UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

July 16, 1998

The Honorable Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Chairman Jackson:

SUBJECT: PROPOSED REVISIONS TO 10 CFR 50.59 (CHANGES, TESTS AND EXPERIMENTS)

During the 453rd and 454th meetings of the Advisory Committee on Reactor Safeguards, June 3-5 and July 8-10, 1998, we met with representatives of the NRC staff and the Nuclear Energy Institute (NEI) to discuss proposed revisions to 10 CFR 50.59 (Changes, Tests and Experiments). We also discussed the Executive Director for Operation's (EDO's) response to the Commission's directions in the Staff Requirements Memorandum (SRM) dated March 24, 1998, regarding SECY-97-205. Our Subcommittee on Plant Operations met on June 19, 1998, to discuss these matters. We also had the benefit of the documents referenced. We previously provided reports to the Commission on April 8, October 9, and December 12, 1997, on the proposed revisions to 10 CFR 50.59 and related matters.

During our meeting with the staff on July 8, 1998, it became apparent that the staff had developed revised documents for consideration by the Commission. These documents were provided to us subsequent to our discussions with the staff. We have not had an opportunity to review these documents in detail. In our preliminary review, however, we found substantial changes had been made to these documents.

Conclusions and Recommendations

1. We disagree with the staff's evaluation of the proposed rulemaking language in response to the SRM dated March 24, 1998. Therefore, we recommend that the revised rulemaking package not be issued for public comment at this time.

2. We believe that the revised guidance is overly prescriptive in defining reduction in margin of safety. The revised rulemaking language will likely add significant regulatory burden without a clear safety benefit.

3. The staff's proposed use of ANSI/ANS-58.8-1994, "Time Response Design Criteria for Safety-Related Operator Actions," for determining when there is only a minimal increase in the probability of malfunction is inappropriate.

4. The staff should expedite completion of a regulatory guide for implementing 10 CFR 50.59, including endorsement of NE. . ´ -07 with exceptions and clarifications as appropriate.

Discussion

We disagree with the staff's evaluation of the rulemaking language provided in the EDO's response to the SRM dated March 24, 1998. We believe that the staff should complete the actions specified by the Commission in the SRM.

The staff's approach to reductions in margin of safety is overly prescriptive. We believe that the language proposed by the staff creates a *de facto* constraint of "zero increase" in probability or consequences. In addition, the lack of a working definition of "minimal" increase in risk may exacerbate the problem of excessive resources being required to perform evaluations for changes that are risk insignificant.

In our November 14, 1995 report, we informed the EDO that we found no technical basis for the estimates of minimum times for operator actions specified in ANSI/ANS-58.8-1994. We did not support the staff's proposed endorsement of ANSI/ANS-58.8-1994 in the proposed final Regulatory Guide 1.164 and stated that we did not believe that this endorsement was the appropriate way to resolve Generic Safety Issue B-17, "Criteria for Safety-Related Operator Actions." Subsequent to the meeting, the staff informed us that it was unaware of our position and agreed to delete ANSI/ANS-58.8-1994 from the revised rulemaking package.

The staff has made some progress in reconciling its differences with NEI 96-07. However, more than a year has passed and the staff has not codified its positions through development of a regulatory guide. We believe that development of a regulatory guide and endorsement of appropriate industry guidance are essential to stabilize the 10 CFR 50.59 process. Therefore, we believe that a regulatory guide should accompany the proposed rulemaking and associated documents in soliciting public comment.

In our October 9, 1997 report, we encouraged the continued development of a plan for a 10 CFR 50.59 process that is consistent with risk-informed, performance-based regulation. In our December 12, 1997 report, we stated that the development of a risk-informed rule should be continued on an expeditious schedule. We continue to believe that 10 CFR 50.59 can accommodate risk-informed decisionmaking.

We believe that a deterministic regulatory framework poses substantial barriers to the development of the concept of minimal changes in accident probabilities or consequences. It is more likely that the minimal change concept can be defined satisfactorily within the framework of frequency-consequence (F-C) curves. A frequency-consequence framework can also accommodate the evaluation of new accident sequences. Dr. Apostolakis has offered a proposal (attached) for the development of a risk-informed framework for 10 CFR 50.59. We are examining how such a

framework might be incorporated in developing an improved 10 CFR 50.59 process. We plan to address this in a future report to the Commission.

Sincerely,

R. L. Seale

R. L. Seale
Chairman

References:

1. Draft Commission paper from L. Joseph Callan, Executive Director for Operations, NRC, to the Commissioners, Subject: Proposed Rulemaking on 10 CFR Parts 50, 52 and 72 Requirements Concerning Changes, Tests and Experiments and Staff Recommendations on Changes to Other Regulations and Enforcement Policy, and attachments, received July 8, 1998.
2. Memorandum dated May 21, 1998, from David B. Matthews, Office of Nuclear Reactor Regulation, NRC, to John T. Larkins, Executive Director, ACRS, Subject: Proposed Rulemaking on 10 CFR 50.59.
3. Memorandum dated May 27, 1998, from L. Joseph Callan, Executive Director for Operations, NRC, to the Commissioners, Subject: Evaluation of Rulemaking Language Proposals Concerning 10 CFR 50.59 (Changes, Tests and Experiments).
4. Memorandum dated March 24, 1998, from John C. Hoyle, Secretary of the Commission, to L. Joseph Callan, Executive Director for Operations, NRC, Subject: Staff Requirements SECY-97-205, Integration and Evaluation of Results from Recent Lessons-Learned Reviews.
5. Letter dated May 12, 1998, from Samuel J. Collins, Office of Nuclear Reactor Regulation, NRC, to Ralph E. Beedle, Nuclear Energy Institute, Subject: 10 CFR 50.59 Safety Evaluations and 10 CFR 50.71(e) Final Safety Analysis Report Updates.
6. Letter dated April 16, 1998, from Ralph E. Beedle, Nuclear Energy Institute, to Shirley Ann Jackson, Chairman, NRC, Subject: 10 CFR 50.59 Safety Evaluations and 10 CFR 50.71(e) FSAR Updates.
7. Letter dated January 9, 1998, from Samuel J. Collins, Office of Nuclear Reactor Regulation, NRC, to Ralph E. Beedle, Nuclear Energy Institute, Subject: NEI 96-07 Guidelines for 10 CFR 50.59 Safety Evaluations.
8. Report dated December 12, 1997, from R. L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: Proposed Revisions to 10 CFR 50.59 (Changes, Tests and Experiments).
9. Report dated October 9, 1997, from R. L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: Proposed Changes to 10 CFR 50.59 and Proposed Revision 1 to Generic Letter 91-18.
10. Report dated April 8, 1997, from R. L. Seale, Chairman, ACRS, to Shirley Ann Jackson, Chairman, NRC, Subject: Proposed Regulatory Guidance Related to Implementation of 10 CFR 50.59 (Changes, Tests and Experiments).
11. Report dated November 14, 1995, from T. S. Kress, Chairman, ACRS, to James M. Taylor, Executive Director for Operations, NRC, Subject: Proposed Final Regulatory Guide

1.164, "Time Response Design Criteria for Safety-Related Operator Actions," to Resolve Generic Safety Issue B-17.

12. U.S. Nuclear Regulatory Commission, NUREG-0933, Supplement, March 16, 1987, "A Prioritization of Generic Safety Issues," Item B-17, "Criteria for Safety-Related Operator Actions," Revision 2.

Attachment: A Proposal for the Development of a Risk-Informed Framework for 10 CFR 50.59 and Related Matters Prepared by ACRS Member Dr. George Apostolakis

ATTACHMENT

A PROPOSAL FOR THE DEVELOPMENT OF A RISK-INFORMED FRAMEWORK FOR 10 CFR 50.59 AND RELATED MATTERS

Prepared by ACRS Member Dr. George Apostolakis

Preamble

While I agree with my colleagues on what needs to be done in the near term, I believe that the issues that the revision of 10 CFR 50.59 has raised stem from some fundamental problems that cannot be eliminated by revising this particular regulation in isolation. A bolder approach is required.

10 CFR 50.59 is intended to limit to below a "minimal" level the impact of unreviewed changes in the plant on the probability or consequences of accidents. The point of reference is clearly the status of the plant before the change, as it has been approved by the staff. This approval is based on traditional "deterministic" calculations, as documented in the plant's Final Safety Analysis Report (FSAR). The staff's interpretation is that the changes ought to be minimal compared to the existing situation and not with respect to regulatory criteria such as a 25 rem exposure to the whole body and a 300 rem exposure to the thyroid. The Nuclear Energy Institute disagrees and argues that the point of reference ought to be the regulatory criteria. In other words, changes that are within the operating margin should not be subjected to staff review.

I understand that, in the majority of cases, 10 CFR 50.59 works very well and there is no controversy. There are several changes per plant per year, however, in which there are questions as to whether the changes are minimal and, consequently, whether staff review is required.

Direction from the Commission

In the Staff Requirements Memorandum dated March 24, 1998, the Commission directed the staff "to incorporate knowledge gained from risk insights, as appropriate" and to "consider the work it has done in updating the Standard Review Plan (NUREG-0800) and, in a different context (severe accidents), on draft Regulatory Guide 1.174 and Standard Review Plan Chapter 19 in formulating what constitutes a 'minimal' change."

The Commission also directed the staff to "evaluate for Commission consideration the advisability of allowing proposed changes that result in the creation of an accident or malfunction of a different type than previously evaluated that has 'minimal' safety impact."

The Problem

A major difficulty is defining the concept of a "minimal" increase in the probability of an "accident" and of a "minimal" change in the probability of equipment malfunction (which is treated separately from the probability of an "accident").

In the memorandum dated May 27, 1998, to the Commission, the EDO stated that any plant change that created the possibility of a new accident that had not been previously evaluated should be reviewed. The EDO also expressed the opinion that "it would be extremely difficult to develop a meaningful definition of minimal safety impact."

What are the Root Causes of the Problem?

Concepts such as a "minimal" change in probability or consequences and "minimal" safety impact are meaningful only in the context within which the evaluation is made. Something that is minimal in one context may be significant in a different context. The deterministic regulatory context is incomplete for such evaluations.

What is the Proper Context?

The proper context for evaluating changes in the spirit of 10 CFR 50.59 should include the information contained in the frequency-consequence curves (F-C curves), as well as the sets of accident sequences that probabilistic risk assessments (PRAs) produce.

Figure 1 is an example of such F-C curves developed in the NUREG-1150 studies. The independent variable is the release fraction of the core inventory of iodine. The ordinate gives the frequency of the release exceeding a given value, R*. As an example, we see in Figure 1 that the frequency of sequences leading to a release fraction greater than 10^{-3} is, for Surry, about 7×10^{-6} per reactor-year. I note that these curves deal with accidents that involve the core only.

These curves are an important element of the context within which we can evaluate what is minimal. Let us assume that a proposed change affects an accident sequence whose consequence is a release fraction greater than 10^{-3} and whose mean frequency is on the order of 10^{-8} per reactor-year. It is evident that changes that even double the frequency of this accident sequence could be considered minimal. If, on the other hand, the frequency of that accident sequence were on the order of 10^{-6} per reactor-year, such a change would not be minimal (in the sense that it would have to be reviewed).

If we consider release fractions greater than 10^{-4}, then the average frequency of the accident sequences leading into that interval is about 2×10^{-5} per reactor-year (for Surry), i.e., about a factor of three greater than the frequency of the interval $R \geq 10^{-3}$. Obviously, a "minimal" change in frequency would have a different numerical value for accidents in this new interval.

I note that these determinations are made with regard to the whole sequence and not separately for "accidents" and "equipment malfunctions," as the current 10 CFR 50.59 requires. The latter is unnecessarily intrusive.

The same reasoning can be applied to "new" accident sequences. What would determine whether they had "minimal" impact would be their frequency of occurrence and their consequences. Thus, if the consequences placed the new sequence in the release internal $R \geq 10^{-3}$, then "minimal" would be defined with respect to the reference value of 7×10^{-6} per reactor-year, as just described. If, on the other hand, the consequences were in the interval $R \geq 10^{-4}$, then the reference value for the frequency would be 2×10^{-5} per reactor-year.

I hasten to add that the preceding paragraphs are not intended to imply that final decisions would have to be made solely on the basis of the F-C curves. The process of "integrated decisionmaking" that is described in Regulatory Guide 1.174 would also apply here (with appropriate modifications). In the same spirit as that of Regulatory Guide 1.174, I am proposing to expand and modify the decisionmaking process of 10 CFR 50.59 to include risk information. Doing so would definitely be responsive to the Commission's direction that the work done on Regulatory Guide 1.174 be considered in revising 10 CFR 50.59.

This simple approach would obviate unnecessary debates regarding the operating and safety margins of the facility and how they ought to be handled.

Are Quantitative Assessments Always Required?

No. I believe that most cases could be handled qualitatively within this context. In other words, the accident sequences and their frequencies would add significantly to the basis for assessing qualitatively whether a change is minimal. I anticipate that a quantitative assessment will be required in very few cases.

Is the Necessary Information Available?

The F-C curves for severe accidents are either available or can be obtained from existing PRAs or Individual Plant Examinations (IPEs). These would have to be supplemented by the results for accidents that the regulations call Classes 1 through 8. This should not be a major problem, however. A first attempt to develop such curves for Class 3-8 accidents was made about 20 years ago in NUREG/CR-0603 (Reference 1). It should be a straightforward process to produce similar results with modern PRA tools and using our current state of knowledge.

The incompleteness of the PRAs/IPEs would be handled in a manner similar to that described in Regulatory Guide 1.174.

Can the Regulatory Guide 1.174 Process be Extended to the Regulation of Lower-Class Accidents?

Yes. What I discussed above dealt with changes that would not require staff review. The intent of Regulatory Guide 1.174 was, of course, to define changes that, after review, would be acceptable. The same idea can be applied to the whole spectrum of accidents.

Severe accidents are the contributors to releases of about 10% or greater of the iodine inventory (Figure 1). Regulatory Guide 1.174 provides acceptable ranges for changes in the frequency of a subset of these releases, namely releases that are "early," that is, those that are caused by accidents in which the containment is either bypassed or fails before vessel breach (these control the prompt fatalities). Figure 2 shows the guidelines adopted in Regulatory Guide 1.174 for large, early release frequency (LERF).

To apply the Regulatory Guide 1.174 approach to releases other than those caused by severe accidents, we must define goals for the frequency of smaller releases similar to the goal of 10^{-5} per reactor-year for large, early releases (Figure 2).

A way of defining goals for the frequency of lower releases is by defining appropriate Farmer curves. An example is given in Figure 3. The issue is what should the position of this curve be to ensure consistency with the Commission's stated Quantitative Health Objectives and subsidiary objectives (the region of severe accidents is indicated in this figure). The slope of the straight line has been the subject of debate ever since Farmer proposed his criterion more than 30 years ago (Reference 2). A slope of -1 reflects a "risk-neutral" attitude, which means that, if the consequences increase by an order of magnitude, the corresponding frequency decreases by an order of magnitude also. The Dutch nuclear regulatory body has adopted Farmer curves for prompt fatalities with a slope of -2, thus exhibiting a strong risk-aversive attitude.

Can the Regulatory Guide 1.174 Process Benefit from the 10 CFR 50.59 Process?

Yes. Regulatory Guide 1.174 requires that all increases in frequency must be reviewed by the staff, that is, Figure 2 does not have a region in which the change in frequency is so small that subjecting it to staff review would be a waste of everyone's resources.

The following interesting comment accompanies this figure in Regulatory Guide 1.174:

"The analysis will be subject to increased technical review and management attention as indicated by the darkness of the shading of the figure."

Clearly, this "attention" is significant when either the goal is exceeded or when the change in frequency approaches the limit of 10^{-6} per reactor-year. An example of a region in which no review would be required is shown in Figure 4.

What Should be Done?

The staff should evaluate the feasibility of employing frequency-consequence curves for the whole spectrum of accidents (Classes 1 through 9). In particular, this evaluation should include: 1. the definition of appropriate metrics for the consequences (I used iodine releases as an example only). 2. the definition of appropriate Farmer curves. 3. the definition of appropriate guidelines as to what constitutes a "minimal impact" on the frequency-consequence curves that would be applied for the whole spectrum of accidents and for all plants.

This effort should be coordinated with the current staff activities on possible revisions to the Safety Goal Policy Statement. For example, in its report to the Commission on "Elevation of CDF to a Fundamental Safety Goal and Possible Revision of the Commission's Safety Goal Policy Statement" dated May 11, 1998, the ACRS recommended that the staff evaluate the possibility of using three regions for some of the objectives. If the Policy Statement is revised to include three regions for LERF, then two Farmer curves should be defined for releases from Class 1 through 9 accidents, so that three regions would also be defined on the F-C plane.

What are the Benefits?

I realize that what I am proposing would be a significant change in the regulations. I do believe, however, that the benefits warrant this bold step. Specifically,

1. The processes of 10 CFR 50.59 and Regulatory Guide 1.174 would be consistent.

2. Debates about "who owns" the operating margins would be unnecessary.

3. A significant first step would be taken toward making Part 50 risk-informed.

4. A significant first step would be taken toward establishing the basis for the determination of rational performance criteria.

5. The regulatory system would be more rational and much less intrusive than the current one.

References

1. U.S. Nuclear Regulatory Commission, NUREG/CR-0603, "A Risk Assessment of a Pressurized Water Reactor for Class 3-8 Accidents," A. Buslik et al., October 1979.

2. F. R. Farmer, "Siting Criteria - A New Approach," presented at the Conference on Containment and Siting of Nuclear Power Plants, International Atomic Energy Agency, Vienna, 1967 (reproduced in *Nuclear Safety,* vol. 8, pp. 539-548).

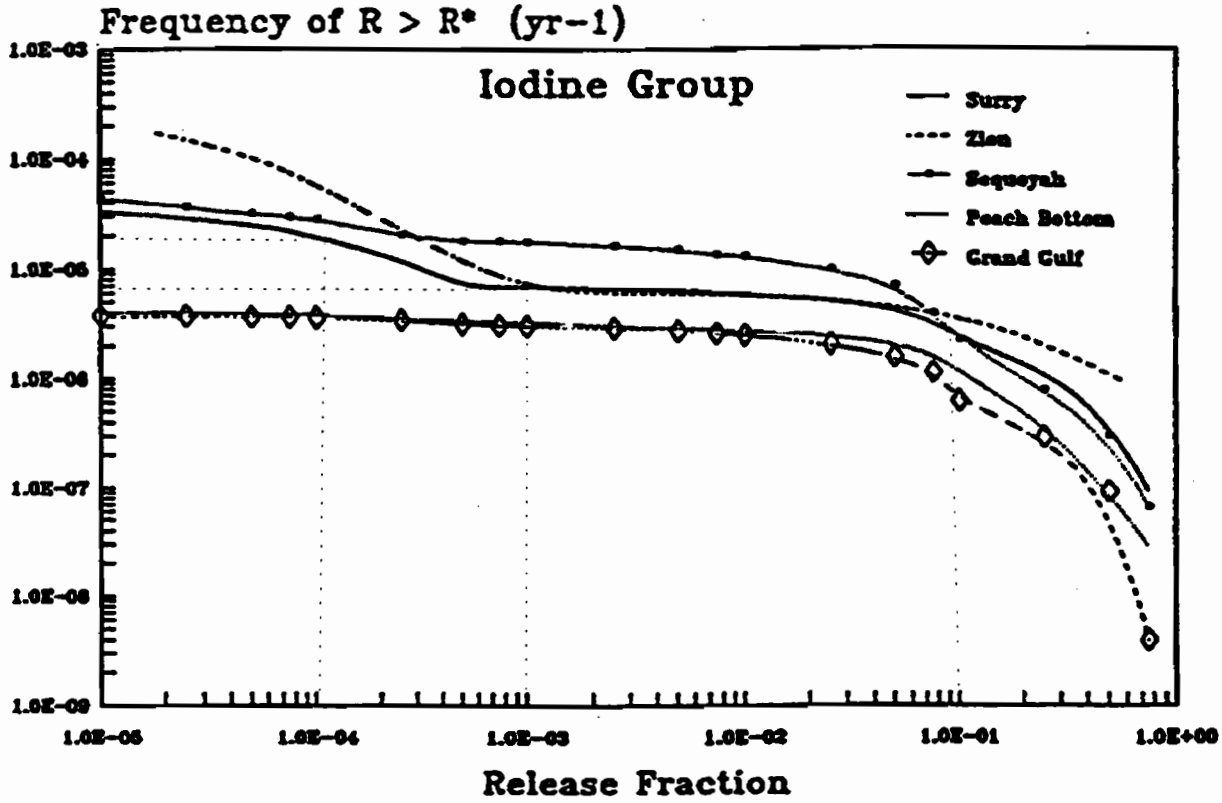

Figure 1. Example of F-C curves for iodine release (Fig. 2.7 of NUREG-1150, vol. 1)

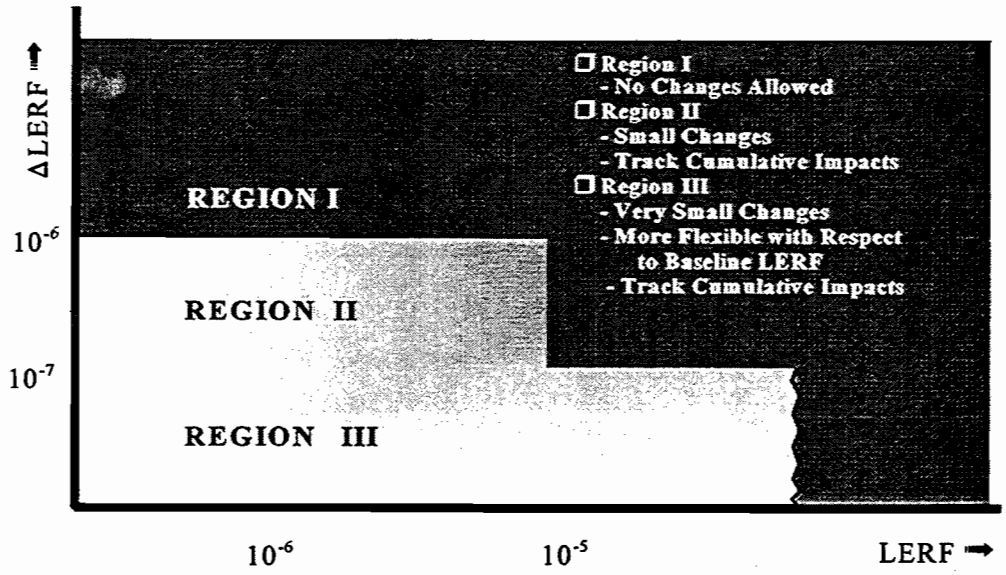

Figure 2. Acceptance Guidelines for Large Early Release Frequency (LERF), as given in RG 1.174.

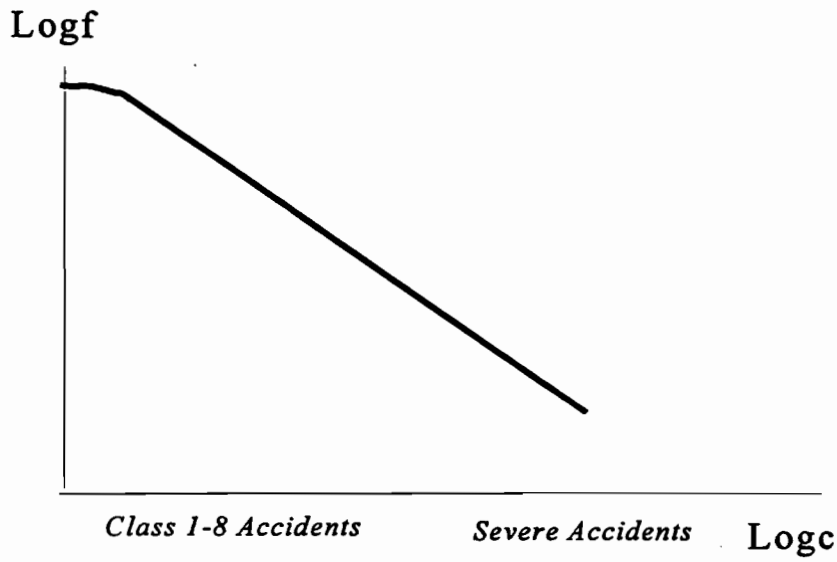

Fig. 3. Example of a Farmer Curve.

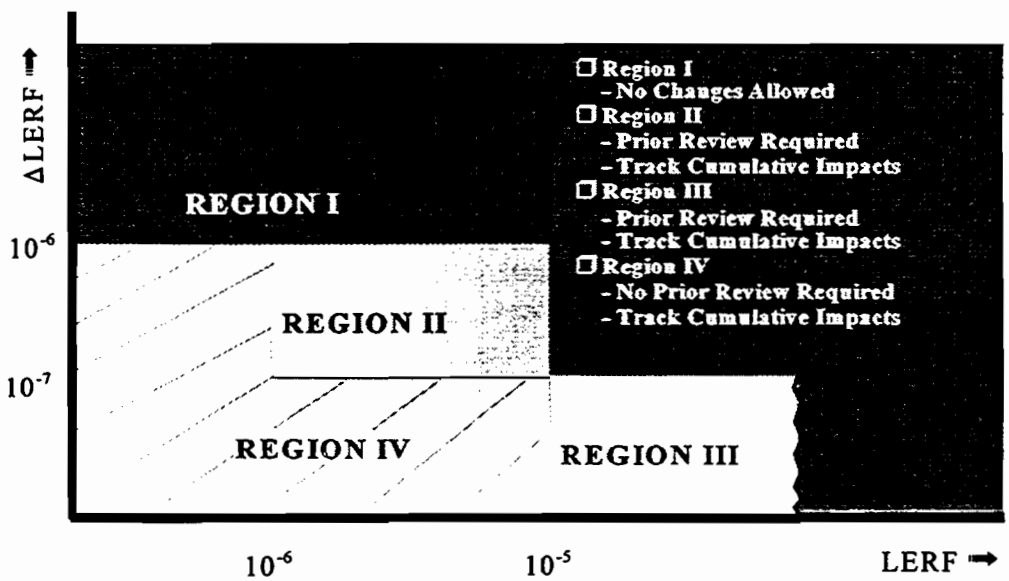

Figure 4. Acceptance guidelines for LERF including a region (IV) in which no prior review is required.