NUCLEAR CRITICALITY SAFETY (NCS)

5.1 PURPOSE OF REVIEW

The purpose of this review is to determine whether the applicant, in the license application and supported by materials on the docket, has made the appropriate commitments to develop, implement, and maintain an NCS program in support of safe operation of the facility as required generally by Federal Regulations and specifically by 10 CFR 70.24, 70.61, 70.62, 70.64, and 70.65.

5.2 RESPONSIBILITY FOR REVIEW

Primary: Nuclear Process Engineer (NCS Reviewer)

Secondary: None

Supporting: Project Manager, Site Representative, and Fuel Cycle Inspector

5.3 AREAS OF REVIEW

The staff should review the application to determine whether (1) the applicant has identified and committed to the responsibilities and authorities for individuals to develop and implement the NCS program; (2) the facility management measures described in 10 CFR 70.62 have been committed to and will support implementing and maintaining the NCS program; (3) an adequate NCS program is described which includes identifying and committing to the Methodologies and Technical Practices used to ensure the safe operation of the facility as required by 10 CFR 70.24 [Criticality Accident Alarm System (CAAS)], 10 CFR 70.61 [Subcriticality of Operations and Margin of Safety for Subcriticality], 10 CFR 70.64 [Baseline Design Criteria (BDC)], and 10 CFR 70.65 [ISA Summary].

The specific areas for review are as follows:

5.3.1 Organization and Administration

The Primary Reviewer should review the application to determine if the applicant has identified and committed to the responsibilities and authorities for individuals to develop and implement the NCS program. The following areas of the application related to the applicant's Organization and Administration should be reviewed:

1. For familiarity, the general Organization and Administration methods used by the applicant (see Section 2.0).

2. The areas of review listed in Section 2.3.1 (Organization and Administration) as they relate to NCS.

3. Experience and education requirements of NCS management positions.

5.3.2 Management Measures

The Primary Reviewer should review the application to determine whether the facility management measures in 10 CFR 70.62 have been committed to by the applicant and whether they demonstrate the applicant's ability to implement and maintain the NCS program. The following areas of the application related to the applicant's Management Measures should be reviewed:

1. Configuration Management, Procedures, Audits and Assessments, Incident Investigations, and other quality assurance elements used by the applicant (see SRP Sections 11.1 through 11.9).

2. The Training, Procedures, and Audits and Assessments programs specifically related to NCS.

5.3.3 Methodologies and Technical Practices

The Primary Reviewer should review the application to determine whether the applicant has implemented NCS Methodologies and NCS Technical Practices used to make NCS determinations to ensure the safe operation of the facility as required by 10 CFR 70.24 [CAAS], 10 CFR 70.61(d) [Subcriticality of Operations and Margin of Safety for Subcriticality], 10 CFR 70.64(a)(9) [BDC], and 10 CFR 70.65(b) [ISA Summary]. The following areas of the application related to the applicant's NCS Methodologies and NCS Technical Practices should be reviewed:

1. The commitment to use the NCS Methodologies identified by the applicant's NCS program.

2. The commitment to use the NCS Technical Practices identified by the applicant's NCS program.

3. The commitment to fulfill the requirements of 10 CFR 70.24 (CAAS) and to have a CAAS that has been incorporated into the Management Measures.

4. The commitment to detect an inadvertent nuclear criticality and promptly notify personnel to ensure that the radiation exposure to workers shall be minimized.

5. The commitment to the requirements of 10 CFR 70.61 (Subcriticality of Operations and Margin of Subcriticality for Safety).

6. The commitment to the requirements in 10 CFR 70.64 (BDC) as they relate to NCS for new facilities and processes.

7. The areas of review listed in Section 3.3 (ISA Summary) as they relate to NCS.

5.4 ACCEPTANCE CRITERIA

To provide for NCS, 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 where a standard applies and the standard has been endorsed by an NRC Regulatory Guide, then a commitment to comply with all of the requirements (i.e., “shalls”) and the appropriate recommendations (i.e., “shoulds”) of the standard should constitute an acceptable program under the NRC regulations with respect to the safety aspects addressed by the standard. Notwithstanding such a general commitment to a standard, the licensee should clarify broad requirements in the standard by more specific commitments in the application. Any variations from the requirements of the standard should be identified and justified in the application.

Individual commitments to the Acceptance Criteria are expected only when the Acceptance Criteria are relevant to the operations and materials to be licensed.

5.4.1 Regulatory Requirements

The regulatory basis for the review should be the general and additional contents of an application as required by 10 CFR 70.22 and 70.65, respectively. In addition, the NCS review should be conducted to ensure compliance with 10 CFR 70.24, 70.61, and 70.62.

5.4.2 Regulatory Guidance

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

1. ANSI/ANS-8.1-1983 (Reaffirmed in 1988), “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors.”

2. ANSI/ANS-8.3-1997, “Criticality Accident Alarm System.”

3. ANSI/ANS-8.5-1996, “Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material.”

4. ANSI/ANS-8.6-1983 (Reaffirmed in 1995), “Safety in Conducting Subcritical Neutron-Multiplication Measurements In Situ.”

5. ANSI/ANS-8.7-1975 (Reaffirmed in 1987), “Guide for Nuclear Criticality Safety in the Storage of Fissile Materials.”

6. ANSI/ANS-8.9-1987 (Reaffirmed in 1995), “Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials.”

7. ANSI/ANS-8.10-1983 (Reaffirmed in 1988), “Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement.”

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

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

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

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

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

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

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

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

5.4.3 Regulatory Acceptance Criteria

5.4.3.1 Organization and Administration

To provide for NCS, the applicant's 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 related to NCS in Section 2.4.3 (Organization and Administration).

2. The applicant commits to the requirements in ANSI/ANS-8.1-1983, “Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors.”

3. The applicant commits to the requirements in ANSI/ANS-8.19-1996, “Administrative Practices for Nuclear Criticality Safety.”

4. The applicant commits to the intent of Section 4.11 of ANSI/ANS-8.1-1983, which is: The applicant shall commit to the use of 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.

5. The applicant commits to provide NCS postings, as necessary, for areas, operations, work stations, and storage locations to provide operators a reference for ensuring conformance and safe operation.

6. The applicant commits to the policy that: "All personnel shall report defective NCS conditions to the NCS function and shall take no further action, unless specified by approved written procedures, until the NCS function has analyzed the situation."

5.4.3.2 Management Measures

To provide for NCS, the applicant's 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:

    a. The applicant commits to the requirements in both ANSI/ANS-8.19-1996, "Administrative Practices for Nuclear Criticality Safety" and ANSI/ANS-8.20-1991, "Nuclear Criticality Safety Training."

    b. The applicant commits to provide instruction in the Training program regarding the use of Process Variables as NCS controls.

    c. The applicant commits to provide instruction in the Training program to all personnel to (1) recognize the CAAS signal and (2) evacuate promptly to a safe area.

    d. The applicant commits to provide instruction in the Training program to all personnel regarding the policy that: "All personnel shall report defective NCS conditions to the NCS function and take no further action, unless specified by approved written procedures, until the NCS function has analyzed the situation."

2. Procedures:

    a. The applicant commits to the requirements in ANSI/ANS-8.19-1996, "Administrative Practices for Nuclear Criticality Safety."

    b. The applicant commits to the policy that: "No single, inadvertent departure from a procedure could cause an inadvertent nuclear criticality."

3. Audits and Assessments:

    a. The applicant commits to the requirements in ANSI/ANS-8.19-1996, "Administrative Practices for Nuclear Criticality Safety."

    b. The applicant commits to conducting and documenting Weekly NCS Walkthroughs (e.g., checklists) of all operating SNM process areas such that all operating SNM process areas should be reviewed at least every two weeks. Identified weaknesses

should be incorporated into the facility Corrective Actions Program and should be promptly and effectively resolved. A graded approach may be used to justify an alternate plan based on the ISA.

c. The applicant commits to conducting and documenting Quarterly NCS Audits such that all NCS aspects of Management Measures (see Sections 11.1 through 11.9) should be audited at least every 2 years. A graded approach may be used to justify an alternate plan based on the ISA.

5.4.3.3.1 Methodologies

To provide for NCS, 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. The applicant commits to the requirements in ANSI/ANS-8.1-1983, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors."

2. The applicant commits to the intent of the requirement in Regulatory Guide 3.71, "Nuclear Criticality Safety Standards for Fuels and Materials Facilities" related to validation reports which is: The applicant should demonstrate: (1) the adequacy of the Margin of Subcriticality for Safety 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(s) of Applicability.

3. The applicant includes a reference to (including date and revision number) and summary description of either a manual or a documented, reviewed, and approved validation report (by NCS and Management) for each methodology which will be used to make an NCS determination (e.g., experimental data, reference books, hand calculations, deterministic computer codes, probabilistic computer codes). The summary description of the reference manual or validation report should have:

    a. A summary of the theory of the methodology in sufficient detail, clarity, and lack of ambiguity that allows understanding of the methodology.

    b. A commitment to apply the methodology only in the Area(s) of Applicability or provide justifications for applying the methodology outside the Area(s) of Applicability.

    c. A commitment to use pertinent computer codes, assumptions, and techniques in the methodology.

    d. A commitment to use mathematical relationships only within the context of their fundamental assumptions and limitations.

    e. A commitment to use the data consistently with reliable experimental measurements.

f. A commitment to use benchmark experiments that cover the intended ranges of applicability and data derived therefrom that will be used to validate the methodology.

g. A commitment to determine 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, when using the methodology.

h. A commitment to use controlled software and hardware when using the methodology.

i. A commitment to use a verification process when using the methodology.

4. The applicant commits to have, at the facility, the reference manual or documented, reviewed, and approved validation report (by NCS 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 in sufficient detail, clarity, and lack of ambiguity that allows understanding of the methodology and independent duplication of results.

b. A description of the Area(s) of Applicability which 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, “Nuclear Criticality Safety in Operations With Fissionable Material Outside Reactors,” any extrapolation beyond the Area(s) 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., mathematical testing).

e. A description of the data used in the methodology consistent with reliable experimental measurements.

f. A description of the benchmark experiments that cover the intended range of applicability and 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 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 1.0 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 1.0).

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

i. A description of the verification process and results.

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

6. The applicant commits to performing NCS determinations using specified methods. The applicant should commit to incorporating these methods into the facility Management Measures:

   a. The applicant should commit to assuming credible optimum conditions (i.e., most reactive conditions physically possible or limited by written commitments to regulatory agencies) for each Controlled Parameter unless specified controls are implemented to limit the Controlled Parameter to a certain range of values.

   b. The applicant should commit to set NCS operating and safety limits derived from experimental data, reference books, hand calculations, deterministic computer codes, or probabilistic computer codes which have either a reference manual or a documented, reviewed, and approved validation report (by NCS and Management).

   c. The applicant should commit to consider the variability and uncertainty in a process and the NCS subcritical limit when setting NCS safety limits.

   d. The applicant should commit to consider the variability and uncertainty in a process and the NCS safety limit when setting NCS operating limits.

5.4.3.3.2 Technical Practices

To provide for NCS, 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. Although the applicant may use a single NCS control to maintain the values of two or more Controlled Parameters, this use constitutes only one component necessary for Double Contingency Protection.

2. Based on the Performance Requirements in 10 CFR 70.61, the applicant commits to the policy that: “No single credible event or failure could result in a criticality accident.”

3. The applicant commits to the preferred use of Passive-Engineered controls to ensure NCS. The applicant should commit to the following preference, in general, for controls to ensure NCS: (1) Passive-Engineered, (2) Active-Engineered, (3) Augmented-Administrative, and (4) Simple-Administrative. When choosing not to use a Passive-Engineered control, the applicant commits to identify and provide justification in the ISA.

4. When evaluating a Controlled Parameter, heterogeneous effects are considered. Heterogeneous effects are particularly relevant for low-enriched uranium processes, where, when all other parameters are equal, heterogeneous systems are more reactive than homogeneous systems.

5. The applicant commits to incorporate Controlled Parameters into the facility Management Measures of 10 CFR 70.62.

6. 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.

7. The applicant commits to describe Controlled Parameters used as NCS control. Examples of Controlled Parameters available for NCS control are: Mass, Geometry, Density, Enrichment, Reflection, Moderation, Concentration, Interaction, Neutron Absorber, and Volume.

8. When Controlled Parameters are controlled for safety reasons by measurement, reliable methods and instruments should be used. It is acceptable if the applicant commits to representative sampling, reliable measurement instruments and methods, and dual independent measurements where there is significant susceptibility to human error.

9. 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 physical measurement of the Mass is needed, the measurement is obtained by using instrumentation.

    d. When 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 double batching of SNM is not possible, the Mass of SNM is limited to no more than 75 percent of the critical Mass.

10. The use of Geometry as a Controlled Parameter should be considered acceptable if:

    a. Before beginning operations, all dimensions and nuclear properties which 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, 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.

11. 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 identified as items relied on for safety (IROFS) in the ISA Summary.

    b. When physical measurement of the Density is needed, the measurement is obtained by using instrumentation.

12. The use of Enrichment as a Controlled Parameter should be considered acceptable if:

    a. When using SNM with differing Enrichment, the SNM is segregated by Enrichment.

    b. When physical measurement of the Enrichment is needed, the measurement is obtained by using instrumentation.

13. 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 one foot 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.

14. The use of Moderation as a Controlled Parameter should be considered acceptable if:

    a. When using Moderation, the applicant commits to the requirements in ANSI/ANS-8.22-1997, “Nuclear Criticality Safety Based on Limiting and Controlling Moderators.”

    b. When Process Variables can affect the Moderation, the Process Variables are identified as IROFS in the ISA Summary.

    c. When physical measurement of the Moderation is needed, the measurement is obtained by using instrumentation.

    d. When designing physical structures, the design precludes the ingress of Moderation.

    e. When sampling of the Moderation is needed, the sampling program uses dual independent sampling methods.

    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.

15. 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 identified as IROFS in the ISA Summary.

    b. High Concentrations of SNM in a process are precluded unless the safety basis for operation at high concentrations is adequate as evaluated in the ISA and reliable controls are instituted.

    c. When using a tank containing Concentration controlled solution, the tank is normally closed so that only proper procedural transfers of concentration-controlled solutions are allowed.

    d. When sampling of the Concentration is needed, the sampling program uses dual independent sampling methods.

    e. After identifying possible precipitating agents, precautions are taken to ensure that such agents will not be inadvertently introduced.

16. The use of Interaction as a Controlled Parameter should be considered acceptable if:

    When maintaining a physical separation between units, engineered devices (i.e., spacers) with a minimum spacing are used. The structural integrity of the spacers should be sufficient for normal and credible abnormal conditions. Augmented administrative controls (e.g., visible marks with proper spacing) may be acceptable if adequately justified in the ISA summary.

17. The use of Neutron Absorber as a Controlled Parameter should be considered acceptable if:

    a. When using Borosilicate-Glass Raschig Rings, the applicant commits to the requirements in ANSI/ANS-8.5-1996, “Use of Borosilicate-Glass Raschig Rings as a Neutron Absorber in Solutions of Fissile Material.”

    b. When using Fixed Neutron Absorbers, the applicant commits to the requirements in ANSI/ANS-8.21-1995, “Use of Fixed Neutron Absorbers in Nuclear Facilities Outside Reactors.”

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

18. The use of Volume as a Controlled Parameter should be considered acceptable if:

a. When using Volume control, geometrical devices are used to restrict the Volume of SNM and engineered devices should limit the accumulation of SNM.

b. When physical measurement of the Volume is needed, the measurement is obtained by using instrumentation.

5.4.3.3.3 Requirements of 10 CFR 70.24 (CAAS)

To provide for NCS, 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 has documented that the facility CAAS meets the requirements of 10 CFR 70.24.

2. The applicant commits to the requirements in ANSI/ANS-8.3-1997, “Criticality Accident Alarm System.”

3. The applicant commits to the requirements in Regulatory Guide 3.71, “Nuclear Criticality Safety Standards for Fuels and Materials Facilities” which effect the ANSI/ANS-8.3 standard:

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

   b. 10 CFR 70.24 requires that each area that needs CAAS coverage to be covered by two detectors.

   c. 10 CFR 70.24 requires 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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 functioning due to Maintenance.

9. Emergency Management:

    a. The applicant commits to the requirements in ANSI/ANS-8.23-1997, "Nuclear Criticality Accident Emergency Planning and Response."

    b. The applicant either has an Emergency Plan or satisfies the alternate requirements found in 70.22(i)(1)(i).

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

    d. The applicant commits to provide emergency power for the CAAS.

5.4.3.3.4 Requirements of 10 CFR 70.61 (Subcriticality of Operations and Margin of Subcriticality for Safety)

To provide for NCS, the applicant's commitment to the Subcriticality of Operations and Margin of Safety for Subcriticality requirements in 10 CFR 70.61 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 ensure both Subcriticality of Operations and Margin of Subcriticality for Safety. As required by ANSI/ANS-8.1-1983, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors," process specifications shall incorporate margins to protect against uncertainties in process variables and against a limit being accidentally exceeded."

2. The applicant commits to the requirements in ANSI/ANS-8.7-1975, "Guide for Nuclear Criticality Safety in the Storage of Fissile Materials."

3. The applicant commits to the requirements in ANSI/ANS-8.9-1987, "Nuclear Criticality Safety Criteria for Steel-Pipe Intersections Containing Aqueous Solutions of Fissile Materials."

4. The applicant commits to the requirements in ANSI/ANS-8.10-1983, “Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement.”

5. The applicant commits to the requirements in ANSI/ANS-8.12-1987, “Nuclear Criticality Control and Safety of Plutonium-Uranium Fuel Mixtures Outside Reactors.”

6. The applicant commits to the requirements in ANSI/ANS-8.15-1981, “Nuclear Criticality Control of Special Actinide Elements.”

7. The applicant commits to the requirements in ANSI/ANS-8.17-1984, “Criticality Safety Criteria for the Handling, Storage, and Transportation of LWR Fuel Outside Reactors.”

8. 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.

9. The applicant commits to the use of controls or control barriers on IROFS to ensure that an inadvertent nuclear criticality will not occur.

10. The applicant commits to incorporating controls and control barriers into the facility Management Measures of 10 CFR 70.62.

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

12. 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.

13. The applicant meets the Acceptance Criteria in Section 3.4.1 (ISA Summary) as they relate to Subcriticality of Operations and Margin of Subcriticality for Safety.

Note: This is the Acceptance Criteria to review the High-Risk Accident Sequences and a cross-section of Low-Risk Accident Sequences.

5.4.3.3.5 Requirements of 10 CFR 70.64 (BDC) [for new facilities and processes only]

To provide for NCS, the applicant's commitment to the BDC requirements in 10 CFR 70.64 should be considered acceptable if the applicant has met the following Acceptance Criteria or has identified and justified an alternative in the application:

The applicant commits to the Double Contingency Principle in determining NCS controls in the design of new facilities or new processes at existing facilities.

5.4.3.3.6 Requirements of 10 CFR 70.65 (ISA Summary)

The applicant is required to meet the performance criteria in 10 CFR 70.61(b) and (c) as well as the performance requirements in 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).

To provide for NCS, the applicant's commitment to the ISA requirements in 10 CFR 70.65 should be considered acceptable if the applicant has met the following Acceptance Criteria or has identified and justified an alternative in the application:

1. Accident Sequences:

    a. The applicant meets the Acceptance Criteria in Section 3.4.3 (ISA Summary) related to Accident Sequences for NCS.

    b. The applicant commits to use Appendix A of ANSI/ANS-8.1-1983, "Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors" in determining Accident Sequences.

2. Consequences:

    a. The applicant meets the Acceptance Criteria in Section 3.4.3 (ISA Summary) related to Consequences for NCS.

    b. The applicant commits to the requirements in ANSI/ANS-8.10-1983, "Criteria for Nuclear Criticality Safety Controls in Operations With Shielding and Confinement." In addition, the applicant should commit to the requirements in RG 3.71, "Nuclear Criticality Safety Standards for Fuels and Materials Facilities" which effect the ANSI/ANS 8.10 standard.

3. Likelihoods:

    a. The applicant meets the Acceptance Criteria in Section 3.4.3 (ISA Summary) related to Likelihoods for NCS.

    b. The applicant commits to implement an NCS program that ensures Double Contingency Protection when practicable. When evaluating Double Contingency Protection, the term "unlikely" should be used in a manner consistent with ANSI/ANS-8.1-1983.

        i. Adherence to Double Contingency Protection: Each process which could have an inadvertent nuclear criticality should have Double Contingency Protection. Double Contingency Protection may be provided by either (a) At Least Two

Parameter Control: the control of at least two independent process parameters or (b) Single Parameter Control: a system of multiple independent controls on a single process parameter. The At Least Two Parameter Control method is the preferred approach due to the difficulty of preventing common-mode failure when controlling only one parameter.

ii. 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.

iii. If the applicant adheres to Double Contingency Protection for an NCS Accident Sequence, then the Likelihood requirements of 10 CFR 70.61(b) should be considered satisfied for that Accident Sequence.

iv. 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 and provide justification in the ISA for exceptions to Double Contingency Protection.

4. Risk:

The applicant meets the Acceptance Criteria in Section 3.4.1 (ISA Summary) related to Risks for NCS.

5. IROFS:

The applicant meets the Acceptance Criteria in Section 3.4.1 (ISA Summary) related to IROFS for NCS.

5.5 REVIEW PROCEDURES

The reviewer should use the Regulatory Guidance of this chapter; references in this chapter; the applicant's 91-01, 70.50, and 70.74 reports; and 10 CFR Part 70 Appendix A reporting requirements.

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 prior to 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 will conduct a complete review of the application and determine its acceptability, consulting with the supporting reviewers to identify and resolve any issues of concern related to the licensing review. The primary reviewer (acting as a secondary or supporting reviewer) should also coordinate with other reviewers concerning NCS regarding the following:

1. In support of the primary reviewer for Section 2.0, the NCS reviewer should determine whether the Acceptance Criteria in Section 2.0 have been met as they relate to NCS.

2. In support of the primary reviewer for Sections 11.1 through 11.9, the NCS reviewer should determine whether the Acceptance Criteria in Sections 11.1 through 11.9 have been met as they relate to NCS.

3. In support of the primary reviewer for Section 3.0, the NCS reviewer should determine whether the Acceptance Criteria in Chapter 3.0 have been met as they relate to NCS.

4. In support of the primary reviewer for Section 8.0, the NCS reviewer should determine whether the Acceptance Criteria in Section 8.0 have been met as they relate to NCS.

The primary reviewer should determine whether the Acceptance Criteria in Section 5.4 have been met and should prepare the SER NCS chapter in accordance with Section 5.6.

5.6 EVALUATION FINDINGS

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

Nuclear Criticality Safety

The staff has reviewed the Nuclear Criticality Safety (NCS) program for [name of facility] according to Chapter 5.0 of the Standard Review Plan. 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, 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 the requirements in 10 CFR 70.24 and in accordance with its 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 and Baseline Design Criteria requirements in 10 CFR 70.64.

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.

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

5.7 REFERENCES

1. Code of Federal Regulations, *Title 10, Energy,* Part 70, "Domestic Licensing of Special Nuclear Material."

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

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

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

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

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

7. DOE Order 420.1 (Change 2). “Facility Safety.” October 24, 1996.