ANS Issues a Response to an Inquiry on ANS-8.10-2015, Criteria for Nuclear Criticality Safety Controls in Operations with Shielding and Confinement (Nuclear News, July 2026)

The ANS Standards Committee received an inquiry on ANS-8.10-2015. The inquiry and response are provided below. Some editorial changes have been made for clarity.

The following responses to the inquiry are listed below based on the current guidance in ANSI/ANS-8.1-2014 (R2023), *Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors* and ANSI/ANS-8.1-2014 (R2023), Erratum (both are included in further reference to ANS-8.1) that provides the process analysis requirement and ANSI/ANS-8.10-2015 (R2025), *Criteria for Nuclear Criticality Safety Controls in Operations with Shielding and Confinement* (ANS-8.10) that provides guidance on process analysis when workers are protected from the consequences of a criticality accident due to shielding and/or confinement.

Inquiry Question 1:

Is a single credible abnormal condition resulting in a criticality accident acceptable with the application of ANS-8.10?

Yes, by invoking the shielding and confinement requirements outlined in ANS-8.10, operations in which a single unlikely change in process conditions that **might** result in a criticality accident is allowable. The standard cautions that these kind of operations should be kept to a minimum. Management may allow increased likelihood of a criticality accident in defining a credible abnormal condition when adequate shielding and confinement ensure the protection of personnel.

The process analysis requirement per ANS-8.1, Section 4.1.2, states:

"Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions…."

ANS-8.1, Section 4 (Nuclear Criticality Safety Practices) provides guidance for management responsibilities. Specifically, ANS-8.1, Section 4.1.1 (Responsibilities) states the following for the use of ANS-8.10 to protect workers:

"…Management shall establish the criteria to be satisfied by nuclear criticality safety controls. Distinction may be made between shielded and unshielded facilities, and the criteria may be less stringent when adequate shielding and confinement assure the protection of personnel. Guidance is provided in ANSI/ANS-8.10-1983 (R2005)."

ANS-8.10, Section 4.2.1 provides guidance on allowed radiation dose.

The shielding and confinement should be such that the total effective dose received by an individual located at any point outside the shielded and confined area will not exceed 10 rem (0.10 Sv) during and subsequent to a criticality accident. In addition, the shielding and confinement should be such that the total effective dose received by an individual outside the restricted area will not exceed 0.5 rem (5 mSv).

ANS-8.10, Section 5.1 provides guidance on single contingency operation.

The number of unlikely changes in process conditions as detailed in Section 4.2.2 of ANSI/ANS-8.1-2014 [1], Double Contingency Principle, may be reduced to unity when the criteria of this standard are met. Design of operations in which a single unlikely change in process conditions might result in a criticality accident should be kept to a minimum. If criticality accident prevention relies primarily on administrative requirements (e.g., failing to add a neutron absorber or exceeding a mass limit might lead to a criticality accident), then procedures should be written such that no single, inadvertent departure from procedures can cause a criticality accident.

Inquiry Question 2:

If a single unlikely change in process conditions leading to a criticality accident is acceptable with the application of ANS-8.10, does ANS-8.10 contradict ANS-8.1, Section 4.1.2 (Process Analysis), that provides the requirement all operations with fissionable material remain subcritical under normal and credible abnormal conditions?

No, application of ANS-8.10 does not contradict the ANS-8.1 process analysis statement. ANS-8.1 does allow management to apply a less stringent definition of "credible abnormal condition" that may allow increased likelihood of an accident in defining a "credible abnormal condition" when adequate shielding and confinement assure the protection of personnel. The purpose of ANS-8.1 and ANS-8.10 is to protect personnel and the public from the consequences of a criticality accident from fissionable operations outside of nuclear reactors. ANS-8.10 focuses more on the protection of personnel rather than the prevention of a criticality accident.

Refer to the following sections.

There are seven technical practices in ANS-8.1, Section 4.2 (Technical Practices) to assist complying with the process analysis requirement. One of these seven technical practices is the recommended Double Contingency Principle, ANS-8.1, Section 4.2.2:

"Process designs should incorporate sufficient factors of safety to require at least two unlikely, independent, and concurrent changes in process conditions before a criticality accident is possible."

ANS-8.1, Section 4 (Nuclear Criticality Safety Practices) provides guidance for management responsibilities. Specifically, ANS-8.1, Section 4.1.1 (Responsibilities) states the following for the use of ANS-8.10 to protect workers:

"…*Management shall establish the criteria to be satisfied by nuclear criticality safety controls. Distinction may be made between shielded and unshielded facilities, and the criteria may be less stringent when adequate shielding and confinement assure the protection of personnel. Guidance is provided in ANSI/ANS-8.10-1983 (R2005)."*

ANS-8.10, Section 5.0 (Criticality Safety Practices) also provides guidance for taking a graded approach to process analysis.

"*Where shielding and confinement were in place, the consequences of previous process criticality accidents have been primarily disruption of processes and related costs. Accordingly, if these consequences are acceptable, an increased likelihood of a criticality accident is acceptable when the consequence to personnel is low due to the facility design. This may be reflected in reduced conservatism in the process analysis. However, plant design and operations are premised on good engineering practices, which dictate that criticality accidents shall not occur under normal and credible abnormal conditions where personnel are at risk."*

Furthermore, ANS-8.10, Section 5.1 (Single Contingency Operation) provides guidance for use of a single contingency when developing nuclear criticality safety controls where workers are protected from the consequences of a criticality accident due to shielding and/or confinement.

"The number of unlikely changes in process conditions as detailed in Section 4.2.2 of ANSI/ANS-8.1 2014, Double Contingency Principle, may be reduced to unity when the criteria of this standard are met. Design of operations in which a single unlikely change in process conditions might result in a criticality accident should be kept to a minimum. If criticality accident prevention relies primarily on administrative requirements (e.g., failing to add a neutron absorber or exceeding a mass limit might lead to a criticality accident), then procedures should be written such that no single, inadvertent departure from procedures can cause a criticality accident."

ANS 8.1. appendix B2 provides the following additional guidance for the application of process analysis to ANS-8.10

The application of PA The PA requirement in Sec. 4.1.2 states, "Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions." The intent of this requirement is to protect the safety of the worker and the public during operations with fissionable material. One aspect of meeting the PA requirement is reconciling the phrase "credible abnormal conditions" with Sec. 1, which states, "Good safety practices should recognize economic considerations, but the protection of operating personnel and the public is the dominant consideration." In those facilities where shielding and confinement of fissionable material operations outside reactors meet the requirements in ANSI/ ANS-8.10-1983 (R2005) [B.1],1) management may accept a higher likelihood of a criticality accident if the worker and public are protected from the potential accident consequences. The word "credible" is not defined in the standard but relies on the judgment of the key professionals involved (nuclear criticality safety staff, operations supervisors, etc.) to determine the credible abnormal conditions for a particular fissionable material operation. The abnormal conditions that are deemed credible can differ from process to process and from site to site. Elimination of all risk is not possible; the goal is to ensure an acceptably low level of risk to workers and the public. Resources expended in the control of criticality accident risks should be consistent with those applied to the control of other hazards with similar consequences.

Inquiry Question 3:

Can ANS-8.10 only be applied when all operations involving fissionable material in the facility are conducted remotely or can ANS-8.10 be applied to remote operations in a facility and ANS-8.1 be applied when personnel must enter the facility?

The purpose of ANS-8.1 and ANS-8.10 is to protect personnel and the public from the consequences of a criticality accident from fissionable operations outside of nuclear reactors. Either standard may be invoked at different times, depending upon the fissionable operation being performed. The conditions for applicability of ANS-8.1 and ANS-8.10 must be met at the time of invoking the standard for an operation. ANS-8.10, Section 1 states that this standard is not applicable for operations requiring personnel entry into the normally unoccupied shielded and confined areas. If personnel are present in credited shielded areas for the fissionable operation, ANS-8.10 cannot be invoked and ANS-8.1 applies. When criticality accident hazards exist in a facility that is governed by both standards, management is responsible for determining which operations within an overall process or facility are to be done under the criteria of these standards to ensure the protection of personnel and the public.

Refer to the following sections.

ANS-8.1, Section 1, Introduction. This section provides overall guidance to criticality safety.

Operations with some fissionable materials introduce risks of a criticality accident resulting in a release of radiation that can be lethal to nearby personnel. However, experience has shown that extensive operations can be performed safely and economically when proper precautions are exercised. The few criticality accidents that have occurred show frequency and severity rates far below those typical of nonnuclear accidents. This favorable record can be maintained only by continued adherence to good operating practices such as are embodied in this standard; however, the standard, by itself, cannot establish safe processes in an absolute sense. Good safety practices should recognize economic considerations, but the protection of operating personnel and the public is the dominant consideration…

ANS-8.1, Section 4.1.1, Responsibilities. This section Identifies management responsibilities

Management shall clearly establish responsibility for nuclear criticality safety…

…Management shall establish the criteria to be satisfied by nuclear criticality safety controls. Distinction may be made between shielded and unshielded facilities, and the criteria may be less stringent when adequate shielding and confinement assure the protection of personnel. Guidance is provided in ANSI/ANS-8.10-1983 (R2005)…

ANS-8.10, Forward. This section provides the philosophy of the standard

This standard amplifies the conditions necessary for the control of criticality in fissionable materials set forth in American National Standard "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," ANSI/ANS-8.1-2014. Criteria for the prevention of criticality accidents are presented herein for facilities that provide adequate protection for personnel and the public against radiation and releases of radioactive materials resulting from accidental criticality. The radiation dose limits contained in the 1983 version of this standard were reexamined…

…This standard recognizes the usefulness and protective features of shielding against radiation and confinement of radioactive materials and allows a relaxation of criticality safety criteria when shielding and confinement meet criteria specified in this standard. If personnel are located remotely from the fissionable materials, distance may serve in lieu of some or all of the shielding. In the context of this standard, the shielding and confinement properties may exist because of the radioactive material processed in normal operations, or they may be designed into the facility expressly to protect against the effects of criticality accidents….

ANS-8.10, Section 1, Introduction. provides the following guidance.

… This standard does not apply to operations (e.g., maintenance) requiring personnel entry into the normally unoccupied shielded and confined areas. While personnel are present in normally unoccupied shielded and confined areas, activities are governed by the applicable requirements and recommendations of ANSI/ANS-8.1-2014…

ANS 8.1. Appendix B2 provides the following additional guidance for the application of process analysis to ANS 8.10

The application of PA The PA requirement in Sec. 4.1.2 states, "Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions." The intent of this requirement is to protect the safety of the worker and the public during operations with fissionable material. One aspect of meeting the PA requirement is reconciling the phrase "credible abnormal conditions" with Sec. 1, which states, "Good safety practices should recognize economic considerations, but the protection of operating personnel and the public is the dominant consideration." In those facilities where shielding and confinement of fissionable material operations outside reactors meet the requirements in ANSI/ANS-8.10-1983 (R2005) [B.1],1) management may accept a higher likelihood of a criticality accident as described above in Response 2

Responses issued to inquiries on ANS standards are published in ANS's magazine, *Nuclear News*, and are available on the ANS website on the Responses to Inquiries webpage. Individuals wishing to submit an inquiry on an ANS standard are asked to provide a completed inquiry submittal form to standards@ans.org.