



U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

15.4.7 INADVERTENT LOADING AND OPERATION OF A FUEL ASSEMBLY IN AN IMPROPER POSITION

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of transient and accident analyses for PWRs/BWRs

Secondary - None

I. AREAS OF REVIEW

The review of fuel-loading errors considers:

1. The spectrum of misloading events analyzed. A sufficient number of fuel-loading errors must be studied by the applicant and presented to show that the worst situation undetectable by incore instrumentation has been identified. The kinds of errors considered should include loading of one or more fuel assemblies into improper locations and, where physically possible, with incorrect orientation. For those reactors in which burnable poison or fuel rods are added to or removed from fuel assemblies at the plant, errors in these processes must be considered.
2. Changes in the power distribution and increased local power density.
3. The provisions made to search for loading errors at the beginning of each fuel cycle.
4. The effect of misloaded fuel on nuclear design parameters, the detection of fuel-loading errors, and any operational restrictions that would assist in staying within fuel rod failure limits.

Revision 2 - March 2007

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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5. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. General information on transient and accident analyses is provided in SRP Section 15.0.
2. Design basis radiological consequence analyses associated with design basis accidents are reviewed under SRP Section 15.0.3.

The specific acceptance criteria and review procedures are contained in the reference SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. General Design Criterion 13 (GDC 13), as it relates to providing instrumentation to monitor variables over anticipated ranges for normal operations, for anticipated operational occurrences, and for accident conditions.
2. 10 CFR Part 100, as it relates to offsite consequences resulting from reactor operations with an undetected misloaded fuel assembly.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

The primary safeguards against fuel-loading errors are procedures and design features to minimize the likelihood of the event. Additional safeguards include incore instrumentation systems which would detect errors. However, should an error be made and go undetected, it is possible in some reactor designs for fuel rod failure limits to be exceeded. Therefore, the following acceptance criteria cover the event of operation with misloaded fuel caused by loading errors:

1. To meet the requirements of GDC 13, plant operating procedures should include a provision requiring that reactor instrumentation be used to search for potential fuel-loading errors after fueling operations.
2. In the event the error is not detectable by the instrumentation system and fuel rod failure limits could be exceeded during normal operation, the offsite consequences should be a

small fraction of the 10 CFR Part 100 criteria. A small fraction is interpreted to be less than 10% of the 10 CFR Part 100 reference values. For the purpose of this review, the radiological consequences of any fuel-loading error should include consideration of the containment, confinement, and filtering systems. The applicant's source terms and methodologies with respect to gap release fractions, iodine chemical form, and fission product release timing should reflect NRC-approved source terms and methodologies.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. Compliance with GDC 13 requires that instrumentation be provided to monitor variables and systems (including those that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems) over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions.

GDC 13 is applicable to this section because the reviewer evaluates the potential for fuel-loading errors that could adversely affect the fission process (power distribution), the integrity of the reactor core, and the reactor coolant pressure boundary. Each of these concerns is specifically addressed in GDC 13. In addition, ensuring the appropriate use of instrumentation (e.g., the incore instruments used to detect fuel-loading errors after fueling operations) is a principal objective of GDC 13.

Meeting the requirements of GDC 13 provides assurance that fuel-loading errors will be detected before they can affect power distribution or core integrity or could produce unacceptable stress on the reactor coolant pressure boundary.

2. To establish the suitability of a nuclear power plant site, 10 CFR Part 100, specifies how the exclusion area, low population zone, and population center distance should be determined. Further, radiation exposure criteria stipulated in 10 CFR Part 100 provide reference values to be used in the site suitability determination based on postulated fission product releases associated with accidental events.

10 CFR Part 100 is applicable to SRP Section 15.4.7 because it specifies the methodology for calculating radiation exposures at the site boundary for postulated accidents or events that might be caused by a fuel-loading error. For events having a moderate-frequency of occurrence, any release of radioactive material must be such that the calculated doses at the site boundary are a small fraction of the 10 CFR Part 100 criteria.

Meeting these criteria provides assurance that, in the event of an undetected fuel-loading error, radiation exposures at the site boundary will not exceed a small fraction of the reference values specified in 10 CFR Part 100.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

1. The reviewer verifies that the various cases of misloaded fuel assemblies outlined in subsection I above have been analyzed by the applicant and the worst case determined. For each case, the effect on the reactor power distribution should be given.
2. The reviewer determines that the effect each postulated error has on reactor instrumentation has been ascertained. For limiting events (where fuel rod failure limits are exceeded), the reviewer verifies that acceptable techniques (see SRP Section 4.4) have been used to calculate the fuel temperature conditions.
3. The reviewer ensures compliance with Acceptance Criterion 1 of subsection II above by reviewing the plant operating procedures to verify that they contain provisions requiring that incore instrumentation be used to search for misloaded fuel after each fueling operation. Since low-power mapping is typically done, searching for misloading can be accomplished by the usual low-power maps.
4. When it is determined that fuel rod failure limits can be exceeded, the reviewer of SRP Section 15.0.3 is requested to perform dose calculations to ensure that Acceptance Criterion 2 of subsection II above is met.
5. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The staff has evaluated the consequences of a spectrum of postulated fuel-loading errors. The staff concludes that the analyses provided by the applicant have shown for each case considered that either the error is detectable by the available instrumentation (and hence remediable) or the error is undetectable but the offsite consequences of any fuel rod failures are a small fraction of 10 CFR Part 100 criteria. The applicant affirms that the available incore instrumentation will be used before the start of a fuel cycle to search for fuel-loading errors.

The staff concludes that the requirements of General Design Criterion 13 and 10 CFR Part 100 have been met. This conclusion is based on the following:

The applicant has met the requirements of GDC 13 with respect to providing adequate provisions to minimize the potential of a misloaded fuel assembly going undetected and meets 10 CFR Part 100 with respect to mitigating the consequences of reactor operations with a misloaded fuel assembly. These requirements have been met by providing acceptable procedures and design features that will minimize the likelihood of loading fuel in a location other than its designated place.

For DC and COL reviews, the findings will also summarize the staff's evaluation of requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 13, "Instrumentation and Control."
2. 10 CFR Part 100, "Reactor Site Criteria."

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.
