# Attachment 1

# Federal Register Notice

[7590-01-P]

NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

RIN 3150 - AG26

Emergency Core Cooling System Evaluation Models

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is amending its regulations to allow holders of operating licenses for nuclear power plants to reduce the assumed reactor power level used in evaluations of emergency core cooling system (ECCS) performance. This amendment provides licensees the option to apply a reduced margin for ECCS evaluation or to maintain the value of reactor power that had been mandated in the regulation. This action allows interested licensees to pursue small, but cost-beneficial, power uprates and reduces unnecessary regulatory burden without compromising the margin of safety of a facility.

EFFECTIVE DATE: The rule becomes effective [*Insert 30 days following the date of FR publication*].

ADDRESSES: Documents related to this rulemaking may be examined at the NRC Public Document Room, 2120 L Street, NW. (Lower Level), Washington, D.C. Documents created or received at the NRC after November 1, 1999, are also available electronically at the NRC's Public Electronic Reading Room on the Internet at http://www.nrc.gov/NRC/ADAMS/index.html. From this site, the public can gain entry into the NRC's Agencywide Document Access and

Management System (ADAMS), which provides text and image files of NRC's public documents. For more information, contact the NRC Public Document Room (PDR) Reference staff at 1-800-397-4209, 202-634-3273, or by email to pdr@nrc.gov.

FOR FURTHER INFORMATION CONTACT: Mr. Joseph E. Donoghue, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001; telephone: 301-415-1131; or by Internet electronic mail to jed1@nrc.gov.

SUPPLEMENTARY INFORMATION:

## Background

A holder of an operating license (i.e., the licensee) for a light-water power reactor is required by regulations issued by the NRC to submit a safety analysis report that contains an evaluation of emergency core cooling system (ECCS) performance under loss-of-coolant accident (LOCA) conditions. 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," requires that ECCS performance under LOCA conditions be evaluated and that the estimated performance satisfy certain criteria. Licensees may conduct an analysis that "realistically describes the behavior of the reactor system during a LOCA" (often termed a "best-estimate analysis"), or they may develop a model that conforms with the requirements of Appendix K to 10 CFR Part 50. ECCS evaluations for most currently licensed power reactors are based on Appendix K requirements. Before this revision, the opening sentence of Appendix K specified that a power level of 102 percent be assumed when conducting ECCS analyses. Licensees have proposed using instrumentation that would reduce the uncertainties associated with measurement of reactor power when compared with existing methods of power measurement. This development could justify a reduced margin between the licensed power level and the power level assumed for ECCS evaluations. This final rule

amends this provision in Appendix K and allows licensees the option of using a value lower than 102 percent of licensed power in their ECCS analyses where justified.

Several licensees have expressed interest in using updated feedwater flow measurement technology discussed later in “Calorimetric Uncertainty and Feedwater Flow Measurement” as a basis for seeking exemptions from the Appendix K power level requirement and to implement power uprates. One licensee, TXU Electric Company, obtained an exemption from the Appendix K requirement for Comanche Peak Units 1 and 2 as well as an increase in licensed power based, in part, on more accurate feedwater flow measurement capability. The prospect of additional exemption requests from other licensees provides the impetus for the final rule.

The objective of this rulemaking is to reduce an unnecessarily burdensome regulatory requirement. Appendix K was originally issued to ensure an adequate performance margin of the ECCS in the event a design-basis LOCA were to occur. The margin is provided by conservative features and requirements of the evaluation models and by the ECCS performance criteria. The original regulation did not require that the power measurement uncertainty be demonstrated, but rather mandated a 2-percent margin. The final rule allows licensees to justify a smaller margin for power measurement uncertainty. Because there will continue to be substantial conservatism in other Appendix K requirements, sufficient margin to ECCS performance in the event of a LOCA will be preserved, which is the underlying purpose of Appendix K. The final rule does not significantly affect plant risk, as discussed in the section entitled, “ECCS Evaluation Conservatism.”

Another objective is to avoid unnecessary exemption requests. A licensee has obtained an exemption from the 2-percent margin requirement in 10 CFR Part 50, Appendix K. The final rule eliminates the need for licensees to obtain exemptions.

The final rule gives licensees the option of applying a reduced margin between the licensed power level and the assumed power level for ECCS evaluation, or maintaining the current margin of 2-percent power. As discussed in the section entitled "ECCS Evaluation Conservatism," the NRC has concluded that the 2 percent power margin requirement in the original rule appeared to be based solely on considerations associated with power measurement extant at the time of the original ECCS rulemaking. The original rule unnecessarily restricted operation for licensees that can show that the uncertainties associated with power measurement instrumentation errors are less than 2 percent.

This amendment gives licensees the opportunity to use a reduced margin if they determine that there is a sufficient benefit. Licensees may apply the margin to gain benefits from operation at higher power, or the margin could be used to relax ECCS-related technical specifications (e.g., pump flows). Another potential benefit could be in modifying fuel management strategies (e.g., possibly by altering core power peaking factors). However, the final rule, by itself, does not allow increases in licensed power levels. Because licensed power level for a plant is a license condition, proposals to raise the licensed power level must be reviewed and approved under the license amendment process. The license amendment request should include a justification of the reduced power measurement uncertainty and the basis for the modified ECCS analysis, including the justification for reduced power

measurement uncertainty, should then be included in documentation supporting the ECCS analysis (see Section-by-Section Analysis).

As licensees apply the final rule and the NRC gains experience reviewing related license amendment requests, the NRC will consider the need for specific guidance to help licensees appropriately account for power measurement uncertainty in safety analyses. In the absence of specific guidance, the NRC expects that power uprate amendment requests based on this amendment to the regulations will address the suitability of non-LOCA analyses for operation at proposed higher power levels. Licensees can refer to available instrumentation guidance such as the Instrument Society of America Standard ISA 67.04, 1982, "Safety-Related Instrumentation Used in Nuclear Power Plants," and NRC Regulatory Guide 1.105, Revision 2, "Instrument Setpoints for Safety-Related Systems."

## Conservatisms in Appendix K ECCS Evaluation Model

Appendix K defines conservative analysis assumptions for ECCS performance evaluations during design-basis LOCAs. Large safety margins are provided by conservatively selecting the ECCS performance criteria as well as conservatively establishing ECCS calculational requirements. The major analytical parameters and assumptions that contribute to the conservatisms in Appendix K are set forth in Sections A through D of the rule: (A) "Sources of Heat During the LOCA" (the 102-percent power provision is a key factor), (B) "Swelling and Rupture of the Cladding and Fuel Rod Thermal Parameters," (C) "Blowdown Phenomena," and (D) "Post-blowdown Phenomena: Heat Removal by ECCS." In each of these areas, several assumptions are typically used to ensure substantial conservatism in the analysis results. For instance: under "Sources of Heat During the LOCA," decay heat is modeled on the basis of an

American Nuclear Society standard with an added 20-percent penalty, and the power distribution shape and peaking factors expected during the operating cycle are chosen to yield the most conservative results. In "Blowdown Phenomena," the rule requires use of the Moody model and the discharge coefficient that yields the highest peak cladding temperature. "Post–Blowdown Phenomena; Heat Removal by the ECCS," requires that the analysis assume the most damaging single failure of ECCS equipment.

One of several conservative requirements in Section A of the original Appendix K was to assume that the reactor was operating at 102 percent power when the LOCA occurred "to allow for *such uncertainties as* instrumentation error...." (Appendix K, Section I.A., first sentence, emphasis added). The phrase, "such as," suggested that the two percent power margin was intended to address uncertainties related to heat source considerations beyond instrument measurement uncertainties. However, the basis for the required assumption of 102 percent power (2 percent power margin) does not appear to be contained in the rulemaking record for the ECCS rules, 10 CFR 50.46 and Appendix K. These rules were adopted in 1974 (39 FR 1001; January 4, 1974), and were preceded by a formal rulemaking hearing which ultimately resulted in a Commission decision on the proposed rulemaking, CLI-73-39, 6 AEC 1085 (December 28, 1973). Neither the statement of considerations (SOC) for the final rule nor the Commission decision appear to provide specific basis for the required assumption of 102 percent power.

The SOC for the January 4, 1974, final rule discusses the 102 percent power assumption in general terms, and does not mention instrumentation uncertainty:

> The Commission believes that the implementation of the new regulations will ensure an adequate margin of performance of the ECCS should a design basis LOCA ever occur. This margin is provided by conservative features of the evaluation models and by the criteria themselves. Some of the major points that contribute to the conservative nature of the evaluations and the criteria are as follows:
>
> (1) *Stored heat*. The assumption of 102 percent of maximum power, highest allowed peaking factor, and highest estimated thermal resistance between the $UO_2$ and the cladding provides a calculated stored heat that is possible but unlikely to occur at the time of a hypothetical accident. While not necessarily a margin over the extreme condition, it represents at least an assumption that an accident happens at a time which is not typical. 39 FR at 1002 (first column)[1].

Thus, while the pre-accident power level assumption is connected with the modeling of the rate of heat generation after the LOCA occurs, a clear basis for the 102 percent assumed power level requirement is not provided, nor does the SOC explain whether there are other uncertainties besides instrumentation uncertainties for which the 102 percent assumed power level is intended to compensate.

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[1]This statement in the SOC was taken unchanged from Section I of the Commission's ECCS decision. See CLI-73-39, 6 AEC 1085, 1093-94 (December 28, 1973).

The Commission's decision in the ECCS rulemaking hearing also does not explain whether the 102 percent assumed power level was intended to address uncertainties other than instrumentation uncertainties. Section I of the Commission decision was the basis for the SOC discussion on the 102 percent assumed power level (See 6 AEC at 1093-94). Section III. A. of the Commission's decision, "Required and Acceptable Features of the Evaluation Model," does not offer a detailed technical basis for the power level chosen, but instead uses the language ultimately adopted in the original Appendix K rule:

> For the heat sources listed in paragraphs 1 to 4 below it shall be assumed that the reactor has been operating continuously at a power level at least 1.02 times the licensed power level (to allow for such uncertainties as instrumentation error), with the maximum peaking factor allowed by the technical specifications (6 AEC at 1100).

Thus, the Commission's decision does not shed further light on the basis for the 102 percent assumed power level, nor whether the Commission had in mind uncertainties other than those associated with the instrumentation for measurement of power level.

NRC review of the ECCS rulemaking hearing record did not disclose presentations relating to quantification of power measurement uncertainties, or the magnitude of other uncertainties that the 102 percent assumed power level may have been intended to address. The Commission decision (CLI-73-39, 6 AEC 1085, December 28, 1973) cited three documents in the rulemaking hearing record. The first, cited in the Commission decision as Exhibit 1113, was "Supplemental Testimony of the AEC Regulatory Staff on the Interim Acceptance Criteria

for Emergency Core Cooling Systems for Light-Water Cooled Power Reactors," (filed October 26, 1972). In Section 10 of the document, stored energy in the fuel was considered, specifically the expected power distributions in fuel rods. The 102-percent power analysis requirement is not discussed. The second item, cited in the Commission decision as Exhibit 1137 was "Redirect and Rebuttal Testimony of Dr. Donald H. Roy on Behalf of Babcock & Wilcox," (October 26, 1972) in which the characteristic of the decay heat release following reactor shutdown was discussed. In this document, the 102-percent assumption is associated with the predicted decay heat generation rate. The over-power condition is associated with a "design-basis maneuvering operation," but the basis for the value of power chosen for the analysis (i.e., 102 percent) is not disclosed. Finally, in the "Concluding Statement of Position of the Regulatory Staff – Public Rulemaking Hearing on: Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Cooled Nuclear Power Reactors," April 16, 1973 (the Concluding Statement), the power level assumption is included as part of the proposed rule itself. The proposed rule language clearly states that the power level assumption is to "allow for instrumentation error." The term "such as" does not appear here. It is unclear when or why the proposed language in this regard was changed to its current form. The power level assumption is mentioned again in the Concluding Statement indirectly in association with power level changes before the LOCA and the effect on decay heat generation. But it is discussed most directly with regard to initial stored energy in the fuel. In the discussion on stored energy, the 102-percent assumption is attributed to "uncertainties inherent in the measurement of the operating power level of the core," (page 144 of the Concluding Statement). Reasons for choosing 102-percent as the value are not discussed.

When Appendix K was first issued, as is the case today, the thermal power generated by a nuclear power plant was determined by steam plant calorimetry, which is the process of performing a heat balance around the nuclear steam supply system (called a calorimetric). The heat balance depends upon measurement of several plant parameters, including flow rates and fluid temperatures. The differential pressure across a venturi installed in the feedwater flow path is a key element in the calorimetric measurement. Licensees have proposed using instrumentation other than a venturi-based system to obtain feedwater flow rate for calorimetrics. The lower uncertainty associated with the new instrumentation is information that was apparently not available during the original Appendix K rulemaking.

In view of the regulatory history for Appendix K, the Commission now believes that the 2-percent margin embodied in the requirement for a 102-percent assumed power level in Appendix K was based solely on uncertainties associated with the measurement of reactor power level.

## Reduction in 102 Percent Assumed Power Level

The Commission believes that other requirements of Appendix K modeling contain substantial conservatisms of much greater magnitude than the 2 percent margin embodied in the requirement for a 102 percent assumed power level. This point was discussed in "Conservatisms in Appendix K ECCS Evaluation Model," above.

The Commission is also aware of new information gained since the 1974 rulemaking which shows that the Appendix K model contains additional conservatisms not recognized in 1974. Evidence from experiments designed to simulate LOCA phenomena suggest that these

conservatisms added hundreds of degrees Fahrenheit to the prediction of peak fuel cladding temperature than would actually occur during a LOCA. The significant conservatism was necessary when the rule was written because of a lack of experimental evidence at that time with respect to the relative effects of analysis input parameters, including pre-accident power level. Since that time, there has been substantial additional research on LOCA. NUREG-1230, "Compendium of ECCS Research for Realistic LOCA Analysis," December 1988, contains the technical basis for improved understanding of LOCA progression and ECCS evaluation gained after the ECCS rule was issued. The NUREG includes a discussion of the basis for uncertainties in detailed fuel bundle power calculations as part of the consideration of overall calculational uncertainty inherent in best-estimate evaluations. Chapters 7 and 8 of the NUREG include consideration of the changes in licensed power level that could result from application of best-estimate evaluation methods. The discussion includes an estimated sensitivity of predicted peak clad temperature (PCT) associated with changes in pre-accident power level. From that estimate, the NRC expects peak cladding temperature changes of approximately 15°F to result from 1-percent changes in plant power level that could result from the final rule.

In view of: (i) substantial conservatisms known in 1974 that were embodied in the Appendix K requirements for ECCS evaluations, (ii) new information developed since the 1974 rulemaking which shows additional conservatism in the Appendix K modeling requirements beyond that understood by the Commission when it adopted the 1974 rule, and (iii) the relative insensitivity of the calculated clad temperatures to assumed power level, the Commission concludes that it is acceptable to allow a reduction in the currently-required 102 percent power level assumption if justified by the actual power level measurement instrumentation uncertainty.

Accordingly, the Commission is amending the Appendix K requirement for an assumed 102 percent power level. This amendment allows a licensee to use an assumed power level of less than 102 percent (but not less than 100 percent), if the licensee has determined that the uncertainties in the measurement of core power level justifies the reduced margin.

Calorimetric Uncertainty and Feedwater Flow Measurement

The NRC staff has approved an exemption to the 102-percent power level requirement for Comanche Peak Units 1 and 2. The basis for the action is application of upgraded feedwater flow measurement technology at the plant. As indicated, the prospect of additional licensees requesting similar action has prompted the final rule. Other methods, systems, or analyses could be used as the basis for demonstrating reduced power measurement uncertainty.

In most nuclear power plants, operators obtain a continuous indication of core thermal power from nuclear instruments that provide a measurement of neutron flux. The nuclear instruments must be periodically calibrated to counteract the effects of changes in flux pattern, fuel burnup, and instrument drift. Steam plant calorimetry, which is the process of performing a heat balance around the nuclear steam supply system (called a calorimetric), is used to determine core thermal power and is the basis for the calibration. The differential pressure across a venturi installed in the feedwater flow path is a key element in the calorimetric measurement. Some plants use this calorimetric value directly to indicate thermal power; the nuclear instruments are used as anticipatory indicators for transients and for reactivity adjustments made with the control rods.

The system in use at Comanche Peak Units 1 and 2 is the Leading Edge Flowmeter (LEFM), manufactured by Caldon, Inc. The LEFM system is an ultrasonic flow meter that measures the transit times of pulses traveling along parallel acoustic paths through the flowing fluid. LEFM technology has been employed in non-nuclear applications, such as petroleum, chemical, and hydroelectric plants for several years. This operating experience will provide reliability data, supplementing data from nuclear applications. Additional information on the Comanche Peak Appendix K exemption and on the Caldon, Inc. LEFM system appears in safety evaluations issued by the NRC staff on March 8, 1999, and May 6, 1999.

ABB Combustion Engineering has expressed interest in the final rule because its flow-measuring system, known as Crossflow (which is also an ultrasonic flow-measuring device), is under NRC review and is expected to be part of a licensee amendment request for power uprate in the near future.

## Public Comment

In the proposed rulemaking (64FR53270; October 1, 1999), the NRC sought comments from the public on four issues related to the revision of Appendix K. The NRC received comments from four utility companies, the Nuclear Energy Institute (NEI), and Caldon, Inc., manufacturer of the LEFM system. All of the commenters supported the proposed rule. NEI and Caldon offered comments on the four issues that the Commission included in the proposed rule. NEI and the New York Power Authority commented on several other issues as well.

The issues that accompanied the proposed rule were:

1. The current rule states that the required 2-percent analysis margin is to account for "*such* uncertainties *as* instrumentation error...." (emphasis added). This suggests that the 2-percent margin was intended to account for other sources of uncertainty in addition to instrumentation error. However, explicit documentation of the basis for the value of the margin does not appear to be contained in the rulemaking record for the original 1974 ECCS rulemaking. The Commission was interested in whether there were other sources of uncertainty, relevant to sources of heat following a LOCA, that should be considered when licensees seek to reduce the margin in the Appendix K requirement for assumed power.

As discussed in the section entitled, "Conservatisms in Appendix K ECCS Evaluation Model," the Commission considered the rulemaking historical record for Appendix K and concluded that instrument uncertainty was likely the only source of uncertainty that was to be accounted for by the 2-percent margin. NEI and Caldon have not identified other sources of uncertainty, relevant to sources of heat following a LOCA, that are connected with the power level assumption.

2. Were there rulemaking alternatives to the proposed rule that were not considered in the regulatory analysis?

The Commission considered rulemaking alternatives in the accompanying regulatory analysis. The alternatives were (i) no rule change, (ii) removal of the 102 percent requirement while requiring justification of a power level margin, (iii) the approach taken in the amended rule to maintain the 102 percent requirement and offer the option to reduce the margin, (iv) elimination of the power level margin, and (v) broad revision of Appendix K addressing all

analysis requirements. Additional alternatives were not identified in the comments received for the proposed rule.

3. What criteria should be used for determining whether a proposed reduction in the 2 percent power margin has been justified, based upon a determination of instrumentation error? For example, should a demonstrated instrumentation error of 1 percent in power level be presumptive of an acceptable reduction in assumed power margin of 1 percent?

The comments from NEI on this point emphasized that any criteria developed to evaluate proposed reductions in ECCS analysis power margin should be based only on the instrumentation error associated with power measurement. NEI said that the conservatism inherent in the ECCS analysis requirements embodied in Appendix K provide sufficient margin to maintain safety so that instrumentation uncertainty should be the only basis for the power level assumption. The comments also stated that the overall impact on safety should be considered and that degradation in safety should not be allowed.

The Commission agrees that the main criteria determining the suitability of proposed power level margin reductions should be the details associated with uncertainties in power level measurement. The Commission also agrees that the overall impact on plant safety should be considered, preferably in a risk-informed manner. However, the commenter contended that a lower probability of exceeding the analyzed power level translates to an overall improved level of safety at a facility. The Commission does not necessarily equate a lower probability of exceeding an analysis limit with improved safety for facilities that obtain approvals to increase reactor thermal power or make other changes based on the amendment. For example, when

plants obtain power uprates in conjunction with the relaxation in the amended rule, other factors come into play that may reduce the overall margin of safety, albeit probably only slightly for the small power increases anticipated with the amendment. Such changes in safety margin, if small and controlled, can be acceptable in light of other substantial conservatisms or associated risk-related information.

Caldon offered detailed comments on this issue. Their comments went beyond general instrumentation uncertainty considerations by proposing a list of criteria that appeared to be based on application of the LEFM to power measurement at a plant. Although the Commission considers the criteria provided by Caldon to be helpful, the Commission is not yet prepared to formalize any criteria for evaluating reductions in the power level margin for ECCS analysis. The safety evaluations associated with the Appendix K exemption and power uprate for Comanche Peak granted to TXU Electric Company set forth basic review criteria, including many of those proposed by Caldon. In those reviews, the NRC staff referred to available instrumentation guidance such as the Instrument Society of America Standard ISA 67.04, 1982, “Safety-Related Instrumentation Used in Nuclear Power Plants,” and NRC Regulatory Guide 1.105, Revision 2, “Instrument Setpoints for Safety-Related Systems.”

The NRC staff intends to gain further experience with licensee proposals that pursue the relaxation offered by the amendment before deciding whether a regulatory guide providing detailed acceptance criteria needs to be developed. Licensee proposals may involve use of advanced flow measurement systems or other approaches to determine the level of power measurement uncertainty and to reduce it. However, the Commission does not believe that

generic acceptance criteria should be too closely based on any particular measurement technology or analysis method.

4. How should the rule address cases in which licensees determine that power measurement instrument error is greater than 2 percent?

Both NEI and Caldon offered comments on this issue. Caldon maintained that current regulatory processes provide a sufficient basis for dealing with such situations. NEI recommended that licensees should conduct Appendix K ECCS evaluations at rated thermal power level plus the value of power measurement uncertainties, regardless of the magnitude of the uncertainty. The comments clearly stated that this position also applies for uncertainties determined to be greater than 2 percent. NEI considered the need for licensees to ensure that safety analyses are valid for their facility. According to NEI, if the required margin for power level measurement were found to be insufficient to account for actual uncertainty levels, then licensees must take appropriate action, including lowering the operating power level. NEI offered alternatives for licensees to accommodate uncertainties above 2 percent, including demonstration that the PCT margin for a facility could accommodate greater-than-expected uncertainty. Also, NEI indicated that other conservatisms in Appendix K methodologies could be applied to “offset” the excessive power measurement uncertainty.

The Commission agrees that licensees who find that the power measurement uncertainty for their facilities is greater than expected should take action to ensure that their plant is operated within the assumptions used in safety analyses. This follows from the requirement in 10 CFR 50 Appendix B, Section III, “Design Control.” The Appendix B

requirement states that design control measures will be applied to items such as accident analyses, and that design changes shall be subject to design control measures. Therefore, licensees must take action if the power measurement uncertainty is greater than typically expected or as determined in a plant-specific analysis. The expected magnitude of uncertainty at a facility could be the 2-percent margin that is preserved in the final rule, or it could be based on a plant-specific analysis supporting a smaller value. As already considered, the basis for the value in the rule is not clearly illuminated in the rulemaking history of Appendix K. However, the Commission believes that the Appendix K value represents a typical value for power measurement uncertainty, unless demonstrated otherwise for a particular facility.

The Commission does not believe that it is necessary to allow application of safety margins based on other conservative factors in an Appendix K ECCS evaluation to offset excessive uncertainties discovered in power measurement for a plant. By proposing to use safety margin "offsets" to justify higher-than-expected power measurement uncertainties, NEI is proposing an alternative to Appendix K ECCS evaluation methods already permitted by § 50.46. The Commission considers the available analysis alternatives offered by § 50.46 (i.e., those based on Appendix K and the so-called best estimate methods) to offer sufficient flexibility to licensees without introducing large complexities to the review and approval process that could be anticipated if Appendix K were to be applied in a "piecemeal" fashion.

The Commission originally instituted the ECCS evaluation requirements with the understanding that substantial conservatisms existed. Later, the relative contributions of various conservative factors were estimated on a largely generic basis to demonstrate the feasibility of best-estimate evaluations. However, when the revisions to § 50.46 were

considered in 1988, the Commission deliberately maintained two distinct options: (i) licensees could use the method defined by Appendix K; or (ii) they could develop a best-estimate approach. The alternatives discussed in the NEI comment can be accommodated by a licensee using the best-estimate option offered by § 50.46, rather than applying Appendix K in a "piecemeal" fashion.

On the basis of the "best-estimate" alternative to Appendix K requirements available in § 50.46, the Commission takes the position that Appendix K requirements should not be applied in a "piecemeal" fashion, as discussed in the NEI comment. Rather than searching for customized adjustments to Appendix K requirements, licensees should develop a "best-estimate" method, as permitted in § 50.46. The Commission position does not present licensees with an onerous burden. Licensees discovering that actual power measurement uncertainty at their plant is greater than the uncertainty assumed in safety analysis can take corrective action to address the problem while continuing plant operation. For example, plant power level may be reduced while the problem is addressed. Therefore, in the final rule the Commission has not adopted the NEI approach of applying offsetting uncertainties.

The comments received from NEI addressed four additional areas:

1. Uncertainties from additional heat sources. NEI commented that utilities would be able to use the amended rule to reduce the decay heat input used in Appendix K evaluations. NEI proposed that licensees could use the power measurement uncertainty to, "ensure that the expected decay heat bounds the full rated plant power plus the uncertainty value."

The NEI comment expands the scope of the proposed revision to Appendix K, bringing into consideration decay heat uncertainty, which is a separate analysis requirement in the rule. The Commission agrees that the decay heat level used in the Appendix K analysis could be reduced commensurate with a lower assumed power level. However, the reduced power level assumption must be justified by an acceptable analysis of the power measurement uncertainty. Also, the decay heat level used in the analysis must continue to meet the requirement in Appendix K (I) (A) (4), "Fission Product Decay." Discussion of the uncertainty involved with decay heat value required by Appendix K (I) (A) (4) is beyond the scope of this rulemaking. Licensees who wish to address the uncertainty of the decay heat level in their ECCS analysis should develop a "best-estimate" method which addresses uncertainties of all of the ECCS analysis parameters.

2. Consistency among NRC documents. NEI pointed out that other Commission documents besides Appendix K contain the 1.02 power level multiplier. In the regulatory analysis accompanying the rule, the Standard Review Plan sections and Regulatory Guide 1.49 are listed as part of the current regulatory framework considered during the rulemaking.

The NRC staff agrees with the comment that changes to guidance documents may be necessary and will make the necessary revisions to these documents to maintain consistency with the amended rule.

3. Requirement for upgrade to feedwater flow measurement. NEI commented that the proposed rule appeared to be based upon application of upgraded feedwater flow technology. NEI recommended that the rule or associated guidance make clear that availability of the

relaxation offered by the final rule is not restricted to licensees applying upgraded flow measurement technology.

The preamble for the proposed rule does indeed discuss application of improved flow measurement technology. This discussion is appropriate because this new technology is the impetus for the exemption granted to one licensee and is a key justification for the Commission action in amending the current rule. In the section, "Calorimetric Uncertainty and Feedwater Flow Measurement," the Commission pointed out that methods other than application of improved flow measurement technology could be used as the basis for demonstrating reduced power measurement uncertainty. Also, in its discussion of the Caldon comments on issue number 3, the Commission acknowledged that licensee proposals may involve use of advanced flow measurement systems or other approaches. To prevent misinterpretation of the rule, the Section-by-Section analysis has been modified to reiterate that other methods not considered in the rulemaking could be used to justify a reduced power measurement uncertainty allowance. Although various approaches to reduce the uncertainty involved with PCT calculation may be used, the only uncertainty considered under this amendment is that associated with power level measurement.

4. Reportability under 10 CFR 50.46(a)(3). NEI cited the Section-by-Section analysis of the proposed rule, where the Commission stated that, "estimated changes in ECCS performance due to final analysis inputs are reported under Sec. 50.46 (a)(3), at least annually." NEI recommended clarification of the statement to reflect an interpretation of § 50.46 so as to relate only to evaluation model parameters, but not to plant design parameters. NEI contended that plant parameters change from cycle to cycle and that changes in PCT caused

by plant specific input parameter changes to design information fall outside the scope of reportability under 10 CFR 50.46(a)(3).

Although the Commission accepts that the results of ECCS evaluations could change as a result of cycle specific variations in model inputs, the Commission does not agree with NEI on this point. In their comment, NEI drew a distinction between design inputs and model inputs to ECCS evaluations. The amended rule does not change the reporting requirements of 10 CFR 50.46 for changes to ECCS evaluations. The regulations are clear on the definition of an ECCS evaluation model and when reports are required. 10 CFR 50.46 (c)(2) defines ECCS evaluation models and provides a list of the elements including, “one or more computer programs and all other information necessary for application of the calculational framework to a specific LOCA, such as...values of parameters, and all other information necessary to specify the calculational procedure.” In other words, the ECCS evaluation model is comprised of the computer code or codes, the input parameters (including plant-specific design parameters), and the calculational results. The Commission should be informed as described in 10 CFR 50.46(a)(3) when even a relatively small change to the calculational framework is made, especially when the PCT result is affected. As discussed in the statement of considerations to the September 16, 1988, final rule (53 FR 35996), the Commission needs to be cognizant of such changes to be able to confirm licensee or vendor assessments of the significance of the changes and to ensure that approved models continue to be used.

10 CFR 50.46 (a)(ii) contains an unambiguous requirement that changes to the ECCS evaluation must be reported at least annually: “For each change to or error discovered in an acceptable evaluation model or in the application of such a model that affects the temperature

calculation, the applicant or licensee shall report the nature of the change or error and its estimated effect on the limiting ECCS analysis to the Commission at least annually as specified in § 50.4." Therefore, on the basis of the definition of an evaluation model in § 50.46, the Commission does not accept the distinction made by NEI between "model parameters" and "design parameters." Based on the requirements of § 50.46, changes to the ECCS evaluation model under the amended Appendix K rule which affect the temperature calculation must be reported at least annually.

The comments from one licensee, the New York Power Authority (NYPA), considered two areas not already discussed:

1. Other potential benefits. NYPA commented that licensees could seek benefits other than increasing licensed power under the amended rule. The commenter offered two examples of such benefits - revised containment analyses conducted at power levels below 102 percent power and relaxation of operating restrictions on ultimate heat sink temperatures.

The Commission agrees that licensees could request the relaxation offered by the amended rule while not pursuing a power level increase. In the Background section the Commission recognized that other benefits are available to licensees and that power level increase is just one option. The examples offered by the NYPA comments may be suitable to a licensee, depending on plant characteristics and plant-specific safety analyses.

2. Changes to technical specifications. NYPA interpreted statements in the proposed rule to suggest that licensees pursuing the relaxation offered in the amendment would need to change their plant technical specifications to include a limiting condition for operation for new

feedwater flow instrumentation. Further, the comments suggested that clarification was needed to address when license amendments were required for changes associated with the rule.

In the Section-by-Section Analysis, the Commission discusses technical specification modifications that might be necessary when a power measurement uncertainty reduction is used in safety analyses. Typically, when an ECCS methodology is changed, a revision is made to the technical specification list of references associated with plant safety analysis methods. Technical specifications for nuclear power plants do not contain explicit requirements for feedwater flow instrumentation. The Commission does not believe that technical specification requirements for feedwater flow instruments are necessary for licensees to use the relaxation offered by the amended rule. Clarification regarding this point has been added to the Section-by-Section Analysis.

## Section-by-Section Analysis

### Appendix K to Part 50 — ECCS Evaluation Models (I)(A) - Sources of heat during the LOCA

This section is amended by removing words from the first sentence in the section to specifically associate the power level requirement with instrumentation error, and by adding a sentence immediately following the first sentence in the section. The new sentence indicates that licensees may assume a power level lower than 102 percent, but not less than 100 percent, if the proposed lower alternative value can be shown to account for core thermal power measurement instrumentation uncertainty. Licensee proposals may involve use of advanced flow measurement systems or other approaches to determine the level of power measurement uncertainty and to support reduction of the power level assumption. Only the uncertainty associated with power level measurement is considered in this amendment.

Appendix K, Part II (1)(a) requires that the values of analysis parameters or their basis be sufficiently documented to allow NRC review. The requirement applies to all analysis input parameters, including those related to other plant instrumentation, such as temperature and pressure. Changes to other inputs are documented in the same manner as the power measurement uncertainty would be documented under the final rule. NRC review and approval is not needed to change a parameter in an approved ECCS evaluation model unless the change is associated with technical specification or license condition modfications, or a final safety analysis report change not covered by § 50.59, “Changes, tests and experiments.” Estimated changes in ECCS performance due to revised analysis inputs are reported under § 50.46 (a)(3), at least annually. As discussed in the Statement of Considerations for a final rule amending Appendix K (53 FR 36001; September 16, 1988), the annual reports keep NRC apprised of changes. This should ensure that the NRC staff can evaluate a licensee’s assessment of the significance of changes and maintain cognizance of modifications made to NRC-approved evaluation models. The licensee must include revised parameters and other changes in the ECCS evaluation model as required by § 50.46 (a)(3) when a single change or an accumulation of changes is expected to affect peak cladding temperature by 50°F or more. The basis for the revised analysis parameter (i.e., the assumed power level) should be included in documentation of the evaluation model, as required by Appendix K, Part II (1)(a).

Licensees could take advantage of the amended rule without a change to technical specifications or to the plant license by simply updating the ECCS analysis and following the reporting requirements of § 50.46. However, in most cases the NRC expects that the analysis supporting the power measurement uncertainty, as well as the description of the relevant instrumentation and associated plant-specific parameters involved in the uncertainty analysis,

would be submitted for NRC review and approval before being used. These requests are expected because most licensees have adopted Generic Letter 88-16, “Removal of Cycle-Specific Parameter Limits from Technical Specifications.” The generic letter provided guidance for licensees to transfer cycle-specific parameters from their technical specifications to a Core Operating Limits Report (COLR). Licensees following the generic letter guidance added an administrative requirement to their technical specifications that specifically identifies NRC-reviewed and approved methods used to determine core operating limits (e.g., topical reports). Because a number of core operating limits are based on LOCA analysis results, ECCS evaluation methods are included in the technical specification list. Therefore, most licensees opting to use the relaxation in the final rule will need to amend technical specifications to include a reference to an NRC-approved topical report that includes the uncertainty analysis justifying reduced power measurement uncertainty. However, a technical specification requirement specifically related to feedwater flow measurement system operability is not needed.

An additional technical specification consideration for licensees pursuing changes based on the final rule could involve nuclear instrument (NI) requirements. Existing plant technical specifications include surveillance requirements to calibrate the power range NIs based on the calorimetric measuring reactor thermal power. The NIs provide the indication of reactor power used as an input for safety systems. Licensees obtaining the relaxation offered in the final rule are expected to change some operating parameter of the plant, whether it be power level, required ECCS flow, etc. By incorporating the justification of reduced uncertainty in power measurement in the basis for their ECCS analysis, licensees would be placing a condition on an input to the calorimetric. The NI calibration required by the plant licensee would then be based

on a calorimetric assuming the reduced power measurement uncertainty. If, for some reason, during the course of plant operation the reduced uncertainty did not apply (e.g., the new feedwater flow meter was no longer operating), the calorimetric would no longer be a valid source of calibration for the NIs. Licensees would need to take action to maintain compliance with their technical specification, for example, by using an alternate input to the calorimetric. The power measurement uncertainties associated with the alternate input would then apply and the plant would need to adjust its operating condition (possibly lower its operating power level) to satisfy the final rule and to maintain the validity of applicable safety analyses. A change to technical specifications for NIs is not required in this situation.

## Referenced Documents

Copies of GL-88-16, and CLI-73-39, and "Supplemental Testimony of the AEC Regulatory Staff on the Interim Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Cooled Power Reactors," and "Redirect and Rebuttal Testimony of Dr. Donald H. Roy on Behalf of Babcock & Wilcox," and "Concluding Statement of Position of the Regulatory Staff – Public Rulemaking Hearing on: Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Cooled Nuclear Power Reactors," and NRC safety evaluations are available for inspection and copying for a fee at the NRC Public Document Room, 2120 L Street, NW. (Lower Level), Washington, D.C. GL-88-16 is also available via the Internet at http://www.nrc.gov/NRC/GENACT/GC/index.html#GL.

NUREG-1230 is available from the Superintendent of Documents, U.S. Government Printing Office, Post Office Box 37082 Washington, DC 20013-7082 or from the National Technical Information Service, Springfield, VA 22161.

## Voluntary Consensus Standards

The National Technology Transfer Act of 1995, Pub. L. 104-113, requires that Federal agencies use technical standards that are developed or adopted by voluntary consensus standards bodies unless the use of such a standard is inconsistent with applicable law or otherwise impractical. In this final rule, the NRC provides holders of operating licenses for nuclear power plants the option of reducing the assumed reactor power level used in ECCS evaluations. This action constitutes a modification to an existing government-unique standard, 10 CFR Part 50, Appendix K issued by the NRC on January 4, 1974. The NRC is not aware of any voluntary consensus standard that could be adopted instead of the government-unique standard. The NRC considered using a voluntary consensus standard. However, an appropriate standard was not identified.

## Finding of No Significant Environmental Impact: Availability

The NRC has determined under the National Environmental Policy Act of 1969, as amended, and the NRC's regulations in Subpart A of 10 CFR Part 51, that this regulation is not a major Federal action significantly affecting the quality of the human environment and, therefore, an environmental impact statement is not required.

The action is likely to result in relatively small changes to ECCS analyses or to the licensed power of nuclear reactor facilities. The NRC staff expects that no significant environmental impact will result from the final rule, because licensee actions based on the rule should not significantly increase the probability or consequences of accidents; no changes will be made in the types of any effluents that may be released off site; and there should be no significant increase in occupational or public radiation exposure. Therefore, there are no

significant radiological environmental impacts associated with the action. The action does not involve non-radiological plant effluents and has no other environmental impact. Therefore, there are no significant non-radiological environmental impacts associated with the final rule.

The determination of the environmental assessment is that there will be no significant offsite impact on the public from this action. Also, the NRC has committed itself to complying in all its actions with Executive Order (E.O.) 12898, "Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations," dated February 11, 1994. The NRC has determined that there are no disproportionately high and adverse impacts on minority and low-income populations. The NRC uses the following working definition of environmental justice: *Environmental justice* means the fair treatment and meaningful involvement of all people, regardless of race, ethnicity, culture, income, or educational level with respect to the development, implementation and enforcement of environmental laws, regulations, and policies. In the letter and spirit of E.O. 12898, the NRC requested public comments on environmental justice considerations or other questions related to this rule, but none were received.

## Paperwork Reduction Act Statement

This final rule increases the burden on licensees opting to use a reduced power level assumption for ECCS analysis (i.e., below 102 percent) to include the change in their annual report required under 10 CFR 50.46 (a)(3)(ii). The public burden to modify the annual report is estimated to average one-half hour per response. The estimated public burden for record keeping, analysis, and other effort associated with this information collection will be included in the Office of Management and Budget FY2000 Information Collection Budget. Existing

requirements were approved by the Office of Management and Budget, approval number 3150-0011.

## Public Protection Notification

If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

## Regulatory Analysis

The Commission has prepared a regulatory analysis on this regulation. Copies of the regulatory analysis may be obtained as indicated in the "ADDRESSES" section.

## Regulatory Flexibility Certification

As required by the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission certifies that this final rule does not have a significant economic impact on a substantial number of small entities. This final rule would affect only the licensing and operation of nuclear power plants. The companies that own these plants do not fall within the definition of “small entities” found in the Regulatory Flexibility Act or within the size standards established by the NRC in 10 CFR 2.810.

## Backfit Analysis

The NRC has determined that the backfit rule in 10 CFR 50.109 does not apply to this final rule and that a backfit analysis is not required for this amendment because the change does not involve any provisions that impose backfits as defined in 10 CFR 50.109(a)(1). The

final rule establishes an alternative approach for ECCS performance evaluations that may be voluntarily adopted by licensees. Licensees may continue to comply with existing requirements in Appendix K. The final rule does not impose a new requirement on current licensees and therefore, does not constitute a backfit as defined in 10 CFR 50.109(a)(1).

Small Business Regulatory Enforcement Fairness Act

In accordance with the Small Business Regulatory Enforcement Fairness Act of 1996, the NRC has determined that this action is not a major rule and has verified this determination with the Office of Information and Regulatory Affairs of`OMB.

List of Subjects in *10 CFR Part* 50

Antitrust, Classified Information, Criminal Penalties, Fire Protection, Intergovernmental Relations, Nuclear Power Plants and Reactors, Radiation Protection, Reactor Siting Criteria, Reporting and Recordkeeping Requirements.

PART 50 — DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

1. The authority citation for Part 50 continues to read as follows:

AUTHORITY: Sections 102, 103, 104, 105, 161, 182, 183, 186, 189, 68 Stat. 936, 937, 938, 948, 953, 954, 955, 956, as amended, sec. 234, 83 Stat. 444, as amended (42 U.S.C. 2132, 2133, 2134, 2135, 2201, 2232, 2233, 2236, 2239, 2282); secs. 201, as amended, 202, 206, 88 Stat. 1242, as amended, 1244, 1246 (42 U.S.C. 5841, 5842, 5846).

Section 50.7 also issued under Pub. L. 95-601, sec. 10, 92 Stat. 2951 (42 U.S.C. 5851). Section 50.10 also issued under secs. 101, 185, 68 Stat. 955, as amended (42 U.S.C. 2131,

2235), sec. 102, Pub. L. 91-190, 83 Stat. 853 (42 U.S.C. 4332). Sections 50.13, 50.54(dd), and 50.103 also issued under sec. 108, 68 Stat. 939, as amended (42 U.S.C. 2138). Sections 50.23, 50.35, 50.55, and 50.56 also issued under sec. 185, 68 Stat. 955 (42 U.S.C. 2235). Sections 50.33a, 50.55a, and Appendix Q also issued under sec. 102, Pub. L. 91-190, 83 Stat. 853 (42 U.S.C. 4332). Sections 50.34 and 50.54 also issued under sec. 204, 88 Stat. 1245 (42 U.S.C. 5844). Sections 50.58, 50.91, and 50.92 also issued under Pub. L. 97-415, 96 Stat. 2073 (42 U.S.C. 2239). Section 50.78 also issued under sec. 122, 68 Stat. 939 (42 U.S.C. 2152). Sections 50.80–50.81 also issued under sec. 184, 68 Stat. 954, as amended (42 U.S.C. 2234). Appendix F also issued under sec. 187, 68 Stat. 955 (42 U.S.C. 2237).

2. Appendix K to Part 50 is amended by revising the introductory paragraph of I. A., “Sources of heat during the LOCA,” to read as follows

Appendix K to Part 50 — ECCS Evaluation Models

I. Required and Acceptable Features of the Evaluation Models

*A. Sources of heat during the LOCA*. For the heat sources listed in paragraphs I. A. 1 to 4 of this appendix it must be assumed that the reactor has been operating continuously at a power level at least 1.02 times the licensed power level (to allow for instrumentation error), with the maximum peaking factor allowed by the technical specifications. An assumed power level lower than the level specified in this paragraph (but not less than the licensed power level) may be used provided the proposed alternative value has been demonstrated to account for uncertainties due to power level instrumentation error. A range of power distribution shapes and peaking factors representing power distributions that may occur over the core lifetime must be studied. The selected combination of power distribution shape and peaking factor should be

the one that results in the most severe calculated consequences for the spectrum of postulated breaks and single failures that are analyzed.

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Dated at Rockville, Maryland, this__ day of _____, 2000.

For the Nuclear Regulatory Commission.

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Annette Vietti-Cook,
Secretary of the Commission.