5 NUCLEAR CRITICALITY SAFETY

5.1 PURPOSE OF REVIEW

The purpose of this review is to determine whether the applicant's nuclear criticality safety (NCS) program is adequate to support safe operation of the facility, as required by 10 CFR Part 70. The reviewers should examine the controls and barriers that are relied on to prevent inadvertent nuclear criticalities and that are designated as IROFS in the applicant's ISA Summary. The NCS review should be coordinated with the onsite ISA review (see Section 3.5.2.3 of this SRP) to examine the NCS evaluations used to prepare the facility's ISA.

5.2 RESPONSIBILITY FOR REVIEW

Primary: Nuclear Process Engineer (NCS Reviewer)

Secondary: None

Supporting: Project Manager and Fuel Cycle Inspector (As needed.)

5.3 AREAS OF REVIEW

The staff should review the application to determine whether (1) the applicant has provided for the appropriate management of the NCS program; (2) the applicant has identified and committed to the responsibilities and authorities of individuals for developing and implementing the NCS program; (3) the facility management measures described in 10 CFR 70.62 have been committed to and will support implementing and maintaining the NCS program; and (4) an adequate NCS program is described that includes identifying and committing to the methodologies and technical practices used to ensure the safe operation of the facility, as required by 10 CFR Part 70.

The specific areas for review are as follows:

5.3.1 Management of the NCS Program

The primary reviewer should review the application to determine whether the applicant has committed to and implemented effective management of the NCS program and has provided enough resources for an effective NCS program. The objectives of an effective NCS program should include:

(a) preventing an inadvertent nuclear criticality

(b) protecting against the occurrence of an identified accident sequence in the ISA Summary that could lead to an inadvertent nuclear criticality

(c) complying with the NCS performance requirements of 10 CFR 70.61

(d) establishing and maintaining NCS safety parameters and procedures

(e) establishing and maintaining NCS safety limits and NCS operating limits for IROFS

(f) conducting NCS evaluations to assure that under normal and credible abnormal conditions, all nuclear processes are remain subcritical, and maintain an approved margin of subcriticality for safety

(g) establishing and maintaining NCS IROFS, based on current NCS determinations

(h) providing training in emergency procedures in response to an inadvertent nuclear criticality

(i) complying with NCS baseline design criteria requirements in 10 CFR 70.64(a)

(j) complying with the NCS ISA Summary requirements in 10 CFR 70.65(b)

(k) complying with the NCS ISA Summary change process requirements in 10 CFR 70.72

5.3.2 Organization and Administration

The reviewer(s) should determine whether the applicant has identified and committed to the responsibilities and authorities of individuals to develop, organize, implement and administer the NCS program. The following matters related to the applicant's organization and administration should be reviewed:

(a) for familiarity, the general organization and administration methods used by the applicant (see SRP Chapter 2)

(b) the areas of review listed in SRP Section 2.3 as they relate to NCS, including the experience, educational requirements, responsibilities, and authorities of NCS management and staff

5.3.3 Management Measures

The reviewer(s) should determine whether the applicant has committed to the facility management measures in 10 CFR 70.62 and whether the commitments demonstrate the applicant's ability to implement and maintain the NCS program. The following matters related to the applicant's management measures should be reviewed in the application:

(1) For familiarity, the general configuration management, maintenance, training and qualifications, procedures, audits and assessments, incident investigations, records management, and other quality assurance elements used by the applicant (see SRP Sections 11.3.1 through 11.3.8); and

(2) Management provisions for the following:

(a) training and qualifications of NCS management and staff

(b) auditing, assessing, and upgrading the NCS program

(c) revising the ISA Summary as it relates to NCS

(d) recommending modifications to operating and maintenance procedures, to reduce the likelihood of occurrence of an inadvertent nuclear criticality

(e) designing and installing a criticality accident alarm system (CAAS) to provide immediate detection and annunciation of an inadvertent nuclear criticality

(f) referring to the corrective action function any unacceptable performance deficiencies that might result in an inadvertent nuclear criticality

(g) referring to the corrective action function any unacceptable performance deficiencies that did result in an inadvertent nuclear criticality

(h) retaining records of the NCS program, including documentation of corrective actions taken

5.3.4 Methodologies and Technical Practices

The reviewer(s) should determine whether the applicant has identified NCS methodologies and NCS technical practices used to make NCS determinations, as required by 10 CFR 70.24, "Criticality Accident Requirements" (for criticality accident alarm systems), 10 CFR 70.61(d), "Performance Requirements" (which require that under normal and credible abnormal conditions, all nuclear processes remain subcritical, and maintain an approved margin of subcriticality for safety), 10 CFR 70.64(a), "Requirements for New Facilities or New Processes at Existing Facilities" (baseline design criteria), and 10 CFR 70.65(b), "Additional Content of Applications", (the ISA Summary). The following matters related to the applicant's NCS methodologies and NCS technical practices should be reviewed in the application:

(1) the commitment to use the NCS methodologies identified in the applicant's NCS program

(2) the commitment to use the NCS technical practices identified in the applicant's NCS program

(3) the commitment to fulfill the requirements of 10 CFR 70.24 and to have a CAAS that has been incorporated into the facility management measures

(4) the commitment to detect an inadvertent nuclear criticality and promptly notify personnel, which should ensure that the radiation exposure to workers will be minimized

(5) the commitment to the requirements of 10 CFR 70.61(d)

(6) the commitment to the requirements in 10 CFR 70.64 as they relate to NCS

(7) the areas of review listed in SRP Section 3.3 as they relate to NCS, including accident sequences, consequences, likelihoods and IROFS

(8) identification and use of appropriate NCS methodologies and NCS technical practices

5.4 ACCEPTANCE CRITERIA

The applicant should provide NCS commitments and describe how the commitments will be met. Commitments and descriptions are expected only when the acceptance criteria are relevant to the operations and materials to be licensed.

The applicant's use of standards should be considered acceptable if the applicant has met the following acceptance criteria:

If an applicant intends to conduct activities to which a standard applies and the standard has been endorsed by an NRC Regulatory Guide, then a commitment to comply with all the requirements (i.e., “shalls”) of the standard is necessary but may not be sufficient to meet the acceptance criteria. Notwithstanding a general commitment to a standard, the applicant should clarify its intended compliance with those requirements in the standard that are expressed only as general principles by more specific commitments and descriptions in the application. Any variations from the requirements of the standard should be identified and justified in the application. The commitments and descriptions should be considered acceptable if the applicant has met the acceptance criteria described below.

5.4.1 Regulatory Requirements

The regulatory basis for the review should be the general and “additional content” of an application, as required by 10 CFR 70.22 and 70.65, respectively. In addition, the NCS review should verify compliance with 10 CFR 70.24, 70.61, 70.62, 70.64, 70.72, and Appendix A of 10 CFR Part 70.

5.4.2 Regulatory Guidance

NRC Regulatory Guide 3.71, “Nuclear Criticality Safety Standards for Fuels and Materials Facilities,” August 1998, endorses the American National Standards Institute (ANSI)/American Nuclear Society (ANS)-8 national standards listed below in part or in full.

- ANSI/ANS-8.1, “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors,” 1983 (Reaffirmed in 1988).
- ANSI/ANS-8.3, “Criticality Accident Alarm System,” 1997.
- ANSI/ANS-8.5, “Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material,” 1996.
- ANSI/ANS-8.6, “Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ,” 1983 (Reaffirmed in 1995).
- ANSI/ANS-8.7, “Guide for Nuclear Criticality Safety in the Storage of Fissile Materials,” 1975 (Reaffirmed in 1987).
- ANSI/ANS-8.9, “Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials,” 1987 (Reaffirmed in 1995).
- ANSI/ANS-8.10, “Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement,” 1983 (Reaffirmed in 1988).

- ANSI/ANS-8.12, “Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors,” 1987 (Reaffirmed in 1993).

- ANSI/ANS-8.15, “Nuclear Criticality Control of Special Actinide Elements,” 1981 (Reaffirmed in 1995).

- ANSI/ANS-8.17, “Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors,” 1984 (Reaffirmed in 1997).

- ANSI/ANS-8.19, “Administrative Practices for Nuclear Criticality Safety,” 1996.

- ANSI/ANS-8.20, “Nuclear Criticality Safety Training,” 1991.

- ANSI/ANS-8.21, “Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors,” 1995.

- ANSI/ANS-8.22, “Nuclear Criticality Safety Based on Limiting and Controlling Moderators,” 1997.

- ANSI/ANS-8.23, “Nuclear Criticality Accident Emergency Planning and Response,” 1997.

NRC endorsement of these standards means that they provide procedures and methodology generally acceptable to NRC staff for the prevention and mitigation of nuclear criticality accidents. However, application of a standard is not a substitute for detailed nuclear criticality safety analyses for specific operations. Applicants should generally use the most current revision of the aforementioned standards. If an applicant commits to an unendorsed standard, then the applicant needs to demonstrate in the application why the unendorsed standard should be acceptable to NRC.

5.4.3 Regulatory Acceptance Criteria

5.4.3.1 Management of the NCS Program

The applicant's management of the NCS program should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant commits to develop, implement, and maintain an NCS program to meet the regulatory requirements of 10 CFR Part 70.

(2) The applicant states the NCS program objectives, which should include those objectives listed in SRP Section 5.3.1.

(3) The applicant establishes NCS safety parameters and procedures.

(4) The applicant outlines an NCS program structure and defines the responsibilities and authorities of key program personnel.

(5) The applicant commits to keep NCS methodologies and NCS technical practices applicable to current configuration by means of the configuration management function.

(6) The applicant commits to use the NCS program to establish and maintain NCS safety limits and NCS operating limits for IROFS in nuclear processes and commits to maintain adequate management measures to ensure the availability and reliability of the IROFS.

(7) The applicant commits to preparation of NCS postings, to NCS training, and to NCS emergency procedure training.

(8) The applicant commits to adhere to the NCS baseline design criteria requirements in 10 CFR 70.64(a) for new facilities and new processes at existing facilities that require a license amendment under 10 CFR 70.72.

(9) The applicant commits to use the NCS program to evaluate modifications to operations, to recommend process parameter changes necessary to maintain the safe operation of the facility, and to select appropriate IROFS and management measures.

5.4.3.2 Organization and Administration

Information related to NCS organization and administration acceptance criteria may be located in the organization and administration part of the application (SRP Chapter 2). The applicant's NCS organization and administration should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant meets the acceptance criteria in SRP Section 2.4 as they relate to NCS, including organizational positions, functional responsibilities, experience, and qualifications of personnel responsible for NCS.

(2) The applicant commits to ANSI/ANS-8.1-1983 and ANSI/ANS-8.19-1996, as they relate to organization and administration.

(3) The applicant commits to the intent of Section 4.11 of ANSI/ANS-8.1-1983, which is to use personnel, skilled in the interpretation of data pertinent to NCS and familiar with the operation of the facility, as a resource in NCS management decisions. These specialists should be independent of operations supervision.

(4) The applicant commits to provide NCS postings in areas, operations, work stations, and storage locations.

(5) The applicant commits to the following policy: Personnel shall report defective NCS conditions to the NCS function and perform actions only in accordance with written, approved procedures. Unless a specific procedure deals with the situation, personnel shall report defective NCS conditions to the NCS function and take no action until the NCS function has evaluated the situation and provided recovery procedures.

(6) The applicant commits to describe organizational positions, experience of personnel, qualifications of personnel, and functional responsibilities, and commits also to outline organizational relations among the individual positions.

(7) The applicant commits to designate an NCS program director who will be responsible for implementation of the NCS program.

(8) The applicant commits to staff the NCS program with suitably trained personnel and to provide sufficient resources for its operation.

5.4.3.3 Management Measures

Information related to NCS management measures acceptance criteria may be located in the management measures part of the application. The applicant's NCS management measures (required by 10 CFR 70.62) should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) Training (see SRP Section 11.4.3.3)

(a) The applicant commits to ANSI/ANS-8.19-1996 and ANSI/ANS-8.20-1991 as they relate to training.

(b) The applicant commits to provide training to all personnel to recognize the CAAS signal and to evacuate promptly to a safe area.

(c) The applicant commits to provide instruction training regarding the policy in SRP Section 5.4.3.2(5).

(2) Procedures (see SRP Section 11.4.3.4)

(a) The applicant commits to ANSI/ANS-8.19-1996 as it relates to procedures and to the policy that no single, inadvertent departure from a procedure could cause an inadvertent nuclear criticality.

(3) Audits and assessments (see SRP Section 11.4.3.5)

(a) The applicant commits to ANSI/ANS-8.19-1996 as it relates to audits and assessments.

(b) The applicant commits to conduct and document weekly NCS walkthroughs (e.g., using checklists) of all operating SNM process areas such that all operating SNM process areas will be reviewed at least every 2 weeks. Identified weaknesses should be referred to the facility corrective action function and should be promptly and effectively resolved. A graded approach may be used to justify an alternate NCS walkthrough schedule if it is based on the ISA and included in the ISA Summary.

(c) The applicant commits to conduct and document quarterly NCS audits such that all NCS aspects of management measures (see SRP Chapter 11) will be audited at least every 2 years. A graded approach may be used to justify an alternate NCS audit schedule if it is based on the ISA and included in the ISA Summary.

5.4.3.4 Methodologies and Technical Practices

The applicant's methodologies and technical practices should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) NCS controlled parameters will be appropriately applied.

(2) NCS limits on IROFS will be appropriately determined.

5.4.3.4.1 Methodologies

The applicant's commitment to NCS methodologies should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) NCS determinations will be performed using acceptable methodologies.

(2) NCS limits on controls and controlled parameters will be established to ensure an adequate margin of subcriticality for safety.

(3) Methods used to develop NCS limits will be validated to ensure that they are within acceptable ranges, and that the applicant utilized both appropriate assumptions, and acceptable computer codes.

(4) An inadvertent nuclear criticality will be detected promptly to ensure that radiation exposures to workers are minimized.

(5) The applicant commits to ANSI/ANS-8.1-1983 as it relates to methodologies.

(6) The applicant commits to the *intent* of the validation report statement in NRC Regulatory Guide 3.71, August 1998, which states that the applicant should demonstrate: (1) the adequacy of the margin of safety for subcriticality by assuring that the margin is large compared to the uncertainty in the calculated value of k-eff, (2) that the calculation of k-eff is based on a set of variables whose values lie in a range for which the methodology used to determine k-eff has been validated, and (3) that trends in the bias support the extension of the methodology to areas outside the area or areas of applicability.

(7) The applicant includes a reference to (including the date and revision number), and summary description of, either a manual or a documented, reviewed, and approved validation report (by NCS function and management) for each methodology that will be used to make an NCS determination (e.g., experimental data, reference books, hand calculations, deterministic computer codes, probabilistic computer codes, consensus standards). When there are changes to either a reference manual or validation report, the change should be reported to NRC by letter. After reviewing the change notification letter, NRC will determine if a review of a reference manual or validation report is necessary. The summary description of a reference manual or validation report should have:

    (a) A summary of the theory of the methodology that is sufficiently detailed and clear to allow understanding of the methodology.

(b) A summary of the area or areas to which the reference manual or validation report applies.

(c) A commitment to apply the methodology only in the area or areas of applicability or provide justifications for applying the methodology outside the area or areas of applicability.

(d) A commitment to use pertinent computer codes, assumptions, and techniques in the methodology.

(e) A commitment to properly perform the mathematical operations in the methodology.

(f) A commitment to use data based upon reliable and reproducible experimental measurements.

(g) A commitment to use plant-specific benchmark experiments and data derived therefrom to validate the methodology.

(h) A commitment to determine the bias, the uncertainty in the bias, the uncertainty in the methodology, the uncertainty in the data, the uncertainty in the benchmark experiments, and the margin of subcriticality for safety, when using the methodology.

(i) A commitment to use controlled software and hardware, when using the methodology.

(j) A commitment to use a verification process when using the methodology.

(8) The applicant commits to have, at the facility, the reference manual or documented, reviewed, and approved validation report (by NCS function and management) for each methodology used to make an NCS determination. The manual or validation report should have:

(a) A description of the theory of the methodology that is sufficiently detailed and clear to allow understanding of the methodology and independent duplication of results.

(b) A description of the area or areas of applicability that identifies the range of values for which valid results have been obtained for the parameters used in the methodology. In accordance with the provisions in ANSI/ANS-8.1-1983, any extrapolation beyond the area or areas of applicability should be supported by an established mathematical methodology.

(c) A description of the use of pertinent computer codes, assumptions, and techniques in the methodology.

(d) A description of the proper functioning of the mathematical operations in the methodology (e.g., a description of mathematical testing).

(e) A description of the data used in the methodology, showing that the data were based on reliable experimental measurements.

(f) A description of the plant-specific benchmark experiments and the data derived therefrom that were used for validating the methodology.

(g) A description of the bias, uncertainty in the bias, uncertainty in the methodology, uncertainty in the data, uncertainty in the benchmark experiments, and margin of subcriticality for safety, as well as the basis for these items, as they are used in the methodology. If the bias is determined to be advantageous to the applicant, the applicant shall use a bias of 0.0 (e.g., in a critical experiment where the k-eff is known to be 1.00 and the code calculates 1.02, the applicant cannot use a bias of 0.02 to allow calculations to be made above the value of 1.00).

(h) A description of the software and hardware that will use the methodology.

(i) A description of the verification process and results.

(9) The applicant commits to incorporate each reference manual or documented, reviewed, and approved validation report (by NCS function and management) for a methodology, as well as the assumptions used, into the facility configuration management program.

(10) The applicant commits to performing NCS determinations in accordance with specified methods incorporated in the facility's management measures and in accordance with the following principles.

(a) NCS safety limits, NCS operating limits, and limits on NCS controlled parameters will be established assuming credible optimum conditions (i.e., most reactive conditions physically possible or limited by written commitments to regulatory agencies) unless specified controls are implemented to control the limit to a certain range of values.

(b) NCS safety limits, NCS operating limits, and limits on NCS controlled parameters will be derived from the NCS determinations.

(c) NCS safety limits, NCS operating limits, and limits on NCS controlled parameters will be based on the proper application of the NCS methodology to the process under study.

(d) NCS operating limits will be derived from NCS safety limits by taking into consideration changes in operating parameters to ensure processes will remain subcritical under both normal and credible abnormal conditions.

(e) NCS operating limits will establish sufficient margins of safety for processes and take into consideration the variability and uncertainty in processes and the NCS subcritical limits.

(f) NCS safety limits will establish sufficient margins of safety for processes and take into consideration the variability and uncertainty in processes and the NCS operating limits.

(g) The margin of subcriticality for safety for a process should be relative compared to the calculated value of k-eff.

(h) K-eff is calculated from a set of variables whose values lie in a range for which the validity of the NCS methodology has been demonstrated.

5.4.3.4.2 Technical Practices

Controlled parameters available for NCS control include the following: mass, geometry, density, enrichment, reflection, moderation, concentration, interaction, neutron absorption, and volume. The applicant's commitment to NCS technical practices should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant's use of a single NCS control to maintain the values of two or more controlled parameters constitutes only one component necessary to meet double contingency protection.

(2) Based on 10 CFR 70.61, the applicant commits to the policy that no single credible event or failure can result in a criticality accident.

(3) The applicant commits to the preferred use of passive engineered controls to ensure NCS. In general, the applicant should commit to the following order of preference, for NCS controls: (a) passive engineered; (b) active engineered; (c) augmented administrative; and (d) simple administrative. When using a control, the choice of the type and manner should be justified.

(4) When evaluating a controlled parameter, the applicant should consider heterogeneous effects. Heterogeneous effects are particularly relevant for low-enriched uranium processes, where, all other parameters being equal, heterogeneous systems are more reactive than homogeneous systems.

(5) The applicant commits to perform an evaluation for all controlled parameters that shows that during both normal and credible abnormal conditions, the controlled parameter will be maintained.

(6) When controlled parameters are controlled by measurement, reliable methods and instruments should be used. Where there is significant susceptibility to human error, the applicant may commit to representative sampling, reliable measurement instruments and methods, and dual independent measurements.

(7) The use of mass as a controlled parameter should be considered acceptable if:

    (a) When a given mass of material has been determined, a percentage factor is used to determine the mass percentage of SNM in that material.

    (b) When fixed geometric devices are used to limit the mass of SNM, a conservative process density is used.

    (c) When the mass is measured, instrumentation is used.

    (d) When using double-batching of SNM as a single parameter limit control from experimental data, and double-batching of SNM is possible, the mass of SNM is limited to no more than 45 percent of the minimum critical mass, based on spherical geometry.

(e) When using double-batching of SNM as a single parameter limit control from experimental data and double-batching of SNM is not possible, the mass of SNM is limited to no more than 75 percent of the critical mass, based on spherical geometry.

(8) The use of geometry as a controlled parameter should be considered acceptable if:

(a) Before beginning operations, all dimensions and nuclear properties that use geometry control are verified. The facility configuration management program should be used to maintain these dimensions and nuclear properties.

(b) When using large single units as a single parameter control from experimental data, the margins of safety are 90 percent of the minimum critical cylinder diameter, 85 percent of the minimum critical slab thickness, and 75 percent of the minimum critical sphere volume.

(9) The use of density as a controlled parameter should be considered acceptable if:

(a) When process variables can affect the density, the process variables are shown in the ISA Summary to be controlled by IROFS.

(b) When the density is measured, the measurement is obtained by the use of instrumentation.

(10) The use of enrichment as a controlled parameter should be considered acceptable if:

(a) A method of segregating enrichments is used to ensure differing enrichments will not be interchanged, or else the most limiting enrichment is applied to all material.

(b) When the enrichment needs to be measured, the measurement is obtained by using instrumentation.

(11) The use of reflection as a controlled parameter should be considered acceptable if:

(a.) When investigating an individual unit, the wall thickness of the unit and all reflecting adjacent materials of the unit are considered. The adjacent materials should be farther than 30.48 cm (12 inches) away from the unit.

(b.) After identifying potential reflectors, the controls to prevent the presence of the potential reflectors are identified as IROFS in the ISA Summary.

(12) The use of moderation (e.g., exclusion of moderators) as a controlled parameter should be considered acceptable if:

(a) When using moderation, the applicant commits to ANSI/ANS-8.22-1997.

(b) When process variables can affect the moderation, the process variables are shown in the ISA Summary to be controlled by IROFS.

(c) When the moderation is measured, the measurement is obtained by using instrumentation.

(d) When designing physical structures, the design precludes the ingress of moderation.

(e) When moderation is needed to be sampled, dual independent sampling methods are used.
(f) When developing firefighting procedures for use in a moderation controlled area, restrictions are placed on the use of moderator material.
(g) After evaluating all credible sources of moderation for the potential for intrusion into a moderation-controlled area, the ingress of moderation is precluded or controlled.

(13) The use of concentration as a controlled parameter should be considered acceptable if:

(a) When process variables can affect the concentration, the process variables are shown in the ISA Summary to be controlled by IROFS.
(b) High concentrations of SNM in a process are precluded unless the process is analyzed to be safe at any credible concentration.
(c) When using a tank containing-concentration controlled solution, the tank is normally closed.
(d) When concentration needs to be sampled, dual independent sampling methods are used.
(e) After identifying possible precipitating agents, precautions are taken to ensure that such agents will not be inadvertently introduced.

(14) The use of interaction as a controlled parameter should be considered acceptable if:

(a) When maintaining a physical separation between units, engineered controls to ensure a minimum spacing or augmented administrative controls are used. The structural integrity of the spacers or racks should be sufficient for normal and credible abnormal conditions.

(15) The use of neutron absorption as a controlled parameter should be considered acceptable if:

(a) When using borosilicate-glass raschig rings, the applicant commits to ANSI/ANS-8.5-1996.

(b) When using fixed neutron absorbers, the applicant commits to ANSI/ANS-8.21-1995.

(c) When evaluating absorber effectiveness, neutron spectra are considered (e.g., cadmium is an effective absorber for thermal neutrons, but ineffective for fast neutrons).

(16) The use of volume as a controlled parameter should be considered acceptable if:

(a) When using volume control, fixed geometry is used to restrict the volume of SNM with engineered devices to limit the accumulation of SNM.

(b) When the volume is measured, instrumentation is used.

5.4.3.4.3 Requirements in 10 CFR 70.24

The applicant's commitment to the CAAS requirements in 10 CFR 70.24 should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant documents that the facility CAAS meets the requirements of 10 CFR 70.24.

(2) The applicant commits to ANSI/ANS-8.3-1997, as modified by Regulatory Guide 3.71, August 1998.

   (a) At or above the 10 CFR 70.24 mass limits, CAAS coverage should be required in each area in which SNM is handled, stored, or used.

   (b) A requirement of 10 CFR 70.24 is that each area that needs CAAS coverage be covered by two detectors.

   (c) A requirement of 10 CFR 70.24 is that a CAAS be capable of detecting a nuclear criticality that produces an absorbed dose in soft tissue of 20 rads of combined neutron and gamma radiation at an unshielded distance of 2 meters from the reacting material within 1 minute.

(3) The applicant commits to having a CAAS that is uniform throughout the facility for the type of radiation detected, the mode of detection, the alarm signal, and the system dependability.

(4) The applicant commits to having a CAAS that is designed to remain operational during credible events such as a seismic shock equivalent to the site-specific design-basis earthquake or the equivalent value specified by the Uniform Building Code.

(5) The applicant commits to having a CAAS that is designed to remain operational during credible events such as a fire, an explosion, a corrosive atmosphere, and other credible conditions.

(6) The applicant commits to having a CAAS alarm that is clearly audible in areas that must be evacuated or provides alternate notification methods that are documented to be effective in notifying personnel that evacuation is necessary.

(7) The applicant commits to rendering operations safe, by shutdown and quarantine if necessary, in any area where CAAS coverage has been lost and not restored within a specified number of hours. The number of hours should be determined on a process-by-process basis, because shutting down certain processes, even to make them safe, may carry a larger risk than being without a CAAS for a short time. The applicant should commit to compensatory measures (e.g., limit access, halt SNM movement) when the CAAS system is not functional.

(8) Emergency management (see SRP Chapter 8)

   (a) The applicant commits to the requirements in ANSI/ANS-8.23-1997 as they relate to NCS;

(b) The applicant either has an emergency plan or satisfies the alternate requirements in 10 CFR 70.22.(h)(1)(i).

(c) The applicant commits to provide fixed and personnel accident dosimeters in areas that require a CAAS. These dosimeters should be readily available to personnel responding to an emergency and there should be a method for prompt onsite dosimeter readouts.

(d) The applicant commits to provide emergency power for the CAAS or provide justification for the use of continuous monitoring with portable instruments.

5.4.3.4.4 Requirements in 10 CFR 70.61(d)

The applicant's commitment to the requirements in 10 CFR 70.61(d) that under normal and credible abnormal conditions, all nuclear processes are subcritical, including use of an approved margin of subcriticality for safety should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant commits to the use of NCS controls and controlled parameters to assure that under normal and credible abnormal conditions, all nuclear processes are subcritical, including use of an approved margin of subcriticality for safety.

(2) As stated in ANSI/ANS-8.1-1983, the applicant commits to the following policy: Process specifications shall incorporate margins to protect against uncertainties in process variables and against a limit being accidentally exceeded.

(3) The applicant commits to the following national standards, as they relate to these requirements: ANSI/ANS-8.7-1975, ANSI/ANS-8.9-1987, ANSI/ANS-8.10-1983, ANSI/ANS-8.12-1987, ANSI/ANS-8.15-1981, and ANSI/ANS-8.17-1984.

(4) If the applicant intends to use administrative k-eff margins for normal and credible abnormal conditions, the applicant commits to NRC pre-approval of the administrative margins.

(5) The applicant commits to determining subcritical limits for k-eff calculations such that: k-subcritical = 1.0 - bias margin, where the margin includes adequate allowance for uncertainty in the methodology, data, and bias to assure subcriticality.

(6) The applicant commits to performing studies to correlate the change in a value of a controlled parameter and its k-eff value. The studies should also include changing the value of one controlled parameter and determining its effect on another controlled parameter and k-eff.

(7) The applicant commits to implement an NCS program that ensures double contingency protection, when practicable. When evaluating double contingency protection, the following should be considered with respect to the contents of both ANSI/ANS-8.1-1983 and the likelihood discussion in SRP Chapter 3:

(a) Adherence to double contingency protection: Each process that has accident sequences that could result in an inadvertent nuclear criticality should have double contingency protection. Double contingency protection may be provided by either: (i) at least two-parameter control (the control of at least two independent process parameters) or (ii) single-parameter control (a system of multiple independent controls on a single process parameter). The first method is the preferred approach because of the difficulty of preventing common-mode failure when controlling only one parameter.

(b) As used in double contingency protection, the term “concurrent” means that the effect of the first process change persists until a second change occurs, at which point the process could have an inadvertent nuclear criticality. It does not mean that the two events initiating the change must occur simultaneously. The possibility of an inadvertent nuclear criticality can be markedly reduced if failures of NCS controls are rapidly detected and the processes rendered safe. If not, processes can remain vulnerable to a second failure for extended periods of time.

(c) Exceptions to double contingency protection: There may be processes where double contingency protection is not practicable. In those processes, the facility should implement sufficient redundancy and diversity in controlled parameters such that at least two unlikely and concurrent events, errors, accidents, or equipment malfunctions are necessary before an inadvertent nuclear criticality is possible. The applicant should commit in the license application, to identify in the ISA Summary any process that could lead to an inadvertent nuclear criticality and for which double contingency was not applied. The applicant must provide adequate justification for this decision in the ISA Summary.

(8) The applicant meets the acceptance criteria in SRP Section 3.4, as they relate to subcriticality of operations and margin of subcriticality for safety.

Note: This is the acceptance criterion for reviewing the application and evaluating the high-risk accident sequences and a selected sampling of other than high-risk accident sequences.

5.4.3.4.5 Requirements in 10 CFR 70.64(a)

The applicant's commitment to the baseline design criteria requirements in 10 CFR 70.64(a) should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant commits to the double contingency principle in determining NCS controls and IROFS in the design of new facilities or new processes at existing facilities that require a license amendment under 10 CFR 70.72.

(2) The applicant commits to double contingency protection as discussed in SRP Section 5.4.3.4.4(9).

5.4.3.4.6 Requirements in 10 CFR 70.65(b) (ISA Summary)

The applicant is required to meet the performance requirements in 10 CFR 70.61(b) and (c), as well as the performance requirements in 10 CFR 70.61(d), which include the requirement to limit the risk of an inadvertent nuclear criticality by assuring that all nuclear processes remain subcritical. The applicant's evaluation of NCS accident sequences should be performed in a manner consistent with the applicant's evaluation of non-NCS accident sequences used to meet 10 CFR 70.61(b) and (c); however 10 CFR 70.61(d) requires the applicant to use prevention methods as the primary means to meet the performance requirements of 10 CFR 70.61(b) and (c).

The applicant's commitment to the requirements in 10 CFR 70.65(b) should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant meets the acceptance criteria in SRP Section 3.4, as they relate to the following: identification of NCS accident sequences, consequences of NCS accident sequences, likelihoods of NCS accident sequences, and descriptions of IROFS for NCS accident sequences.

(2) The applicant commits to use Appendix A of ANSI/ANS-8.1-1983 in determining NCS accident sequences.

(3) The applicant commits to ANSI/ANS-8.10-1983, as modified by Regulatory Guide 3.71, August 1998, in determining the consequences of NCS accident sequences.

5.4.3.4.7 Additional NCS Program Commitments

The applicant's description of additional commitments regarding the NCS program should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(1) The applicant commits to use the NCS program to promptly detect any NCS deficiencies by means of operational inspections, audits, or investigations, and to refer to the facility's corrective action function any unacceptable performance deficiencies in IROFS, NCS function, or management measures, so as to prevent recurrence.

(2) The applicant commits to support the facility change mechanism process by performing NCS determinations to evaluate changes to processes, operating procedures, IROFS, and management measures.

(3) The applicant commits to upgrade the NCS program to reflect changes in the ISA or new NCS methodologies and to modify operating and maintenance procedures in ways that could reduce the likelihood of occurrence of an inadvertent nuclear criticality.

(4) The applicant commits to retain records of NCS programs and to document any corrective actions taken.

(5) The applicant commits to use the NCS methodologies and technical practices in SRP Section 5.4.3.4 to evaluate NCS accident sequences in operations and processes.

(6) The applicant's description of measures to implement the facility change process requirements in 10 CFR 70.72 should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(a) The applicant commits to a change control process that is sufficient to ensure that the safety basis of the facility will be maintained during the lifetime of the facility. The change process should be documented in written procedures and should ensure that all potentially affected SNM processes are evaluated to determine the effect of the change on the safety basis of the process, including the effect on bounding process assumptions, on the reliability and availability of NCS controls, and on the NCS of connected processes. The change control process should have procedures for the review and approval of facility changes by the NCS function to determine the potential effects on NCS.

(b) The change control process should be connected to the facility's configuration management system to ensure that changes to the NCS basis are incorporated into procedures, evaluations, postings, drawings, other safety basis documentation, and the ISA Summary.

(c) The applicant commits to a program to determine whether facility changes require NRC approval in accordance with the 10 CFR 70.72(c). This program should be documented in written procedures and must involve individuals qualified to determine the incremental effect of changes to the safety basis as documented in the ISA Summary. All proposed changes should be compared to the approved ISA Summary.

(7) The applicant's description of measures to implement the reporting requirements in 10 CFR 70 Appendix A should be considered acceptable if the applicant has met the following acceptance criteria or has identified and justified an alternative in the application:

(a) The applicant has a program for evaluating the criticality significance of NCS events and an apparatus in place for making the required notification to the NRC Operations Center. The determination of significance of NCS events should be made by qualified individuals. The determination of loss or degradation of double contingency protection should be made against the license and 10 CFR 70 Appendix A.

(b) The applicant incorporates the reporting criteria of Appendix A and the report content requirements of 10 CFR 70.50 into the facility emergency procedures.

(c) The applicant commits to issue the necessary report based on whether the IROFS credited were lost, irrespective of whether the safety limits of the associated parameters were actually exceeded.

(d) The applicant commits to the following: If the licensee cannot ascertain within one hour of whether the criteria of 10 CFR 70 Appendix A Paragraph (a) or (b) apply, the event should be treated as a one-hour reportable event.

5.5 REVIEW PROCEDURES

The reviewer should use the regulatory guidance of this chapter; references in this chapter; and the applicant's reports to the NRC (e.g., NRC Bulletin 91-01, 10 CFR 70.50, and 70.74).

5.5.1 Acceptance Review

The primary reviewer should review the applicant's NCS information for completeness with respect to the requirements in 10 CFR 70.22, 70.24, 70.61, 70.62, 70.64, and 70.65, and the acceptance criteria in Section 5.4. If deficiencies are identified, then either the applicant should be requested to submit additional material before the start of the safety evaluation or the application should be denied.

5.5.2 Safety Evaluation

When an acceptable application is received from the applicant, the primary reviewer should conduct a complete review of the application and determine its acceptability. The primary reviewer should consult with the supporting reviewers to identify and resolve any issues of concern related to the licensing review. The primary reviewer should also coordinate with other primary reviewers of SRP Chapters 2, 3, 8 and 11 to confirm that all acceptance criteria pertinent to NCS have been met.

The primary reviewer for Chapter 5 should determine whether the acceptance criteria in SRP Section 5.4 have been met and should prepare the SER NCS chapter in accordance with SRP Section 5.6.

5.6 EVALUATION FINDINGS

Note: The evaluation finding for the ISA Summary requirements for 10 CFR 70.65 should be in SRP Section 3.6.

If the staff's review verifies that sufficient information has been provided in the safety program description to satisfy the acceptance criteria in SRP Section 5.4, the staff should document its review as follows:

> The staff has reviewed the Nuclear Criticality Safety (NCS) program for *[name of facility*] according to SRP Chapter 5. The staff has reasonable assurance that:
>
> (1) The applicant will have in place a staff of managers, supervisors, engineers, process operators, and other support personnel who are qualified to develop, implement, and maintain the NCS program in accordance with the facility organization and administration and management measures.
>
> (2) The applicant's conduct of operations will be based on NCS methodologies and NCS technical practices, which will ensure that the fissile material will be possessed, stored, and used safely according to the requirements in 10 CFR Part 70.
>
> (3) The applicant will develop, implement, and maintain a criticality accident alarm system in accordance with both the requirements in 10 CFR 70.24 and the facility emergency management program.

(4) The applicant will have in place an NCS program in accordance with the subcriticality of operations and margin of subcriticality for safety requirements in 10 CFR 70.61(d) and baseline design criteria requirements in 10 CFR 70.64(a).

(5) Based on this review, the staff concludes that the applicant's NCS program meets the requirements of 10 CFR Part 70 and provides reasonable assurance for the protection of public health and safety, including workers and the environment.

5.7 REFERENCES

H. K. Clark,, "Maximum Safe Limits for Slightly Enriched Uranium and Uranium Oxide," Du Pont de Nemours and Co. DP-1014, Aiken, SC, 1966.

R. A. Knief, "Nuclear Criticality Safety --Theory and Practice," American Nuclear Society, La Grange Park, IL, 1985.

H. C. Paxton and N. L. Pruvost, LA-10860-MS, "Critical Dimensions of Systems Containing ^{235}U, ^{239}Pu, and ^{233}U," Los Alamos National Laboratory, Los Alamos, NM, 1987.

N. L. Pruvost and H. C. Paxton, LA-12808/UC-714, "Nuclear Criticality Safety Guide," Los Alamos National Laboratory, Los Alamos, NM, 1996.

W. R. Stratton (D. R. Smith Revisor), DOE/NCT-04, "A Review of Criticality Accidents," U.S. Department of Energy, March 1989.

U.S. Code of Federal Regulations, Title 10, Part 70, 'Domestic Licensing of Special Nuclear Material,' U.S. Government Printing Office, Washington, DC.

U.S. Department of Energy, DOE Order 420.1 (Change 2), "Facility Safety," October 24, 1996.

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