-3.8.2, Criteria for the Functional and Physical Characteristics of Radiological Emergency Response Facilities

Scope: This standard establishes the criteria for facilities needed to provide an adequate overall emergency response. The standard addresses: (1) emergency response facilities (2) facility features and requirements, and (3) parameters needed to provide a basis for determining an adequate inventory of equipment and supplies for the anticipated emergency response. Normal plant equipment that is to be used during an emergency, such as sampling system equipment, safety-related systems, or system instrumentation, are not within the scope of this standard.

ANS-3.8.3, Criteria for Radiological Emergency Response Plans and Implementing Procedures

Scope: This standard establishes criteria for developing a radiological emergency response plan and implementing procedures necessary to coordinate an integrated emergency response at a commercial nuclear power plant. The radiological emergency response plan is the administrative document that establishes the licensee's commitments to emergency preparedness and response. The procedures are the licensee's documents that implement the radiological emergency response plan. Implementing procedures address the following areas: (1) emergency classification, (2) emergency response organization duties and responsibilities, (3) notification, (4) emergency response facilities activation and operation, (5) emergency teams, (6) personnel protection, (7) environmental , assessment, (8) public information, (9) de-escalation, (10) recovery planning, (11) maintaining emergency preparedness.

ANS-3.8.4, Criteria for Maintaining Radiological Emergency Response Capability

Scope: This standard provides criteria and recommendations for emergency preparedness exercises, drills, surveillance activities, and training. This standard does not address detailed accident scenarios, but provides criteria regarding the frequency, type, and scope of exercises, drills, and training needed, and the extent of the realism necessary for the exercise to be effective. This standard provides criteria for emergency exercises involving the facility and offsite support groups and criteria for evaluating exercises.

ANS-3.8.6, Criteria for the Conduct of Offsite Radiological Assessment for Emergency Response for Nuclear Power Plants

Scope: This standard describes the purpose of dose assessment and provides dose assessment criteria to be used when formulating protective action recommendations for the public. The standard describes the use of field monitoring data in support of dose assessment, and the integration of dose assessments with plant status assessments for protective action recommendations.

ANS-3.8.7, Criteria for Planning, Development, Conduct, and Evaluation of Drills and Exercises for Emergency Preparedness
Scope: This standard establishes criteria for the administration of a program of radiological emergency response drills and exercises in support of emergency preparedness at nuclear power plants. The topics discussed in this standard are applicable to both exercises and drills unless specifically identified otherwise. The standard addresses: (1) Types of emergency drills and exercises, and the reasons for each. (2) Planning activities associated with drills and exercises. (3) Development of scenarios for drills and exercises. (4) Conduct of drills and exercises. (5) Evaluation of drills and exercises. Simulator drills and exercises conducted as part of a larger emergency response exercise are within the scope of this standard. Simulator drills and exercises conducted as part of licensed operator training, and periodic retraining, are not within the scope of this standard. Exercise scenario artificialities needed to drive emergency response activities are often obtained by intentionally defeating operating actions or by inserting simulator manipulations. These actions or manipulations might produce responses which are in excess of the capabilities called for in American National Standard for Nuclear Power Plant Simulators for Use in Operator Training and Examination, ANSI/ANS-3.5-1993. Therefore, these exercises are not to be used to evaluate the adequacy of simulator performance or operator accident mitigation capability.

ANS-40.21, Siting, Construction, and Operation of Commercial Low Level Radioactive Waste Burial Grounds

Scope: This standard provides a matrix of minimum criteria to be met in determining the siting, construction and operation of a commercial low level radioactive waste burial ground. The standard will balance siting (i.e., natural criteria), construction (i.e., engineered safeguards) and operation (i.e., acceptance criteria) to provide a safety matrix that provides for the containment of the facility.

ANS-27, Fuel Cycle, Waste Management & Decommissioning

ANS-40.35, Volume Reduction of Low-Level Radioactive Waste or Mixed Waste

Scope: This standard sets forth the general design specifications, procurement, and performance requirements for operation of low-level waste (LLW) and mixed waste (MW) volume reduction (VR) processing systems for nuclear power plants and other nuclear facilities. This standard may be applied to the specification of other LLW VR systems (such as government nuclear facilities) if consideration is given to any additional design features required by the hazardous nature of the wastes to be processed by them. For the purpose of this standard, a nuclear facility's LLW VR processing systems begin at the point where treatment of aqueous waste generates a solid waste, or where solid, slurry, or liquid organics wastes are collected, and ends at a waste storage, shipping, or disposal area. VR techniques may include processes such as drying, incineration, chemical decomposition, flash boiling, mechanical, or high-temperature reduction or destruction techniques, or both. Some VR systems may include, as an integral part of the system, a means for immobilization of the waste. Compaction and solidification techniques are in the scope of American National Standard Solid Radioactive Waste Processing Systems for Light Water Reactor Plants, ANSI/ANS-55.1-1992.

ANS-40.37, Mobile Low-Level Radioactive Waste Processing Systems

Scope: This standard sets forth design, fabrication, and performance recommendations and requirements for Mobile Low-Level Radioactive Waste Processing (MRWP) systems (including components) for nuclear facilities. The purpose of this standard is to provide guidance to ensure that the MRWP systems are designed, fabricated, installed, and operated in a manner commensurate with the need to protect the health and safety of the public and plant personnel.

ANS-57.1, Design Requirements for Light Water Reactor Fuel Handling Systems

Scope: This standard sets forth the required functions of fuel handling systems at light water reactor nuclear power plants. It provides minimum design requirements for equipment and tools to handle nuclear fuel and control components safely.

ANS-57.2, Design Requirements for Light Water Reactor Spent Fuel Facilities at Nuclear Power Plants

Scope: This standard presents necessary design requirements for facilities at nuclear power plants for the pool storage and preparation for shipment of spent fuel from light-water moderated and cooled nuclear power stations, including consideration of the impact of high burn-up fuels. It contains requirements for the design of the following: (1) Fuel storage pool (2) Fuel storage racks (3) Pool makeup, instrumentation and cleanup systems (4) Pool structure and integrity (5) Radiation shielding (6) Residual heat removal (7) Ventilation, filtration and radiation monitoring systems (8) Shipping cask handling and decontamination (9) Building structure and integrity (10) Fire protection and communication Design requirements for spent fuel storage in an Independent Spent Fuel Storage Installation (ISFSI) subsequent to such initial pool storage are covered in ANSI/ANS Standard 57.7.

ANS-57.3, Design Requirements for New Fuel Storage Facilities at LWR Plants

Scope: This standard defines the required functions of wet or dry storage facilities for new fuel, including high burn-up fuel, at light water reactor nuclear power plants. It provides minimum design requirements for safe storage of new nuclear fuel and control components at such plants. The fuel storage facilities covered by this standard are used for receiving, inspecting and storing fuel containing new and recycled uranium and mixed oxides. The basis of this standard is that the intended function of the facilities will be performed in an efficient and economical manner to (a) preclude criticality, (b) ensure protection to new fuel assemblies, control components, plant personnel, and the public, and (c) maintain radiation exposures as low as reasonably achievable.

ANS-57.5, Light Water Reactors Fuel Assembly Mechanical Design and Evaluation

Scope: This standard sets forth a series of design conditions and functional requirements for the design of fuel assemblies for light water cooled commercial power reactors. It includes specific requirements for design, as well as design criteria to ensure adequate fuel assembly performance. The standard establishes a procedure for performing an evaluation of the mechanical design of fuel assemblies. It does not address the various aspects of neutronic or thermal-hydraulic performance

except where these factors impose loads or constraints on the mechanical design of the fuel assemblies.

ANS-57.7, Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)

Scope: This standard provides design criteria for systems and equipment of a facility for the receipt and storage of spent fuel from light water reactors. It contains requirements for the design of major buildings and structures including the shipping cask unloading and spent fuel storage pools, cask decontamination, unloading and loading areas, and the surrounding buildings which contain radwaste treatment, heating, ventilation and air conditioning, and other auxiliary systems. It contains requirements and recommendations for spent fuel storage racks, special equipment and area layout configurations, the pool structure and its integrity, pool water cleanup, ventilation, residual heat removal, radiation monitoring, fuel handling equipment, cask handling equipment, prevention of criticality, radwaste control and monitoring systems, quality assurance requirements, materials accountability, and physical security.

ANS-57.8, Fuel Assembly Identification

Scope: This standard describes requirements for the unique identification of fuel assemblies utilized in nuclear power plants. It defines the characters and proposed sequence to be used in assigning identification to fuel assemblies. This standard was developed primarily for commercial light-water reactor fuel, but may be used for any reactor fuel contained in discrete fuel assemblies that can be identified with a serial number as specified by this standard. Additionally, this standard describes requirements for a matrix system for identification in mapping the location of fuel rods within a fuel assembly. The matrix system establishes unique x-y coordinates for each possible rod location.

ANS-57.9, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type)

Scope: This standard is intended to be used by the owner and operator of a dry storage-type independent spent fuel storage installation (ISFSI) in specifying the design requirements and by the designer in meeting the minimum requirements of such installations. The standard includes requirements for the following: the design of major buildings and structures, shipping cask unloading and handling facilities, cask decontamination, loading and unloading areas, spent fuel storage areas and racks, fuel handling equipment, radiation shielding, special equipment and area layout configurations, air or gas quality, storage area integrity, air or gas cleanup, fuel inspection,

ventilation, residual heat removal, radiation monitoring, prevention of criticality, radwaste control and monitoring systems, provisions to facilitate decommissioning, quality assurance, materials accountability, and physical security.

ANS-57.10, Design Criteria for Consolidation of LWR Spent Fuel

Scope: This standard provides design criteria for the process of consolidating LWR spent nuclear fuel in either a wet or a dry environment. It addresses processes for consolidating fuel either horizontally or vertically. The standard sets forth requirements for utilizing equipment and systems to perform consolidation, handle fuel rods and nonfuel-bearing components, and handle broken fuel rods. This standard also contains requirements for facility or installation interfaces, nuclear safety, structural design, thermal design, accountability, safeguards, decommissioning, and quality assurance.

ANS-28, HTGR Design Criteria

ANS-53.1, Nuclear Safety Criteria for the Design of Modular Helium-Cooled Reactor Plants

Scope: This standard establishes the nuclear safety criteria, functional performance and design requirements of structures, systems, and components (SSC) for modular helium reactor (MHR) plants applicable to performance-based, risk-informed regulation.

ANS-29, Advanced Initiatives

ANS-29.1, Operational Reactivity Management and Oversight at Light Water, Pressurized Water Power Reactors

Scope: This standard provides guidance for PWR operation and reactor engineering staffs regarding the care and prior planning of plant manipulations that can affect reactor reactivity as well as the review, post manipulation, to verify that reactivity performance met expectations and to improve processes and procedures.

RISC, Risk Informed Standards Committee

The RISC is responsible for the development and maintenance of standards that establish safety and risk criteria and methods for probabilistic analysis, risk assessment, and risk management. These criteria and methods are applicable to design, development, construction, operation, decontamination and decommissioning, waste management, and environmental restoration for nuclear facilities.

ANS-58.24, Severe Accident Progression and Radiological Release (Level 2) PRA Methodology to Support Nuclear Installation Applications

Scope: This standard provides criteria and acceptable methods for the evaluation of containment performance and radiological releases to the environment. The radiological releases considered result from postulated accidents that cause fuel damage and are used in risk-informed applications requiring Level 2 probabilistic risk assessment (PRA). The standard addresses sequences initiated by internal or external events during full power operation.

ANS-58.25, Standard for Radiological Accident Offsite Consequence Analysis (Level 3 PRA) to Support Nuclear Installation Applications

Scope: This standard provides requirements for application of risk-informed decisions related to the consequences of accidents involving release of radioactive materials to the environment. The consequences to be addressed include health effects (early and late) and longer term environmental impacts. The required capabilities allow determination of the efficacy of mitigation strategies on reducing consequences.

American Nuclear Society

Standards Committee

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