UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 2 2 1985

MEMORANDUM FOR: Themis P. Speis, Director
Division of Safety Technology

Warren Minners, Chief
Safety Program Evaluation Branch

SUBJECT: PROPOSED REVISION TO THE ECCS RULE
AND DRAFT REGULATORY GUIDE

As requested in your August 6, 1985 memo, we have reviewed the proposed revision to the ECCS rule and the draft regulatory guide. I generally support this revision. The supporting regulatory analysis includes an economic analysis of potential savings that may not be strictly correct. RES may wish to get advice from CAG on this analysis. Furthermore, the assumption of a 5% increase in stretch power is unsupported. Nevertheless, it is obvious that even if only small increase in power resulted from a change in the ECCS rule it would be worthwhile.

Bob Colmar, raised the policy question in his August 15, 1985 memo to Jim Watt, as to whether changes in rules such as this, that have the primary purpose of effecting cost savings should be initiated by the industry. If savings are to be had, that should be incentive enough for the industry to propose changes. The NRC should limit itself to changes that improve safety.

I disagree with this position. In this case there are no cost savings that would accrue to either the utilities or the vendors. The savings would be to the rate payers (i.e., the nation), but they have no advocate except their government. Since there are no incentives for industry to propose changes and the NRC has some responsibility for knowingly imposing the original overly conservative rule, I recommend that the NRC initiate relaxing the ECCS requirements.

However, I wish to emphasize that the treatment of uncertainty, as discussed in Bob's memo, is a fatal flaw in this rule and regulatory guide as now written. Nowhere is it specified how licensees are to calculate the values to be compared to the criteria. The staff must decide before issuing the rule as to the degree of conservatism required. The present draft of the rule and regulatory guide gives no indication of this. Thus, staff review will be ad hoc which is unacceptable. Therefore, the degree of acceptable conservatism must be specified (preferably quantitatively) before NRR concurs.

Warren Minners, Chief
Safety Program Evaluation Branch

cc: [redacted]
J. Watt
Z. Rosztoczy

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Enclosure 4

Marked-Up Copy of Draft Commission Paper

DRAFT

DEC 8 1985

For: The Commissioners

From: Victor Stello, Jr
~~William J. Dircks~~
Acting
Executive Director for Operations

BL*

Subject: REVISION OF THE ECCS RULE CONTAINED IN APPENDIX K AND SECTION 50.46 OF 10 CFR PART 50

Purpose: To obtain Commission approval to publish a notice of proposed rulemaking revising the ECCS rule contained in Appendix K and Section 50.46 of 10 CFR Part 50.

Category: This paper covers a major policy matter. Resource estimates are Category 1.

Issues:

(a) Whether the results of NRC-sponsored research, other research, and licensing experience should be reflected in the ECCS rule.

(b) Whether the ECCS rule should be revised to allow certain changes or corrections to be made to the ECCS evaluation models without requiring a complete reanalysis by the applicant or licensee.

Summary: Section 50.46 of 10 CFR Part 50 requires that calculations be performed to show that the emergency core cooling systems (ECCS) will adequately cool the reactor in the event of a loss-of-coolant accident (LOCA). Appendix K sets forth certain required and acceptable features that the evaluation models, used to perform these calculations, must contain. The results of these calculations are used to determine the acceptability of the ECCS

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427-4254

* PA - Division of PWR Licensing-A Comments
PB - Division of PWR Licensing-B Comments
BL - Division of BWR Licensing Comments

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performance. In many instances, these calculations result in technical specification limits on the reactor operation (e.g., peak local power) in order to comply with the 2200°F cladding temperature limit and other limits of § 50.46. These limits restrict the total power output and optimal operation ~~of some reactors~~ in terms of efficient fuel utilization, maneuvering capability and surveillance requirements for some reactors. ~~It is estimated that~~ Removing these restrictions on operation ~~may~~ would allow increased U.S. electricity production, worth several hundred million dollars a year, without loss of benefit to the public health and safety. BL BL

The NRC has spent over $700M sponsoring research on ECCS performance since the ECCS rule was written. It is estimated that DOE (including AEC and ERDA), U.S. industry and foreign researchers have spent a similar amount investigating ECCS performance. This extensive research has shown that these restrictions are too stringent. Thus, the staff recommends that the ECCS rule be amended to reflect the results of this research and to remove unnecessary operating restrictions. A number of alternative approaches have been considered by the staff and each approach evaluated in terms of safety, impact on the industry, NRC and industry resources required, and risk of litigation both during the rulemaking process and during application of the rule. As a result, the staff recommends eliminating the requirement to use Appendix K features. ~~It is believed that~~ The prescriptive nature of Appendix K is no longer necessary in view of the current improved knowledge of ECCS performance. More realistic analyses, combined with uncertainty evaluations, ~~could~~ can be used as an alternative method to demonstrate conformance with § 50.46 criteria for ECCS performance.

Recommend re-wording for more positive stance, as examples.

Alternatives: The staff has considered the following options for amending the ECCS rule:

A. Retain the existing rule with its present conservatism (no change).

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B. Modify the ECCS rule as stated in the advance notice of proposed rulemaking published in the Federal Register on December 6, 1978 (Enclosure "A"). PB

Note: Changes made to be consistant with "Discussion" Section PB

C. Modify certain models contained in Appendix K, for which research investigations have been completed and a well documented data base exists. These changes would be ~~have been~~ selected in areas for which new experimental data has shown that the existing models contain a larger degree of conservatism than justified by current data uncertainties or are obviously unrealistic. PB

D. Eliminate the requirement to use Appendix K models and allow realistic models to be used. Reduce the 2200°F and 17% oxidation limits of § 50.46 appropriately to ensure that sufficient conservatism exists to cover uncertainties in the realistic calculation.

E. Eliminate the requirement to use Appendix K models and allow realistic models combined with an evaluation of the uncertainty in the overall calculation, similar to that discussed in SECY-83-472, to be used. The § 50.46 limits of 2200°F and 17% oxidation would be unchanged. PB

Background: 10 CFR 50.46 provides "Acceptance Criteria for Emergency Core Cooling Systems (ECCS) in Light Water Nuclear Power Reactors." This section requires that calculations of loss-of-coolant accidents (LOCA) be performed to show that the ECCS will maintain cladding temperatures, cladding oxidation, and hydrogen generation to within certain specified limits. It also requires that a coolable core geometry be maintained and that long term decay heat removal be provided. Appendix K sets forth certain rules on how these calculations must be performed. The criteria of § 50.46 and the calculational methods specified in Appendix K were formally issued in January 1974 after extensive rulemaking

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hearings and are based on the understanding of ECCS performance available at that time.

In the ten years following the rulemaking, over $700M has been spent by the NRC on research investigating ECCS performance. It is estimated that a similar amount has been spent by DOE (including AEC and ERDA), the U.S. industry, and foreign researchers; resulting in a total estimated expenditure of over $1.5 billion. The majority of this LOCA research is complete and has greatly improved the understanding of ECCS performance during a LOCA. The methods specified in Appendix K, combined with other analysis methods currently in use, are now known to be highly conservative; that is, the actual temperatures during a LOCA would be much less than the temperatures calculated with current evaluation models using ~~using~~ Appendix K methods. This fact is best illustrated by comparisons showing temperatures during LOCA simulations in LOFT which are more than 600°F lower than calculations performed using Appendix K procedures. The ECCS research has gone beyond confirming that Appendix K is conservative, it has allowed quantification of that conservatism. The results of experiments, computer code development, and code assessment now allow more realistic calculations of ECCS performance during a LOCA than is possible using Appendix K procedures. ~~along with reasonable estimates of uncertainty.~~ These codes and experiments also permit the uncertainties in the calculations to be estimated. PB BL

In order to highlight the contributions of research toward improving understanding of LOCA phenomena, it is useful to discuss two categories of research. The first category of research includes phenomena for which Appendix K requires specific calculational models to be used. Examples include decay heat, metal-water reaction rate, discharge model, reflood heat transfer at low reflood rates, and other heat transfer phenomena. Enclosure "B" provides a discussion of these research findings. In some cases research has shown the required models to be inadequate (e.g., discharge model) and in one case nonconservative.

All

However, most of the requirements of Appendix K have been shown to be more conservative than needed to protect public health and safety. The best example is the decay heat calculation which is now known to be conservative by over 20% during the initial phases of the LOCA.

The second category of research is more general and was directed toward a best estimate understanding of the overall performance of ECCS. This research includes many investigations into specific phenomena in the areas of heat transfer and two phase flow. Many facilities such as the THTF, FLECHT and the foreign CCTF and SCTF facilities have been used to obtain specific heat transfer data. This research data has been used, by the NRC and the industry, to develop major new computer codes ~~such as TRAC and RELAP5~~ which account for complex phenomena such as non-equilibrium and multidimensional effects and provide an ability to perform best estimate calculations of ECCS performance. TRAC and RELAP5 are advanced codes developed by the NRC. In addition, major integral test facilities such as LOFT, Semiscale, TLTA, MIST, FIST and a number of foreign facilities provide complete simulations of LOCA and other transients for comparison with the calculations of the new computer codes. This allows assessment of the overall uncertainty of the calculations and identification of needed improvements. This research, further described in Enclosure "B", now allows significantly improved calculations of ECCS performance over those possible when Appendix K was developed. The staff has prepared a report which [documents in detail] the ECCS research which has been performed and the current knowledge of ECCS performance ("Technical Basis for Revisions of ECCS Rule," NUREG-xxxx).

NOTE: [Use "summaries" if more appropriate.]

It is also known that some plants are now restricted in operating flexibility by limits resulting from conservative calculations using current models and Appendix K requirements. In addition, Appendix K requires reanalyses to be performed in the event that errors are discovered or certain changes are made to approved

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evaluation models. Very often, the reanalyses contribute little to safety, but require significant staff and industry resources. These restrictions may be preventing optimal operation of some plants. Based on research performed, it is now known that these restrictions can be relaxed without affecting safety. Some research results have been used in licensing calculations, but many important results cannot be used since Appendix K specifically requires certain methods now known to be overly conservative. Thus a modification to the ECCS rule is desirable to relax unnecessary operating restrictions.

On December 6, 1978, the Commission published an advance notice of proposed rulemaking (43 FR 57157) calling for a two-phase approach to the revision of 10 CFR Part 50 and Appendix K (Enclosure "A"). The first step would have been to make procedural changes and to permit minor technical changes which would not have reduced the conservatism contained in Appendix K. The second phase would have made further technical changes based on research results and operating experience.

Staff activity on the ECCS rulemaking was severely curtailed as a result of the high priority efforts required by the TMI-2 accident. This ECCS rulemaking essentially sat dormant until July 1981, when it was brought up again in the context of simplifying and streamlining the regulatory process.

Should previous comments be referenced ?

BL

The staff has reviewed the comments made by outside organizations on the advance notice of proposed rulemaking, as well as a number of other comments received since that time. In general, the commenters support a rule change that would permit greater flexibility in meeting the regulations and would incorporate the use of presently available research information. Many felt that the Phase 1 scope should be expanded to allow additional model changes such as use of the new decay heat standard. The

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most consistent comment received from the industry, licensees, NRC contractors, and other government agencies was that a hearing like that required to support the original rulemaking should not be used to accomplish needed changes to the requirements. Many commenters indicated that they would not support a revision to the ECCS rule included in 10 CFR Part 50 and Appendix K if a lengthy hearing ~~was~~ were required. The ACRS has also supported a revision to the ECCS rule, as most recently stated in the ACRS annual report to Congress (NUREG-1105). Based on the comments received from the advance notice of proposed rulemaking and general support for a revision to the ECCS rule the staff reactivated the effort to modify the ECCS rule. BL

Because of the delay in changing the ECCS rule, the staff has used an interim approach, described in SECY-83-472, to accommodate requests for improved evaluation models like that received from the General Electric Co. This interim approach requires a realistic calculation with an evaluation of the uncertainty in the calculation, to demonstrate that an adequate conservatism or safety factor exists in the improved evaluation model. PB

Discussion: Many options can be proposed for revising the ECCS rule. Based on staff discussions, taking into account the numerous comments received and the industry efforts in response to SECY-83-472, the staff developed several different options for revising the ECCS rule. In this section, each option is discussed and evaluated.

Alt. A: Retain the existing ECCS rule with its present conservatism (no change).

PRO: a. The current well-established and stable licensing process would be retained.

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c. Would not allow all data from NRC sponsored research to be used.

Alt. C: Modify certain models contained in ~~the ECCS rule~~ Appendix K, for which research investigations have been completed and a well-documented data base exists. These changes would be selected in areas for which new experimental data has shown that ~~existing~~ the models contain a larger degree of conservatism than justified by current data uncertainties or are obviously unrealistic. | PB | PB

PRO: a. Plants would no longer be limited in operation by current ECCS rule restrictions.

b. Research results would be reflected in the licensing process.

CON: a. The revised ECCS rule might not contain sufficient conservatism to account for calculational uncertainty. Additional analyses would be required to demonstrate that sufficient conservatism remained in the calculation.

b. The ECCS rule would have to be changed in the future to make use of research results from the 2D/3D program or other information which may become available.

Could write rule ~~to~~ allow use of new data when "well-documented" and accepted by NRC. BL

Alt. D: Eliminate the requirement to use Appendix K models and allow realistic models to be used. Reduce the 2200°F and 17% oxidation limits of § 50.46 appropriately to ensure that sufficient conservatism exists to cover uncertainties in the ~~best estimate~~ realistic calculation. | PB

All

PRO: a. Maximum use of completed and future research could be made in licensing to relax unnecessary operating restrictions.

b. Licensing models would provide more realistic calculations to allow more accurate determination of the effect of equipment changes or failures and operating procedures.

c. The uncertainty evaluation would quantify the conservatism in the calculations which could change as the accuracy of the calculations improved.

d. The industry and NRC staff are already investing effort to follow this approach.

CON: The elimination of Appendix K requirements and the introduction of realistic models into the licensing process would represent a substantial change in the licensing process and may increase the risk of a legal challenge.

In all alternatives considered, the current Appendix K would remain available for those applicants or licensees not desiring to use a revised evaluation model.

The staff believes that Alternatives A and B, which would provide little or no change in the ECCS rule, are unacceptable. The ECCS rule should be changed because:

(1) A data base now exists that supports relaxation of the ECCS rule.

operational restrictions resulting from loss-of-coolant accident (LOCA) analyses and still result in an adequate level of conservatism in the ECCS analyses. This revision in the analysis methods is expected to reduce the calculated peak clad temperature in a typical plant and allow an increase in the local peak power or total power, as discussed in Enclosure "C". The additional flexibility could also be used to improve safety (e.g., reduce the neutron flux on the reactor vessel wall to help alleviate the pressurized thermal shock problem) and improve the efficiency of reactor operations. These changes would allow some plants to increase total power, improve fuel burnups, have longer fuel cycles, accommodate steam generator tube plugging and reduce equipment surveillance requirements, thereby reducing operating costs. Enclosure "D" is a Regulatory Analysis describing these potential cost savings.

Resource Estimates: NRC staff resources to implement the proposed rule change are thought to be negligible under the assumption that no unusual or special rulemaking procedures (e.g. hearings) will be established by the Commission. If the Commission chooses to hold hearings, resources would have to be diverted from other high priority activities. Given that the rule is implemented, the impact of the changes on resource requirements will depend on the number of applicants or licensees which make use of the rule change.

The major staff resources required under the proposed rule change would be to review the realistic models and uncertainty analysis required by the revised ECCS Rule. Based on previous experience with the General Electric Co. SAFER model and the learning that has resulted from these efforts, it is estimated that approximately one staff year would be required to review each generic model submitted. There are ~~three~~ four major reactor vendors (although GE already has a revised evaluation model approved under the existing

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using the interim method discussed in SECY-83-472, GE would promptly update their methodology under a new rule PB

Appendix K) and several fuel suppliers and utilities which perform their own analyses and potentially might submit generic models for review. However, it is expected that only ~~2~~ 3 or ~~3~~ 4 generic models would be submitted since not all plants would benefit from the rule change. Thus, about ~~2-3~~ 3-4 staff years would be required to review the expected generic models. Once a generic model is approved, the plant specific review is very short. [In addition, several vendors are currently planning to submit realistic models in conjunction with the use of SECY-83-472. Therefore, staff resources would be expended to review these models. Since these models would not change as a result of the revised ECCS rule, there should be no net increase in resources required over that already planned to be expended.] In summary, while it is difficult to accurately estimate, we expect that the proposed rule change will have a small overall impact on NRC resources.

BL believes some BWRs, with new model, would still take advantage of new rule BL

BL BL BL BL

Recommendations: That the Commission:

1. Approve the publication of proposed amendments, as set forth in Enclosure "E", which would allow certain changes and corrections to be made to the ECCS evaluation models without requiring an immediate reanalysis by applicants or licensees and would permit the use of realistic calculations, along with uncertainty analyses, to be used in the evaluation of ECCS performance. Evaluation models based on Appendix K features could also continue to be used.

2. Note that:

   a. The notice of proposed rulemaking in Enclosure "E" will be published in the Federal Register, allowing 60 days for public comment.

   b. Pursuant to § 51.21 and 51.31 of 10 CFR Part 51 of Part 51 of the Commission's regulations, a preliminary All

environmental assessment and finding of no significant impact is attached as Enclosure "F".

c. Pursuant to the Regulatory Flexibility Act of 1980, the proposed rule contains a statement that the Commission certifies that the rule will not, if promulgated, have a significant economic impact upon a substantial number of small entities and a copy of this certification will be forwarded to the Chief Counsel for Advocacy, SBA by the Division of Rules and Records, ADM;

d. The subcommittee on Nuclear Regulation of the Senate Committee on Environment and Public Works, the Subcommittee on Energy and the Environment of the House Committee on Interior and Insular Affairs, the Subcommittee on Energy Conservation and Power of the House Committee on Energy and Commerce, and the Subcommittee on Environment, Energy and Natural Resources of the House Committee on Government Operations will be informed.

e. ~~That~~ A Regulatory Analysis is attached as Enclosure "D"; BL

f. A public announcement will be issued (Enclosure "G"); and

g. Copies of the Notice of Proposed Rulemaking will be distributed by the Office of Administration, Division of Technical Information and Document Control to each affected applicant, licensee, and other interested parties.

h. The ACRS has been regularly consulted concerning this proposed rule change and has been provided this information for comment.

All

Scheduling: Recommend affirmation at an open meeting. No specific circumstance is known to the staff which would require Commission action by any particular date in the near term.

Victor Stello, Jr
~~William J. Dircks~~
Acting Executive Director for Operations

BL

Enclosures:

"A" - Advanced Notice of Proposed Rulemaking, 12/06/78
"B" - Summary of ECCS Research
"C" - Conservatism in Appendix K and 50.46
"D" - Regulatory Analysis
"E" - Notice of Proposed Rulemaking
"F" - Environmental Assessment
~~"G" - Draft Public Announcement~~

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ENCLOSURE "B"

SUMMARY OF ECCS RESEARCH

many investigations into specific phenomena in the areas of heat transfer and two phase flow. Many facilities such as the THTF, FLECHT and the foreign CCTF and SCTF facilities have been used to obtain specific heat transfer data. This research data has been used, by the NRC and the industry, to develop major new computer codes ~~such as TRAC and RELAP5~~ which account for complex phenomena such as non-equilibrium and multidimensional effects and provide an ability to perform best estimate calculations of ECCS performance. TRAC and RELAP5 are advanced codes developed by the NRC. In addition, major integral test facilities such as LOFT, Semiscale, TLTA, MIST, FIST and a number of foreign facilities provide complete simulations of LOCA and other transients for comparison with the calculations of the new computer codes. This allows assessment of the overall accuracy of the calculations and identification of needed improvements. This research now allows significantly improved calculations of ECCS performance over those possible when Appendix K was developed.

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in the transient as assumed in Appendix K models. However, as previously discussed, rewets, which are not allowed in Appendix K calculations, also occurred after the initial flow reversal resulting in better than expected cooling of the rods. Research in the Full Length Emergency Core Cooling Heat Transfer (FLECHT) facility investigated heat transfer during the reflood phase of the LOCA transient.[7,8] A key recent finding is that flow blockages due to clad swelling, of which Appendix K requires consideration, do not degrade heat transfer during reflood.[9,9a] Much of the results of the FLECHT program have been used in evaluation models, with the exception of low reflood rate research which is specifically excluded from evaluation models by Appendix K.

ECCS Bypass research has also been performed which investigated the potential for escaping steam to prevent ECCS water from entering the vessel. This concern arose prior to the writing of the ECCS Rule due to early tests in the ~~Semi~~S scale facility during which all the injected ECCS fluid was expelled from the vessel.[10] An extensive research program on ECCS Bypass has greatly improved the understanding of this phenomena.[11,12] It is now known that the results of the ~~Semi~~S scale tests were due to the extremely small size of the facility tests and the timing of the ECC injection, and that ~~this~~ the complete ECC bypass observed is not expected in a reactor. This research program is essentially complete, except for final proof of the scaling of this phenomena which will be demonstrated by tests in the full scale Upper Plemun Test Facility in 1986 as discussed below.

These major separate effects programs have been supported by a number of model development programs. These programs are usually small research programs performed at universities designed to look at certain phenomena in great detail and serve as a link between analysis and experiments. These research programs have studied heat transfer and two phase flow in the detail required to develop models or correlations used to predict the phenomena. Most of the models and correlations for heat transfer and fluid flow used in both evaluation models and best estimate codes were originally developed from very small test facilities operating at low temperatures and pressures in which it was practical to conduct tests of the detail and number required to understand the physical phenomena. These models and correlations were then checked against a more limited number of tests in larger and more expensive separate effects facilities described above. Model development programs have also helped develop instruments required to study these phenomena in large test facilities. Examples of model development programs include the mist-flow studies at SUNY[34] and flow heat transfer work at Lehigh[35].

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Whereas separate effects tests were used to investigate certain phases of the LOCA transient or concentrate or certain specific phenomena, integral tests have been conducted to simulate the entire LOCA transient to ensure that the overall process is understood. The NRC has sponsored three major integral test facilities, each of which have undergone a number of upgrades over the years. The Loss of Fluid Test (LOFT) facility was the major NRC integral test facility. LOFT is an actual nuclear reactor operating at temperatures and pressures similar to commercial reactors, although only about 1/5 as large as the PWR which it simulates. The LOFT program conducted three large break LOCA tests, two intermediate LOCA tests, nine small LOCA tests and numerous separate effect tests.(13,14,15) The LOFT results demonstrated that actual temperatures during the large break LOCA tests were significantly lower than those predicted using evaluation model calculations. One of the reasons for this was the re-wets that occurred in the LOFT tests after the initial rod heat-up which are not allowed in Appendix K calculations. LOFT results also provided data to compare with best estimate calculations to allow identification of areas where the calculations required improvement. Another key finding of the LOFT program was that the actual nuclear fuel rods which were used in LOFT behave differently from the electrical heater rods used to simulate nuclear rods in other tests. The actual nuclear rods tend to be cooled better than the electrical rods used in most experiments.

OELO tests included? If not, these should be referenced PB

PB

The Semiscale facility is another NRC sponsored integral PWR test facility. Semiscale operates at full reactor pressures and temperatures, but is much smaller than LOFT and uses electrical heaters to simulate the nuclear rods. As a smaller, non-nuclear facility, Semiscale is less expensive to operate and many more tests could be conducted. Semiscale has been the "workhorse" test facility. Tests were conducted to investigate scaling of the LOFT results and to assist in planning of LOFT tests. Larger numbers of tests to investigate specific blowdown, refill and reflood phenomena, alternate ECCS concepts and the influence of various assumed initial conditions and failures were conducted over a long period.(16,17,18)

The TLTA served as the NRC's BWR integral facility. Initially a separate effects facility studying only the blowdown phase of the large-break LOCA, the TLTA was upgraded to include ECCS injection and to simulate the entire BWR large-break LOCA transient.(19,20) TLTA tests also showed temperatures significantly lower than evaluation model calculations. Several reasons for

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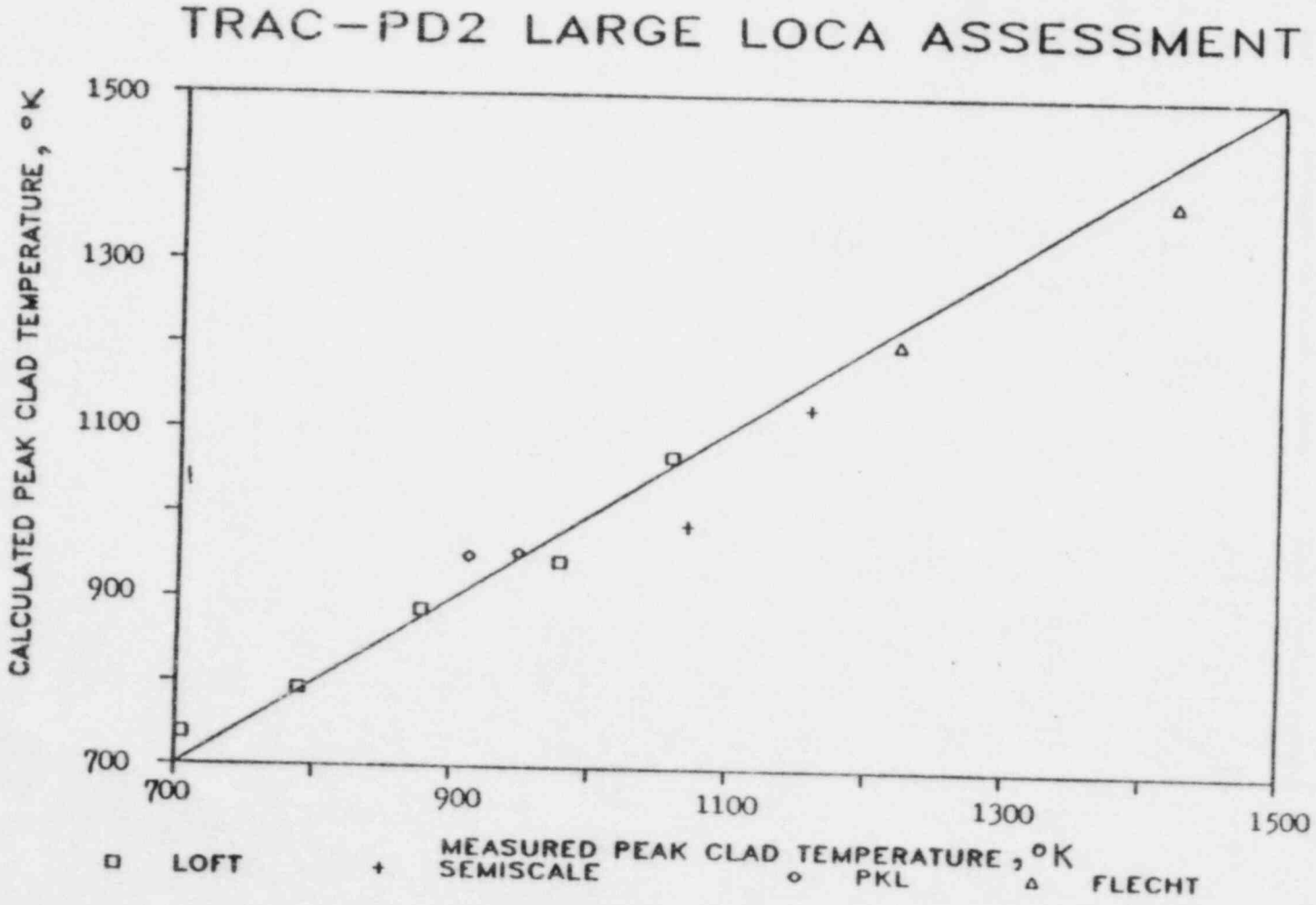

Figure 12. Comparison of TRAC-PD2 calculated peak clad temperatures with experimental data from large LOCA simulations in various facilities. Assessment work such as this helps to determine the uncertainty in the code calculations. (derived from NUREG/CR-3866)

Enclosure "B"

All

ENCLOSURE "C"

CONSERVATISM IN APPENDIX K AND 50.46

AND

EFFECT OF REDUCING THIS CONSERVATISM

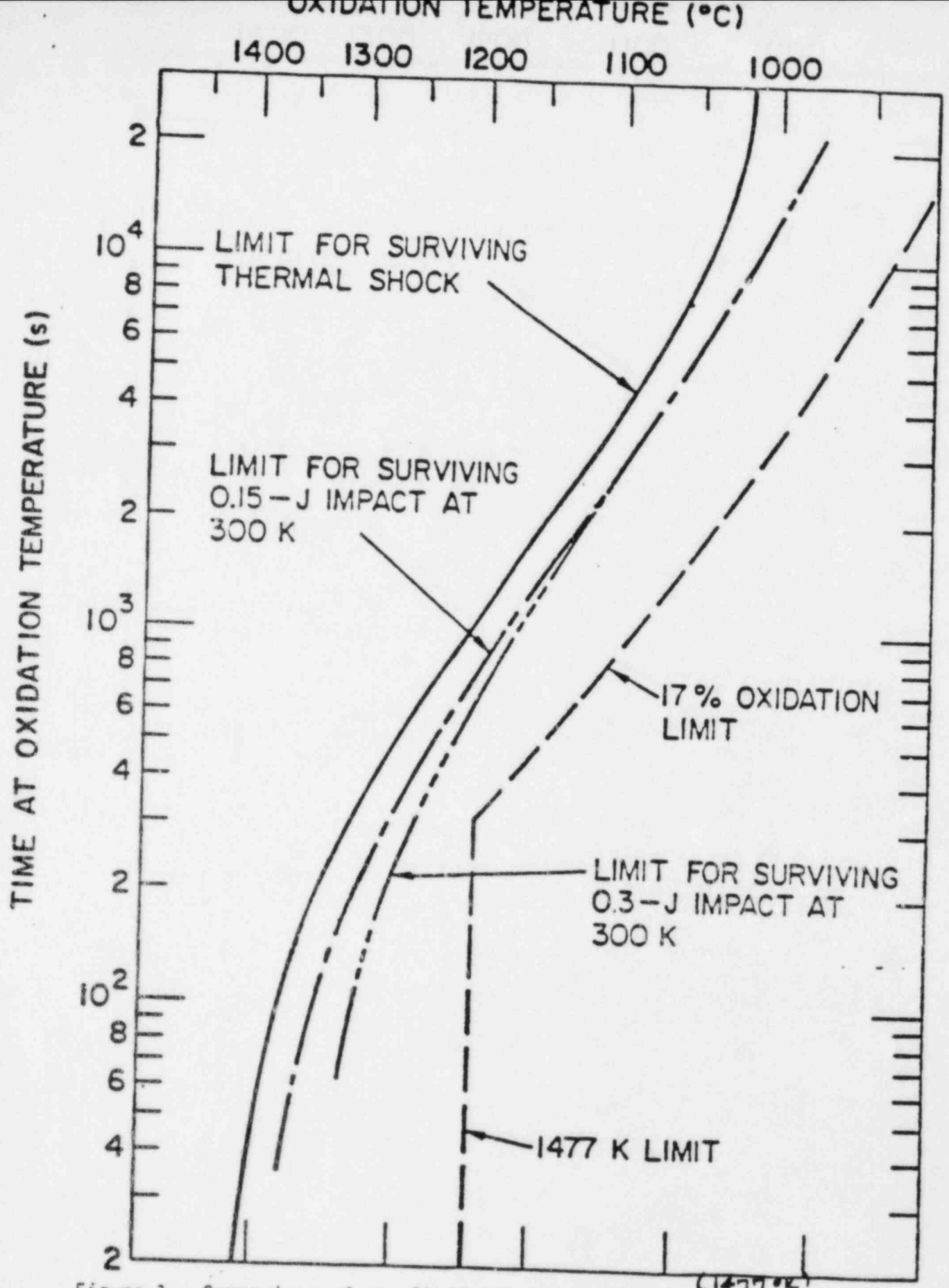

Figure 1. Comparison of the 50.46 criteria of 2200°F and 17% cladding oxidation with estimates of where actual cladding damage would occur. (NUREG-0562)

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ENCLOSURE "E"

NOTICE OF PROPOSED RULEMAKING

required. The primary effect of the rule would be to allow an increase in the peak local power in the reactor. This could be used to either tailor the power shape within the reactor or increase the total power. Changing the power shape without changing the total power would have a negligible effect on the environmental impact. The total power could also be increased, but would be expected to be increased by no more than about 5% due to hardware limitations in existing plants. This 5% power increase is not expected to cause difficulty in meeting the existing environmental limits. The only change in non-radiological waste would be an increase in waste heat rejection commensurate with any increase in power. For stations operating with an open (once through) cooling system, this additional heat would be directed to a surface water body. Discharge of this heat is regulated under the Clear Water Act administered by the U.S. EPA or designated state agencies. The environmental assessment and finding of no significant impact on which this determination is based are available for inspection at the NRC Public Document Room, 1717 H Street NW, Washington, DC. Single copies of the environmental assessment and the finding of no significant impact are available from L. M. Shotkin, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington DC. 20555, telephone (301)427-4254.

PB

PAPERWORK REDUCTION ACT STATEMENT

This proposed rule amends information collection requirements that are subject to the Paperwork Reduction Act of 1980 (44 U.S.C. 3501 et seq.). This rule has been submitted to the Office of Management and Budget for review and approval of the paperwork requirements.

All

3. In § 50.46, paragraph(a) is revised to read as follows:

§ 50.46 Acceptance criteria for emergency core cooling systems for light water nuclear power reactors.*

(a)(1)(i) [Except-as-provided-in-paragraph-(a)(2)-and-(3)-of-this section;] Each boiling and pressurized light-water nuclear power reactor fueled with uranium oxide pellets within cylindrical Zircaloy cladding [shall] must be provided with an emergency core cooling system (ECCS) which [shall] must be designed [such] so that its calculated cooling performance following postulated loss-of-coolant accidents conforms to the criteria set forth in paragraph (b) of this section. ECCS cooling performance [shall] must be calculated in accordance with an [acceptable] evaluation model that has been accepted by the NRC staff and [shall] must be calculated for a number of postulated loss-of-coolant accidents of different sizes, locations, and other properties sufficient to provide assurance that the entire spectrum of postulated loss-of-coolant accidents is covered. [Appendix-K;-ECCS-Evaluation-Models;-sets-forth-certain-required-and-acceptable-features-of-evaluation-models:] Except as provided in paragraph (a)(1)(ii) of this section, the evaluation model must include sufficient supporting justification to show that the analytical technique realistically describes the behavior of the reactor system during a loss-of-coolant accident. Comparisons to applicable experimental data must be made and uncertainties in the analysis method and inputs must be identified and assessed so that the uncertainty in the calculated results can be estimated. This uncertainty must be accounted for so that, when the

*Comparative text has been used to indicate deletions and additions by dashing through and underlining.

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ENCLOSURE "F"

ENVIRONMENTAL ASSESSMENT

DRAFT

DEC 3 1985

NUCLEAR REGULATORY COMMISSION

[10 CFR PART 50]

Acceptance criteria for Emergency Core Cooling Systems;
Environmental Assessment and Draft Finding of No Significant Impact

The U.S. Nuclear Regulatory Commission (The Commission) is considering revisions to §50.46 and Appendix K of 10 CFR Part 50 which specify requirements of emergency core cooling systems (ECCS) for light water reactors.

ENVIRONMENTAL ASSESSMENT

IDENTIFICATION OF PROPOSED ACTION:

As written, inconsistent with rule change PB

Section 50.46(a)(1) would be revised to eliminate the requirement to use the features of Appendix K when calculating ECCS performance during a loss-of coolant accident (LOCA). The amended rule would require that the uncertainty of the calculation be evaluated and considered when comparing the results of the calculation with the temperature limits and other criteria of §50.46(b). Section 50.46(a)(2) would be revised to allow continued use of the features of Appendix K as an alternative to the uncertainty evaluation required by the amended §50.46(a)(1). Section 50.46(a)(3) would be revised to specify requirements for reanalyses and reporting which are excluded from consideration in this environmental assessment per §51.22 of 10 CFR Part 51. Appendix K of 10 CFR Part 50 would be revised to make minor technical changes to the acceptable features of the calculations.

NEED FOR PROPOSED ACTION:

The proposed revisions of 10 CFR Part 50 and Appendix K are required in order to permit new knowledge of ECCS performance gained through research to be used in the calculations of ECCS performance. The improved calculations would allow relaxation of restrictions which are preventing optimal operation

All

Enclosure 5

BACKFIT ANALYSIS

ANALYSIS AND DETERMINATION THAT THE PROPOSED RULEMAKING TO AMEND 10 CFR 50 CONCERNING STATION BLACKOUT COMPLIES WITH THE BACKFIT RULE 10 CFR 50.109

The Commission's existing regulations establish requirements for the design and testing of onsite and offsite electric power systems (10CFR Part 50, Appendix A, General Design Criteria 17 and 18). However, as operating experience has accumulated, the concern has arisen regarding the reliability of both the offsite and onsite emergency AC power systems. These systems provide power for various safety systems including reactor core decay heat removal and containment heat removal which are essential for preserving the integrity of the reactor core and the containment building, respectively. In numerous instances emergency diesel generators have failed to start and run during tests conducted at operating plants. In addition, a number of operating plants have experienced a total loss of offsite electric power, and more such occurrences are expected. Existing regulations do not require explicitly that nuclear power plants be designed to withstand the loss of all AC power for any specified period.

This issue has been studied by the staff as part of Unresolved Safety Issue (USI) A-44, "Station Blackout." Both deterministic and probabilistic analyses were performed to determine the timing and consequences of various accident sequences and to identify the dominant factors affecting the likelihood of core melt accidents from station blackout. These studies indicate that station blackout can be a significant contributor to the overall plant risk. Consequently, the Commission is proposing to amend its regulations to require that plants be capable of withstanding a total loss of AC power for a specified duration and to maintain reactor core cooling during that period.

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Based on the analysis described below and the analysis in NUREG-1109, for Comment, "Regulatory Analysis for the Resolution of Unresolved Safety Issue A-44, Station Blackout" (published in January 1986), the Commission has determined that a substantial increase in the protection of the public health and safety will be derived from the backfit in the proposed station blackout rule, and that the backfit is justified in view of the direct and indirect costs of implementing the proposed rule. In reaching this determination, the Commission has considered how this backfit should be prioritized and scheduled in light of other regulatory activities ongoing at operating nuclear power plants. Station blackout warrants a high priority ranking based on both its status as an "unresolved safety issue" and the results and conclusions reached in resolving this issue. As noted in the implementation section of the proposed rule (§50.63(d)), the schedule for equipment modification (if needed to meet the requirements of the proposed rule) shall be mutually agreed upon by the licensee and NRC. Modifications that cannot be scheduled for completion within two years after NRC accepts the licensee's specified station blackout duration must be justified by the licensee.

Analysis of 50.109(c) Factors

1. Statement of the specific objectives that the proposed backfit is designed to achieve.

   The NRC staff has completed a review and evaluation of information developed over the past 5 years on Unresolved Safety Issue (USI) A-44, Station Blackout. As a result of these efforts, the NRC is proposing to amend 10 CFR Part 50, by the introduction of new Section 50.63, "Station Blackout," and an additional paragraph to General Design Criterion 17, "Electric Power Systems," in Appendix A.

   The objective of the proposed rule is to reduce the risk of severe accidents associated with station blackout by making station blackout a relatively small contributor to total core melt frequency. Specifically,

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the proposed rule would require all light-water-cooled nuclear power plants to be able to cope with a station blackout for a specified duration, and to have procedures and training for such an event. A draft Regulatory Guide, to be issued along with the proposed rule, would provide an acceptable method to determine the station blackout duration for each plant. The duration would be determined for each plant based on a comparison of the individual plant design with factors that have been identified as the main contributors to risk of core melt resulting from station blackout. These factors are: (1) the redundancy of onsite emergency AC power sources, (2) the reliability of onsite emergency AC power sources, (3) the frequency of loss of offsite power and (4) the probable time needed to restore offsite power.

2. General description of the activity that would be required by the licensee or applicant in order to complete the backfit.

In order to assure that each nuclear power plant is able to withstand and recover from a station blackout for a specified minimum duration, licensees would be required to assess their plants' capability to withstand and recover from a station blackout. This evaluation would include:

- Verifying the adequacy of station battery power, condensate storage tank capacity, and plant/instrument air for the station blackout duration.

- Verifying adequate reactor coolant pump seal integrity for the station blackout duration so that seal leakage due to lack of seal cooling would not result in a sufficient primary system coolant inventory reduction to lose the ability to cool the core.

- Verifying operability of equipment needed to operate during a station blackout for environmental conditions associated with total loss of AC power (i.e., loss of heating, ventilation and air conditioning).

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Depending on the plant's existing capability to cope with a station blackout, licensees may or may not need to backfit hardware modifications (e.g., adding battery capacity) to comply with the proposed rule. (See item 8 for additional discussion.) Licensees would be required to have procedures and training to cope with and recover from a station blackout.

3. Potential change in the risk to the public from the accidental off-site release of radioactive material.

   Based on an analysis of potential consequences presented in Section 4 of NUREG-1109, if the proposed rule were implemented, the estimated total risk reduction to the public from 67* operating reactors is 80,000 person-rem.

4. Potential impact on radiological exposure of facility employees.

   For 67 operating reactors, the estimated total reduction in occupational exposure resulting from reduced core melt frequencies and associated post-accident cleanup and repair activities is 2,000 person-rem (Table 8 in NUREG-1109). No increase in occupational exposure is expected from operation and maintenance or implementing the proposed rule. Equipment additions and modifications contemplated do not require work in and around the reactor coolant system and therefore would not be expected to result in significant radiation exposure (Table 8 in NUREG-1109).

5. Installation and continuing costs associated with the backfit, including the cost of facility downtime or the cost of construction delay.

*The value-impact analysis in NUREG-1109 was based on plant-specific information for a total of 67 reactors. Although there are currently about 100 operating reactors, the overall value-impact ratio in NUREG-1109 would not change significantly because of the increase in the number of operating plants.

For 67 operating reactors, the total estimated cost for assessing the station blackout coping capability, procedures and training, installation of hardware backfits (if necessary), plant downtime, and operation and maintenance is $40 million. (See Tables 6 and 8 in NUREG-1109).

6. The potential safety impact of changes in plant or operational complexity, including the relationship to proposed and existing regulatory requirements.

The proposed rule for plants to be able to cope with a station blackout should not add to plant or operational complexity. The relationship between the proposed station blackout rule and proposed and existing regulatory requirements is discussed in Section 4.2 of NUREG-1109. This discussion includes the following NRC generic programs:

- Generic Issue B-56 "Proposed Actions for Enhancing Reliability of Diesel Generators at Operating Plants,"
- Generic Issue 23, "Reactor Coolant Pump Seal Failures."
- USI A-45, "Shutdown Decay Heat Removal Requirements."
- Generic Issue A-30, "Adequacy of Safety-Related DC Power Supply."

7. The estimated resource burden on the NRC associated with the proposed backfit and the availability of such resources.

For 67 operating reactors, the estimated total cost for NRC review of industry submittals required by the proposed rule is $500,000 (based on an estimated average of 120 person-hours per reactor; see Table 8 in NUREG-1109).

8. The potential impact of differences in facility type, design or age on the relevancy and practicality of the proposed backfit.

The proposed rule applies to all PWRs and BWRs. However, in determining the specific minimum station blackout coping capability for each plant, differences in plant design (e.g., number of emergency diesel generators) and the reliability of the offsite and onsite emergency AC power systems could result in different coping capabilities. For example, plants with an already low risk from station blackout would be required to withstand a station blackout for a relatively short period of time; and few, if any, hardware backfits would be required as a result of the proposed rule. Plants with currently higher risk from station blackout would be required to withstand somewhat longer duration blackouts; and, depending on their existing capability, may need some modifications to achieve the longer station blackout capability.

9. Whether the proposed backfit is interim or final and, if interim, the justification for imposing the proposed backfit on an interim basis.

The proposed rule is a final resolution of USI A-44; it is not an interim measure.