Overview and Status of Domestic and International Standards for Nuclear Criticality Safety

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Introduction

- For many years, the domestic and international consensus standards for nuclear criticality safety (NCS) have provided guidance for those who conduct hands-on operations with fissionable materials
- These consensus standards have been crucial to reducing the number of criticality accidents in process facilities
- The last known process criticality accident inside the United States was in 1978 at the Idaho Chemical Processing Plant, and outside the United States at Tokai-mura, Japan, in 1999



3 OVERVIEW AND STATUS OF STANDARDS FOR NUCLEAR CRITICALITY SAFETY Figure 1. Chronology of process criticality accidents.

Figure from LA-13638 "A Review of Criticality Accidents"



Domestic NCS consensus standards

- The domestic consensus standards for NCS include the American Nuclear Society (ANS) series-8 standards (ANS-8)
 - The first NCS standard was initiated around 1960 and published as the first approved standard in 1964
 - This standard, ASA N6.1-1964, "Safety Standard for Operations with Fissionable Materials Outside Reactors," was the precursor to today's American National Standards Institute/American Nuclear Society (ANSI/ANS)-8.1-2014 standard for operations with fissionable material outside reactors
- Based on the NCS community's needs, the number of domestic standards has grown significantly to a total of 18 active standards and 1 standard under development
- These standards fall loosely into three main categories:
 - administrative standards,
 - application-specific standards, and
 - emergency planning and response standards
- Over the years, based on need, existing standards have been augmented, new standards have been generated, or due to lack of use, some standards have been withdrawn



Organizational overview



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Organizational overview

- These organizations work in concert to develop and maintain the ANSI/ANS standards
- The rules and procedures for developing and maintaining the standards, including roles and responsibilities for working group members, working group chairs, subcommittee chairs, consensus committee chairs, and so forth, are continuously modified to improve the process
- The ANS standards website provides reference information about the ANS standards process and describes how volunteers can find participation opportunities



Status report of domestic standards

- There are currently eighteen standards under the purview of the ANS-8 subcommittee:
 - seven standards are being revised,
 - eleven standards are in maintenance mode (inactive),
 - and one standard is under development
 - The ANSI/ANS-8.3, ANSI/ANS-8.7, ANSI/ANS-8.20, ANSI/ANS-8.21, ANSI/ANS-8.23, and ANSI/ANS-8.24 standards are in various stages of revision
 - The ANSI/ANS-8.28 standard, "Administrative Practices for Non-Destructive Assay Measurements for Nuclear Criticality Safety," is currently under development by a large working group
 - The interest in the ANSI/ANS-8.28 standard is driven largely by the Defense Nuclear Facilities Safety Board (DNFSB) recommendation for fissile material hold-up NCS concerns in 2007 (DNFSB recommendation 2007-1)
 - A standard revision involves some modification (specific or general), while standard reaffirmation involves the confirmation that the standard content adequately addresses the domestic need
 - New standard projects and standard revisions are initiated by the standard working group chair's submittal of the Project Initiation Notification System (PINS) form



Status of the domestic ANS-8 standards

Standard	Title	Status	Comment	
ANSI/ANS-8.1-2014	Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors	Maintenance	PINS – ANS-8 approval (04Aug17) PINS – NCSCC ballot in progress (29Sep17)	
ANSI/ANS-8.3-1987	Criticality Accident Alarm System	Revision	Reaffirmation – NCSCC approval (18Sep17) Revision in progress	
ANSI/ANS-8.5-1996 (R2012)*	Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material	Maintenance	Reaffirmation – NCSCC approval (18Sep17) This standard will likely be subsumed by ANSI/AN 8.21 during its revision.	
ANSI/ANS-8.6-1983 (R2010)	Safety in Conducting Subcritical Neutron- Multiplication Measurements in Situ	Maintenance	Reaffirmation – NCSCC approval (20Jul17)	
ANSI/ANS-8.7-1998 (R2012)	Nuclear Criticality Safety in the Storage of Fissile Materials	Revision	Reaffirmation – ANS-8 ballot in progress (22Sep17) Revision in progress.	
ANSI/ANS-8.10-2015	Criteria for Nuclear Criticality Safety Controls in Operations with Shielding and Confinement	Maintenance	Inactive Initial discussions have started about the next revision.	
ANSI/ANS-8.12-1987 (R2016)	Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors	Maintenance	ANS-8.12 was reaffirmed in 2016. The revision efforts prior to reaffirmation will be continued in the near future. The standard has a new working group chair.	
ANSI/ANS-8.14-2004 (R2016)	Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors	Maintenance	Inactive	
ANSI/ANS-8.15-2014	Nuclear Criticality Control of Selected Actinide Elements	Maintenance	Inactive	





Status of the domestic ANS-8 standards (continued)

Standard	Title	Status	Comment
ANSI/ANS-8.17-2004 (R2017)	Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors	Maintenance	Inactive
ANSI/ANS-8.19-2014	Administrative Practices for Nuclear Criticality Safety	Maintenance	Inactive
ANSI/ANS-8.20-1991 (R2015)	Nuclear Criticality Safety Training	Revision	Revision is in the final stages.
ANSI/ANS-8.21-1995 (R2011)	Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors	Revision	Standard – ANS-8 Approval – 07May16 Standard – NCSCC Approval – 29Oct17
ANSI/ANS-8.22-1997 (R2016)	Nuclear Criticality Safety Based on Limiting and Controlling Moderators	Maintenance	ANS-8.22 was reaffirmed in 2016. A PINS is being developed to address revision goals and the comments provided during reaffirmation ballot.
ANSI/ANS-8.23-2007 (R2012)	Nuclear Criticality Accident Emergency Planning and Response	Revision	The standard was reaffirmed in 2012, and a general revision is in progress.
ANSI/ANS-8.24-2007 (R2012)	Validation of Neutron Transport Methods for Nuclear Criticality Safety Calculations	Revision	Standard – ANS-8 Approval – 11Jun16 Standard – NCSCC Approval – 06Oct17
ANSI/ANS-8.26-2007 (R2016)	Criticality Safety Engineer Training and Qualification Program	Maintenance	Inactive. ANS-8.26 was reaffirmed in 2016, and a new revision is being considered.
ANSI/ANS-8.27-2015	Burnup Credit for LWR Fuel	Maintenance	Inactive since being revised in 2015.
ANSI/ANS-8.28-20xx	Administrative Practices for Non-Destructive Assay Measurements for Nuclear Criticality Safety	(NEW) In Development	Standard development is in progress, and the working group has been very active .



International consensus NCS standards – organizational overview

- Within the International Organization for Standardization (ISO), there are approximately 220 technical committees (TCs)
- ISO TC85 covers nuclear energy, nuclear technologies, and radiological protection
- One of the three subcommittees (SCs) within TC85 is SC5, Nuclear Fuel Cycle, and one of the five working groups (WGs) under SC5 is WG8, Nuclear Criticality Safety
- ISO TC85/SC5 has 19 participating countries that review, comment, and vote on the standards developed by WG8
- Those countries are represented by one of their national standards bodies



Participating countries (P-member) and their representing standards body

Argentina (IRAM)	Islamic Republic of Iran (ISIRI)	Sweden (SIS)	
Belgium (NBN)	Japan (JISC)	Switzerland (SNV)	
Bulgaria (BDS)	Kenya (KEBS)	United Kingdom (BSI)	
Canada (SCC)	Republic of Korea (KATS)	United States of America (ANSI)	
China (SAC)	Netherlands (NEN)	Ukraine (DSSU)	
France (AFNOR)	Russian Federation (GOST R)	United Kingdom (PSI)	
India (BIS)	Spain (AENOR)		

- Countries highlighted in red are very active in the development of ISO NCS standards, participating in annual meetings and discussions
- Countries highlighted in blue are moderately active in the development of ISO NCS standards, participating in occasional annual meetings and discussions



ISO/TC85 organizational structure



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- ISO TC85/SC5/WG8 is analogous to ANS Subcommittee 8 except that there are fewer standards
- The process used to generate new ISO standards is somewhat different than the process for generating standards for ANS
- ISO working groups spend a significant amount of time debating the content of standards before a new work item proposal (NP) ballot is submitted for consideration
- After a successful NP ballot—which consists of a majority vote by participating member (P-member) countries and at least 5 P-member countries committing to working on the development of the project—the working groups can elect to go through a committee draft (CD) stage that incorporates NP ballot comments



- A CD ballot can then be processed to ensure the proposed standard is on solid ground before proceeding to the draft international standard (DIS) stage
- If there is consensus among the working group members that the proposed standard is ready for the DIS stage, the CD stage may be skipped. The DIS ballot stage is a three-month balloting process
- The proposed standard is translated to French, and both English and French versions are submitted to all ISO P-member countries for ballot
- The default track duration is 36 months of development work, including working and committee draft stages
- There is an accelerated track for less complicated or well-developed standards with 24 months of development time
- For complicated standards, an extended track is available with 48 months of development time



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ISO standards development process



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- There are currently 8 ISO active standards under the purview of WG8
- Four standards are under development by WG8
- There are also numerous support documents in development to support working group activities or standard revisions as guidance or reference material to support WG8 standards
- Four standards are proposed, seven are in maintenance mode (active, in-use), and one is in revision
- The ISO 1709 standard entitled "Nuclear Energy Fissile Materials Principles of Criticality Safety in Storing, Handling, and Processing" recently went through the DIS ballot process successfully and has been updated, as it is the backbone ISO standard for NCS



- The ISO 1709 standard is analogous to the ANSI/ANS-8.1 domestic standard
- The four proposed standards in development by WG8 are:
 - Solid waste (UK): an NP ballot to be submitted this year after several years of informal development,
 - Compliance verification of as-built dimensions standard (FR): NP ballot completed last year, provides guidance for dimensions derived from NCS analysis
 - NCS training for operators (UK): analogous to the ANSI/ANS-8.20 domestic standard
 - NCS risk assessment standard (CA); intended to supplement the NCS process evaluation requirements and recommendations in ISO 1709 and ISO 14943, "Nuclear Fuel Technology – Administrative Criteria Related to Nuclear Criticality Safety"



Standard	Title	Status	Comments
ISO 1709-1995	Nuclear Energy – Fissile Materials – Principles of Criticality Safety in Storing, Handling, and Processing	Revision	Draft international standard ballot completed. Comments being resolved.
ISO 7753-1987	Nuclear Energy – Performance and Testing Requirements for Criticality Detection and Alarm Systems	Maintenance	Systematic review in 2016 indicated a revision to this standard is warranted. France will lead a revision of this standard starting in late 2017.
ISO 11311-2011	Nuclear Criticality Safety – Critical Values for Homogeneous Plutonium-Uranium Oxide Fuel Mixtures Outside of Reactors	Maintenance	This standard was last reviewed and confirmed in 2016. Therefore, this version remains current.
ISO 11320-2011	Nuclear Criticality Safety – Emergency Preparedness and Response	Maintenance	This standard was last reviewed and confirmed in 2016. Therefore, this version remains current.
ISO 14943-2004	Nuclear Fuel Technology – Administrative Criteria Related to Nuclear Criticality Safety	Maintenance	This standard was last reviewed and confirmed in 2013. Therefore, this version remains current.
ISO 16117-2013	Nuclear Criticality Safety – Estimation of the Number of Fissions of a Postulated Criticality Accident	Maintenance	Published in 2013.
ISO 27467-2009	Nuclear Criticality Safety – Analysis of a Postulated Criticality Accident	Maintenance	This standard was last reviewed and confirmed in 2014. Therefore, this version remains current.



Standard	Title	Status	Comments
ISO 27468-2011	Nuclear Criticality Safety – Evaluation of Systems Containing PWR UOX Fuels – Bounding Burnup Credit Approach	Maintenance	This standard was last reviewed and confirmed in 2016. Therefore, this version remains current. Germany had the only revise/amend vote but does not use the standard.
_ *	Nuclear Criticality Safety – Solid Waste (excluding Irradiated and non- Irradiated Fuel)	Proposed Standard	NP ballot in progress
_	Nuclear criticality safety — Geometrical nuclear criticality safety dimensions — Compliance verification of the as-built dimensions with the nuclear criticality safety dimensions limits	Proposed Standard	NP ballot completed in April 2016. Comments incorporated. A draft international standard ballot is to be initiated in late 2017.
-	Nuclear Criticality Safety – Risk Assessment	Proposed Standard	Preliminary drafts still being debated in WG8.
-	Nuclear Criticality Safety – Criticality Safety Training for Operations	Proposed Standard	Preliminary drafts still being debated in WG8. Preparing for a new work item proposal ballot in 2017.

*ISO designation not yet assigned.



Summary and final thoughts

- An overview and status report of domestic and international NCS consensus standards has been presented
- There is substantial interest in the domestic and international NCS standards, which drives significant progress in the development of the standards
- Standards work is a continuous process that requires user experience from all
 organizations using the standards to ensure NCS on a daily basis; this
 experience is crucial to ensure that current and proposed standards are
 developed with the necessary content to ensure NCS in facilities with operations
 with fissionable materials outside of nuclear reactors
- Interested stakeholders should consider participating to ensure that their experiences and needs are considered in the domestic and international NCS standards



Photograph and list of the TC85/SC5/WG8 participants in Conshohocken, PA, for the TC85 Plenary Meeting, May 2017



First Name	Surname	Country
Aurelie	BARDELAY	FR
Douglas	BOWEN	US
Geoffrey	EDWARDS	CA
Eric	FILLASTRE	FR
Mickael	HAMPARTZOUNIAN	FR
Neil	HARRIS	UK
Susan	JOHNSTON	CA
Vladimir	KHOTYLEV	CA
Dennis	MENNERDAHL	SE
Andy	SUTTON	UK
Christopher	TRIPP	US
Ben	WEBBORN	UK
Yuichi	YAMANE	JP



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Are there any questions?

