Comparison of ISO and ANSI/ANS Nuclear Criticality Safety Standards

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INTRODUCTION

This paper provides a high-level comparison between the international and domestic Nuclear Criticality Safety (NCS) standards, as requested by members of the Nuclear Criticality Safety Division. Currently, there are 18 enacted American National Standards Institute (ANSI)/American National Standards (ANS) and 1 ANSI/ANS standard in progress. There are 11 NCS standards from the International Organization for Standardization (ISO), Technical Committee 85 (TC85) on Nuclear Energy, Subcommittee 5 (SC5) on Nuclear Fuel Cycle, Working Group 8 (WG8). There are NCS standard revisions in progress for both standards organizations.

BACKGROUND

ANSI/ANS standards have existed since the mid-1960s. The ANS website [1] provides some background and history for these standards, in addition to resources and guidance about the standards development process. Similar information for ISO standards is available at the ISO website [2]. Both ANSI and ISO mandate a rigorous consensus process to develop and maintain NCS standards for use by facility personnel handling, storing, and processing fissionable materials outside of reactors. Each standards organization relies on end user volunteers to develop and maintain applicable NCS consensus standards. The two standards organizations have a slightly different process for developing consensus standards; however, both processes involve robust consensus processes. A separate paper will be submitted in the future to highlight differences in the development of NCS consensus standards.

COMPARISON OF ANSI/ANS AND ISO NCS STANDARDS

The ISO and ANSI/ANS NCS standards can be placed in three groups:

1. Administrative standards—These support NCS programs in administrative matters such as program development, training and qualifications, NCS evaluation process, control/limit implementation, and control maintenance.
2. Application standards—These NCS standards are applicable for specific uses to support NCS program activities such as the use of fixed or soluble neutron poisons or the use of moderation control to ensure NCS.
3. NCS Accident Management Standards—These NCS standards provide guidance to detect and provide emergency planning and response in the event of a criticality accident.

Tables I–III provide a comparison of the available NCS standards for each standards organization. They also indicate proposed standards that are being explored. A dash in a table cell indicates that there is currently no comparable standard available or in development. The tables also indicate when the standard was revised or reaffirmed, e.g., 2018 or R2019. There is a single ANS standard in development, ANSI/ANS-8.28-20XX, that is currently in the ANS-8 balloting process. It is applicable to administrative practices for the use of nondestructive assay measurements to support NCS programs. Two projects currently are being discussed in WG8 as proposed ISO standards: (1) a proposed standard for an NCS risk assessment methodology and (2) a proposed standard for the validation of computational methods for NCS.

TABLE 1. Administrative NCS Standards Comparison

ANSI/ANS Subcommittee 8 Standards	ISO TC85/SC5/WG8 Standards
ANSI/ANS-8.1-2014 (R2019) NCS in Operations with Fissionable Materials Outside Reactors (Revision in progress)	**ISO 1709:2018** Principles of Criticality Safety in Storing, Handling & Processing (Amendment is in progress) **PROPOSED** Nuclear Criticality Risk Assessment Methodology
ANSI/ANS-8.10-2015 (R2020) Criteria for NCS Controls in Operations with Shielding and Confinement	–
ANSI/ANS-8.19-2014 (R2019) Administrative Practices for NCS	**ISO 14943:2004** Administrative Criteria Related to NCS **ISO 21391:2019** Geometrical Dimensions for Subcriticality Control

ANSI/ANS Subcommittee 8 Standards	ISO TC85/SC5/WG8 Standards
ANSI/ANS-8.20-1991 (R2020) NCS Training (ANS-8 comments being addressed)	**ISO 23133:2021** NCS Training for Operations (Recently published)
ANSI/ANS-8.24-2017 Validation of Neutron Transport Methods for NCS Calculations	**PROPOSED** Validation of Computational Methods Standard (US/FR are the project leads)
ANSI/ANS-8.26-2007 (R2016) Criticality Safety Engineer Training and Qualification Program	–
PROPOSED ANSI/ANS-8.28-20XX Administrative Practices for the Use of Non-Destructive Assay Measurements for NCS (ANS-8 ballot recently completed; comments being addressed)	–

TABLE II. Application Standards Comparison

ANSI/ANS Subcommittee 8 Standards	ISO TC85/SC5/WG8 Standards
ANSI/ANS-8.5-1996 (R2017) Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material (To be withdrawn after ANS/ANS-8.21 has been approved)	–
ANSI/ANS-8.6-1983 (R2017) Safety in Conducting Subcritical Neutron-Multiplication Measurements in Situ	–
ANSI/ANS-8.7-1998 (R2017) NCS in the Storage of Fissile Materials	–
ANSI/ANS-8.12-1987 (R2016) Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors (Revision in Progress; Journal article to be published with new MOX subcritical limits)	**ISO 11311:2011** Critical Values for Pu/U Mixtures (Proposed amendment in progress) **ISO 27468:2011** Evaluation of Systems Containing PWR UOX Fuels
ANSI/ANS-8.14-2004 (R2016) Use of Soluble Neutron Absorbers in Nuclear Facilities Outside Reactors	–
ANSI/ANS-8.15-2014 (R2019) Nuclear Criticality Control of Selected Actinide Nuclides	–
ANSI/ANS-8.17-2004 (R2019) Criticality Safety Criteria for the Handling, Storage and Transportation of LWR Fuel Outside Reactors	–
ANSI/ANS-8.21-1995 (R2019) Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors (NCSCC ballot comments being resolved)	–
ANSI/ANS-8.22-1997 (R2016) NCS Based on Limiting and Controlling Moderators	–
ANSI/ANS-8.27-2015 (R2020) Burnup Credit for LWR Fuel	–
–	**ISO 22946:2020** Solid Waste Excluding Irradiated and non-Irradiated Nuclear Fuel (Recently published)

TABLE III. NCS Accident Management Standards Comparison

ANSI/ANS Subcommittee 8 Standards	ISO TC85/SC5/WG8 Standards
ANSI/ANS-8.3-1997 (R2017) Criticality Accident Alarm System (ANS-8 ballot completed; comments being addressed)	**ISO 7753:1987** Performance and Testing Requirements for Criticality Detection and Alarm Systems (Revision in progress) **ISO 16117:2013** Estimation of the Number of Fissions in a Postulated Criticality Accident **ISO 27467:2009** Analysis of a Postulated Criticality Accident
ANSI/ANS-8.23-2019 Nuclear Criticality Accident Emergency Planning and Response	**ISO 11320:2011** Emergency Preparedness & Response

Since 2015, four ANSI/ANS standards (8.10-2015, 8.23-2019, 8.24-2017, and 8.27-2015) and one ISO WG8 standard (1709-2018) have been revised. Three new ISO WG8 standards (21391:2019, 22946:2020, and 23133:2021) have been published. Six ANSI/ANS standards are currently being revised or developed (8.1-2014, 8.3-1997, 8.12-1987, 8.20-1991, 8.21-1995, and 8.28-20XX). Three ISO WG8 standards are in progress (1709:2018, 11311:2011, 7753:1987).

OTHER ANSI/ANS AND ISO STANDARDS PROJECTS IN PROGRESS

ISO WG8 Standards Projects

There are other projects in progress for ISO WG8 standards that are discussed in this section. Based on the conclusions of the last WG8 meeting held on December 1, 2020, there are 12 current work items. Six of them involve the ISO standards development or revision work (mentioned in Tables I–III). The ISO 23133:2021 standard

for NCS training for operations staff was the most recent WG8 standard published by ISO. The remaining work items involve WG8 business and standard support such as the development of new WG8 protocols to improve the quality of standards that are developed/revised, or WG8 formal notes and internal procedures to keep track of important decisions made in working group meetings, e.g., definitions, roles and responsibilities, WG8 meeting preparations, ballot preparations, collaborations.

ANSI/ANS-8 Standard Projects

There are a few projects in progress within the ANS-8 series standards. At the working group level, one project involves the training of associate (non-voting) members who have volunteered for ANS-8 standard working groups. The intent is to train the next generation of ANS-8 working group volunteers. Once an associate member has been involved in working group business, and the working group chair believes the volunteer is sufficiently knowledgeable of the standard, the member could earn full membership status (voting member) in the working group. Another project in progress in the working groups is the generation of basis statements for the recommendations and requirements for each standard to train new working group members and to provide assistance with interpretation and clarification requests from the NCS community. It is crucial that working groups of the future understand the bases for the requirements and recommendations in the standard long after working group members have retired or moved on. The ANS-8 subcommittee is also working with the NCS Consensus Committee to make standard definitions uniform across all standards, creating an NCS standard glossary document to assist with future revision efforts.

CONCLUSIONS

This paper summarizes the key differences between the ISO TC85/SC5/WG8 and ANSI/ANS-8 consensus NCS standards. The hard work done by the ANS-8 and WG8 volunteers allows for applicable, high-quality consensus standards for use by the NCS community. This paper provides

- Current status of each ANSI/ANS and ISO standard,
- Work in progress,
- Revisions/amendments in progress, and
- WG8/ANS-8 non-standard business in progress.

A subsequent paper will be submitted in the near future that will focus on a comparison of the development process for ISO and ANSI/ANS standards.

REFERENCES

1. American Nuclear Society Standards Resources, https://www.ans.org/standards/resources/, American Nuclear Society, La Grange Park, Ill (2021).
2. International Standards Institute, https://www.iso.org/standards.html, International Organization for Standardization, ISO Central Secretariat, Vernier, Geneva, Switzerland (2021).