NOV 27 1991

NOTE TO: Frank J. Congel, Director
Division of Radiation Protection
and Emergency Preparedness, NRR

FROM: James E. Richardson, Director
Division of Engineering Technology, NRR

SUBJECT: REVIEW OF PROPOSED REVISION OF 10 CFR PART 100, INCLUDING NEW APPENDIX B, AND PROPOSED REVISIONS TO 10 CFR PART 50, INCLUDING APPENDIX S - GEOSCIENCE AND ENGINEERING COMMENTS

In response to your note of October 21, 1991, we are providing geoscience and engineering comments on the proposed revisions to 10 CFR Parts 100 and 50. Enclosed is a markup of the proposed revision of 10 CFR Parts 100 and 50 and associated documents.

On the basis of an October 2 and 3, 1991 meeting with their consultants, the RES staff is considering a revision to the procedure for calculating ground motion. Examples of this new procedure are currently being developed by LLNL, and the text of Appendix B to 10 CFR 100, the Draft Regulatory Guide on Seismic Sources and the proposed revision to Standard Review Plan 2.5.2 should be revised to reflect a new procedure. The markup contains suggested text for Appendix B to reflect the new procedure. Because this new procedure was not used in past licensing reviews, it is not correct to state that the proposed rule codifies existing staff practice (i.e., Regulatory Analysis, page RA-12). Also, note that in this package the OBE is no longer defined in the siting creteria as a fraction of the SSE; the OBE is now only associated with the functionality of structures, equipment, and components required for safe and continued operation. At this time we project that RES should be able to meet the schedule.

These comments were prepared by Goutam Bagchi, Chief, David Terao of the Advanced Reactor Engineering Section and Robert Rothman, Section Chief, Phyllis Sobel, Geophysicist, and Gustaaf Giese-Koch, Geophysicist of the Geosciences Section of the Structural and Geosciences Branch.

Original Signed By:
James E. Richardson

James E. Richardson, Director
Division of Engineering Technology
Office of Nuclear Reactor Regulation

Enclosure:
As stated

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Gladys Bailey — P1-37

Unfortunately the original enclosure was thrown out.

~~Typed~~ I gave you the best copy I could.

Phyllis Sobel

Enclosure

Enclosures:
1. Commission Paper
2. Federal Register Notice of Rulemaking
3. Regulatory Analysis
4. Environmental Assessment
5. Proposed Revision to 10 CFR Part 50
6. Proposed Revision to 10 CFR Part 100
7. Proposed Revised Regulatory Guide 4.7, (General Site Suitability Criteria)
8. Listing - Appendix A Revision Documents
9. Proposed Revision to 10 CFR Part 100, Appendix B
10. Proposed Revision to 10 CFR Part 50, Appendix S
11. Summary of Draft Regulatory Guide DG-1015, (Seismic Sources)
12. Proposed Draft Regulatory Guide DG-1015, (Seismic Sources)
13. Proposed Revision 3 to Standard Review Plan Section 2.5.2 (Vibratory Ground Motion)
14. Proposed Draft Regulatory Guide DG-1016, Second Proposed Revision 2 to Regulatory Guide 1.12, (Seismic Instrumentation)
15. Proposed Draft Regulatory Guide DG-1017, (Plant Shutdown)
16. Proposed Draft Regulatory Guide DG-1018, (Plant Restart)
17. EPRI Report NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake"

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DRAFT of October 10, 1991

For: The Commissioners

From: James M. Taylor
Executive Director for Operations

Subject: REVISION OF 10 CFR PART 100, REACTOR SITE CRITERIA; REVISIONS TO 10 CFR PART 50; AND NEW APPENDIX B TO 10 CFR PART 100 AND APPENDIX S TO 10 CFR PART 50

Purpose: To obtain Commission approval to publish for public comment proposed revisions to reactor siting regulations and associated Regulatory Guides for future applicants that will decouple siting from plant design and reflect advancements in the state-of-the-art of earth sciences and earthquake engineering with regard to reactor siting.

Summary: This proposed rule change to 10 CFR Part 100, "Reactor Site Criteria," is intended to accomplish three major changes. The first change would be to add a new section to Part 100 for future plants eliminating the use of a postulated accident source term and the use of dose calculations in the determination of acceptability of a nuclear power plant site. The existing requirements would be retained for existing plants. This proposed rule change would set a minimum size for the exclusion area and would set population density criteria around reactor sites. Requirements regarding the evaluation of man-related hazards and the feasibility of carrying out protective actions in the event of a radiological emergency are incorporated into 10 CFR Part 100. Requirements are also proposed for periodic reporting of population changes and significant changes in offsite activities after site approval.

The second change is to revise Appendix A, "Seismic and Geologic Siting criteria for Nuclear Power Plants," to 10 CFR Part 100 to ~~update~~ reflect current understanding and ~~to reflect~~ the

Contact: Leonard Soffer, RES
492-3916

Dr. Andrew Murphy, RES
492-3860

advancements in the state-of-the-art of earth sciences and earthquake engineering with regard to reactor siting. The revised criteria will not be applied to existing plants. Therefore the proposed revised criteria will be designated Appendix B so that the licensing bases for existing plants is maintained.

The third part of this rulemaking is revisions to Part 50. One portion of the Part 50 revision is to add, on an interim basis, the source term and dose calculations being deleted from Part 100. The source term and dose calculations to be added to Part 50 would be for evaluating plant features, not site suitability. A second portion is to transfer all criteria from Part 100 Appendix A not associated with the selection of the site or establishment of the safe shutdown earthquake.

Background: A. Reactor Siting Criteria (non-seismic):

The present criteria regarding reactor siting were issued in May 1962. There were only a few small power reactors operating at that time. The present regulation requires that every reactor have an exclusion area which has no permanent residents; transient use is permitted. A low population zone immediately beyond the exclusion area is also required. The regulation recognizes the importance of accident considerations in reactor siting; hence a key element in it is the determination of the size of the exclusion area via the postulation of a large accidental fission product release within containment and the evaluation of the radiological consequences, in terms of doses. Doses are calculated for two hypothetical individuals located at any point (generally, the closest point) on the exclusion area boundary, and at the outer radius of the low population zone, and are required to be within specified limits (25 rem to the whole body and 300 rem to the thyroid gland). In addition, the nearest population center, containing about 25,000 or more residents, is required to be no closer than one and one-third times the outer radius of the low population zone. The effect of these requirements is to set both individual and, to some extent, societal limits on dose (and implicitly on risk); without setting numerical criteria on exclusion area and low population zone size. Numerical limits on population are also not specified.

In SECY-90-341, dated October 4, 1990, and a subsequent memorandum from J. Taylor to the Commissioners, dated December 13, 1990, the staff proposed to decouple siting from plant design for future plants via a two step rulemaking. Step one is to modify Part 100 to address directly the site criteria while moving the dose requirements currently in Part 100 to Part 50 on an interim basis. Step two is to update Part 50 to reflect current source term information and to replace the interim dose requirements with updated design criteria. The Commission, in Staff Requirements Memorandum (SRM) dated January 25, 1991, approved the staff recommendation. This paper presents ~~the~~ step one of the proposed rule change.

B. Seismic Siting and Earthquake Engineering Criteria:

Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100, "Reactor Siting Criteria," was originally issued as a proposed rule on November 25, 1971 (36 FR 22601), published as a final rule on November 13, 1973 (38 FR 31279), and became effective on December 13, 1973. There have been two amendments to 10 CFR Part 100, Appendix A. The first amendment, issued November 27, 1973 (38 FR 32575), corrected the final rule by adding the legend under the diagram. The second amendment resulted from a petition for rule making (PRM 100-1) requesting that an opinion interpreting and clarifying Appendix A with respect to the determination of the Safe Shutdown Earthquake be issued. A notice of filing of the petition was published on May 14, 1975 (40 FR 20983). The substance of the petitioner's proposal was accepted and published as an immediately effective final rule on January 10, 1977 (42 FR 2052).

The proposed regulatory action reflects changes intended to (1) benefit from the experience gained in applying the existing regulation; (2) ~~resolve~~ avoid interpretative questions; (3) provide needed regulatory flexibility to incorporate state-of-the-art improvements in the geosciences and earthquake engineering; (4) simplify the language to a more "plain English" text; and (5) acknowledge various internal staff and industry comments.

Discussion: The proposed rule changes included with this paper primarily involves two related but basically separate changes. The first change involves eliminating the requirement to calculate radiation doses as a means of establishing minimum distances and low population zones. In its place, a fixed minimum exclusion distance and specific population density guidelines are recommended. As part of this change, criteria regarding evaluation of man-made hazards and the feasibility of carrying out protective actions in the event of a radiological emergency are incorporated in 10 CFR Part 100. Requirements are also proposed for periodic reporting of population changes and significant changes in offsite activities after site approval. The second change involves updating the siting seismic and geologic criteria ~~earth sciences information~~ in Appendix A to Part 100 and relocating seismic plant design criteria to Appendix S of 10 CFR Part 50. ~~For the most part~~, these changes ~~codify existing staff practice and~~ are addressed separately in the discussion that follows.

NOTE: These changes do not entirely codify staff practice (i.e. there [illegible] concept of controlling [illegible] from [illegible])

A. Reactor Siting Criteria (non-seismic):

The proposed revision to Part 100 retains, for existing plants and test reactors, the current criteria, including the dose requirements. The current criteria are designated subpart A and apply to plants currently licensed or applying for a license prior to the effective data of the proposed rule and for test reactors. A new subpart B is added to Part 100. Subpart B contains the proposed new requirements for applicants after the effective date of the proposed rule.

These proposed changes are based on current staff practice and for the most part are derived from the guidelines in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." In developing the proposed changes, the staff considered the Commission's Safety Goal Policy Statement along with the recommendation of the Siting Policy Task Force (NUREG-0625) of 1979. The proposed rule would require a minimum exclusion area distance of 0.4 miles for stationary power reactors. The proposed rule states that at the time of initial site approval, population density values averaged over any radial distance out to 30 miles should not exceed 500 people per square mile. In addition, the

projected population density 40 years after the time of site approval should not exceed 1000 people per square mile out to 30 miles. radial distance of

The proposed rule adds or modifies existing requirements for obtaining information to characterize meteorological and hydrological factors at a site. This information will then be reviewed by the staff and used as interface criteria in matching a proposed design to the site. The proposed rule would also require the applicant to evaluate potential man-made hazards around the site and would require that those which should be included in the plant's design basis be identified. This information will also be used as interface criteria in matching a proposed design to the site.

The proposed rule reflects the requirement currently in 10 CFR Part 52.17 for review of emergency evacuation considerations for early site permits. The rule would require that important site factors, such as population distribution, topography, and transportation routes be considered and examined in order to determine whether there are any site characteristics that could pose a significant impediment to the development of an emergency plan. Limitations of access or egress in the immediate vicinity of a nuclear power plant should be identified at the site approval phase.

The proposed rule would require that holders of early site permits prepare and present to the Commission periodic reports regarding population changes as well as significant changes in any man-related activities (such as changes in industrial, military and transportation facilities) that might represent a potential hazard to a nuclear plant. This would help to ensure that the site approval remains acceptable.

A proposed revision to Regulatory Guide 4.7, for consistency with the proposed rule change, is also included in the package.

B. Seismic Siting and Earthquake Engineering Criteria:

The staff proposes to amend its regulations to update the ~~criteria in regard to~~ seismic siting and engineering criteria for nuclear power plants. The

proposed rule would allow NRC to benefit from experience gained in the application of the procedures and methods set forth in the current regulation, the difficulties encountered, and ~~incorporate~~ the rapid advancement in the state-of-the-art of earth sciences. The proposed regulations would better reflect industry design practices and the associated staff review procedures that have evolved since the regulation was issued. The proposed regulatory action is applicable only to applicants that apply for a construction permit, early site permit, design certification, or combined license (construction permit and operating license) on or after the effective date of the regulations.

Criteria not associated with the selection of the site or establishment of the safe shutdown earthquake ground motion have been placed into Part 50. This action is consistent with the location of other design requirements in Part 50.

Because the revised criteria presented in the proposed regulation will not be applied to existing plants, the licensing bases for existing nuclear power plants must remain part of the regulations. Therefore, the proposed revised criteria on seismic and geologic siting would be designated as a new Appendix B to 10 CFR Part 100 and would be added to the existing body of regulations. In addition, earthquake engineering criteria will be located in 10 CFR Part 50, Appendix S. Since Appendix S is not self initiating, applicable sections of Part 50 (§50.8, §50.34 and §50.54) are revised to reference Appendix S. The proposed rule would also make conforming amendments to 10 CFR Parts 52 and 100. §52.17(a)(1)(vi), §100.8, and §100.20(c)(1) and (3) would be amended to note Appendix B to Part 100.

The staff has developed the following draft regulatory guides and standard review plan section to provide prospective licensees with the necessary guidance for implementing the proposed regulations:

DG-1015, "Identification and Characterization of Seismic Sources." The draft guide provides general guidance and recommendations, describes acceptable procedures and provides a list of references that present acceptable methodologies

to identify and characterize capable tectonic sources and seismogenic sources.

DG-1016, Second Proposed Revision 2 to Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes." The draft guide describes seismic instrumentation type and location, operability, characteristics, installation, actuation, and maintenance that are acceptable to the NRC staff.

DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions." The draft guide provides guidelines that are acceptable to the NRC staff for a timely evaluation of the recorded seismic instrumentation data and to determine whether or not plant shutdown is required.

DG-1018, "Restart of a Nuclear Power Plant Shut Down Due to a Seismic Event." The draft guide provides guidelines that are acceptable to the NRC staff for performing inspections and tests of nuclear power plant equipment and structures prior to restart of a plant that has been shut down due to a seismic event.

Draft Standard Review Plan Section 2.5.2, Proposed Revision 3 "Vibratory Ground Motion." The draft describes procedures to assess the ground motion potential of seismic sources at the site and to assess the adequacy of the Safe Shutdown Earthquake Ground Motion seismic design.

General

The draft guides and standard review plan section are being presented along with, and should be issued simultaneously with, the proposed revision to the regulations.

During the development of the proposed regulations the staff benefitted from two public meetings with interested industry groups. Principal attendees included staff from the Nuclear Management and Resources Council (NUMARC), Electric Power Research Institute (EPRI), Department of Energy (DOE) and industry. During the first meeting (March 6, 1991) the staff discussed schedule and technical topics for potential inclusion in the revision of Appendix A to Part 100. The second meeting (April 17, 1991) provided industry and

other interested members of the public with an opportunity to express their views on the Appendix A revision.

The enclosed Federal Register Notice contains information on the scope of this rulemaking and requests public input. The Federal Register Notice also addresses actions related to the development of several new and revision of several existing Regulatory Guides and Standard Review Plan Sections.

Coordination: The Office of the General Counsel has reviewed this paper and has no legal objections. [The ACRS was briefed on the staff's approach on ~~November~~ _, 1991.]

Recommendation: That the Commission:

1. Approve the issuance of the enclosed draft documents for a 90 day public comment period.

2. Certify that this rule, if promulgated, will not have a significant economic effect on a substantial number of small entities pursuant to the Regulatory Flexibility Act of 1980 (5 U.S.C. 605 (b)).

3. Note:

   a. The proposed rule (and notice of availability of draft regulatory guides and draft standard review plan section) would be published in the Federal Register for a 90-day public comment period (Enclosures 1, 4, 5, 6, 7, 8, 9, 10).

   b. A notice of availability of a Regulatory Analysis and an Environmental Assessment and Finding of No Significant Environmental Impact is being supplied concurrently to the Public Document Room (Enclosure 2).

   c. Because Appendix S to Part 50 and Appendix B to Part 100 are new, an "information collection requirement" is being submitted to OMB for review (Enclosure 3). It is noted that the estimated burden on the staff and industry remains the same; the proposed revisions to the

regulations reflect current staff practice.

d. Because the requirement for periodic assessment and report of population and man-made hazards in Part 100 is new, an "information collection requirement" is being submitted to OMB for review (also in Enclosure 3). It is noted that the estimated burden on the staff and industry should be small.

e. A public announcement (Enclosure 11) will be issued when the notice of proposed rulemaking and notice of availability of the draft regulatory guides and draft standard review plan section are filed with the Office of the Federal Register.

f. The appropriate Congressional committees will be informed (Enclosure 12).

g. Copies of the Federal Register notices will be distributed to all power reactor permittees and licensees. The notices will be sent to other interested parties upon request.

h. The Chief Counsel for Advocacy of the Small Business Administration will be notified of the Commission's determination, pursuant to the Regulatory Flexibility Act of 1980 (5 U.S.C. 605 (b)), that these proposed regulations, draft regulatory guides, and draft standard review plan section will not have a significant economic effect on a substantial number of small entities.

i. A Backfit Analysis is not required for this proposed rule, because these amendments do not involve any provisions which would impose backfits as defined in §50.109(a)(1).

James M. Taylor
Executive Director
for Operations

Enclosures:

DRAFT FEDERAL REGISTER NOTICE

PROPOSED REVISION OF

10 CFR PART 100

AND

APPENDIX A TO 10 CFR PART 100

COMMENTS ON OBE/SSE PACKAGE
D. TERAO

COMMENT 1:

Page FRN-10:

In the draft Federal Register Notice, Section V.B. Seismic and Earthquake Engineering Criteria (Item 4, Reduced analysis), an example is given of a situation where only the OBE is currently associated with a design requirement. The example states that for seismic anchor motion, a fraction of the SSE response will be used to carry out the design in conjunction with this change. Because we have not yet determined how seismic anchor motions will be evaluated without an OBE, we should not completely rule out the possibility that full SSE anchor motions will be used (not just a fraction). We also note that on pages RA-9 and 10 of the regulatory analysis, the exact paragraph appears in G. Reduced Analysis, without the seismic anchor motion example. We recommend that the sentence on page FRN-10 in the draft Federal Register - - "for situations where only ... conjunction with this change." - - be deleted.

COMMENT 2:

Page FRN-22:

In Section IV(a)(2), "Operating Basis Earthquake" the definition of the OBE still contains: the words "within applicable stress and deformation limits." If the intent of the OBE is to only ensure structures, systems, and components necessary for continued operation without undue risk to the health and safety of the public remain functional, then the additional clarification "that is, within applicable stress and deformation limits" might confuse the issue. One might interpret this phrase to mean that explicit stresses and deformations need to be calculated.

We recommend that the phrase "that is, within applicable stress and deformation limits" be changed to "that is, within stress and deformation limits that ensure sufficient dimensional stability so as not to impair the system's functional capability or the component's operability."

CHANGES TO APPENDIX B TO 10 CFR PART 100
DRAFT FEDERAL REGISTER NOTICE PAGES 26, 28, 29

INSERT A

EMEs are a characteristic of seismic sources in a probabilistic seismic hazard analysis. Alternative approaches are considered in estimating the magnitude of the EMEs and they are not necessarily associated with any given return period.

INSERT B

A deterministic hazard analysis shall be used to determine the controlling earthquakes and a probabilistic seismic hazard analysis shall be used to assess the controlling earthquakes. The controlling earthquakes are used to estimate ground motions at the site and are described in terms of magnitude and distance from the site.

For the deterministic analysis, the controlling earthquake shall be evaluated for each seismogenic and capable tectonic source identified in part IV (a). This may result in several controlling earthquakes being used to estimate ground motions in different frequency ranges. As a minimum the controlling earthquake shall be the largest historical earthquake in each seismic source. Probabilistic estimates of seismic hazard shall be calculated and the results deaggregated to determine significant sources. The significant sources derived from the probabilistic analysis shall be used to make sure the controlling earthquakes developed from the deterministic analysis are appropriate.

INSERT C

Assume the controlling earthquakes are situated at the point on the seismic source nearest to the site. For the case when the site is located within a seismogenic source, the controlling earthquake will be located within 25 km of the site. The uncertainty in the ground motion shall be accounted for by using the mean plus one standard deviation (84th percentile) of the ground motion estimates determined for the site.

[7590-01]

NUCLEAR REGULATORY COMMISSION

10 CFR Parts 50, 52 and 100

RIN 3150-AD93

Reactor Site Criteria
Including Seismic and Earthquake Engineering Criteria for
Nuclear Power Plants

AGENCY: Nuclear Regulatory Commission.

ACTION: Proposed rule.

SUMMARY: The Nuclear Regulatory Commission is proposing to amend its regulations to update the criteria used in decisions regarding reactor siting including geologic, seismic, and earthquake engineering considerations for nuclear power plants. The proposed regulations would allow NRC to benefit from experience gained in the application of the procedures and methods set forth in the current regulation, the difficulties encountered, and [illegible] the rapid advancement in the state-of-the-art of earth sciences and earthquake engineering. The proposed regulation primarily consists of two separate changes, namely the source term and dose considerations, and seismic and earthquake engineering considerations of reactor siting. The proposed regulatory action is applicable only to applicants that apply for a construction permit, early site permit, design certification, or combined license (combined construction permit and operating license) on or after the effective date of the regulations.

DATE: Comment period expires 90 days after date of publication in the Federal Register. Comments received after this date will be considered if it is practical to do so, but the Commission is able to assure consideration only for comments received on or before this date.

ADDRESSES: Mail written comments to: Secretary, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Attention: Docketing and Service Branch.

Deliver comments to: 11555 Rockville Pike, Rockville, Maryland, between 7:45 am and 4:15 pm Federal workdays.

Copies of the regulatory analysis, the environmental assessment and finding of no significant impact, and comments received may be examined at: the NRC Public Document Room at 2120 L Street NW. (Lower Level), Washington, DC.

FOR FURTHER INFORMATION CONTACT: Dr. Andrew J. Murphy, Office of Nuclear Regulatory Research, Mail Stop NLS-217A, U.S. Nuclear Regulatory Commission, Washington, DC 20555, Telephone (301) 492-3860 concerning the seismic and earthquake engineering aspects. Mr. Leonard Soffer, Office of Nuclear Regulatory Research, Mail Stop NLS-324, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone 301-492-3916 concerning other siting aspects.

SUPPLEMENTARY INFORMATION:

I. Background.

I. Background

The present regulation regarding reactor site criteria (10 CFR 100) was promulgated April 12, 1962 (27 FR 3509). Staff guidance on exclusion area and low population zone sizes as well as population density was issued in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations", published as a draft in September 1974. Revision 1 to this Guide was issued in November 1975. On June 1, 1976, the Public Interest Research Group (PIRG) filed a petition for rulemaking (PRM-100-2) requesting that the NRC incorporate minimum exclusion area and low population zone radii and population density limits into the regulations. In August 1978, the Commission directed the NRC staff to develop a general policy statement on nuclear power reactor siting. The "Report of the Siting Policy Task Force", (NUREG-0625) was issued in August 1979 and provided recommendations regarding siting of future nuclear power reactors. On July 29, 1980 (45 FR 50350), the NRC issued an Advance Notice of Proposed Rulemaking (ANPR) regarding revision of reactor site criteria which discussed the recommendations of the Siting Policy Task Force and sought public comments. The proposed rulemaking was deferred by the Commission in December 1981 to await development of a Safety Goal and improved research on accident source terms. On August 4, 1986 (51 FR 23044), the NRC issued its Policy Statement on Safety Goals which stated quantitative health objectives with regard to both early and latent cancer fatality risks. On November 29, 1988, the NRC issued (28 NRC 829) a denial of the PIRG petition (PRM-100-2) on the basis that it would unnecessarily restrict NRC's regulatory siting policies and would not result in a substantial increase in the overall protection of the public health and safety. Because of possible renewed interest in power reactor siting, the NRC is proceeding with a rulemaking in this area. This should be regarded as a partial granting of the petition which requested incorporation of exclusion area size and population density via rulemaking.

Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100, "Reactor Siting Criteria," was originally issued as a proposed rule on November 25, 1971 (36 FR 22601), published as a final rule on November 13, 1973 (38 FR 31279), and became effective on December 13, 1973. There have been two amendments to 10 CFR Part 100, Appendix A. The first amendment, issued November 27, 1973 (38 FR 32575), corrected the final rule by adding the legend under the diagram. The second amendment resulted from a petition for rule making (PRM 100-1) requesting that an opinion interpreting and

clarifying Appendix A with respect to the determination of the Safe Shutdown Earthquake be issued. A notice of filing of the petition was published on May 14, 1975 (40 FR 20983). The substance of the petitioner's proposal was accepted and published as an immediately effective final rule on January 10, 1977 (42 FR 2052).

II. Objectives

The objectives of this proposed regulatory action are to:

1. state directly criteria for future sites which, through experience and importance to risk, have been shown key to protecting public health and safety;

2. provide a stable regulatory basis for seismic and geologic siting and applicable earthquake engineering design of future nuclear power plants that will update and clarify regulatory requirements and provide a flexible structure to permit consideration of new technical understandings.

3. relocating from Part 100 to Part 50 those requirements which apply to plant design, effectively decoupling siting from plant design; and

III. Genesis

The proposed regulatory action reflects changes which are intended to (1) benefit from the experience gained in applying the existing regulation and from research; (2) resolve interpretative questions; (3) provide needed regulatory flexibility to incorporate state-of-the-art improvements in the geosciences and earthquake engineering; (4) simplify the language to a more "plain English" text; and (5) acknowledge various internal staff and industry comments.

The proposed regulatory action will apply to applicants who apply for a construction permit, early site permit, design certification, or combined license after the effective data of the final regulations.

Criteria not associated with the selection of the site or establishment of the safe shutdown earthquake ground motion have been placed into Part 50. This action is consistent with the location of other design requirements in Part 50.

Because the revised criteria presented in the proposed regulation will not be applied to existing plants, the licensing bases for existing nuclear power plants must remain part of the regulations. Therefore, the proposed revised reactor siting criteria would be designated Subpart B in 10 CFR Part 100 for site applications after the effective data of the final regulations and the criteria on seismic and geologic siting would be designated as a new Appendix B to 10 CFR Part 100. These new sections would be added to the existing body of regulations. The dose calculations and the earthquake engineering criteria will be located in 10 CFR Part 50 (§50.34(a) and Appendix S, respectively). Since Appendix S is not self initiating, applicable sections of Part 50 (§50.34 and §50.54) are revised to reference Appendix S. The proposed rule would also make conforming amendments to 10 CFR Parts 52 and 100. 52.17(a)(1)(vi) and 100.20(c)(1) and (3) would be amended to note Appendix B to Part 100.

IV. Alternatives

The first alternative considered by the Commission was to continue using current regulations for site suitability determinations. This is not considered an acceptable alternative. Although the siting related issues associated with the current generation of nuclear power plants are completed or nearing completion, there is good reason to initiate the proposed regulatory action in

light of the current and future staff review of future reactors (particularly certified designs) by decoupling siting from plant design such that the certified design would not be dependent on site parameters to establish the fission product retention characteristics of the design. Further, the current regulation has created difficulty for applicants and the staff in terms of inhibiting flexibility in applying updated information and using updated methods of analysis in the licensing process.

A second alternative considered was the deletion of the existing regulation (LPZ and dose calculations from Part 100 and Appendix A to Part 100). This is not considered an acceptable alternative because these provisions form part of the licensing bases for many of the operating nuclear power plants and others that are in various stages of obtaining their operating license.

For seismic and earthquake engineering, a third alternative considered was the replacement of the entire regulation with a regulatory guide. This is not considered acceptable because a regulatory guide is non-mandatory. The Commission believes that there could be an increase in the risk of radiation exposure to the public if the siting and earthquake engineering criteria were non-mandatory.

The approach of establishing the revised requirements in new sections of Part 100 and relocating plant design requirements to Part 50 while retaining the existing regulation was chosen as the best alternative. The public will benefit from a clearer, more uniform, and more consistent licensing process which incorporates updated information and is subject to fewer interpretations. The NRC staff will benefit from improved regulatory implementation (both technical and legal), fewer interpretive debates, and increased regulatory flexibility. Applicants will derive the same benefits in addition to avoiding licensing delays due to unclear regulatory requirements.

V. Major Changes

V.A Reactor Siting Criteria (non-seismic).

The site criteria contained in the proposed rule are based upon previous guidance issued in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations," and the risk insights and accident release characteristics of present light water reactors (LWR's), and particularly those plants analyzed in NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," dated December 1990. However, the proposed criteria decouple siting from plant design and, as such, are independent of the plant type to be built in the site. The Commission considers this a reasonable position since it is expected that future reactors licensed under Part 50 or under Part 52 of the Commission's regulations will reflect through their design, construction and operation an extremely low probability for accidents that could result in release of significant quantities of radioactive fission products. In addition, the recommendations of the Siting Policy Task Force were considered in making these changes as discussed in Section XII.

Rationale for Individual Criteria

A. Exclusion Area- An exclusion area surrounding the immediate vicinity of the plant has been a requirement from the very beginning for siting power reactors. This area has been found to provide a high degree of protection to the public from a variety of potential plant accidents and also affords protection to the plant from potential man-related hazards.

The present regulation has no numerical size requirement for the exclusion area, in terms of distance, and instead assesses the consequences of a postulated radioactive fission product release within containment, coupled with assumptions regarding containment leakage, performance of certain fission product mitigation systems and site meteorology for a hypothetical individual located at any point on the exclusion area boundary. The plant and site combination is considered to be acceptable if the calculated consequences do not exceed the values given in the present rule. Regulatory Guide 4.7 suggests an exclusion area distance of 0.4 miles, since this has been found, in conjunction with typical engineered safety features, to meet the dose values in the existing rule.

The Commission considers an exclusion area to be an essential feature of a reactor site, and is retaining this requirement for future reactors. However, in keeping with the recommendation of the Siting Policy Task Force to decouple site requirements from reactor design, the proposed rule would eliminate the use of a postulated source term, assumptions regarding mitigation systems and meteorology, and the calculation of radiological consequences to determine the sizes of the exclusion area and low population zone. It would instead require a minimum exclusion area distance of 0.4 miles for power reactors.

This distance, together with typical engineered safety features previously reviewed by the staff, has generally been found to satisfy the dose guidelines in the present rule. An exclusion area of this size or larger is fairly common for most power reactors in the U.S., and has not been unduly difficult for most prospective applicants to find and obtain.

Finally, this distance has also been found to readily satisfy the prompt fatality quantitative health objective of the Commission's Safety Goals Policy, when coupled with plant designs as reflected by those in NUREG—1150. Hence, the minimum exclusion area distance proposed would assure a very low level of risk to individuals, even for those located very close to the plant.

Although an exclusion area size of about 0.4 miles is considered appropriate for reactor power levels of current designs, the Commission is also considering whether or not this size unduly penalizes potential reactors having significantly lower power levels. Hence the Commission requests comments on whether the minimum size of the exclusion area should be fixed at 0.4 miles regardless of reactor power level, or whether it should vary according to reactor power level with a minimum value of about 0.25 miles.

B. Low Population Zone- The present rule requires that a low population zone (LPZ) be defined immediately beyond the exclusion area. Residents are permitted in this area, but the number and density must be such that there is a reasonable probability appropriate protective measures could be taken in their behalf in the event of a serious accident. In addition, the nearest densely populated center containing more than about 25,000 residents must be located no closer than one and one-third times the outer radius of the LPZ. Finally, the dose to a hypothetical individual located at the outer radius of the LPZ over the entire course of the accident must not be in excess of the dose values given in the rule. Regulatory Guide 4.7 suggests that an outer radius of about three miles for the LPZ has been found to satisfy the dose values in the present rule.

Several practical problems have arisen in connection with the low population zone. Before 1980 the LPZ generally defined the distance over which public protective actions were contemplated in the event of a serious accident. Part 50.47 now requires plume exposure Emergency Planning Zones (EPZ) of about ten miles for each plant.

The low population zone also places restrictions on the proximity of the nearest densely populated center of 25,000 or more residents. However, without numerical requirements for the outer radius of the low population zone, this

requirement has little practical effect. Typical low population zones for existing power reactors have several thousand residents. If Regulatory Guide 4.7 were followed and a distance of three miles were selected as the low population zone outer radius, a maximum population within the low population zone at the time of site approval would be about 14,000 residents. Finally, the staff has sometimes experienced difficulty in defining a "densely populated center."

The Commission considers that the functions intended for the "low population zone", namely, a low density of residents and the feasibility of taking protective actions, have in fact been taken over by other regulations or can be accomplished by other means. Protective action requirements are defined via the use of the EPZ's, while restrictions on population close to the plant can be assured via proposed population density criteria. For these reasons, the Commission is proposing to eliminate the requirement of a low population zone for future power reactor sites for purposes of determining site suitability.

C. Population Density Criteria- The present rule contains no population density requirements other than the requirement, noted above, that the distance to the nearest population center containing more than about 25,000 residents must be no closer than one and one-third times the outer radius of the LPZ. This was recognized as a potential problem when the present rule was promulgated. As the Commission in 1962 noted in its Statement of Considerations (27 FR 3509) accompanying the issuance of the regulation, "...in some cases where very large cities are involved, the population center distance may have to be greater than those suggested by these guides."

As a result of the significant increase in reactor power levels during the 1960's, the staff issued Regulatory Guide 4.7 in 1974. With respect to population density this guide states as follows:

> "Areas of low population density are preferred for nuclear power station sites. High population densities projected for any time during the lifetime of a station are considered during both the NRC staff review and the public hearing phases of the licensing process. If the population density at the proposed site is not acceptably low, then the applicant will be required to give special attention to alternative sites with lower population densities.
>
> If the population density, including weighted transient population, projected at the time of initial operation of a nuclear power station exceeds 500 persons per square mile averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), or the projected population density over the lifetime of the facility exceeds 1000 persons per square mile averaged over any radial distance out to 30 miles, special attention should be given to the consideration of alternative sites with lower population densities."

As noted above, the basis for this guide was that it provided reasonable separation of reactor sites from large population centers, while also assuring an adequate selection of sites, even in the Northeastern U.S. However, no comparison with explicit risk criteria were provided at that time.

An illustration of the degree of separation distance provided by this Guide for population centers of various sizes may be useful. Under this guide, a population center of about 25,000 or more residents may be no closer than 4 miles from a reactor, since a density of 500 persons per square mile within this distance would yield a total population of about 25,120 persons. Similarly, a city of 100,000 or more residents may be no closer than about 10 miles; a city of 500,000 or more persons may be no closer than about 20 miles, and a city of 1,000,000 or more persons may be no closer than about 30 miles from the reactor.

The Commission has examined these guidelines with regard to the Safety Goal. The Safety Goal quantitative health objective in regard to latent cancer fatality states that, within a distance of ten miles from the reactor, the risk to the population of latent cancer fatality from nuclear power plant operation, including accidents, should not exceed one-tenth of one percent of the likelihood of latent cancer fatalities from all other causes. In addition to the risks of latent cancer fatalities, the Commission has also investigated the likelihood and extent of land contamination arising from the release of quantities of long-lived radioactive species, such as Cesium-137, in the event of a severe reactor accident.

The results of these analyses indicate that the cancer fatality quantitative health objective noted above is met for current plant designs regardless of the population density around the site.

Since the population density values of Regulatory Guide 4.7 have been in use since 1975, since these afford an adequate supply of sites in every region of the nation, the Commission sees no merit in significantly relaxing these values by allowing nuclear power plants to be located significantly closer to population centers than has heretofore been the case. The Commission recognizes, however, that nuclear power plants meeting current safety standards could be located at sites significantly denser than 500 people per square mile and meet the latent cancer fatality Safety Goal. In addition, the Commission considers it reasonable to continue to specify the population distribution out to 30 miles, even though the Quantitative Health Objectives of the Commission's Safety Goal Policy only apply out to 10 miles, for latent fatalities. The 30 mile distance will ensure that no large population centers are located closer than about 30 miles from the site. From analysis done in support of this rule change, the likelihood of land contamination from a severe accident sufficient to require long term condemnation of land beyond 30 miles is very remote. Thus considering population distributions out to 30 miles in the site approval process will help ensure that large population centers would not be subject to contamination from a reactor accident sufficient to cause their being uninhabitable for long periods of time.

For these reasons, the Commission is proposing that, at the time of initial site approval, population density values of no more than 500 people per square mile averaged over any radial distance out to 30 miles are preferred for new nuclear power plant sites. Similarly, in keeping with Regulatory Guide 4.7, the projected population density 40 years after initial site approval should not exceed 1000 people per square mile.

The present proposed rule indicates that these population density levels are preferred not to be exceeded for new nuclear power plant sites. The Commission is also requesting comments on whether sites exceeding these population densities should be accepted, and, if so, under what condtions.

Several points regarding population projections and their application should be made. First, since the validity and reliability of population projections, particularly for relatively small regions, decreases markedly as the projection time period increases, population projections for the purpose of assessing site suitability are to be limited to a time period of 40 years after initial site approval. Population projections beyond this time period become unreliable and speculative.

Second, population projections are intended to be used as a factor in the siting process to evaluate a potential nuclear power plant site and to determine whether alternative sites having lower population densities should be considered. Because of uncertainties in population projections and because analyses have also shown that current plant designs can meet the Commission's Safety Goals and that other risks can be kept at a very low level at sites having significantly higher

population densities than those being proposed for approval, the Commission does not intend to consider licensing actions against an operating nuclear power plant solely on the basis of unexpected population growth during its operating period.

D. Meteorological Factors- Since radiological doses are no longer to be calculated for the purpose of determining site suitability, the need for assessment of site meteorological data and characteristics for site suitability purposes comes under question. Meteorological data may still be needed for safety analysis and for assessing the adequacy of certain plant features, as well as to determine plant adequacy in regard to meteorological extremes, such as tornados and maximum probable precipitation. Therefore, the rule contains a requirement to collect and characterize meteorological data representative of the site.

The Commission has examined the variations in site metorology that have influenced dose calculations in past licensing reviews. Individual site meteorology characteristics have been used primarily toward the determination of atmospheric dispersion or dilution factors, in order to evaluate doses to hypothetical individuals at the exclusion area and low population zone outer radius. The degree of dilution increases with the distance between the release point and any exposed individual, but also is affected by other factors, including the time of day. In this regard, the dilution factor (X/Q), could vary very significantly within a given site, showing a pronounced diurnal variation. When the time averaged dilution factor of a given site is compared, however, with that of other sites, the variation between one site and another is much less. Analyses reported in NUREG/CR-2239, "Technical Guidance for Siting Criteria Development," dated December 1982, for example, show that predicted average individual consequences such as risk of early fatality or risk of latent cancer fatality for an identical postulated release of radioactivity to the environment using data for 29 different weather stations in the United States yielded individual consequences that varied by about a factor of two. Based upon these considerations, the Commission has determined that the average meteorological dilution characteristics between one site and another are sufficiently similar that characterization of individual site meteorology is not a significant factor in determining site suitability.

E. Hydrological Factors- This area is important in establishing the magnitude of external hazards for which the plant should be designed. The proposed rule adds or modifies existing requirements for obtaining information to characterize hydrological factors at a site important to risk. This information will then be reviewed by the staff and used as interface criteria in matching a proposed design to the site.

F. Nearby Industrial and Transportation Facilities- This area of review is proposed to be incorporated into the regulations for the purpose of site suitability. This area of review has, in fact, been a part of the staff review for many years. The acceptance standard is the same as that currently in staff review guidance documentation. Hence, the proposed rule involves no substantive changes in this area and merely codifies what has been staff practice for a number of years.

G. Feasibility of Carrying out Protective Actions- The proposed rule would require that important site factors, such as population distribution, topography, and transportation routes be considered and examined in order to determine whether there are any site characteristics that could pose a significant impediment to the developer of an emergency plan.

Planning for emergencies is part of the Commission's defense-in-depth approach. The Commission concludes that site characteristics that may represent

an impediment to the development of adequate emergency plans, such as limitations of access or egress in the immediate vicinity of a nuclear power plant should be identified at the site approval phase.

H. Periodic Reporting of Population and Other Activities- ~~Activities~~ around a site may ~~not remain~~ unchanged. In addition to population changes, which may be estimated or projected for relatively near-term periods with some degree of confidence, significant changes in the nature of the industrial, military and transportation facilities may also occur.

The proposed rule would require that site permit holders prepare periodic reports to the Commission regarding population changes as well as significant changes in any man-related activities that might represent a potential hazard. Reports updating the population around the site out to a distance of thirty miles would be required every ten years after the date of initial site approval. Updating of this information every ten years would allow for use of the most recent Census data, as this became available, without becoming unduly burdensome.

With regard to periodic reporting of nearby man-related facilities, the concern is with the early identification of activities or facilities that are potentially hazardous. Hence, the Commission concludes that such activities should be updated on a more frequent schedule than that for population. Reporting of such changes in activity every five years is considered sufficient to provide reasonably early notification that such changes are underway or in existence. On the other hand, man-related activities potentially hazardous to a plant are typically major industrial or transport facilities such as major highways, large pipelines, major airports, etc. Relatively minor changes in industrial activity have been shown to be of little concern. For this reason, the Commission concludes that only significant changes in industrial activity, with the potential for affecting the safe operation of a plant, need be reported periodically.

In regard to this area, the Commission is also requesting comments on whether periodic reporting of population and significant offsite activities should be extended to include future plants and existing plants, as well as site permit holders.

Once a plant is built on a site, changes in offsite conditions can be, and are, tracked by the NRC resident inspector. Thus holders of construction permits or operating licenses need not report such information.

Interim Change to Part 50

The proposed change to 10 CFR 50 simply relocates the requirements previously contained in 10 CFR 100 for each applicant to calculate a whole body and a thyroid dose at specified distances. Since these requirements would be used in reactor design rather than siting, it is more appropriately located in 10 CFR 50, thus leaving 10 CFR 100 with site criteria only. The source term and methodology for performing the dose calculations remain unchanged from that stated in 10 CFR 100.

These requirements apply to all future applicants for a power reactor. They are intended to be an interim requirements until such time as more specific requirements for future applicants are developed governing containment performance and other fission product cleanup systems.

V.B Seismic and Earthquake Engineering Criteria.

The following are major changes associated with the proposed seismic and earthquake engineering criteria rulemaking:

1. Reflect current practices. The proposed regulations would better

reflect industry design practices and the associated staff review procedures that have evolved since the initial regulation (Appendix A to 10 CFR Part 100) was issued in 1973. Many of these practices and procedures were incorporated into the revision of Standard Review Plan Sections 2.5.2, 3.7.1, 3.7.2, and 3.7.3 that are associated with the resolution of Unresolved Safety Issue (USI) A-40, "Seismic Design Criteria."

2. Use probabilistic analyses. The proposed regulation will require the use of both deterministic and probabilistic analyses. The lack of recognition of probabilistic analyses in the existing regulation has made it difficult to treat issues like uncertainty and recurrence rate. The proposed rule states that probabilistic estimates of seismic hazard should be calculated and the underlying assumptions and associated uncertainties should be documented to assist in the staff's ~~overall~~ evaluation of ~~the site and proposed design basis~~.

3. Eliminate the diverse definitions of the Operating Basis Earthquake (OBE). The OBE is now only associated with the functionality of structures, equipment, and components required for safe and continued operation. Previously, the OBE was also associated with a likelihood of occurrence and a minimum percentage of the Safe Shutdown Earthquake (SSE). In some cases, for instance, piping, the multi-facets of the OBE made it possible for the OBE to have more design significance than the SSE.

4. Reduced analyses. Applicants that choose to set the ~~Operating Basis Earthquake~~ OBE at one-third of the Safe Shutdown Earthquake Ground Motion can satisfy OBE functionality requirements without performing any explicit response analysis. There is high confidence that, at this earthquake level with other postulated concurrent loads, most critical structures, systems and components will not exceed currently used design limits. For situations where only OBE is currently associated with the design requirements, for example seismic anchor motion movement, a fraction of the SSE response will be used to carry out the design in conjunction with this change. Applicants have the option of selecting an OBE greater than one-third the SSE; however, a suitable analysis and design must be performed.

5. Required plant shutdown. The revised regulations state in Part 50, consistent with other conditions of licenses, that plant shutdown is required if the ~~Operating Basis Earthquake~~ OBE is exceeded. Specific guidance is provided to define what constitutes an OBE exceedance that would require a plant shutdown. In addition, guidance is provided for an orderly plant shutdown and the re-starting of a plant that has been shut down because of earthquake ground motion.

6. Limit level of detail. The level of detail presented in the proposed regulations has been limited to general guidance. The proposed regulations would identify and establish basic requirements. Detailed guidance, that is, the procedures acceptable to the NRC for meeting the requirements, has been removed and placed in regulatory guides or standard review plan sections.

7. Provide greater flexibility. The proposed regulations would provide ~~a~~ flexible ~~structure~~ that will permit the consideration of new technical understandings and state of the art advancements.

8. Clarify interpretations. Changes have been made to resolve past questions of interpretation. As an example, the definitions and required investigations sections of the proposed regulations have been significantly changed to eliminate or modify phrases that were more applicable to only the western United States.

9. Clarify text. The proposed regulations would use more explicit terminology. For instance, the Safe Shutdown Earthquake (SSE) is now referenced as the Safe Shutdown Earthquake Ground Motion (SSE). Appropriate changes within the text ~~highlight this~~ the ground motion used as the design basis as not

associated with a single earthquake but a composite of many expected earthquakes.

VI. Siting Policy Task Force Recommendations

The Siting Policy Task Force made nine recommendations with regard to revision of the reactor siting criteria. The individual recommendations and the disposition and actions being taken in regard to each of these are discussed below.

Recommendation 1

Revise Part 100 to change the way protection is provided for accidents by incorporating a fixed exclusion area and protection action distance and population density and distribution criteria.

1. Specify a fixed minimum exclusion distance based on limiting the individual risk from design basis accidents. Furthermore, the regulations should clarify the required control by the utility over activities taking place in land and water portions of the exclusion area.
2. Specify a fixed minimum emergency planning distance of 10 miles. The physical characteristics of the emergency planning zone should provide reasonable assurance that evacuation of persons, including transients, would be feasible if needed to mitigate the consequences of accidents.
3. Incorporate specific population density and distribution limits outside the exclusion area that are dependent on the average population of the region.
4. Remove the requirement to calculate radiation doses as a means of establishing minimum exclusion distances and low population zones.

Disposition and Action

Recommendation 1 has been or is largely being adopted by the Commission. With regard to item 1, a fixed minimum exclusion area distance of 0.4 miles, commensurate with past staff experience in the review of design basis accidents, is being proposed. The Commission believes that the existing requirements regarding control over any land portion of the exclusion area together with current emergency planning requirements make any new requirements on exclusion area control unnecessary. The recommendations in item 2 were adopted by the Commission shortly after the Three Mile Island accident and are presently in 10 CFR Part 50.47. The recommendations in item 3 are being adopted, except that population density and distribution limits are proposed to be applicable nationwide. The recommendation of Item 4 is being adopted.

Recommendation 2

Revise Part 100 to require consideration of the potential hazards posed by man-made activities and natural characteristics of sites by establishing minimum standoff distances for:

1. Major or commercial airports,
2. LNG terminals,
3. Large propane pipelines,
4. Large natural gas pipelines,
5. Large quantities of explosive or toxic materials,
6. Major dams, and
7. Capable faults.

Disposition and Action

Recommendation 2 is being adopted in part and rejected in part. Part 100 is to be revised to include consideration of man-related hazards. However, establishment of minimum standoff distances by regulation for the hazards cited

is considered infeasible because staff review has found that acceptable separation distances are not readily quantified and can depend upon many factors such as the topography, size and operational aspects of such facilities, as well as distance from the reactor. Accordingly, the rule will require that the hazards be identified so that they can be adequately considered in the design of the reactor to be located on the site.

Recommendation 3

Revise Part 100 by requiring a reasonable assurance that interdictive measures are possible to limit groundwater contamination resulting from Class 9 accidents within the immediate vicinity of the site.

Disposition and Action

The Commission is not adopting this recommendation. However, requirements on future reactor designs will address the need to consider containment failure under severe accident conditions and will minimize containment failure under such conditions. This will reduce the likelihood of groundwater contamination resulting from so-called Class 9 accidents. The Commission concludes that the intent of this recommendation will be adopted via requirements on future reactor designs.

Recommendation 4

Revise Appendix A to 10 CFR 100 to better reflect the evolving technology in assessing seismic hazards.

Disposition and Action

The Commission is adopting this recommendation.

Recommendation 5

Revise Part 100 to include consideration of post-licensing changes in offsite activities.

1. The NRC staff shall inform local authorities (planning commission, county commissions, etc.) that control activities within the emergency planning zone (EPZ) of the basis for determining the acceptability of a site.
2. The NRC staff shall notify those federal agencies as in item 1 above that may reasonably initiate a future federal action that may influence the nuclear power plant.
3. The NRC staff shall require applicants to monitor and report potentially adverse offsite developments.
4. If, in spite of the actions described in items 1 through 3, there are offsite developments that have the potential for significantly increasing the risk to the public, the NRC staff will consider restrictions on a case-by-case basis.

Disposition and Action

This recommendation is already in effect or being adopted. Item 1 is already covered by existing emergency planning requirements. Item 2 is accomplished by issuance of the Environmental Imapct Statement (EIS) by the NRC staff. Item 3 is being adopted into the proposed Part 100 for early site permit holders and is addressed by the NRC resident inspector for operating reactors. With regard to item 4, the Commission retains the right to order restrictions on a case-by-case basis.

Recommendation 6

Continue the current approach relative to site selection from a safety viewpoint, but select sites so that there are no unfavorable characteristics requiring unique or unusual design to compensate for site inadequacies.

Disposition and Action

The Commission is not adopting this recommendation. Commission site requirements should provide assurance of a high degree of safety. The use of

design features to compensate for site inadequacies may depend upon economic considerations. The Commission concludes that any economic decision to propose design modifications to meet safety standards should be left for the utility or applicant.

Recommendation 7

Revise Part 100 to specify that site approval be established at the earliest decision point in the review and to provide criteria that would have to be satisfied for this approach to be subsequently reopened in the licensing process.

Disposition and Action

The Commission considers that the early site permit provisions of 10 CFR Part 52 accomplishes this recommendation.

Recommendation 8

Revise Part 51 to provide that a final decision disapproving a proposed site by a state agency whose approval is fundamental to the project would be a sufficient basis for NRC to terminate review. Such termination of a review would then be reviewed by the Commission.

Disposition and Action

The Commission is not adopting this recommendation since incorporation of it is considered unnecessary.

Recommendation 9

Develop common bases for comparing the risks for all external events.

Disposition and Action

The Siting Policy Task Force's primary recommendation in this area was that an interdisciplinary effort should be undertaken with the objective of developing quantitative risk comparisons of all external events and natural phenomena. The Commission considers this to be a desirable objective but notes that the Siting Policy Task Force made no specific recommendations with regard to siting criteria or rulemaking. The Commission therefore considers this recommendation inapplicable in the present context of examination of siting criteria, but notes that recent developments in probabilistic risk analysis (PRA) have emphasized examination of the risk from external events.

VII. Related Regulatory Guides and Standard Review Plan Section

The NRC is developing the following draft regulatory guides and standard review plan section to provide prospective licensees with the necessary guidance for implementing the proposed regulations. The notice of availability for these materials is published elsewhere in this Federal Register:

1. DG-1015, "Identification and Characterization of Seismic Sources and Design Ground Motion." The draft guide provides general guidance and recommendations, describes acceptable procedures and provides a list of references that present acceptable methodologies to identify and characterize capable tectonic sources and seismogenic sources.

2. DG-1016, Second Proposed Revision 2 to Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes." The draft guide describes seismic instrumentation type and location, operability, characteristics, installation, actuation, and maintenance that are acceptable to the NRC staff.

3. DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions." The draft guide provides guidelines that are acceptable to the NRC staff for a timely evaluation of the recorded seismic instrumentation data and to determine whether or not plant shutdown is required.

4. DG-1018, "Restart of a Nuclear Power Plant Shut Down Due to a Seismic Event." The draft guide provides guidelines that are acceptable to the NRC staff

for performing inspections and tests of nuclear power plant equipment and structures prior to restart of a plant that has been shut down due to a seismic event.

5. Draft Standard Review Plan Section 2.5.2, Proposed Revision 3 "Vibratory Ground Motion." The draft describes procedures to assess the ground motion potential of seismic sources at the site and to assess the adequacy of the Safe Shutdown Earthquake Ground Motion, ~~seismic design~~.

6. Draft Regulatory Guide 4.7, designated as Revision 2, dated December 1991, "General Site Suitability Criteria for Nuclear Power Plants." This guide discusses the major site characteristics related to public health and safety and environmental issues which the NRC staff considers in determining the suitability of sites.

VIII. Future Regulatory Action

Several existing regulatory guides will be revised to incorporate editorial changes or maintain the existing design or analysis philosophy . These guides will be issued to coincide with the publication of the final regulations that would implement this proposed action.

The following regulatory guides will be revised to incorporate editorial changes or to be consistent with changes in Part 100. For example, the type of changes contemplated would be to reference new paragraphs in Appendix B to Part 100 or Appendix S to Part 50. No technical changes will be made in these Regulatory Guides.

1. 1.57, "Design Limits and Loading Combinations for Metal Primary Containment System Components"
2. 1.59, "Design Basis Floods for Nuclear Power Plants"
3. 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants"
4. 1.83, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes"
5. 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis"
6. 1.102, "Flood Protection for Nuclear Power Plants"
7. 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes"
8. 1.122, "Development of Floor Response Spectra for Seismic Design of Floor-Supported Equipment or Components"

The following regulatory guides will be revised technically to maintain existing design or analysis philosophy. For example, the types of changes contemplated would be to change OBE to a fraction of the SSE:

1. 1.27, "Ultimate Heat Sink for Nuclear Power Plants"
2. 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants"
3. 1.124, "Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports"
4. 1.130, "Service Limits and Loading Combinations for Class 1 Plate-and-Shell-Type Component Supports"
5. 1.132, "Site Investigations for Foundations of Nuclear Power Plants"
6. 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants"
7. 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants

(Other than Reactor Vessels and Containments)"

8. 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants"

During the revision of the regulatory guides cited above, if additional changes are made, the applicable guide(s) will be distributed for public comment.

IX. Electronic Format Submittal of Public Comments

The comment resolution process will be improved if each comment is identified to the document title, section heading and paragraph number to which it responds. Commenters may submit, in addition to the original paper copy, a copy of the letter in an electronic format on IBM PC DOS compatible 3.5 or 5.25 inch double sided double density (DS/DD) diskettes. Data files should be provided in Wordperfect 5.1 format. ASCII code is also acceptable or if formatted text is required, data files should be provided in IBM Revisable - Form Text Document Content Architecture (RFT/DCA) format.

X. Finding of No Significant Environmental Impact: Availability

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

The revisions associated with the reactor siting criteria in 10 CFR Part 100 and the relocation of the plant design requirements from 10 CFR Part 100 to 10 CFR Part 50 has been evaluated against the current requirements. The staff's evaluation has concluded that relocating the requirement for a dose calculation to Part 50 and adding more specific site criteria to Part 100 does not decrease the protection of the public health and safety over the current regulations. The additional reporting requirements for early site permit holders does not result in any occupational radiation exposure. The proposed ammendments do not affect non—radiological plant effluents and have no other environmental impact.

The amendment of Appendix A to 10 CFR Part 100 as stated in 10 CFR Part 100, Appendix B and 10 CFR Part 50, Appendix S reflects current licensing practice and will not change the radiological environmental impact offsite. Onsite occupational radiational exposure associated with inspection and maintenance will not change. These activities are principally associated with seismic instrumentation. The proposed amendments do not affect non-radiological plant effluents and have no other environmental impact.

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, 2120 L Street, NW. (Lower Level), Washington, DC. Single copies of the environmental assessment and finding of no significant impact are available from Mr. Leonard Soffer, Office of Nuclear Regulatory Research, Mail Stop NL/S-324, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 492-3916 and Dr. Andrew Murphy, Office of Nuclear Regulatory Research, Mail Stop NL/S-217A, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 492-3860.

XI. 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.

The public reporting burden for this collection of information is not expected to change from the existing regulations, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Information and Records Management Branch (MNBB 7714), U.S. Nuclear Regulatory Commission, Washington, DC 20555; and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-3019, (3150-0011 and 3150-0093), Office of Management and Budget, Washington, DC 20503.

XII. Regulatory Analysis

The Commission has prepared a draft regulatory analysis on this proposed regulation. The analysis examines the costs and benefits of the alternatives considered by the Commission. The draft analysis is available for inspection in the NRC Public Document Room, 2120 L Street, NW. (Lower Level), Washington, DC. Single copies of the analysis are available from Mr. Leonard Soffer, Office of Nuclear Regulatory Research, Mail Stop NL/S-324, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 492-3916 or Dr. Andrew J. Murphy, Office of Nuclear Regulatory Research, Mail Stop NL/S-217A, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 492-3860.

The Commission requests public comment on the draft regulatory analysis. Comments on the draft analysis may be submitted to the NRC as indicated under the ADDRESSES heading.

XIII. Questions

In addition to soliciting comments on all aspects of this rulemaking, the Commision specifically requests comment on the following questions.

1. Should a smaller exclusion area distance be allowed for plants less than 3800 MW ?

2. Should renewals of early site permits under 10 CFR Part 52 ~~by~~ be judged against the proposed population distribution limits of 10 CFR Part 100.21?

3. Should the proposed population distribution limits of 10 CFR Part 100.21 be fixed limits above which the site would be unacceptable?

4. Should the population and offsite hazard reporting requirements proposed for holders of early site permits (10 CFR Part 100.23) be applied to existing and future holders of construction permits and operating licenses?

XIV. Regulatory Flexibility Certification

In accordance with the Regulatory Flexibility Act of 1980, (5 U.S.C. 605(b)), the Commission certifies that this rule will not, if promulgated, have a significant economic impact on a substantial number of small entities. This

proposed rule affects only the licensing and operation of nuclear power plants. Nuclear power plant site applicants do not fall within the definition of small businesses as defined in Section 3 of the Small Business Act (15 U.S.C. 632), the Small Business Size Standards of the Small Business Administrator (13 CFR Part 121), or the Commission's Size Standards (50 CFR 50241; December 9, 1985).

XV. Backfit Analysis

The NRC has determined that the backfit rule, 10 CFR 50.109, does not apply to this proposed rule, and therefore, that a backfit analysis is not required for this proposed rule, because these amendments do not involve any provisions which would impose backfits as defined in 10 CFR 50.109(a)(1).

List of Subjects

10 CFR Part 50 - Antitrust, Classified information, Criminal penalty, Fire protection, Incorporation by reference, Intergovernmental relations, Nuclear power plants and reactors, Radiation protection, Reactor siting criteria, Reporting and recordkeeping requirements.

10 CFR Part 52 - Administrative practice and procedure, Antitrust, Backfitting, Combined license, Early site permit, Emergency planning, Fees, Inspection, Limited work authorization, Nuclear power plants and reactors, Probabilistic risk assessment, Prototype, Reactor siting criteria, Redress of site, Reporting and recordkeeping requirements, Standard design, Standard design certification.

10 CFR Part 100 - Nuclear power plants and reactors, Reactor siting criteria.

For the reasons set out in the preamble and under the authority of the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and 5 U.S.C. 553, the NRC is proposing to adopt the following amendments to 10 CFR Parts 50, 52 and 100.

PART 50 - DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

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

AUTHORITY: Secs. 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. 1244, 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. 936, 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).

For the purposes of sec. 223, 68 Stat. 958, as amended (42 U.S.C. 2273), §§ 50.46(a) and (b), and 50.54(c) are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C. 2201(b)); §§ 50.7(a), 50.10(a)-(c), 50.34(a) and (e), 50.44(a)-(c), 50.46(a) and (b), 50.47(b), 50.48(a), (c),(d), and (e), 50.49(a), 50.54(a)(i), (i)(1), (1)-(n), (p), (q), (t), (v), and (y), 50.55(f), 50.55a(a), (c)-(e), (g), and (h), 50.59(c), 50.60(a), 50.62(b), 50.64(b), 50.65 and 50.80(a) and (b) are issued under sec. 161i, 68 Stat. 949, as amended (42 U.S.C. 2201(i)); and §§50.49d, (h), and (j), 50.54(w),(z),(bb),(cc), and (dd), 50.55(e), 50.59(b), 50.61(b), 50.62(b), 50.70(a), 50.71(a)-(c) and (e), 50.72(a), 50.73(a) and (b), 50.74, 50.78, and 50.90 are issued under sec. 161(o), 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

2. In §50.8, paragraph (b) is revised to read as follows:

§50.8 Information collection requirements: OMB approval

(a) * * *

(b) The approved information collection requirements contained in this part appear in 50.30, 50.33, 50.33a, 50.34, 50.34, 50.34a, 50.35, 50.36, 50.36a, 50.48, 50.49, 50.54, 50.55, 50.55a, 50.59, 50.60, 50.61, 50.63, 50.64, 50.65, 50.71, 50.72, 50.80, 50.82, 50.90, 50.91, and Appendices A, B, E, G, H, I, J, K, M, N, O, Q, R, and S.

* * * * *

3. In §50.34, paragraph (a)(1) is revised to read as follows:

§50.34 Contents of applications; technical information.

(a) * * *

(1) A description of the site and a safety assessment of the facility should be performed. Special attention should be directed to plant design features intended to mitigate the radiological consequences of accidents. In performing this assessment, an applicant should assume a fission product release from the core [1] into the containment assuming that the facility is operated at the maximum power level contemplated. The applicant should perform an evaluation and analysis of the postulated fission product release, using the containment leak rate and any fission product cleanup systems intended to mitigate the consequences of such accidents, together with applicable site characteristics, including site meteorology, to evaluate the offsite radiological consequences. The evaluation should determine that:

(i) An individual located at any point on the boundary of the

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[1] The fission product release assumed for this evaluation should be based upon a major accident, hypothesized or determined from considerations of possible accidental events, that would result in potential hazards not exceeded by those from any accident considered credible. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release into the containment of appreciable quantities of fission products.

exclusion area for two hours immediately following the onset of the postulated fission product release would not receive a total radiation dose to the whole body in excess of 25 rem [2] or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure.

(ii) An individual located at any point on the outer radius of a low population zone who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a total radiation dose to the whole body in excess of 25 rem or a total radiation dose in excess of 300 rem to the thyroid from iodine exposure. For purposes of this evaluation, a low population zone boundary of 3.0 miles should be assumed.

With respect to operation at the projected initial power level, the applicant is required to submit information prescribed in paragraphs (a)(2) through (8) of this section, as well as the the information required by this paragraph, in support of the application for a construction permit.

NOTE: Reference is made to Technical Information Document (TID) 14844, dated March 23, 1962, which contains a fission product release into containment which has been used in past evaluations. The fission product release given in TID-14844 may be used as a point of departure upon consideration of severe accident research insights available since its issuance, upon consideration of plant design features intended to mitigate the consequences of accidents, or upon characteristics of a particular reactor.

4. In §50.34, paragraph (a)(12) is added to read as follows:

§50.34 Contents of applications; technical information.

(a) * * *

(12) On or after [EFFECTIVE DATE OF THIS REGULATION] applicants who apply for early site permits, design certifications, or combined licenses for nuclear power plants, as partial conformance to General Design Criteria 2 of Appendix A to this part, shall implement the earthquake engineering criteria in Appendix S

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[2] The whole body dose of 25 rem referred to above has been stated to correspond numerically to the once in a lifetime accidental or emergency dose for radiation workers which, according to NCRP recommendations may be disregarded in the determination of their radiation exposure status (see NBS Handbook 69 dated June 5, 1959). More recently, this whole body dose value has also been provided as guidance for radiation workers performing emergency services involving life saving activities or protection of large populations where lower doses are not practicable (see EPA, Manual of Protective Action Guides and Protective Actions for Nuclear Incidents, Draft, September 1990). However, neither its use nor that of the 300 rem value for thyroid exposure as set forth in this section are intended to imply that these numbers constitute acceptable limits for emergency doses to the public under accident conditions. Rather, this 25 rem whole body value and the 300 rem thyroid value have been set forth in this section as reference values, which can be used in the evaluation of plant design features with respect to potential severe reactor accidents, in order to assure that such designs provide assurance of low risk of public exposure to radiation, in the event of such accidents.

of this part. Prior to [EFFECTIVE DATE OF THIS REGULATION], applicable earthquake engineering criteria for nuclear power plants are contained in Section VI of Appendix A to Part 100 of this chapter.

* * * * *

5. In §50.54, paragraph (ee) is added to read as follows:

§50.54 Conditions of licenses.

* * * * *

(ee) For licensees of nuclear power plants that have implemented the earthquake engineering criteria in Appendix S of this part, plant shutdown will be required if the criteria in Paragraph IV(a)(3) of Appendix S are exceeded.

6. Appendix S to Part 50 is added to read as follows:

* * * * *

Appendix S To Part 50 - EARTHQUAKE ENGINEERING ~~CRITERIA~~ REQUIREMENTS FOR NUCLEAR POWER PLANTS

GENERAL INFORMATION

This appendix applies to applicants who apply for a construction permit, design certification, or combined license on or after [EFFECTIVE DATE OF THIS REGULATION]. Prior to [EFFECTIVE DATE OF THIS REGULATION], applicable earthquake engineering ~~criteria~~ requirements for nuclear power plants are contained in Section VI of Appendix A to Part 100 of this chapter.

Criteria associated with the selection of the site or establishment of the safe shutdown earthquake ground motion are located in Appendix B to Part 100 of this chapter, consistent with the location in the regulation of other siting requirements. The effective date of Appendix B is also [EFFECTIVE DATE OF THIS REGULATION]. ~~Taken together, this appendix and Appendix B to Part 100 provide the seismic, geologic and earthquake engineering criteria~~ for nuclear power plants ~~constructed~~ pursuant to applications applied for and issued after the effective date of this regulation. ~~Ensuring consistency of regulatory approach~~ licensing

Changes that were made to Appendix A to Part 100, as reflected in this appendix, in general, are clarifications and state-of-the-art advancements in earthquake engineering. Consistent with Appendix B to Part 100, this appendix is general in nature with more detailed information contained in supporting regulatory guides or standard review plan sections. Nuclear power plants licensed before these revisions to the regulation pose no undue risk to public health and safety and there is no present basis for immediate action on any regulatory requirements for these plants.[3]

I. INTRODUCTION

Each applicant for an early site permit, design certification, or combined license is required by §50.34(a)(12) and General Design Criterion 2 of Appendix A to this Part to design, construct and operate nuclear power plant structures, systems, and components

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[3] U.S. Nuclear Regulatory Commission (USNRC), "Policy Statement on Severe Accidents," 50 FR 32138, August 8, 1985.

This appendix along with the SSE ground motion derived from Appendix B to Part 100 form the seismic design, construction and operation requirements

important to safety to withstand the effects of natural phenomena, such as earthquakes, without loss of capability to perform their safety functions. Also, a condition of all operating licenses for nuclear power plants, as specified in §50.54(ee), is plant shutdown if the critera in Paragraph IV(a)(3) of this appendix are exceeded. The investigations required to obtain the geologic and seismic data necessary to determine site suitability are described in Appendix B to Part 100 of this chapter. Also identified are the geologic and seismic factors required to be taken into account in the siting ~~and~~ design, construction and operation of nuclear power plants.

It is the purpose of these criteria to set forth the principal considerations which guide the Commission in its evaluation of the suitability of the plant design bases established in consideration of the seismic event.

II. SCOPE

These ~~criteria~~ requirements, which apply to nuclear power plants, provide reasonable assurance that a nuclear power plant can be constructed and operated at a proposed site without undue risk to the health and safety of the public.

The evaluations described in this appendix are within the scope of investigations permitted by §50.10(c)(1) of this chapter.

III. DEFINITIONS

As used in these criteria:

(a) The Safe Shutdown Earthquake Ground Motion (SSE) is the vibratory ground motion for which certain structures, systems, and components shall be designed to remain functional. These structures, systems, and components are those necessary to assure:

(1) The integrity of the reactor coolant pressure boundary,

(2) The capability to shut down the reactor and maintain it in a safe shutdown condition, or

(3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of §50.34(a)(1) of this chapter.

(b) The Operating Basis Earthquake produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public shall remain functional.

(c) A response spectrum is a plot of the maximum responses (acceleration, velocity or displacement) of a family of idealized single-degree-of-freedom ~~damped~~ oscillators against natural frequencies of the oscillators, to a specified vibratory motion input at their supports. with a given damping value

(d) Combined license means a combined construction permit and operating license with conditions for a nuclear power facility issued pursuant to Part 52, Subpart C of this chapter.

(e) Standard design means a design which is sufficiently detailed and complete to support certification in accordance with Part 52, Subpart B of this chapter, and which is usable for a multiple number of units or at a multiple number of sites without reopening or repeating the review.

(f) Standard design certification, design certification, or certification means a Commission approval, issued pursuant to Part 52, Subpart B of this chapter, of a standard design for a nuclear power facility. A design so approved may be referred to as a "certified standard design."

(g) ~~Zero Period~~ Peak Ground Acceleration is the numerical value that corresponds to

the acceleration level of the input design earthquake response spectra at frequencies where the response curve is asymptotic to a line perpendicular to the acceleration axis.

IV. APPLICATION TO ENGINEERING DESIGN

The following are pursuant to the seismic and geologic design basis requirements of paragraphs V(a) through (f) of Appendix B to Part 100 of this chapter:

(a) **Vibratory Ground Motion**

(1) **Safe Shutdown Earthquake Ground Motion.** The Safe Shutdown Earthquake Ground Motion shall be derived from free-field ground motion response spectra at the free ground surface or hypothetical rock outcrop, as appropriate. In view of the limited data available on vibratory ground motions of strong earthquakes, it usually will be appropriate that the design response spectra be smoothed spectra developed from an ensemble of response spectra related to the vibratory motions caused by more than one earthquake. The horizontal Safe Shutdown Earthquake Ground Motion at the foundation level of the structures shall be an appropriate response spectrum with a ~~zero period~~ acceleration of at least 0.1g.

The nuclear power plant shall be designed so that, at the Safe Shutdown Earthquake Ground Motion, certain structures, systems, and components will remain functional. These structures, systems, and components are those necessary to assure (i) the integrity of the reactor coolant pressure boundary, (ii) the capability to shut down the reactor and maintain it in a safe condition, or (iii) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of §50.34(a)(1) of this chapter. In addition to seismic loads, applicable concurrent normal operating, functional and accident-induced loads shall be taken into account in the design of these safety-related structures, systems, and components. The design of the nuclear power plant shall also take into account the possible effects of the Safe Shutdown Earthquake Ground Motion on the facility foundations by ground disruption, such as fissuring, lateral spreads, differential settlement, liquefaction, and landsliding, as required in Paragraph V(f) of Appendix B to Part 100 of this chapter.

The required safety functions of structures, systems and components shall be assured during and after the vibratory ground motion associated with the Safe Shutdown Earthquake Ground Motion through suitable analyses, testing or qualification methods.

The evaluation shall take into account soil-structure interaction effects and the expected duration of vibratory motion. It is permissible to design for strain limits in excess of yield strain in some of these safety-related structures, systems, and components during the Safe Shutdown Earthquake Ground Motion and under the postulated concurrent conditions, provided that the necessary safety functions are maintained.

(2) **Operating Basis Earthquake.** The Operating Basis Earthquake shall be defined by response spectra. When subjected to the effects of the vibratory motion of the Operating Basis Earthquake in combination with normal operating loads, all structures, systems, and components of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public shall remain functional, that is, within applicable stress and deformation limits.

The value of the Operating Basis Earthquake shall be set to one of the following choices:

(i) if the Operating Basis Earthquake is set at one-third of the Safe Shutdown Earthquake Ground Motion level, the requirement of the Operating Basis

Earthquake as stated above, can be satisfied without the applicant performing any explicit response analyses,[4] or

(ii) if an applicant chooses an Operating Basis Earthquake greater than one-third the Safe Shutdown Earthquake Ground Motion an explicit suitable analysis and design shall be performed to demonstrate that the requirement for the Operating Basis Earthquake, as stated above, is satisfied. The design shall take into account soil-structure interaction effects and the expected duration of vibratory ground motion.

(3) **Required Plant Shutdown.** If vibratory ground motion exceeding that of the Operating Basis Earthquake occurs, shutdown of the nuclear power plant will be required.[5] The Operating Basis Earthquake is set pursuant to Paragraph (c)(2)(i) or (ii). Prior to resuming operations, the licensee will be required to demonstrate to the Commission that functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public.

(4) **Required Seismic Instrumentation.** Suitable instrumentation shall be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly.

(b) **Surface Deformation.** The design basis for surface deformation shall be taken into account in the design of the nuclear power plant by providing reasonable assurance that in the event of such deformation certain structures, systems, and components will remain functional. These structures, systems, and components are those necessary to assure (i) the integrity of the reactor coolant pressure boundary, (ii) the capability to shut down the reactor and maintain it in a safe shutdown condition, or (iii) the capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of §50.34(a)(1) of this chapter. In addition to surface deformation induced loads, the design of such safety features shall take into account: seismic loads, including aftershocks, and applicable concurrent functional and accident-induced loads. The design provisions shall be based on an assumption that the design basis for surface deformation can occur in any direction and azimuth and under any part of the nuclear power plant unless evidence indicates this assumption is not appropriate, and shall take into account the estimated rate at which the surface deformation may occur.

(c) **Seismically Induced Floods and Water Waves and Other Design Conditions.** The design basis for seismically induced floods and water waves from either locally or distantly generated seismic activity and other design conditions determined pursuant to Paragraphs V(e) and (f) of Appendix B to Part 100 of this chapter shall be taken into account in the design of the nuclear power plant so as to prevent undue risk to the health and safety of the public.

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PART 52 - EARLY SITE PERMITS; STANDARD DESIGN CERTIFICATIONS;

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[4] A separate analyses to compute structure, equipment and piping response associated with the Operating Basis Earthquake is not required. Applicable design provisions associated with this Operating Basis Earthquake, for instance, fatigue, are discussed in regulatory guides.

[5] Plant shutdown criteria are provided in a regulatory guide.

7. The authority citation for Part 52 continues to read as follows:

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

8. In §52.17, paragraph (a)(1)(vi) is revised to read as follows:

§52.17 Contents of applications.

(a) * * *

(1) * * *

(vi) The seismic, meteorological, hydrologic, and geologic characteristics of the proposed site (see Appendix A or B, as appropriate, to 10 CFR Part 100);

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PART 100 - REACTOR SITE CRITERIA

9. The authority citation for Part 100 continues to read as follows:

AUTHORITY: Secs. 103, 104 161, 182, 68 Stat. 936, 937, 948, 953, as amended (42 U.S.C. 2133, 2134, 2201, 2232); sec. 201, as amended, 202, 88 Stat. 1242, as amended, 1244 (42 U.S.C. 5841, 5842).

10. Part 100 is revised to read as follows:

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11. Appendix B to Part 100 is added to read as follows:

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Appendix B to Part 100 -- CRITERIA FOR THE SEISMIC AND GEOLOGIC SITING OF NUCLEAR POWER PLANTS AFTER [EFFECTIVE DATE]

GENERAL INFORMATION

This appendix applies to applicants who apply for a construction permit, early site permit, or combined license on or after [EFFECTIVE DATE OF THIS REGULATION]. Prior to [EFFECTIVE DATE OF THIS REGULATION] applicable seismic and geologic siting criteria, including application to engineering design, for nuclear power plants are contained in Appendix A to Part 100 of this chapter.

Criteria not associated with the selection of the site or establishment of the safe shutdown earthquake ground motion have been placed in Appendix S to Part 50 of this chapter which contains other design requirements. The effective date of Appendix S is also [EFFECTIVE DATE OF THIS REGULATION]. Taken together, this appendix and Appendix S to Part 50 provide the seismic, geologic and earthquake engineering criteria for nuclear power plants constructed pursuant to applications applied for and issued on or after the

effective date of this regulation.

Changes that were made to Appendix A to Part 100, as reflected in this appendix, in general, are clarifications and state-of-the-art advancements in the geosciences, for instance, the use of probabilistic analyses. Nuclear power plants licensed before these revisions to the regulation pose no undue risk to public health and safety and there is no present basis for immediate action on any regulatory requirements for these plants.[6]

I. PURPOSE

General Design Criterion 2 of Appendix A to Part 50 of this chapter requires that nuclear power plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions. It is the purpose of these criteria to set forth the principal seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants and the suitability of the plant design bases established in consideration of the seismic and geologic characteristics of the proposed sites.[7]

These criteria are based on the current geophysical, geological and seismological information concerning faults and earthquake occurrence and effects. They will be revised as necessary when more complete information becomes available.

II. SCOPE

These criteria, which apply to nuclear power plants, describe the nature of the investigations required to obtain the geologic and seismic data necessary to determine site suitability and provide reasonable assurance that a nuclear power plant can be constructed and operated at a proposed site without undue risk to the health and safety of the public. Geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants are identified.

The investigations described in this appendix are within the scope of investigations permitted by § 50.10(c)(1) of this chapter.

Each applicant for a construction permit, early site permit, or combined license shall investigate all seismic and geologic factors that may affect the design and operation of the proposed nuclear power plant irrespective of whether such factors are explicitly included in these criteria. Both deterministic and probabilistic evaluations shall be conducted. Additional investigations and/or more conservative determinations than those included in these criteria may be required for sites located in areas having complex geology or in areas of high seismicity. If an applicant believes that the particular seismology and geology of a site indicate that some of these

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[6] U.S. Nuclear Regulatory Commission (USNRC), "Policy Statement on Severe Accidents," 50 FR 32138, August 8, 1985.

[7] Considerations presented in this regulation are general. Acceptable methods and additional discussion are provided in Regulatory Guides and Standard Review Plan Sections.

criteria, or portions thereof, need not be satisfied, the specific sections of these criteria should be identified in the license application, and supporting data to justify clearly such departures shall be presented.

III. DEFINITIONS

As used in these criteria:

(a) The magnitude of an earthquake is a measure of the size of an earthquake and is related to the energy released in the form of seismic waves. "Magnitude" means the numerical value on a standardized scale such as, but not limited to, Moment Magnitude, Surface Wave Magnitude, Body Wave Magnitude or Richter Magnitude scales.

(b) An expected maximum earthquake (EME) is the largest earthquake that can reasonably be expected to occur in a given seismic source ~~characterized by its magnitude~~. Because of uncertainty, the Expected Maximum Earthquake is described by a distribution about the expected value.

(c) The Safe Shutdown Earthquake Ground Motion (SSE) is the vibratory ground motion for which certain structures, systems, and components shall be designed to remain functional. These structures, systems, and components are those necessary to assure:

(1) The integrity of the reactor coolant pressure boundary,

(2) The capability to shut down the reactor and maintain it in a safe shutdown condition, or

(3) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures of §50.34(a)(1) of this chapter.

(d) Operating Basis Earthquake. The definition and application of the Operating Basis Earthquake to engineering design is discussed in Appendix S to Part 50 of this chapter.

(e) A fault is a tectonic structure along which differential slippage of the adjacent earth materials has occurred parallel to the fracture plane. A fault may have gouge or breccia between its two walls and includes any associated monoclinal flexure or other similar geologic structural feature.

(f) Surface faulting is differential ground displacement at or near the surface caused directly by fault movement and is distinct from nontectonic types of ground disruptions, such as landslides, fissures, and craters.

(g) Surface deformation is distortion of soils and rocks at or near ground surface by the processes of folding, faulting, compression or extension as a result of various earth forces. Tectonic surface deformation is associated with earthquake processes.

(h) A seismic source is a general term referring to both seismogenic sources and capable tectonic sources.

(i) A seismogenic source is a portion of the earth which is assumed to have uniform earthquake potential (same expected maximum earthquake and frequency of recurrence) distinct from the earthquake potential of the surrounding area. A seismogenic source ~~is not expected to~~ will not cause surface displacements. Seismogenic sources cover a wide range of possibilities from a well-defined tectonic structure to simply a large region of diffuse seismicity (seismotectonic province) thought to be characterized by the same earthquake recurrence model. A seismogenic source is also characterized by its involvement in the current tectonic regime as reflected in the Quaternary (approximately the last 2 million years).

(j) A capable tectonic source is a tectonic structure which can generate both earthquakes and tectonic surface deformation such as faulting or

Add to definitions: The Controlling Earthquake is the earthquake used to estimate ground motions at the site.

folding at or near the surface in the present seismotectonic regime. It is characterized by at least one of the following characteristics:

(1) Presence of surface or near surface deformation of landforms or geologic deposits of recurring nature within the last approximately 500,000 years or at least once in the last approximately 50,000 years.

(2) A reasonable association with one or more large earthquakes or sustained earthquake activity which are usually accompanied by significant surface deformation.

(3) A structural association with a capable tectonic source according to characteristics (1) of this paragraph such that movement on one could be reasonably expected to be accompanied by movement on the other.

In some cases, the geologic evidence of past activity at or near the ground surface along a particular capable tectonic source may be obscured at a particular site. This might occur, for example, at a site having a deep overburden. For these cases, evidence may exist elsewhere along the structure from which an evaluation of its characteristics in the vicinity of the site can be reasonably based. Such evidence shall be used in determining whether the structure is a capable tectonic source within this definition.

Notwithstanding the foregoing paragraphs III(j) (1), (2) and (3), structural association of a structure with geologic structural features which are geologically old (at least pre-Quaternary) such as many of those found in the Eastern region of the United States shall, in the absence of conflicting evidence, demonstrate that the structure is not a capable tectonic source within this definition.

(k) A response spectrum is a plot of the maximum responses (acceleration, velocity or displacement) of a family of idealized single-degree-of-freedom damped oscillators against natural frequencies of the oscillators to a specified vibratory motion input at their supports.

(l) Combined license means a combined construction permit and operating license with conditions for a nuclear power facility issued pursuant to Part 52, Subpart C of this chapter.

(m) Early site permit means a Commission approval, issued pursuant to Part 52, Subpart A of this chapter, for a site or sites for one or more nuclear power facilities.

(n) Standard design means a design which is sufficiently detailed and complete to support certification in accordance with Part 52, Subpart B of this chapter, and which is usable for a multiple number of units or at a multiple number of sites without reopening or repeating the review.

(o) Zero Period Acceleration is the numerical value that corresponds to the acceleration level of the input design earthquake response spectra at frequencies where the response curve is asymptotic to a line perpendicular to the acceleration axis.

IV. REQUIRED INVESTIGATIONS

The geological, seismological and engineering characteristics of a site and its environs shall be investigated in sufficient scope and detail to permit an adequate evaluation of the proposed site, and to provide sufficient information to support both probabilistic and deterministic determinations required by these criteria and to permit adequate engineering solutions to actual or potential geologic and seismic effects at the proposed site. The size of the region to be investigated and the type of data pertinent to the investigations shall be determined by the nature of the region surrounding the proposed site. The investigations shall be carried out by a review of the pertinent literature and field investigations as identified in paragraphs (a)

through (e) of this section.

(a) **Vibratory Ground Motion.**

The purpose of the investigations is to obtain information needed to assess determine the Safe Shutdown Earthquake ground motion. The seismic sources (capable tectonic sources and seismogenic sources) in the site region shall be identified and evaluated. ~~Earthquakes~~ Controlling earthquakes shall be evaluated for each seismic source.

(b) **Tectonic Surface Deformation.**

The purpose of the investigations is to determine whether or not there is the potential for tectonic surface deformation near the site and, if so, to what extent the nuclear power plant needs to be designed for these occurrences.

(c) **Non-Tectonic Deformation.**

Paragraph (b) concerns investigations required for tectonic surface deformation which can occur coseismically. There are, however, other surface deformations not directly attributable to tectonics such as those associated with subsidence or collapse as in karst terrane, glacially induced offsets, and growth faulting. These phenomena can represent significant surface displacement hazards to a site, but can in many cases be monitored, controlled, or mitigated by engineering, or it can be demonstrated that conditions that were the cause of the displacements no longer exist. Geological and geophysical investigations shall be carried out to identify and define nontectonic deformation features and, where possible, distinguish them from tectonic surface displacements. If such distinction is not possible, the questionable features shall be treated as tectonic deformation.

(d) **Seismically Induced Floods and Water Waves.**

For coastal sites, the potential for nearby and distant tsunamis and other waves that could affect the site must be assessed. Included in this assessment is also the determination of the potential for slides that could generate waves. Information regarding distant and locally generated waves or tsunamis, which have affected the site, and available evidence of runup and drawdown associated with these events shall be analyzed. Local features of coastal or undersea topography which could modify wave runup or drawdown must be considered. For sites located near lakes or rivers, analyses shall include the potential for seismically induced floods or water waves, as, for example, from the failure during an earthquake of a dam upstream or from slides of earth or debris into a nearby lake.

(e) **Volcanic Activity.**

The purpose of the investigations is to assess the potential volcanic hazards that would adversely affect the safe operation of the nuclear power plant.

V. SEISMIC AND GEOLOGIC DESIGN BASES

(a) Determination of the ~~Expected Maximum~~ Controlling Earthquake

~~For each seismogenic and capable tectonic source identified in part IV, the expected maximum earthquake shall be evaluated. As a minimum the expected maximum earthquake shall be the largest historical earthquake in each source. The uncertainty in determining the expected maximum earthquake shall be accounted for in the probabilistic analysis.~~ Insert

(b) Determination of the Ground Motion at the Site.

The ground motion at the site shall be estimated from all controlling earthquakes ~~up to and including the expected maximum earthquake associated with each source which could potentially affect the site using both probabilistic and deterministic approaches.~~ Appropriate models, including local site conditions, shall be used to account for uncertainty in estimating the ground motion for

Insert C

the site. ~~The uncertainty in the ground motion shall be accounted for.~~ The ground motion is defined by both horizontal and vertical free-field ground motion response spectra at the free ground surface or hypothetical rock outcrop, as appropriate.

(c) ~~Determination~~ Comparison of Earthquake Ground Motion ~~for~~ to Safe Shutdown Earthquake ~~the Seismic Design Basis.~~

The Safe Shutdown Earthquake Ground Motion is ~~determined by~~ compared to response spectra developed from the envelope of the ~~comparable of the~~ ground motions determined in Paragraph V(b). ~~Deterministic and~~ Probabilistic seismic hazard analyses shall also be used to assess the adequacy of the Safe Shutdown Earthquake Ground Motion. The probability of exceeding the Safe Shutdown Earthquake Ground Motion is considered acceptably low if it compares favorably (that is, similar to that shown for the lower half of the population) to that at operating nuclear power plants in existence at the time of the effective date of regulation.

The horizontal Safe Shutdown Earthquake Ground Motion at the foundation level of the structures shall be an appropriate response spectrum with a ~~zero~~ peak ground ~~period~~ acceleration of at least 0.1g.

(d) Determination of ~~Need to Design for~~ Likelihood of Surface Tectonic and Non-Tectonic Deformations.

Sufficient geological, seismological and geophysical data shall be provided to clearly establish ~~justify the determination~~ that surface deformation ~~should or should not~~ need to be taken into account in the design of a nuclear power plant. ~~shall be provided in the license application.~~

(e) Determination of Design Bases for Seismically Induced Floods and Water Waves.

The size of seismically induced floods and water waves which could affect a site from either locally or distantly generated seismic activity shall be determined, taking into consideration the results of the investigation required by paragraph (d) of section IV.

(f) Determination of Other Design Conditions.

(1) Soil Stability. Vibratory ground motion associated with the Safe Shutdown Earthquake Ground Motion can cause soil instability due to ground disruption such as fissuring, lateral spreads, differential settlement, and liquefaction, which ~~is~~ are not directly related to surface faulting. Geological features which could affect the foundations of the proposed nuclear power plant structures shall be evaluated, taking into account the information concerning the physical properties of materials underlying the site and the effects of the Safe Shutdown Earthquake Ground Motion.

(2) Slope stability. Stability of all slopes, both natural and artificial, the failure of which could adversely affect the nuclear power plant, shall be considered. An assessment shall be made of the potential effects of erosion or deposition and of combinations of erosion or deposition with seismic activity, taking into account information concerning the physical property of the materials underlying the site and the effects of the Safe Shutdown Earthquake Ground Motion.

(3) Cooling water supply. Assurance of adequate cooling water supply for emergency and long-term shutdown decay heat removal shall be considered in the design of the nuclear power plant, taking into account information concerning the physical properties of the materials underlying the site and the effects of the Safe Shutdown Earthquake Ground Motion and the design basis for tectonic and nontectonic surface deformation. Consideration of river blockage diversion or other failures which may block the flow of cooling water, coastal uplift or subsidence, or tsunami runup and drawdown, and failure of dams and intake structures shall be included in the evaluation, where appropriate.

Where surface deformation is likely, a complete assessment of the extent and the nature of surface deformation must be characterized quantitatively in the license application.

(4) Distant structures. Those structures which are not located in the immediate vicinity of the site but which are safety related shall be designed to withstand the effect of the Safe Shutdown Earthquake Ground Motion and the design basis for surface faulting determined on a comparable basis to that of the nuclear power plant, taking into account the material underlying the structures and the different location with respect to that of the site.

VI. APPLICATION TO ENGINEERING DESIGN

Pursuant to the seismic and geologic design basis requirements of paragraphs V(a) through (f), applications to engineering design are contained in Appendix S to Part 50 of this chapter for the following areas:

(a) Vibratory ground motion.
  (1) Safe Shutdown Earthquake Ground Motion.
  (2) Operating Basis Earthquake.
  (3) Required Plant Shutdown.
  (4) Required Seismic Instrumentation.
(b) Surface Tectonic Deformation.
(c) Seismically Induced Floods and Water Waves and Other Design Conditions.

Dated at Rockville, Maryland, this __ day of _____, 1991.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,
Secretary of the Commission.

DRAFT REGULATORY ANALYSIS

PROPOSED REVISIONS OF 10 CFR PART 100,

AND 10 CFR PART 50

DRAFT REGULATORY ANALYSIS
PROPOSED REVISION OF 10 CFR PART 100
AND 10 CFR Part 50

STATEMENT OF THE PROBLEM

This Regulatory Analysis covers two considerations. First is the revision of the "Reactor Siting Criteria," 10 CFR Part 100, for future plants. The second considerations is the revision of 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." Both considerations address the relocation of plant design criteria from Part 100 to 10 CFR Part 50. This regulatory analysis is presented as two parts for each of the sections, corresponding to these two considerations.

Reactor Siting Criteria (non-seismic):

10 CFR Part 100, "Reactor Siting Criteria," sets forth a framework that guides the Commission in its evaluation of the suitability of proposed sites for stationary power and testing reactors. The present criteria regarding reactor siting were issued in May 1962. There were only a few small power reactors operating at that time. The present regulation requires that every reactor have an exclusion area which has no residents, although transient use is permitted. A low population zone immediately beyond the exclusion area is also required. The regulation recognizes the importance of accident considerations in reactor siting; hence a key element in it is the determination of the size of the exclusion area via the postulation of a large accidental fission product release within containment and the evaluation of the radiological consequences, in terms of doses. Doses are calculated for two hypothetical individuals located at any point (generally, the closest point) on the exclusion area, and at the outer radius of the low population zone, and are required to be within specified limits (25 rem to the whole body and 300 rem to the thyroid gland). In addition, the nearest population center, containing about 25,000 or more residents, is required to be no closer than one and one-third times the outer radius of the low population zone. The effect of these requirements is to set both individual and, to some extent, societal limits on dose (and implicitly on risk), without setting numerical criteria on exclusion area and low population zone size. In practice these siting criteria contained in 10 CFR 100 do more to influence reactor design than site criteria.

Since the issuance of Part 100 in 1962, there have been significant changes and developments in reactor technology. The nuclear power industry has developed and matured significantly; from the existence of a few small power plants generating a very small fraction of the nation's electrical energy, the industry has grown today to the point where there are presently about 110 power reactors in operation in the United States. These supply about 20 percent of the nation's electricity. Reactor power levels have also significantly increased. Early plants typically had reactor power levels of about 150 megawatts thermal, whereas today's plants have power levels about 20 to 25 times greater.

There has been increased development of and reliance upon fission product cleanup systems in modern plants to mitigate the consequences of postulated accidents. As a result, it is possible for present nuclear power plants to be located at sites with a very small exclusion area and still meet the dose criteria of Part 100.

There has also been an increased awareness and concern regarding the effect of potential nuclear accidents. Although accident considerations have been of key importance in reactor siting from the very beginning, major developments such as the issuance of the Reactor Safety Study (WASH-1400) in 1975, the occurrence of the Three Mile Island accident in 1979, the accident at Unit 4 of the Chernobyl reactor in the Soviet Union in 1986, and the issuance of NUREG-1150 "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants" have greatly increased awareness, knowledge and concerns in this area.

Finally, since its initial promulgation in 1962, the Commission has approved more than 75 sites for nuclear power plants, and has had an opportunity to review a number of others. As a result of these reviews, much experience has been gained regarding the site factors that influence risk and their range of acceptability.

The major impetus for the proposed rule is increased interest in new nuclear power generation and the possibility that applicants will request site approval for new nuclear power plants. The Commission believes that, in the event such requests materialize, the criteria for siting power reactors should address directly those site factors important to risk and should reflect significant experience learned since the regulation was first issued in 1962.

Seismic Siting and Earthquake Engineering Criteria:

Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100, "Reactor Siting Criteria," sets forth a framework that guides the staff in its evaluation of the adequacy of applicants' investigations of geologic and earthquake phenomena and proposed plant design parameters. The issuance of Appendix A was an important step in establishing a definitive regulatory framework for dealing with earth science issues in the licensing of nuclear power plants. The Appendix contains the following statement:

> "These criteria are based on the limited geophysical and geological information available to date concerning faults and earthquake occurrence and effect. They will be revised as necessary when more complete information becomes available."

The bases for Appendix A were established in the late 1960's and it became effective December 13, 1973. Since then, with advances in the sciences of seismology and geology, along with the occurrence of some issues in licensing cases not foreseen in the development of Appendix A, a number of significant difficulties have arisen in the application of this regulation. Specific problematic areas include the following:

1. In making geoscience assessments, there is a need for considerable latitude and judgement. This latitude and judgement is required because of limitations in data, the state of the art of geologic and seismic analyses, and the rapid evolution taking place in the geosciences in terms of accumulating knowledge and in modifying concepts. This need appears to have been recognized when Appendix A was developed. However, having geoscience assessments detailed in Appendix A, a regulation, has created difficulty for applicants and the staff in terms of inhibiting the use of needed judgement and latitude. Also, it has inhibited flexibility in applying basic principles to new situations and the use of evolving

methods of analyses in the licensing process.

2. Various sections of Appendix A lack clarity and are subject to different interpretations and dispute. Also, some sections in the Appendix do not provide sufficient information for implementation. As a result of being both overly detailed in some areas and not detailed enough in others, the Appendix has been the source of licensing delays and debate and has inhibited the use of some types of analyses.

3. In other siting areas, such as hydrology, regulatory guidance has been handled effectively through use of regulatory guides. Many problems encountered in implementing Appendix A could best be alleviated through the use of regulatory guides and a program for continuous updating.

4. In the existing regulation, the Operating Basis Earthquake (OBE) is associated with functionality, likelihood of occurrence, and a minimum fraction of the Safe Shutdown Earthquake (SSE). These multi-aspects have resulted in seismic criteria that have led to overly stiff piping systems and excessive use of snubbers and supports which, in fact, could result in less reliable piping systems.

5. The stipulation in Appendix A that the ~~Safe Shutdown Earthquake~~ SSE response spectra be defined at the foundation of the nuclear power plant structures has often led to confrontations with many in the engineering community who regard this stipulation as inconsistent with sound practice.

OBJECTIVES

Reactor Siting Criteria (non-seismic):

The objectives of the proposed regulatory action are to provide a stable regulatory basis for the siting of nuclear power plants by decoupling decisions of site suitability from those affecting plant design.

This will be accomplished by:

a. stating directly those site criteria which, through experience and importance to risk, future sites should meet and

b. relocating from Part 100 to Part 50 those requirements which apply to reactor design.

The major changes associated with the revision of the regulation are:

1. The proposed regulatory action will apply to applicants who apply for an early site approval on or after the effective date of the final regulations. The current regulation will remain in place and be applicable to all licensees and applicants prior to the effective date of the final regulations.

2. Part 100 will state directly these criteria applicable to the site

(e.g. exclusion area distance, population distribution).

3. Criteria such as source term and dose calculations would be used for evaluating plant features not site suitability and will be placed into Part 50 consistent with the location in the regulation of other design requirements.

Since the revision to the regulation will not be a backfit, the licensing bases for existing nuclear power plants must remain in the regulation. Therefore, the revised regulation will be designated as a new subpart to Part 100 for future plants while maintaining the current Part 100 for existing plants.

Finally, in support of the above changes, Regulatory Guide 4.7 has been revised.

Seismic Siting and Earthquake Engineering Criteria:

The objectives of the proposed regulatory action are to:

1. Provide a stable regulatory basis for seismic and geologic siting and applicable earthquake engineering design of future nuclear power plants that will avoid licensing delays due to unclear regulatory requirements and provide a flexible structure to permit consideration of new technical understandings; and

2. Have the revision to the regulation completed prior to the receipt of an early site application.

The major points associated with the revision of the regulation are:

1. The proposed regulatory action will apply to applicants who apply for an early site permit, design certification, or combined license (construction permit and operating license) on or after the effective date of the revised regulation.

2. Criteria not associated with the selection of the site or establishment of the safe shutdown earthquake ground motion have been placed into Part 50. This action is consistent with the location of other design requirements in Part 50.

Because the revised criteria presented in the proposed regulation will not be applied to existing plants, the licensing bases for existing nuclear power plants must remain in the regulations. Therefore, the proposed revised criteria on seismic and geologic siting would be designated as a new Appendix B to 10 CFR Part 100 and would be added to the existing body of regulations.

Earthquake engineering criteria will be located in 10 CFR Part 50, Appendix S. Since Appendix S is not self initiating, applicable sections of Part 50 (§50.34, §50.54) are revised to reference Appendix S.

The proposed rule would also make conforming amendments to 10 CFR Parts 52 and 100. 52.17(a)(1)(vi) and Paragraphs 100.20(c)(1) and (3) would be amended to note Appendix B to Part 100.

Finally, in support of the above changes, regulatory guides and standard review

plan sections will be revised or developed, as appropriate.

ALTERNATIVES

Reactor Siting Criteria (~~non-seismic~~):

The alternatives considered included:

- no action (e.g. continue to use existing Part 100)
- delete the existing Part 100 and replace it with an entirely new Part 100 which eliminates the dose calculation and specifies site criteria.
- for seismic and earthquake engineering, replace the entire regulation with a regulatory guide
- retain the existing Part 100 for current plants and add a new section to Part 100 for future plants which eliminates the dose calculation and specifies site criteria.

No action is not considered an acceptable alternative. Although the siting related issues associated with the current generation of plants are completed or nearing completion, the proposed regulatory action would benefit the licensing process for future reactors (particularly certified designs) by decoupling siting from plant design such that the certified design would not be dependent on site parameters to establish the fission product retention characteristics of the design.

Deletion of the existing regulation also is not considered an acceptable alternative since it is the licensing bases for virtually all the operating nuclear power plants and those that are in various stages of obtaining their operating license.

Replacing the entire regulation with a regulatory guide is not considered acceptable because a regulatory guide is non-mandatory. The staff believes that there could be an increase in the risk of radiation exposure to the public if the siting and earthquake engineering criteria were non-mandatory.

Therefore, the last option is the preferable course of action and is the option evaluated further in this analyses.

Seismic Siting and Earthquake Engineering Criteria:

The first alternative considered by the Commission was to avoid initiating a rulemaking proceeding. This is not an acceptable alternative. Although the siting related issues associated with the current generation of nuclear power plants are completed or nearing completion, there is a renewed sense of urgency to initiate the proposed regulatory action in light of the current and future staff review of advanced reactor seismic design criteria. The current regulation has created difficulty for applicants and the staff in terms of inhibiting flexibility in applying basic principles to new situations and using evolved methods of analysis in the licensing process.

A second alternative considered was the deletion of the existing regulation (Appendix A to Part 100). This is not an acceptable alternative because these provisions form part of the licensing bases for many of the operating nuclear power plants and others that are in various stages of obtaining their operating

license.

A third alternative considered was the replacement of the entire regulation with a regulatory guide. This is not acceptable because a regulatory guide is non-mandatory. The staff believes that there could be an increase in the risk of radiation exposure to the public if the siting and earthquake engineering criteria were non-mandatory.

Since there are problems with implementing the existing regulation (Appendix A to Part 100), the only satisfactory alternative is to revise the regulation. The approach of establishing the revised requirements in a new Appendix B while retaining the existing regulation was chosen as the best alternative.

Finally, the following memoranda or reports provide further support for a revision to Appendix A to Part 100:

1. Staff Requirements Memorandum from Chilk to Taylor dated January 25, 1991, Subject: SECY-90-341 - Staff Study on Source Term Update and Decoupling Siting from Design.

> "The staff should further ensure that the revisions to Appendix A of Part 100 are available to support the time schedule shown in the paper [Commission Briefing on Source Term Update and Decoupling Siting from Design (SECY-90-341), dated December 13, 1990] for option 2, and are technically supportable with the information that will be available at the time the draft comes forward for Commission action."

2. Memorandum from Taylor to Beckjord dated September 6, 1990, Subject: Revision of Appendix A, 10 CFR Part 100, "Seismic and Geologic Siting Criteria for Nuclear Power Plants."

> "I approve of your plan to begin work on the development of a revised regulation and this activity should be assigned a high priority status."

3. NUREG-0625, Siting Policy Task Force.

> "Revise Appendix A to 10 CFR Part 100 to better reflect the evolving technology in assessing seismic hazards."

4. NUREG-1061, "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee," Vol 5, April 1985.

> "The Committee recommends that
>
> o Rulemaking amending Appendix A to 10 CFR Part 100 be undertaken to permit decoupling of the OBE and SSE. "...."

CONSEQUENCES

a. Costs and Benefits

Benefits

Reactor Siting Criteria (non-seismic):

The revision to Part 100 will be beneficial to all. The industry and public will benefit from a clearer, more uniform and consistent licensing process.

Benefits to industry, the public and the NRC staff will result from the following changes:

1. Clear Statement Of Site Criteria. The proposed revision to Part 100 provides clear criteria regarding acceptable exclusion area distances and population distribution. Applicants will be able to select sites that meet these criteria without having to be dependent upon a reactor design. In addition, the criteria have been selected to be consistent with past experience and with the quantitative health objectives in the NRC Safety Goal Policy.

2. Current Practices Will Be Reflected. The proposed regulations reflect industry design practices and the associated staff review procedures that have evolved since Part 100 was issued in 1962. An example of this is the review of nearby industrial and transportation facilities which will be incorporated into the regulations for the purpose of site suitability and has been a part of the staff review for many years. The criteria and standards are the same as those currently in staff review guidance documentation (Standard Review Plan, etc.). Hence, the proposed rule involves no substantive changes in this area and merely codifies what has been staff practice for a number of years. Additionally, the numerical population density values and the exclusion area distance outlined in Regulatory Guide 4.7 will be codified in the proposed rulemaking.

3. Source Term And Dose Calculations. The proposed rule would eliminate the use of a postulated source term, assumptions regarding mitigation systems and meteorology, and the calculation of radiological consequences to determine the sizes of the exclusion area and low population zone. It would instead require a minimum exclusion area distance.

4. Text Clarification And Elimination of Low Population Zone. The Commission considers that the functions intended for the "low population zone", namely, a low density of residents and the feasibility of taking protective actions, have in fact been taken over by other regulations or can be accomplished by other means. Protective action requirements are defined via the use of the EPZ's, while restriction on population close to the plant can be assured via proposed population density criteria. For these reasons, the Commission is proposing to eliminate the requirement of a low population zone for future power reactor sites.

In addition, the proposed rule would require that important site factors, such as population distribution, topography, and transportation routes be considered and examined in order to determine whether there are any site

characteristics that could pose a significant impediment to the development of an emergency plan. This proposed requirement is also consistent with 10 CFR Part 52.

Planning for emergencies is part of the Commission's defense-in depth approach. The Commission concludes that site characteristic that may represent an impediment to development of adequate emergency plans, such as limitations of access or egresses in the immediate vicinity of a nuclear power plant should be identified at the early stage of site approval rather than at a later date prior to operation thus avoiding significant licensing delays.

5. Risk To The Public. The NRC Staff has generated a reduced set of source terms based on the NUREG-1150 analyses and the Independent Risk Assessment Plant. These source terms were used in the MELCOR Accident Consequences Code System (MACCS) for six reactor-containment designs. The results of these analyses indicate that the risk to the public is acceptably low and the guidelines of the Commission's Safety Goal Policy are met for all plants up to 3800 MWth, the largest capacity plant considered in the analyses.

Seismic Siting and Earthquake Engineering Criteria:

The revision of Appendix A to Part 100 will be beneficial to all. The public will benefit from a clearer, more uniform and consistent licensing process subject to fewer interpretations. The NRC staff will benefit from improved regulatory implementation (both technical and legal), fewer interpretive debates, and increased regulatory flexibility. Applicants will derive the same benefits in addition to avoiding licensing delays due to unclear regulatory requirements.

The proposed regulatory action reflects changes intended to (1) benefit from the experience gained in applying the existing regulation; (2) resolve interpretative questions; (3) provide needed regulatory flexibility to incorporate state-of-the-art improvements in the geosciences and earthquake engineering; (4) simplify the language to a more "plain English" text; and (5) acknowledge various internal staff and industry comments.

Benefits to applicants or NRC staff will result from the following changes:

1. Reflect current practices. The proposed regulations would reflect industry design practices and the associated staff review procedures that have evolved since the initial regulation (Appendix A to Part 100) was issued in 1973. Many of these practices and procedures were incorporated into the revision of Standard Review Plan Sections 2.5.2, 3.7.1, 3.7.2, and 3.7.3 that are associated with the resolution of Unresolved Safety Issue (USI) A-40, "Seismic Design Criteria."

2. Define seismic sources. Better definition of seismic source types and streamlined procedures for their use in specifying ground motion expected at a plant site will eliminate what has been a major source of licensing delays.

3. Use probabilistic analyses. The proposed regulation will require

the use of both deterministic and probabilistic analyses. The lack of recognition of probabilistic analyses in the existing regulation has made it difficult to treat issues like uncertainty and recurrence period. The proposed rule states that probabilistic estimates of seismic hazard should be calculated and the underlying assumptions and associated uncertainties should be documented to assist in the staff's overall evaluation of the site and proposed design basis. The major purposes and associated rational for carrying out the probabilistic hazard analysis are to: (i) Systematically include uncertainties in the various factors (such as, seismic sources, seismicity and ground motion attenuation characteristics) associated with ground motion and hazard estimates. The probabilistic method enables alternative hypotheses and diverse expert opinion in these estimates to be included in a quantitative fashion. Also, the influence of these factors on the ground motion and hazard estimates can be displayed. (ii) Identify, in terms of magnitude and distance, significant contributions to ground motion at the nuclear power plant site, enabling a differentiation between seismic sources that are significant from those that are not. Standardized plant designs will be performed using a smooth ground response spectra chosen well in advance of the actual nuclear power plant site determination. Discrepancies between the ground response spectra used in design and the site-specific response spectra can be quickly identified and evaluated. Also, if new information, not considered in the initial probabilistic analysis emerges, a framework and structured approach exists by which the impact of this new information on the plant's design basis ground motion can be quickly assessed. As a result, extensive unnecessary plant reevaluations will be avoided. (iii) Demonstrate that the probability of exceeding the ~~Safe Shutdown Earthquake~~ Ground Motion ~~(SSE)~~ compares favorably~~, that is, similar~~ to that shown for the lower half of the population of current (1991) operating nuclear power plants. (iv) Provide hazard estimates for use in the seismic probabilistic risk assessment (PRA)~~ or~~ to demonstrate the adequacy of the hazard estimate used in the design. For future plants, the results of the probabilistic risk assessment (equipment and plant capacity estimates, and core damage frequency estimates) will be available. This information coupled with the probabilistic hazard information can provide a quick assessment of new seismic information to assess the impact on the health and safety of the public.

4. Eliminate the ~~many diverse definitions of~~ the Operating Basis Earthquake (OBE). The OBE is now only associated with the functionality of structures, equipment, and components. Previously, the OBE was also associated with a likelihood of occurrence and a minimum percentage of the ~~Safe Shutdown Earthquake~~ (SSE)~~.~~ In some cases, for instance, piping, the multi-facets of the OBE made it possible for the OBE to have more design significance than the SSE.

5. Reduced analyses. Applicants that choose to set the ~~Operating Basis Earthquake~~ at one-third of the ~~Safe Shutdown Earthquake~~ Ground Motion can satisfy OBE functionality requirements without performing any explicit response analysis. There is high confidence that, at this earthquake level, with other postulated concurrent loads, most

critical structures, systems and components will not exceed currently used design limits. Applicants have the option of selecting an OBE greater than one-third the SSE; however, a suitable analysis and design must be performed.

6. Required plant shutdown. The revised regulations state in Part 50, consistent with other conditions of licenses, that plant shutdown is required if the ~~Operating Basis Earthquake~~ is exceeded. Specific guidance is provided to define what constitutes an ~~OBE~~ exceedance that would require a plant shutdown. In addition, guidance is provided for an orderly plant shutdown and the re-starting of a plant that has been shut down because of earthquake ground motion.

7. Limit level of detail. The level of detail presented in the proposed regulations has been limited to general guidance. The proposed regulations would identify and establish basic requirements. Detailed guidance, that is, the procedures acceptable to the NRC for meeting the requirements, has been removed and placed in regulatory guides or standard review plan sections.

8. Provide greater flexibility. The proposed regulations would provide a flexible structure that will permit the consideration of new technical understandings and state of the art advancements.

9. Clarify interpretations. Changes have been made to resolve past questions of interpretation. As an example, the definitions and required investigations sections of the proposed regulations have been significantly changed to eliminate or modify phrases that were more applicable to only the western United States.

10. Clarify text. The proposed regulations would use more explicit terminology. For instance, the Safe Shutdown Earthquake (SSE) is now referenced as the Safe Shutdown Earthquake Ground Motion (SSE). Appropriate changes within the text highlight that the ground motion used as the design basis is not associated with a single earthquake but a composite of ~~many~~ the expected earthquakes.

Costs

Reactor Siting Criteria (non-seismic):

The costs associated with the revised regulations are subdivided into two categories; the first is associated with siting criteria modifications (Part 100), the second is associated with (Part 50) modifications.

Part 100

The overall cost impact associated with revising the siting criteria aspects of the regulation are neutral. Important factors in this regard are:

1. Elimination of Dose Calculation. The proposed approach of eliminating the use of postulated accident source term and the use of dose calculations in determining the acceptability of site and replacing it with population distribution criteria and a minimum size in the exclusion area is expected to reduce time and costs

required in obtaining site approval. The values specified for the exclusion area distance and the population distribution are those currently specified in Regulatory Guide 4.7 and thus do not represent new criteria or practice.

2. Nearby Industrial and Transportation Facilities. This area of review is proposed to be incorporated into the regulations for the purpose of site suitability and has been a part of the staff review for many years. The criteria and standards are the same as those currently in staff review guidance documentation (Standard Review Plan, etc.). Hence, the proposed rule involves no substantive changes in this area and merely codifies what has been staff practice for a number of years.

3. Feasibility of Carrying out Protective Actions. The proposed rule would require that important site factors, such a population distribution, topography, and transportation routes be considered and examined in order to determine whether there are any site characteristics that would pose a significant impediment to the development of an emergency plan.

The cost impact associated with this revision is neutral. It is expected to increase time and costs for site approval but should significantly reduce time and costs at the OL or COL stage by avoiding licensing delays.

4. Periodic Reporting of Population and Other Activities. The proposed rule would require that periodic reports be prepared and presented to the Commission regarding population changes as well as significant changes in any man-related activities that might represent a potential hazard to the nuclear plant. Reports updating the population around the plant out to a distance of thirty miles would be required every ten years after the date of initial plant operation and reports on changes in man-related hazards every five years.

The reporting of this information over the life of the plant and any required evaluations would have minimal and inconsequential cost impact when considered in the overall costs required for obtaining site approval.

5. Elimination of Some Meteorological Information. The present regulation has no numerical size requirement for the exclusion area, in terms of distance, and instead assesses the consequences of a postulated radioactive fission product release within containment, coupled with assumptions regarding containment leakage, performance of certain fission product mitigation systems and site meteorology for a hypothetical individual located at any point on the exclusion area boundary ~~as well as~~ hydrological information. The plant and site combination is considered to be acceptable if the calculated consequences do not exceed the values given in the present rule. Regulatory Guide 4.7 suggests an exclusion area distance of 0.4 miles, since this has been found, in conjunction with typical engineered safety features, to meet the dose values in the existing rule.

The Commission considers an exclusion area to be an essential feature of a reactor site, and is retaining this requirement for future reactors. However, in keeping with the recommendation of the Siting Policy Task Force to decouple site requirements from reactor design, the proposed rule would eliminate the use of a postulated source term, assumptions regarding mitigation systems and meteorology, and the calculation of radiological consequences to determine the sizes of the exclusion area and low population zone. It would instead require a minimum exclusion area distance of 0.5 miles for reactors. The elimination of some meteorological information is expected to reduce time and costs associated with obtaining site approval.

Part 50

The overall cost impact associated with revising the reactor licensing aspects of the regulation are neutral because the source term and dose calculations have always been required under Part 100 for site suitability but will now be required under Part 50 and used in evaluating plant features. Therefore there is no change in cost.

Seismic Siting and Earthquake Engineering Criteria:

The costs associated with the proposed regulations are subdivided into two categories; the first is associated with the geosciences and site investigations (Appendix B to Part 100), the second is associated with earthquake engineering (Appendix S to Part 50).

Appendix B to Part 100

As substantiated below, the overall cost impact associated with the geosciences and site investigation aspects of the proposed regulation are neutral. Specific examples include:

1. Reduced Licensing Delays. The licensing process will be enhanced because information needed for the staff review can be incorporated in the safety analysis reports at the time of docketing instead of later through staff questions and applicant responses.

2. Probabilistic Analyses. Probabilistic analyses to determine vibratory ground motion, surface tectonic deformation, and seismically induced floods and water waves will marginally increase the cost required for plant site investigations. However, the proposed revisions reflect what is already current staff practice. For sites in the eastern U.S., the availability of probabilistic methods may actually simplify the task of analyzing earthquake-induced ground motion. Furthermore, probabilistic analysis will make it possible to more readily ~~incorporate~~ additional data that may become available during site review.

3. Seismic Sources. The new approach towards seismic sources (using seismogenic sources instead of tectonic provinces), better definition of the location to be used for sources in the site vicinity, and other ~~streamlining in~~ the licensing approach are expected to reduce

time and costs required for obtaining site approval.

Appendix S to Part 50

As substantiated below, the overall cost impact associated with the earthquake engineering aspects of the proposed regulation are neutral or reduced. Specific examples include:

1. Reduced OBE Analysis. The response analyses associated with the ~~Operating Basis Earthquake~~ (OBE) may be eliminated if the applicant sets the OBE at one-third of the ~~Safe Shutdown Earthquake Ground Motion~~ (SSE). Selecting an OBE value greater than one-third of the SSE does not increase the analytical effort above current requirements.

2. Control Point Location. Changing the location of the control point (the point at which the vibratory ground motion is applied) from the foundation level to the free-field does not affect costs. The following discussion from Section 2.1.1.4 of NUREG-1233 (pages 13 and 14) is applicable:

> "A number of recent plants were designed to the 1975 Standard Review Plan requirements which specified the free-field motion at the free-surface for soil-structure interaction analysis. During the operating license (OL) review, the implementation of the current position of input motion at the foundation level in the free field resulted in a modification of some structural floor beams of seismic Category I structures at one plant. No hardware changes resulted at other plants. (Note that the staff's investigation was limited to the safe shutdown systems and structures that housed them, and allowance was made for tested strength values in some cases.)"

3. Plant Shutdown. Although the new seismic instrumentation requirements are different, the cost is essentially the same as that currently used in operating plants. The maintenance and calibration costs with the new solid-state seismic instrumentation should be less than that associated with the current instrumentation. The time associated with the processing of instrumentation data will be less since data will not be shipped from the site for evaluation, thereby reducing the potential for prolonged plant shutdown while data are being evaluated. In general, the ability to expeditiously assess the effects of the earthquake on the plant will save both staff and licensee resources.

IMPACTS

a. Other NRC Programs

None for the non—seismic siting criteria.

Although Appendix A to 10 CFR Part 100 is titled "Seismic and Geologic Siting Criteria for Nuclear Power Plants," it is also referenced in two other Parts of the regulation. They are (1) Part 40, "Domestic Licensing of Source Material," Appendix A, "Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Waste Produced by the Extraction or Concentration of Source Material from Ores Processed Primarily for Their Source Material Content," Section I, Criterion 4(e), and (2) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste," Paragraphs (a)(2)(b) and (a)(2)(f)(1) of §72.102. The proposed regulation, Appendix B to Part 100, is still applicable only to nuclear power plants. The need to revise Part 72 and Appendix A to Part 40, subject to the implementation of Appendix B to Part 100, should be a separate rulemaking initiative.

b. Other Government Agencies Since the siting and licensing of nuclear power plants is carried out solely by NRC staff, no impact is projected on other government agencies.

c. Constraints

None.

DECISION RATIONALE

Reactor Siting Criteria (non-seismic):

The major considerations that have guided the Commission in this proposed revision to the reactor site criteria are as follows:

1. The criteria will assure a low risk both for individuals as well as for society in general, even in the event of severe, but unlikely reactor accidents. The proposed criteria are consistent with the Commission Safety Goal Policy with respect to the risk of both prompt and latent cancer fatalities. In addition, the Commission has also examined the risks associated with land contamination or property damage in the event of significant releases for long-lived radioactive species, such as cesium. The proposed criteria are expected to result in a low likelihood of any significant offsite contamination of densely populated areas.

2. The criteria will assure that both man-made as well as natural events associated with the site location are identified and used in matching a design with the site.

3. The criteria will assure that a range of protective actions can feasibly be carried out to protect the public in the event of emergency.

4. The criteria will assure that potential changes in population or in the nature of facilities located nearby will be identified and evaluated as to their hazards to the plant.

The proposed revisions reflect current staff practice.

The revised regulations will not reduce risk, but will improve the description in the regulations of current staff practice in licensing.

Seismic Siting and Earthquake Engineering Criteria:

The recommendations to revise the existing regulation (Appendix A to 10 CFR Part 100) and replace it with the proposed regulations pertaining to the geosciences and site investigations (Appendix B to Part 100), and earthquake engineering (Appendix S to Part 50) are based primarily on ~~the~~ deterministic and qualitative arguments. The staff's evaluation augments the regulatory analysis associated with the implementation of Unresolved Safety Issue (USI) A-40, Seismic Design Criteria (NUREG-1233). USI A-40 was implemented in August 1989 through the revision of Standard Review Plan Sections 3.7.1, Seismic Design Parameters, 3.7.2, Seismic System Analysis, 3.7.3, Seismic Subsystem Analysis, and 2.5.2, Vibratory Ground Motion.

The staff's conclusion is that for operating reactor and operating license applicants, the proposed regulations would have little effect on risk. Operating plants have generally been, and will be, seismically upgraded by plant-specific actions such as implementation of the Systematic Evaluation Program (SEP), the implementation of Generic Letter 88-20, Supplement 4, Individual Plant Examinations of External Events (IPEEE) for Severe Accident Vulnerabilities, the proposed implementation of USI A-46, Verification of Seismic Adequacy of Equipment in Operating Plants, and NRC Bulletin programs. Therefore, this regulatory action will be "forward-fit" applicable only to applicants who apply for an early site permit, design certification, or combined license (construction permit and operating license) on or after the effective date of the final regulations.

For applicants of early site permits, design certifications, or combined licenses (construction permit and operating license), no increases in costs are envisioned to implement the proposed regulations. The proposed regulations reflect current staff practice and most applicants are aware of these requirements. In addition, the proposed regulations will reduce delays in the licensing process because information needed for the staff review can be incorporated in the safety analysis reports at the time of docketing instead of later through staff questions and applicant responses. Implementation of the proposed regulations will lead to more uniform safety margins. Therefore, the staff proposed that all new applicants be required to comply with the proposed regulations.

The proposed regulations will not reduce risk, but will improve the description in the regulation of current staff practice in licensing.

Current Regulatory Action

The current regulatory action consists of the following:

1. Revisions to §50.8, §50.34, §50.54, and §52.17.

2. Revisions to §100.1, §100.2, §100.3, and §100.8.

3. Add Subpart B §100.20, §100.21, §100.22 and §100.23.

4. New Appendix B to Part 100, Criteria for the Seismic and Geologic Siting of Nuclear Power Plants After [Effective Date]

5. New Appendix S to Part 50, Earthquake Engineering Criteria for Nuclear Power Plants

6. New Regulatory Guides:

   a. DG-1015, "Identification and Characterization of Seismic Sources"

   b. DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions"

   c. DG-1018, "Restart of a Nuclear Power Plant Shut Down Due to a Seismic Event"

7. Revised Regulatory Guide:

   a. Proposed Revision 2 to Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations"

   b. DG-1016, Second Proposed Revision 2 to Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes"

8. Revised Standard Review Plan Section:

   2.5.2, Vibratory Ground Motion

Future Regulatory Action

Several existing regulatory guides will be revised to incorporate editorial changes or maintain the existing design or analysis philosophy . These guides will be issued to coincide with the publication of the final regulations that would implement this proposed action.

The following regulatory guides will be revised to incorporate editorial changes For example, the type of changes contemplated would be to reference new paragraphs in Appendix B to Part 100 or Appendix S to Part 50:

1. 1.57, "Design Limits and Loading Combinations for Metal Primary Containment System Components"

2. 1.59, "Design Basis Floods for Nuclear Power Plants"

3. 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants"

4. 1.83, "Inservice Inspection of Pressurized Water Reactor Steam Generator Tubes"

5. 1.92, "Combining Modal Responses and Spatial Components in Seismic Response Analysis"

6. 1.102, "Flood Protection for Nuclear Power Plants"

7. 1.121, "Bases for Plugging Degraded PWR Steam Generator Tubes"

8. 1.122, "Development of Floor Response Spectra for Seismic Design of Floor-Supported Equipment or Components"

The following regulatory guides will be revised to maintain existing design or analysis philosophy. For example, the types of changes contemplated would be to change OBE to a fraction of the SSE:

1. 1.27, "Ultimate Heat Sink for Nuclear Power Plants"

2. 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants"

3. 1.124, "Service Limits and Loading Combinations for Class 1 Liner-Type Component Supports"

4. 1.130, "Service Limits and Loading Combinations for Class 1 Plate-and-Shell-Type Component Supports"

5. 1.132, "Site Investigations for Foundations of Nuclear Power Plants"

6. 1.138, "Laboratory Investigations of Soils for Engineering Analysis and Design of Nuclear Power Plants"

7. 1.142, "Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments)"

8. 1.143, "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants"

During the revision of the regulatory guides cited above, if additional changes are made, the applicable guide(s) will be distributed for public comment. Several regulatory guides will be revised to incorporate editorial changes or, maintain the existing design or analysis philosophy.

IMPLEMENTATION

This regulatory action is applicable only to applicants that apply for an early site permit, design certification, or combined license (construction permit and operating license) on or after the effective date of the final regulations.

DRAFT ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT

PROPOSED REVISION OF

10 CFR PART 100

AND

APPENDIX A TO 10 CFR PART 100

DRAFT ENVIRONMENTAL ASSESSMENT AND FINDING OF NO SIGNIFICANT IMPACT PROPOSED REVISION OF 10 CFR PART 100, 10 CFR PART 100 APPENDIX A, AND 10 CFR PART 50

The Nuclear Regulatory Commission is amending its regulations to update the criteria used in the reactor siting; seismic and geologic siting; and earthquake engineering for nuclear power plants. ~~This is~~ two separate but related areas and each area is discussed separately. These are

Identification of Proposed Action

Reactor Siting Criteria (non—seismic):

Title 10 CFR Part 100, "Reactor Site Criteria," was originally issued in May 1962. The proposed amendment will apply to applicants who apply for site approval on or after the effective date of the final regulation. Since the revision to the regulation will not be a backfit, the bases for existing nuclear power plants must remain in the same regulation. Therefore, the revised regulation on siting will be designated 10 CFR Part 100, Subpart B.

Criteria not associated with the selection of the site will be relocated into Part 50 consistent with the location in the regulation of other design requirements. Hence, source term and dose calculations will be used for evaluating plant features, and not site suitability.

The proposed rule would eliminate the use of a postulated accident source term and the use of a dose calculation in the determination of acceptability for a nuclear power plant site. It would also eliminate the designation of a low population zone. Instead, it would set a minimum size for the exclusion area and would set population density criteria around proposed nuclear power reactor sites. In addition, criteria regarding the evaluation of man—made hazards and the feasibility of carrying out protective actions in the event of an emergency are to be incorporated. Finally, requiremtns are also proposed for reporting population changes and significant changes in offsite activities periodically.

Seismic Siting and Earthquake Engineering Criteria:

Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants," to 10 CFR Part 100, "Reactor Siting Criteria," was originally issued as a proposed rule on November 25, 1971 (36 FR 22601); published as a final rule on November 13, 1973 (38 FR 31279); and became effective on December 13, 1973. There have been two amendments to 10 CFR Part 100, Appendix A. The first amendment, issued November 27, 1973 (38 FR 32575), corrected the final rule by adding the legend under the diagram. The second amendment resulted from a petition for rule making (PRM 100-1) requesting that an opinion interpreting and clarifying Appendix A with respect to the determination of the Safe Shutdown Earthquake be issued. A notice of filing of the petition was published on May 14, 1975 (40 FR 20983). The substance of the petitioner's proposal was accepted and published as an immediately effective final rule on January 10, 1977 (42 FR 2052).

The proposed amendment will apply to applicants who apply for a construction permit, early site permit, design certification, or combined license

(construction permit and operating license) on or after the effective date of the revised regulation. Because the revised criteria presented in the proposed regulation will not be applied to existing plants, the licensing bases for existing nuclear power plants must remain part of the regulations. Therefore, the proposed revised criteria on seismic and geologic siting would be designated as a new Appendix B to 10 CFR Part 100, "Criteria for the Seismic and Geologic Siting of Nuclear Power Plants After [Effective Date]," and would be added to the existing body of regulations.

Criteria not associated with the selection of the site or establishment of the safe shutdown earthquake ground motion have been placed into Part 50. This action is consistent with the location of other design requirements in Part 50. Hence, earthquake engineering criteria would be located in Appendix S to 10 CFR Part 50, "Earthquake Engineering Criteria for Nuclear Power Plants."

The proposed regulatory action reflects changes intended to (1) benefit from the experience gained in applying the existing regulation; (2) resolve interpretative questions; (3) provide needed regulatory flexibility to incorporate state-of-the-art improvements in the geosciences and earthquake engineering; (4) simplify the language to a more "plain English" text; and (5) acknowledge various internal staff and industry comments.

Need for the Proposed Action

Reactor Siting Criteria (non-seismic):

Since its initial promulgation in 1962, the Commission has approved more than 75 sites for nuclear power plants, and has had an opportunity to review a number of others. As a result of these reviews, much experience has been gained regarding the site factors that influence risk and their range of acceptability.

Additionally, there has also been an increased awareness and concern regarding the effect of potential nuclear accidents. Although accident considerations have been of key importance in reactor siting from the very beginning, major developments such as the issuance of the Reactor Safety Study (WASH-1400) in 1975, the occurrence of the Three Mile Island accident in 1979, the Chernobly accident in the Soviet Union in 1986, and the issuance of NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," in December 1990, have greatly increased awareness, knowledge, and concerns in this area.

The major impetus for the proposed rule is increased interest in new nuclear power generation and the possibility that applicants will request site approval for new nuclear power plants. The Commission believes that, in the event such requests materialize, the criteria for siting power reactors should address directly those site factors important to risk and should reflect the significant experience learned since the regulation was first issued in 1962.

Seismic Siting and Earthquake Engineering Criteria:

The experience gained in the application of the procedures and methods set forth in the current regulation, the difficulties encountered, and the rapid advancement in the state-of-the-art of earth sciences have made it necessary to update the 1973 criteria.

Environmental Impacts of the Proposed Action

Reactor Siting Criteria (non-seismic):

Part 100, Subpart B, contains the considerations which will guide the Commission in its evaluation of the suitability of a proposed site for nuclear power plants after the effective date of the final regulation. The revision to Part 50 will contain the engineering considerations which guide the Commission in its evaluation of the suitability of the plant design. The amendment to 10 CFR Part 100 as stated in the proposed rule making package reflects current licensing practice with additional reporting requirements and will not change the radiological envirnmental impact. Further, the Policy Statement on Severe Accidents Regarding Future Design and Existing Plants, published August 8, 1985 (50 FR 32138), affirms the Commission's belief that a new design for a nuclear power plant can be shown to be acceptable for severe accident concerns if the criteria and procedural requirements cited in 50 FR 32138 are met. Stated differently, the proposed regulatory action (10 CFR Part 100, Subpart B) are specifically based on maintaining the present level of risk of radiological releases, thus having zero effect comparer to the regulation (10 CFR Part 100, Subpart A) they replace for future siting applications.

Seismic Siting and Earthquake Engineering Criteria:

Proposed Appendix B to Part 100 contains the seismic and geologic considerations which guide the Commission in its evaluation of the suitability of proposed sites for nuclear power plants. Proposed Appendix S to Part 50 contains the earthquake engineering considerations which guide the Commission in its evaluation of the suitability of the plant design bases. The amendment of Appendix A to 10 CFR Part 100 as stated in Appendices B and S reflect current licensing practice and will not change the radiological environmental impact offsite. Further, the Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants, published August 8, 1985 (50 FR 32138) affirms the Commission's belief that a new design for a nuclear power plant can be shown to be acceptable for severe accident concerns if the criteria and procedural requirements cited in 50 FR 32138 are met. Stated differently, the proposed regulatory actions (Appendix B to Part 100 and Appendix S to Part 50) are specifically based on maintaining the present level of risk of radiological releases, thus having zero effect compared to the regulation (Appendix A to Part 100) they replace.

Onsite occupational radiational exposure associated with inspection and maintenance will not change. These activities are principally associated with seismic instrumentation. The regulatory guide pertaining to seismic instrumentation (Second Proposed Revision to Regulatory Guide 1.12, Nuclear Power Plant Instrumentation for Earthquakes) specifically cites occupational radiation exposure as a consideration in selecting the location of the instruments.

The proposed amendments do not affect non-radiological plant effluents and have no other environmental impact. Therefore, the Commission concludes that there are also no significant non-radiological environmental impacts associated with the proposed amendments to the regulations.

Alternatives to the Proposed Action

As required by Section 102(2)(E) of NEPA (42 U.S.C.A. 4332(2)(E)), the staff has considered possible alternatives to the proposed action.

The first alternative considered by the Commission was to avoid initiating a rulemaking proceeding. This is not an acceptable alternative. Although the siting related issues associated with the current generation of nuclear power plants are completed or nearing completion, there is a renewed sense of urgency to initiate the proposed regulatory action in light of the current and future staff review of advanced reactor seismic design criteria. The current regulation has created difficulty for applicants and the staff in terms of inhibiting flexibility in applying basic principles to new situations and the use of evolving methods of analyses in the licensing process. Further, ~~by~~ decoupling siting requirements from plant design requirements such that the certified design would not be dependent on site parameters to establish the fission product retention characteristics of the design would benefit the licensing process.

A second alternative considered was the deletion of the existing regulation. This is not an acceptable alternative because these provisions form the licensing bases for many of the operating nuclear power plants and others that are in various stages of obtaining their operating license.

For the seismic siting and earthquake engineering criteria areas, another alternative considered was the replacement of the entire regulation with a regulatory guide. This is not acceptable because a regulatory guide is non-mandatory. The staff believes that there could be an increase in the risk of radiation exposure to the public if the siting and earthquake engineering criteria were non-mandatory.

The approach of establishing the revised requirements in ~~2~~ new sections of the regulations while retaining the existing regulation was chosen as the best alternative. The public will benefit from a clearer, more uniform and consistent licensing process subject to fewer interpretations. The NRC staff will benefit from improved regulatory implementation (both technical and legal), fewer interpretive debates, and increased regulatory flexibility. Applicants will derive the same benefits in addition to avoiding licensing delays due to unclear regulatory requirements. The adoption of revised siting and engineering criteria would increase the efficiency of regulatory actions associated with any resurgence of licensing activity.

Alternative Use of Resources

No alternative use of resources was considered.

Agencies and Persons Consulted

Reactor Siting Criteria (non-seismic):

NRC Staff developed the enclosed rulemaking recommendations. No outside agencies or consultants were used in developing this rulemaking package.

Seismic Siting and Earthquake Engineering Criteria:

Staff developed reports ~~incorporating contractor evaluations are the bases for~~ the Commission's recommendations.

Finding of No Significant Impact

The Commission has determined under the National Environmental Policy Act of 1969, as amended, that the proposed amendments to 10 CFR Parts 50 and 100, relocating dose calculation requirements and specifying siting criteria (population, seismic, and geologic), and earthquake engineering criteria for nuclear power plants, if adopted, would not have a significant effect on the quality of the human environment and that an environmental impact statement is not required.

This determination is based on the following:

1. The proposed amendments to the regulations reflect current practice achieved through the staff's evaluation of applicants safety analysis reports at the time of docketing and applicant's response to staff initiated questions based on their review of submitted information and the results of research in the earthsciences and seismic engineering.

2. The foregoing environmental assessment.

3. The qualitative, deterministic and probabilistic assessments pertaining to the seismic event in the cited references.

4. The Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants, published August 8, 1985 (50 FR 32138) affirming the Commission's belief that a new design for a nuclear power plant can be shown to be acceptable for severe accident concerns if the criteria and procedural requirements cited in 50 FR 32138 are met.

References

NUREG-1070, "NRC Policy on Future Reactor Designs, Decisions on Severe Accident Issues in Nuclear Power Plant Regulation," July 1985.

NUREG-1233, "Regulatory Analysis for USI A-40, "Seismic Design Criteria" Final Report," September 1989.

NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities, Final Report," Attachment to Appendix D, Value/Impact Analysis for the Implementation of Individual Plant Examination of External Events, June 1991.

10 CFR PART 50, APPENDIX S

COMPARATIVE TEXT

See comments in Federal Register Notice

U.S. NUCLEAR REGULATORY COMMISSION

Proposed Revision 2
December 1991

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 4.7

GENERAL SITE SUITABILITY
CRITERIA FOR NUCLEAR POWER
STATIONS

See page 4.7-1, 13, 20

A. INTRODUCTION

The Energy Reorganization Act of 1974 places on the Nuclear Regulatory Commission (NRC) the responsibility for the licensing and regulation of private nuclear facilities from the standpoint of public health and safety. ~~Paragraphs 100.10(b) and (c) of~~ Title 10, CFR Part 100, "Reactor Site Criteria," requires that the population density, use of the site environs including proximity to ~~man-made~~ hazards, and the physical characteristics of the site, including seismology, meteorology, geology, ~~and~~ hydrology, ~~be taken into~~ account in determining the acceptability of a site for a nuclear power reactor. Seismic and geologic site criteria for nuclear power plants are provided in Appendix A and Appendix B to 10 CFR Part 100. Appendix A to 10 CFR Part 50 establishes the minimum requirements for the principal design criteria for water-cooled nuclear power plants; a number of these criteria are directly related to site characteristics as well as to events and conditions outside the nuclear power unit.

The National Environmental Policy Act of 1969 (NEPA) (83 Stat. 852), implemented by Executive Order 11514 and the Council on Environmental Quality's Guidelines of August 1, 1973 (38 FR 20550), requires that all agencies of the Federal Government prepare detailed environmental statements on proposed major Federal actions which can significantly affect the quality of the human environment. A principal objective of NEPA is to require the Federal agency to consider, in its decision-making process, the environmental impacts of each proposed major action and the available alternative actions, including alternative sites.

Part 51, "Licensing and Regulatory Policy and Procedures for Environmental Protection," of Title 10, Code of Federal Regulations, sets forth the Nuclear Regulatory Commission's policy and procedures for the preparation and processing of environmental impact statements and related documents pursuant to Section 102(2)(C) of the NEPA.

The limitations on the Commission's authority and responsibility pursuant to the NEPA imposed by the Federal Water Pollution Control Act (86 Stat. 916) are addressed in an Interim Policy Statement published in the Federal Register on January 29, 1973 (38 FR 2679).

This guide discusses the major site characteristics related to public health and safety and environmental issues which the NRC staff considers in determining the suitability of sites for light-water-cooled (LWR) ~~and high temperature gas-cooled (HTGR)~~ nuclear power stations.* The guidelines may be used by applicants in identifying suitable candidate sites for nuclear power stations. The decision that a station may be built on a specific candidate site is based on a detailed evaluation of the proposed site-plant combination and a cost-benefit analysis comparing it with alternative site-plant combinations as discussed in Regulatory Guide 4.2. "Preparation of Environmental Reports for Nuclear Power Stations."

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* For the purposes of this guide, nuclear power station refers to the nuclear reactor unit(s), nuclear steam supply, electric generating units, auxiliary systems, including the cooling system and structures such as docks that are located on a given site, and any new electrical transmission towers and lines erected in connection with the facilities.

C. REGULATORY POSITION

1. Geology/Seismology

Sites that include ~~capable faults~~, as defined in ~~Appendix A~~ Appendix B to 10 CFR Part 100, are not suitable for nuclear power stations. The state of the art has not progressed to the point at which it is possible to design a nuclear power station for surface or near-surface displacement with a sufficiently high level of confidence to ensure that the integrity of the safety-related features of the plant will remain intact.

Sites within about 5 miles of a ~~surface capable fault~~, greater than 1000 feet in length are usually not suitable for a nuclear power station. In any case, extensive and detailed geologic and seismic field studies and analyses should be conducted for such a proposed site.

Sites located near geologic structures for which an adequate data base to determine "capability" does not exist at the time of application are likely to be subject to a longer licensing process in view of the need for extensive and detailed geologic and seismic investigations of the site and surrounding region and for the rigorous analyses of the site-plant combination.

Sites with competent bedrock for foundations generally have suitable foundation conditions. In regions where there are few or no such sites, it is prudent to select sites in areas with competent and stable solid soils, such as dense sands and glacial tills. Other materials may also provide satisfactory foundation conditions, but in any case, a detailed geologic and geotechnical investigation will be required to determine static and dynamic engineering properties of the material underlying the site in accordance with ~~Sections IV(a)(4) and V(d) of Appendix A~~ Appendix B to 10 CFR Part 100.

2. Atmospheric Extremes and Dispersion

As noted in Section B.2 of this guide, site atmospheric conditions are site suitability characteristics principally with respect to the calculation of radiation doses resulting from the release of fission products as a consequence of a postulated accident. ~~and the establishment of exclusion area boundary, low population zone boundary, and distance to a population center. Accordingly, the regulatory position on atmospheric dispersion of radiological effluents is incorporated into the following section, "Population Considerations."~~ Accordingly, each applicant for site approval must collect meteorological and hydrological information for at least one year that is representative of the site conditions including wind speed, wind direction, precipitation, and atmospheric stability.

Nonradiological atmospheric considerations such as local fogging and icing, cooling tower drift, cooling tower plume lengths and plume interactions between cooling tower plumes, and plumes from nearby industrial facilities should be considered in evaluating the suitability of potential sites.

3. Population Consideration

Areas of low population density are preferred for nuclear power station sites. High population densities projected for anytime during the lifetime of a station are considered during both the NRC staff review and the public hearing phases of the licensing process. If the population density at the proposed site is not acceptably low, then the applicant will be required to give special attention to alternative sites with lower population densities.

If the population density, including weighted transient population, projected at the time of site approval ~~initial operation of a nuclear power station~~ exceeds 500 persons per square mile averaged over any radial distance out to 30 miles, (cumulative population at a distance divided by the area at that distance), or the projected population density ~~over the lifetime of the facility~~ for 40 years after site approval exceeds 1,000 persons per square mile averaged

Considerations	Relevant Regulations and Regulatory Guides	Regulatory Experience and Position
A.1 Geology/Seismology		
Geologic and seismic characteristics of a site, such as surface faulting, ground motion, and foundation conditions (including liquefaction, subsidence, and landslide potential), may affect the safety of a nuclear power station.	10 CFR Part 100, Appendix A B, "Criteria for the Seismic and Geologic Siting ~~Criteria for~~ of Nuclear Power Plants after [EFFECTIVE DATE]." Regulatory Guide 1.70, Chapter 2 (identifies safety-related site characteristics). Regulatory Guide 1.29 (discusses plant safety features which should be controlled by engineering design).	Sites that include capable ~~faults~~ are not suitable for a nuclear power station. Sites within about 5 miles of a ~~surface~~ capable ~~fault~~ (greater than 1000 feet in length) are generally not suitable for a nuclear power station. Sites should be selected in areas for which an adequate geologic data base exists to determine "capability." Delay in licensing can result from a need for extensive geologic and seismic investigations. Conservative design of safety-related structures will be required when geologic, seismic, and foundation information is questionable. Sites with competent bedrock generally have suitable foundation conditions. If bedrock sites are not available, it is prudent to select sites in areas known to have a low subsidence and liquefaction potential. Investigations will be required to determine the static and dynamic engineering properties of the material underlying the site as stated in 10 CFR Part 100, ~~Sec. IV(a)(4) and Sec. V(d) of Appendix A and~~ Appendix B.

10 CFR PART 100, APPENDIX B

COMPARATIVE TEXT

See comments in Federal Register Notice

DRAFT REGULATORY GUIDE DG-1015

SEISMIC SOURCES

NOTE: THIS DRAFT IS CURRENTLY UNDER FURTHER REVISION TO FULLY REFLECT THE POSITION OUTLINED IN THE SUMMARY OF THIS GUIDE. HOWEVER, THIS GUIDE INCLUDES DETAILS OF THE REQUIRED SITE INVESTIGATIONS.

This regulatory guide is still undergoing significant revision. Our comments on an updated version will be provided at a later date - RES already has our comments on the attached version.

DRAFT STANDARD REVIEW PLAN SECTION 2.5.2

PROPOSED REVISION 3

ADDITIONAL EDITORIAL REVISIONS ARE BEING MADE TO THIS SRP SECTION TO FULLY REFLECT THE STAFF POSITION OUTLINED IN SUMMARY OF DG-1015. HOWEVER, ALL THE TECHNICAL POSITIONS AND APPROACHES REQUIRED TO DETERMINE THE GROUND MOTION REMAIN UNCHANGED.

STANDARD REVIEW PLAN 2.5.2
PROPOSED REVISION 3

2.5.2 VIBRATORY GROUND MOTION

REVIEW RESPONSIBILITIES

Primary - Structural and Geosciences Branch (ESGB)

Secondary - None

AREAS OF REVIEW

The Structural and Geosciences Branch review covers the seismological and geological investigations carried out to ~~establish~~ evaluate ~~the acceleration for~~ the safe shutdown earthquake (SSE) ~~and the operating basis earthquake (OBE)~~ for the site. ~~The safe shutdown earthquake is that earthquake that is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake that produces the maximum vibratory ground motion for which safety related structures, systems, and components are designed to remain functional. The operating basis earthquake is that earthquake that, considering the regional and local geology, seismology, and specific characteristics of local subsurface material, could reasonably be expected to affect the plant site during the operating life of the plant; it is that earthquake that produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional.~~ The SSE represents the potential for earthquake ground motion at the site and is the vibratory ground motion for which all safety related structures, systems and components are designed to ensure public safety. The SSE is based upon a detailed evaluation of the ~~expected maximum~~ earthquake ~~(EMEQ)~~ potential, taking into account regional and local geology, seismicity, and specific characteristics of local subsurface material. It is defined as the free-field ground response spectra at the plant site and is described by horizontal and vertical response spectra corresponding to the expected ground motion at the free-field ground surface or a hypothetical rock outcrop.

Seismological and geological investigations are described in Regulatory Guide ~~(1.XXX)~~ Identification and Characterization of Seismic Sources. These investigations describe the seismicity of the site region and correlation of earthquake activity with seismic sources. Seismic sources are identified and characterized, including the ~~EMEQ magnitude~~ associated with each seismic source. All seismic sources, any part of which is within ~~(XXX)~~ miles of the site, must be identified. Sources at larger distances which are

controlling earthquake[1]

capable of earthquakes large enough to affect the site must also be identified. Seismic sources can be capable tectonic sources or seismogenic sources; a seismotectonic province is a type of seismogenic source.

The principal regulation used by the staff in determining the scope and adequacy of the submitted seismologic and geologic information and attendant procedures and analyses is Appendix B, ~~"Seismic and Geologic Siting Criteria for~~ Nuclear Power Plants" to 10 CFR Part 100 (Ref. 1). Additional guidance (regulations, regulatory guides, and reports) is provided to the staff through References 2 through 8.

Specific areas of review include seismicity (Subsection 2.5.2.1), geologic and tectonic characteristics of the site and region (Subsection 2.5.2.2), correlation of earthquake activity with geologic structure or tectonic provinces (Subsection 2.5.2.3), maximum earthquake potential (Subsection 2.5.2.4), seismic wave transmission characteristics of the site (Subsection 2.5.2.5), and safe shutdown earthquake (Subsection 2.5.2.6)~~, and operating basis earthquake (Subsection 2.5.2.7)~~. Both deterministic and probabilistic evaluations are used to assess the SSE.

The geotechnical engineering aspects of the site and the models and methods employed in the analysis of soil and foundation response to the ground motion environment are reviewed under SRP Section 2.5.4. The results of the geosciences review are used in SRP Sections 3.7.1 and 3.7.2.

II. ACCEPTANCE CRITERIA

The applicable regulations (Refs. 1, 2, and 3) and regulatory guides (Refs. 4, 5, and 6) and basic acceptance criteria pertinent to the areas of this section of the Standard Review Plan are:

1. 10 CFR Part 100, Appendix B, "Seismic and Geologic Siting ~~Criteria for~~ Nuclear Power Plants." These criteria describe the kinds of geologic and seismic information needed to determine site suitability and identify geologic and seismic factors required to be taken into account in the siting and design of nuclear power plants (Ref. 1).

2. 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants"; General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena." This criterion requires that safety-related portions of the structures, systems, and components important to safety shall be designed to withstand the effects of earthquakes, tsunami, and seiches without loss of capability to perform their safety functions (Ref. 2).

3. 10 CFR Part 100, "Reactor Site Criteria." This part describes

criteria that guide the evaluation of the suitability of proposed sites for nuclear power and testing reactors (Ref. 3).

4. Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants." This guide describes programs of site investigations related to geotechnical aspects that would normally meet the needs for evaluating the safety of the site from the standpoint of the performance of foundations under anticipated loading conditions including earthquake. It provides general guidance and recommendations for developing site-specific investigation programs as well as specific guidance for conducting subsurface investigations, including the spacing and depth of borings as well as sampling intervals (Ref. 4).

5. Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." This guide discusses the major site characteristics related to public health and safety which the NRC staff considers in determining the suitability of sites for nuclear power stations (Ref. 5).

6. Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants." ~~This guide gives one method acceptable to the NRC staff for defining the response spectra corresponding to the expected maximum ground acceleration (Ref. 6). See also~~ For design purposes smoothed response spectra are generally used - for example, a standard spectral shape which has been used in the past is Regulatory Guide 1.60 (Ref. 6). These smoothed spectra are still acceptable when an appropriate peak acceleration is used as the high frequency asymptote and the smoothed spectra compare favorable with site specific response spectra derived from the deterministic and probabilistic procedures discussed in Subsection 2.5.2.6.

The primary required investigations are described in 10 CFR Part 100, Section IV(a) of Appendix A (Ref. 1). The acceptable procedures for determining the seismic design bases are given in Section V(a) and Section VI(b) of the appendix. The seismic design bases are predicated on a reasonable, conservative determination of the SSE ~~and the OBE~~. As defined in Section III of 10 CFR Part 100, Appendix A (Ref. 1), the SSE ~~and OBE are~~ is based on consideration of the regional and local geology and seismology and on the characteristics of the subsurface materials at the site and ~~are~~ is described in terms of the vibratory ground motion ~~that they would produce~~ at the site. No comprehensive definitive rules can be promulgated regarding the investigations needed to establish the seismic design bases; the requirements vary from site to site.

2.5.2.1 Seismicity. In meeting the requirement of Reference I, this subsection is accepted when the complete historical record of earthquakes in the region is listed and when all available

parameters are given for each earthquake in the historical record. The listing should include all earthquakes having Modified Mercalli Intensity (MMI) greater than or equal to IV or magnitude greater than or equal to 3.0 that have been reported ~~in all tectonic provinces~~ for all seismic sources, any parts of which are within ~~200 (150)~~ 200 miles of the site. A regional-scale map should be presented showing all listed earthquake epicenters and should be supplemented by a larger-scale map showing earthquake epicenters of all known events within 50 miles of the site. The following information concerning each earthquake is required whenever it is available: epicenter coordinates, depth of focus, origin time, highest intensity, magnitude, seismic moment, source mechanism, source dimensions, distance from the site, and any strong-motion recordings (references from which the information was obtained should be identified). All magnitude designations such as m_b, M_L, M_s, M_w, etc., should be identified. In addition, any reported earthquake-induced geologic failure, such as liquefaction, landsliding, landspreading, and lurching should be described completely, including the level of strong motion that induced failure and the physical properties of the materials. The completeness of the earthquake history of the region is determined by comparison to published sources of information (e.g., Refs. 9 through 13). When conflicting descriptions of individual earthquakes are found in the published references, the staff should determine which is appropriate for licensing decisions.

2.5.2.2 Geologic and Tectonic Characteristics of Site and Region. In meeting the requirements of References 1, 2, and 3, this subsection is accepted when all ~~geologic structures within the region and tectonic activity~~ seismic sources that are significant in determining the earthquake potential of the region are identified, or when an adequate investigation has been carried out to provide reasonable assurance that all significant ~~tectonic structures~~ seismic sources have been identified. Information presented in Section 2.5.1 of the applicant's safety analysis report (SAR) and information from other sources (e.g., Refs. 9 and 14 through 18) dealing with the current tectonic regime should be developed into a coherent, well-documented discussion to be used as the basis for ~~determining seismotectonic provinces and~~ the earthquake-generating potential of seismogenic sources and capable tectonic sources ~~the identified geologic structures~~. Specifically, each ~~tectonic province~~ seismic source, any part of which is within ~~200 (150)~~ 200 miles of the site, must be identified. The staff interprets seismotectonic provinces to be regions of uniform ~~earthquake potential (seismotectonic provinces)~~ seismicity (same expected earthquake and frequency of recurrence) distinct from the seismicity of the surrounding area. The proposed seismotectonic provinces may be based on seismicity studies, differences in geologic history, differences in the current tectonic regime, etc. The staff considers that the most important factors for the determination of seismotectonic provinces include both (1)

development and characteristics of the current tectonic regime of the region that is most likely reflected in the ~~neotectonics (Post-Miocene or about 5~~ current tectonic regime, that is reflected in the Quaternary (approximately the last 2 million years and younger geologic history) and (2) the pattern and level of historical seismicity. Those characteristics of geologic structure, tectonic history, present and past stress regimes, and seismicity that distinguish the various ~~seismotectonic~~ provinces and the particular areas within those provinces where historical earthquakes have occurred should be described. Alternative regional tectonic models derived from available literature sources, including previous SARs and NRC staff Safety Evaluation Reports (SERs), should be discussed. The model that best conforms to the observed data is accepted. In addition, in those areas where there are capable ~~faults~~ tectonic sources, the results of the additional investigative requirements described in ~~10 CFR Part 100, Appendix A, Section IV(a)(8) (Ref. 1),~~ SRP Section 2.5.1 must be presented. The discussion should be augmented by a regional-scale map showing the ~~tectonic provinces~~ seismic sources, earthquake epicenters, locations of geologic structures and other features that characterize the seismotectonic provinces, and the locations of any capable ~~faults~~ tectonic sources.

2.5.2.3 Correlation of Earthquake Activity with ~~Geologic Structure~~ Seismogenic Sources, Capable Tectonic Sources or SeismoTectonic Provinces. In meeting the requirements of Reference 1, acceptance of this subsection is based on the development of the relationship between the history of earthquake activity and the ~~geologic structures or seismotectonic provinces~~ seismic sources of a region. The applicant's presentation is accepted when the earthquakes discussed in Subsection 2.5.2.1 of the SAR are shown to be associated with either ~~geologic structure or tectonic province~~ capable tectonic sources or seismogenic sources. Whenever an earthquake hypocenter or concentration of earthquake hypocenters can be reasonably correlated with geologic structures, the rationale for the association should be developed considering the characteristics of the geologic structure (including geologic and geophysical data, seismicity, and the tectonic history) and the regional tectonic model. The discussion should include identification of the methods used to locate the earthquake hypocenters, an estimate of their accuracy, and a detailed account that compares and contrasts the geologic structure involved in the earthquake activity with other areas within the seismotectonic province. Particular attention should be given to determining the capability of faults with which instrumentally located earthquake hypocenters are associated.

The presentation should be augmented by regional maps, all of the same scale, showing the ~~seismotectonic provinces~~ seismic sources, the earthquake epicenters, and the locations of geologic structures and measurements used to define provinces. Acceptance of the proposed ~~seismotectonic provinces~~ is based on the staff's independent review of the geologic and seismic information.

2.5.2.4 Maximum Earthquake Potential. In meeting the requirements of Reference 1, this subsection is accepted when the vibratory ground motion due to the ~~maximum credible earthquake~~ ~~MCE~~ associated with each ~~geologic structure or the maximum historic earthquake associated with each tectonic province~~ seismic source has been assessed and when the earthquake(s) that would produce the ~~maximum~~ most severe vibratory ground motion at the site has been determined. The ~~maximum credible earthquake~~ is the largest earthquake that can reasonably be expected to occur on a ~~geologic structure~~ given seismic source in the current tectonic regime. The ~~MCE~~ is not necessarily associated with any given return period. Considerable judgement is involved in estimating the magnitude of the ~~MCE~~. Suggested procedures for estimating the ~~MCE~~ are given in Regulatory Guide ~~1.xxx~~. ~~Geologic or seismological evidence may warrant a maximum earthquake larger than the maximum historic earthquake.~~ Earthquakes associated with each ~~geologic structure or tectonic province~~ seismic source must be identified. Where an earthquake is associated with geologic structure, the ~~maximum credible earthquake~~ ~~MCE~~ that could occur on that structure should be evaluated, taking into account significant factors, for example, the type of the faulting, fault length, fault slip rate, rupture length, rupture area, moment, and earthquake history (e.g., Refs. 19 through 22).

In order to determine the ~~maximum credible earthquake~~ ~~MCE~~, that could occur on those faults that are shown or assumed to be capable tectonic sources, the staff accepts conservative values based on historic experience in the region and specific considerations of the earthquake history and geologic history of movement on the faults. Where the earthquakes are associated with a seismotectonic province, the largest historic earthquake within the province should be identified. Isoseismal maps should also be presented for the most significant earthquakes. The ground motion at the site should be evaluated assuming appropriate seismic energy transmission effects and assuming that the ~~maximum earthquake~~ ~~MCE~~ associated with each ~~geologic structure or with each tectonic province~~ seismic source occurs at the point of closest approach of the structure or province to the site. (Further description is provided in Subsection 2.5.2.6.)

The earthquake(s) that would produce the most severe vibratory ground motion at the site should be defined. If different potential earthquakes would produce the most severe ground motion in different frequency bands, these earthquakes should be specified. The description of the potential earthquake(s) is to include the maximum intensity or magnitude and the distance from the assumed location of the potential earthquake(s) to the site. For the seismotectonic province surrounding the site, the ~~MCE~~ is assumed to occur ~~randomly~~ within 25 km of the site. The staff independently evaluates the site ground motion produced by the ~~largest earthquake~~ ~~MCE~~ associated with each ~~geologic structure or~~

~~tectonic province~~ seismic source. Acceptance of the description of the potential earthquake(s) that would produce the largest ground motion at the site is based on the staff's independent analysis.

2.5.2.5 Seismic Wave Transmission Characteristics of the Site. In meeting the requirements of Reference 1, this subsection is accepted when the seismic wave transmission characteristics (amplification or deamplification) of the materials overlying bedrock at the site are described as a function of the significant frequencies. The following material properties should be determined for each stratum under the site: seismic compressional and shear wave velocities, bulk densities, soil index properties and classification, shear modulus and damping variations with strain level, and water table elevation and its variation. In each case, methods used to determine the properties should be described in Subsection 2.5.4 of the SAR and cross-referenced in this subsection. For the ~~maximum earthquake~~ ~~SSE~~ determined in Subsection 2.5.2.4, the free-field ground motion (including significant frequencies) must be determined, and an analysis should be performed to determine the site effects on different seismic wave types in the significant frequency bands. If appropriate, the analysis should consider the effects of site conditions and material property variations upon wave propagation and frequency content.

The free-field ground motion (also referred to as control motion) should be defined to be on a ground surface and should be based on data obtained in the free field. Two cases are identified depending on the soil characteristics at the site and subject to availability of appropriate recorded ground-motion data. When data are available, for example, for relatively uniform sites of soil or rock with smooth variation of properties with depth, the control point (location at which the control motion is applied) should be specified on the soil surface at the top of the finished grade. The free-field ground motion or control motion should be consistent with the properties of the soil profile. For sites composed of one or more thin soil layers overlying a competent material, or in case of insufficient recorded ground-motion data, the control point is specified on an outcrop or a hypothetical outcrop at a location on the top of the competent material. The control motion specified should be consistent with the properties of the competent material.

Where vertically propagating shear waves may produce the maximum ground motion, a one-dimensional equivalent-linear analysis (e.g., Ref. 23 or 24) or nonlinear analysis (e.g., Refs. 25, 26, and 27) may be appropriate and is reviewed in conjunction with geotechnical and structural engineering. Where horizontally propagating shear waves, compressional waves, or surface waves may produce the maximum ground motion, other methods of analysis (e.g., Refs. 28 and 29) may be more appropriate. However, since some of the variables are not well defined and the techniques are still in the developmental stage, no generally agreed-upon procedures can be

promulgated at this time. Hence, the staff must use discretion in reviewing any method of analysis. To insure appropriateness, site response characteristics determined from analytical procedures should be compared with historical and instrumental earthquake data, when available.

2.5.2.6 Safe Shutdown Earthquake. In meeting the requirements of Reference 1, this subsection is accepted when the vibratory ground motion specified for the SSE is described in terms of the free-field response spectrum and is at least as conservative as that which would result at the site from the ~~maximum earthquake~~ CEUS (determined in Subsection 2.5.2.4) considering the site transmission effects (determined in Subsection 2.5.2.5). If several different ~~maximum potential earthquakes~~ CEUS produce the largest ground motions in different frequency bands (as noted in Subsection 2.5.2.4), the vibratory ground motion specified for the SSE ~~must be as conservative in each frequency band as that for each earthquake.~~ must be the envelope of the composite of the ground motions.

The staff reviews the free-field response spectra of engineering significance (at appropriate damping values). Ground motion may vary for different foundation conditions at the site. When the site effects are significant, this review is made in conjunction with the review of the design response spectra in Section 3.7.1 to ensure consistency with the free-field motion. The staff normally evaluates response spectra on a case-by-case basis. The staff considers compliance with the following conditions acceptable in the evaluation of the SSE. In all these procedures, the proposed free-field response spectra shall be considered acceptable if they equal or exceed the estimated 84th percentile ground-motion spectra from the ~~maximum or controlling earthquake~~ CEUS described in Subsection 2.5.2.4.

The following steps summarize the staff review of the SSE.

1. Both horizontal and vertical component site-specific response spectra should be developed statistically from response spectra of recorded strong motion records that are selected to have similar source, propagation path, and recording site properties as the ~~controlling earthquake(s)~~ CEUS. It must be ensured that the recorded motions represent free-field conditions and are free of or corrected for any soil-structure interaction effects that may be present because of locations and/or housing of recording instruments. Important source properties include magnitude and, if possible, fault type, and tectonic environment. Propagation path properties include distance, depth, and attenuation. Relevant site properties include shear velocity profile and other factors that affect the amplitude of waves at different frequencies. A sufficiently large number of site-specific time histories and/or response spectra should be used to obtain an adequately

broadband spectrum to encompass the uncertainties in these parameters. An 84th percentile response spectrum for the records should be presented for each damping value of interest and compared to the SSE free-field and design response spectrum (e.g., Refs. 30, 31, 32, and 33). The staff considers direct estimates of spectral ordinates preferable to scaling of spectra to peak accelerations. In the Eastern United States, relatively little information is available on magnitudes for the larger historic earthquakes; hence, it may be appropriate to rely on intensity observations (descriptions of earthquake effects) to estimate magnitudes of historic events (e.g., Refs. 34 and 35). If the data for site-specific response spectra were not obtained under geologic conditions similar to those at the site, corrections for site effects should be included in the development of the site-specific spectra.

2. Where a large enough ensemble of strong-motion records is not available, response spectra may be approximated by scaling that ensemble of strong-motion data that represent the best estimate of source, propagation path, and site properties (e.g., Ref. 36). Sensitivity studies should show the effects of scaling.

3. If strong-motion records are not available, site-specific peak ground acceleration, velocity, and displacement (if necessary) should be determined for appropriate magnitude, distance, and foundation conditions. Then response spectra may be determined by scaling the acceleration, velocity, and displacement values by appropriate amplification factors (e.g., Ref. 37). ~~Where only estimates of peak ground acceleration are available, it is acceptable to select a peak acceleration and use this peak acceleration as the high frequency asymptote to standardized response spectra such as described in Regulatory Guide 1.60 (Ref. 6) for both the horizontal and vertical components of motion with the appropriate amplification factors.~~ For each ~~controlling earthquake~~ EME, the peak ground motions should be determined using current relations between acceleration, velocity, and, if necessary, displacement, earthquake size (magnitude or intensity), and source distance. Peak ground motion should be determined from state-of-the-art relationships. Relationships between magnitude and ground motion are found, for example, in References 38, 39, 40, and 41 and relationships between ground motion and intensity are found, for example, in References 41, 42, and 43. Due to the limited data for high intensities greater than Modified Mercalli Intensity (MMI) VIII, the available empirical relationships between intensity and peak ground motion may not be suitable for determining the appropriate reference acceleration for seismic design.

4. Response spectra developed by theoretical-empirical modeling

of ground motion may be used to supplement site-specific spectra if the input parameters and the appropriateness of the model are thoroughly documented (e.g., Refs. 19, 44, 45 ~~and~~ 46, and 53). Modeling is particularly useful for sites near capable ~~faults~~ tectonic sources that may experience ground motion that is different in terms of frequency content and wave type from ground motion caused by more distant earthquakes.

5. Probabilistic estimates of seismic hazard should be calculated (e.g., Refs. 41 and 47) and the underlying assumptions and associated uncertainties should be documented to assist in the staff's overall deterministic approach. The probabilistic studies should highlight which seismic sources are significant to the site. ~~Uniform hazard spectra (spectra that have a uniform probability of exceedance over the frequency range of interest) showing uncertainty should be calculated for 0.01, 0.001, and 0.0001 annual probabilities of exceedance at the site.~~ The probability of exceeding the SSE response spectra should also be estimated and comparison of results made with other probabilistic studies. ~~Suggested procedures are contained in Appendix A to this SRP Section.~~ (Reg Guide DG-1015)

The time duration and number of cycles of strong ground motion is required for analysis of site foundation liquefaction potential and for design of many plant components. The adequacy of the time history for structural analysis is reviewed under SRP Section 3.7.1. The time history is reviewed in this SRP section to confirm that it is compatible with the seismological and geological conditions in the site vicinity and with the accepted SSE model. At present, models for deterministically computing the time history of strong ground motion from a given source-site configuration may be limited. It is therefore acceptable to use an ensemble of ground-motion time histories from earthquakes with similar size, site-source characteristics, and spectral characteristics or results of a statistical analysis of such an ensemble. Total duration of the motion is acceptable when it is as conservative as values determined using current studies such as References 48, 49, 50, and 51.

~~2.5.2.7 Operating Basis Earthquake. In meeting the requirements of Reference 1, this subsection is acceptable when the vibratory ground motion for the OBE is described and the response spectrum (at appropriate damping values) at the site specified. Probability calculations (e.g., Refs. 41, 47, and 52) should be used to estimate the probability of exceeding the OBE during the operating life of the plant. The maximum vibratory ground motion of the OBE should be at least one-half the maximum vibratory ground motion of the SSE unless a lower OBE can be justified on the basis of probability calculations. It has been staff practice to accept the OBE if the return period is on the order of hundreds of years~~

~~(e.g., Ref. 31).~~

III. REVIEW PROCEDURES

Upon receiving the applicant's SAR, an acceptance review is conducted to determine compliance with the investigative requirements of 10 CFR Part 100, Appendix B (Ref. 1). The reviewer also identifies any site-specific problems, the resolution of which could result in extended delays in completing the review.

After SAR acceptance and docketing, those areas are identified where additional information is required to determine the earthquake hazard. These are transmitted to the applicant as draft requests for additional information.

A site visit may be conducted during which the reviewer inspects the geologic conditions at the site and region around the site as shown in outcrops, borings, geophysical data, trenches, and those geologic conditions exposed during construction if the review is for an operating license. The reviewer also discusses the questions with the applicant and his consultants so that it is clearly understood what additional information is required by the staff to continue the review. Following the site visit, a revised set of requests for additional information, including any additional questions that may have been developed during the site visit, is formally transmitted to the applicant.

The reviewer evaluates the applicant's response to the questions, prepares requests for additional clarifying information, and formulates positions that may agree or disagree with those of the applicant. These are formally transmitted to the applicant.

The safety analysis report and amendments responding to the requests for additional information are reviewed to determine that the information presented by the applicant is acceptable according to the criteria described in Section II (Acceptance Criteria) above. Based on information supplied by the applicant, obtained from site visits or from staff consultants or literature sources, the reviewer independently identifies and evaluates the relevant ~~seismotectonic provinces~~ seismogenic sources and capable tectonic sources, evaluates the capability of faults in the region, and determines the earthquake potential for each ~~province and each capable fault or tectonic structure~~ seismogenic source or capable tectonic source using procedures noted in Section II (Acceptance Criteria) above. The reviewer evaluates the vibratory ground motion that the ~~potential earthquakes~~ ~~which~~ could produce at the site and ~~defines~~ compares that ground motion to the safe shutdown ~~earthquake and operating basis earthquake~~.

IV. EVALUATION FINDINGS

If the evaluation by the staff, on completion of the review of the

geologic and seismologic aspects of the plant site, confirms that the applicant has met the requirements or guidance of applicable portions of References 1 through 6, the conclusion in the SER states that the information provided and investigations performed support the applicant's conclusions regarding the seismic integrity of the subject nuclear power plant site. In addition to the conclusion, this section of the SER includes (1) ~~definitions~~ an evaluation of ~~tectonic provinces~~ seismogenic sources and capable tectonic sources; (2) evaluations of the capability of geologic structures in the region; (3) ~~determinations~~ evaluation of the ~~OBE earthquake(s)~~ SSE and free-field response spectra based on evaluation of the potential earthquakes; and (4) time history of strong ground motion~~, and (5) determinations of the OBE free field response spectra~~. Staff reservations about any significant deficiency presented in the applicant's SAR are stated in sufficient detail to make clear the precise nature of the concern. The above evaluation determinations or redeterminations are made by the staff during both the construction permit (CP) and operating license (OL) phases of review.

OL applications are reviewed for any new information developed subsequent to the CP safety evaluation report (SER). The review will also determine whether the CP recommendations have been implemented.

A typical OL-stage summary finding for this section of the SER follows:

> In our review of the seismologic aspects of the plant site we have considered pertinent information gathered since our initial seismologic review which was made in conjunction with the issuance of the Construction Permit. This new information includes data gained from both site and near-site investigations as well as from a review of recently published literature.
>
> As a result of our recent review of the seismologic information, we have determined that our earlier conclusion regarding the safety of the plant from a seismological standpoint remains valid. These conclusions can be summarized as follows:
>
> 1. Seismologic information provided by the applicant and required by Appendix B to 10 CFR Part 100 provides an adequate basis to establish that no ~~capable faults~~ seismic sources exist in the plant site area which would cause earthquakes to be centered there.
>
> 2. The response spectrum proposed for the safe shutdown earthquake is the appropriate free-field response spectrum in conformance with Appendix B to 10 CFR Part 100.

The new information reviewed for the proposed nuclear power plant is discussed in Safety Evaluation Report Section 2.5.2.

The staff concludes that the site is acceptable from a seismologic standpoint and meets the requirements of (1) 10 CFR Part 50, Appendix A (General Design Criterion 2), (2) 10 CFR Part 100, and (3) 10 CFR Part 100, Appendix B. This conclusion is based on the following:

1. The applicant has met the requirements of:

   a. 10 CFR Part 50, Appendix A (General Design Criterion 2) with respect to protection against natural phenomena such as faulting.

   b. 10 CFR Part 100 (Reactor Site Criteria) with respect to the identification of geologic and seismic information used in determining the suitability of the site.

   c. 10 CFR Part 100, Appendix B (Seismic and Geologic Siting ~~Criteria for~~ Nuclear Power Plants) with respect to obtaining the geologic and seismic information necessary to determine (1) site suitability and (2) the appropriate design of the plant. Guidance for complying with this regulation is contained in Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants," Regulatory Guide 4.7, "General Site Suitability for Nuclear Power Stations," and Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants."

V. IMPLEMENTATION

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

Except in those cases in which the applicant/licensee proposes an acceptable alternative method for complying with specific portions of the Commission's regulations, the methods described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and NUREGs (Refs. 4 through 8).

The provisions of this SRP section apply to reviews of construction permit (CP), operating license (OL), preliminary design approval (PDA), final design approval (FDA), and combined license (CP/OL)

applications docketed after the date of issuance of this SRP section.

VI. REFERENCES

1. 10 CFR Part 100, Appendix A, "Seismic and Geologic Siting ~~Criteria for~~ Nuclear Power Plants."

2. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

3. 10 CFR Part 100, "Reactor Site Criteria."

4. Regulatory Guide 1.132, "Site Investigations for Foundations of Nuclear Power Plants."

5. Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations."

6. Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants."

7. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

8. NUREG-0625, "Report of Siting Policy Task Force" (1979).

9. NUREG/CR-1577, "An Approach to Seismic Zonation for Siting Nuclear Electric Power Generating Facilities in the Eastern United States," prepared by Rondout Associates, Inc., for the U.S. Nuclear Regulatory Commission. Authored by N. Barstow, K. Brill, O. Nuttli, and P. Pomeroy (1981).

10. C. W. Stover et al., 1979-1981, Seismicity Maps of the States of the U.S., Geological Survey Miscellaneous Field Studies Maps.

11. "Earthquake History of the United States," Publication 41-1, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (1982).

12. T. R. Toppozada, C. R. Real, S. P. Bezore, and D. L. Parke, "Compilation of Pre-1900 California Earthquake History, Annual Technical Report-Fiscal Year 1978-79, Open File Report 79-6 SAC (Abridged Version)," California Division of Mines and Geology (1979).

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NOTES: Need to revise reference list to add EPRI and LLNL probability study and other references that are significant. Also some of the older references could be deleted.

~~Add Appendix A - PROBABILISTIC INVESTIGATIONS~~

Since we are going to accept the CAV criterion, for shutdown, do with conditions we still want to call ~~the~~ it the OBE or do we want to use a term like vibratory motion requiring plant shutdown ?. OR threshold exceedance OR exceedance of the EPRI criterion

I Concur ⟹

DRAFT REGULATORY GUIDE DG-1016

SEISMIC INSTRUMENTATION

DRAFT REGULATORY GUIDE DG-1016

SECOND PROPOSED REVISION 2 TO REGULATORY GUIDE 1.12

NUCLEAR POWER PLANT INSTRUMENTATION FOR EARTHQUAKES

A. INTRODUCTION

Paragraph (c) of §20.1, "General Provisions," to 10 CFR Part 20, "Standards for Protection Against Radiation," requires licensees to make every reasonable effort to maintain radiation exposures, and release of radioactive materials in effluents to unrestricted areas, as low as is reasonably achievable. Proposed Paragraph (a)(12) of §50.34, "Contents of Applications; Technical Information" to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that on or after the effective date of this regulation, applicants who apply for early site permits, design certifications, or combined licenses for nuclear power plants, as partial conformance to General Design Criteria 2, "Design Basis for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, shall implement the earthquake engineering criteria in Proposed Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," to 10 CFR Part 50. Prior to the effective date of this regulation, applicable earthquake engineering criteria for nuclear power plants are contained in Section VI of Appendix A, "Seismic and Geologic Siting Criteria," to 10 CFR Part 100, "Reactor Site Criteria." Paragraph (c) of §50.36, "Technical Specifications," to 10 CFR Part 50 requires the technical specifications of a facility to include surveillance requirements to ensure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions of operation will be met. Paragraph IV(a)(4) of Proposed Appendix S to 10 CFR Part 50 requires that suitable instrumentation shall be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly. (Paragraph VI of Proposed Appendix B, "Criteria for the Seismic and Geologic Siting of Nuclear Power Plants After [Effective Date]," to 10 CFR Part 100 also cites Appendix S to 10 CFR Part 50). Paragraph (IV)(a)(3) of Proposed Appendix S to 10 CFR Part 50

set note on front page

also requires that if vibratory ground motion exceeding that of the Operating Basis Earthquake (OBE) occurs, shutdown of the nuclear power plant will be required.[1] This guide describes seismic instrumentation that would be acceptable to the NRC staff for satisfying the requirements of Parts 20 and 50, and Proposed Appendix S to Part 50.

B. DISCUSSION

When an earthquake occurs, it is important to assess immediately the effects of the earthquake at the nuclear power plant. State-of-the-art solid-state digital time-history accelerographs installed at appropriate locations will provide data on the frequency, amplitude, and phase relationship of the seismic response of the free-field, containment structure, and other Category I structures so that a comparison and evaluation of such response with that used as the design basis can be made.

The following

Factors ~~that~~ should be considered in selecting the location for the instruments~~, are highlighted~~.

X

It may not be necessary that each of two or more identical nuclear power units on a given site be provided with seismic instrumentation if essentially the same seismic response at each of the several units is expected from a given earthquake.

Time limits associated with an immediate evaluation of seismic instrumentation data are quantified.

Based upon an evaluation of seismic instrumentation operational experience, it was noted that instruments have been known to be out of service during plant shutdown. The instrumentation system should be operable at all times. The and even sometimes during plant operation

[1] Guidance is being developed in Draft Regulatory Guide DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions," to provide plant shutdown criteria.

guidelines that will be followed by the NRC staff if the seismic instrumentation is inoperable are identified.

Information pertaining to instrumentation characteristics, installation, activation, remote indication and maintenance is provided to ensure (1) that the data provided are comparable with that used in the design of the nuclear power plant, (2) that exceedance of the ~~Operating Basis~~ Earthquake can be determined, and (3) that the equipment will perform as required.

see note on last page

C. REGULATORY POSITION

The seismic instrumentation type, locations, operability, characteristics, installation, actuation, remote indication, and maintenance described below are acceptable to the NRC staff for satisfying the requirements indicated in Paragraph (c) of §20.1 to 10 CFR 20, Paragraph (c) of §50.36 to 10 CFR 50, and Paragraph IV(a)(4) of Proposed Appendix S to 10 CFR 50 for ensuring the safety of nuclear power plants.

I. Seismic Instrumentation Type and Location.

I.1 State-of-the-art solid-state digital instrumentation should be used that will enable the quick processing of data at the plant site.

I.2 A triaxial time-history accelerograph should be provided at each of the following locations:

1. Free-field

2. Containment foundation

3. Two elevations (excluding the foundation) on the internal containment structure

4. Two independent Category I structure foundations, for instance, the Diesel Generator Building and the Auxiliary Building, where the response is different from that of the containment structure.

5. An elevation (excluding the foundation) on each of the independent Category I structures selected in Regulatory Position 1(b)(iv) above.

6. If seismic isolators are used, instrumentation should be placed on the rigid and isolated portions of the structures at approximately the same elevations.

I.3 The specific locations should be determined by the nuclear plant designer to obtain the most pertinent information. Maintaining occupational radiation exposures as low as reasonably achievable (ALARA) for the location, installation and maintenance of seismic instrumentation should be considered in accordance with 10 CFR 20.1(c) and Regulatory Guide 8.8[2]. In general:

1. An ALARA design review of location, installation, and maintenance of proposed instrumentation should be performed in the planning stage by the facility in accordance with Regulatory Guide 8.8.

2. Instrumentation should be located in as low a dose rate area as is practical, consistent with other requirements.

3. Instruments should be selected that require minimal maintenance and in-service inspection, and minimal time and

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[2] Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable."

numbers of personnel to conduct installation and maintenance.

4. Consistent with this Regulatory Position, instrumentation should be located to facilitate maintenance, installation, and removal; to minimally impact other maintenance and operations; and to require the minimal degree of plant modification (e.g., removal/replacement of interferences).

2. Instrumentation at Multi-Unit Sites.

Instrumentation in addition to that installed for a single unit will not be required if essentially the same seismic response is expected at the other units based on the seismic analysis used in the seismic design of the plant. However, in case of separate control rooms, annunciation as specified in Regulatory Position 7 should be applicable to both control rooms.

3. Seismic Instrumentation Operability.

3.1 The guidance being developed in Draft Regulatory Guide DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions," is based on the assumption that the nuclear power plant has operable seismic instrumentation,[3] including the equipment and software required to process the data within four hours after an earthquake. This is necessary to determine if the plant should be shut down by comparing the recorded data against OBE exceedance criterion and to evaluate the results of the operator walkdown inspections within eight hours of the event.

3.2 Instrumentation should be maintained in operation during periods

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[3] If the seismic instrumentation is inoperable, the guidelines being developed in Appendix A to Draft Regulatory Guide DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions," would be used to determine if the Operating Basis Earthquake has been exceeded.

of plant shutdown. The maintenance and repair procedures should make provisions for keeping the maximum number of instruments in service during plant operation and shutdown.

4. Instrumentation Characteristics

4.1 In-service testing provisions should be included in the design. These instruments should be capable of periodic channel checks during normal plant operation.

4.2 The instruments should have the capability for in-place functional testing.

4.3 The instrumentation of the foundation and at elevations within the same building/structure should be interconnected for common starting and common timing, and should contain provisions for an external remote alarm to indicate actuation.

5. Instrumentation Installation

5.1 The instrumentation should be designed and installed so that the vibratory transmissibility over the amplified region of the design spectra frequency range is essentially unity, that is, the mounting is rigid.

5.2 The instrumentation should be oriented so that the horizontal axes are parallel to the orthogonal horizontal axes assumed in the seismic analysis.

5.3 Protection should be provided against accidental impacts.

6. Instrumentation Actuation

6.1 Both vertical and horizontal input vibratory ground motion should actuate the same time-history accelerograph. One or more seismic triggers may be used to accomplish this. *

6.2 Spurious triggering should be avoided.

6.3 The seismic trigger mechanisms of the time-history accelerograph should be set for a threshold ground acceleration of not more than 0.02g.

6.4 Sufficient back-up memory should be available so that the entire pre trigger earthquake ground motion can be recorded. Sampling at 200 samples per second in response spectrum from 0.5 to 50 Hz.

7. Remote Indication

Upon actuation of the free-field or any foundation-level time-history accelerograph, a remote indication in the control room should be activated.

8. Maintenance

8.1 The purpose of the maintenance program is to ensure that the equipment will perform as required. As stated in Regulatory Position 4(b), the maintenance and repair procedures should make provisions for keeping the maximum number of instruments in service during plant operation and shutdown.

8.2 The frequency of maintenance is:

1.	Channel Checks:[4]	Every Month
2.	Channel Functional Test:	Every 6 Months
3.	Channel Calibration:	Refueling and after recording of an earthquake

[4] Systems shall be given channel checks every two weeks for the initial three months of service after startup. Failures of active devices normally occur during initial operation. After the initial three month period, successful results in at least three consecutive checks is sufficient to revert to the monthly channel check. The monthly channel check shall include checking the batteries.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This proposed revision has been released to encourage public participation in its development. Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of applications for an early site permit, design certification, or combined license submittals docketed after the implementation date to be specified in the active guide.

APPENDIX A
DEFINITIONS

Acceleration Sensor. An instrument capable of sensing absolute acceleration and transmitting the data to a recorder.

Channel Calibration (Primary Calibration). The determination and adjustment, if required, of an instrument, sensor, or system such that it responds within a specific range and accuracy to an acceleration, velocity or displacement input, as aprlicable, traceable to the National Institute of Standards and Technology (NIST), or an acceptable physical constant.

Channel Check. The qualitative verification of the functional status of the instrument sensor. This check is an "in-situ" test and may be the same as channel functional test.

Channel Functional Test (Secondary Calibration). The determination without adjustment that an instrument, sensor, or system responds to a known input, not necessarily traced to the National Institute of Standards and Technology (NIST), of such character that it will verify the instrument, sensor or system is functioning in a calibratible manner.

Containment - See Primary Containment and Secondary Containment.

Containment Foundation. The foundation of the containment or reactor building. For the foundation which supports more than just the containment structure or reactor building, the area which is within the close proximity of the containment shell shall also be considered as part of the containment foundation.

Internal Containment Structure. A structure internal to the Primary or Secondary Containment and supported by the Containment Foundation.

Operating Basis Earthquake (OBE). The Operating Basis Earthquake produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public shall remain functional.

Primary Containment. The principle structure of a unit that acts as the barrier, after the fuel cladding and reactor pressure boundary, to control the release of radioactive material. It includes (1) the containment structure, and its access openings, penetrations, and appurtenances, (2) those valves, pipes, closed systems, and other components used to effect isolation of the containment atmosphere from the environment, and (3) those systems or portions of systems that, by their system functions, extend the containment structure boundary (e.g., the connecting steam and feedwater piping) and provide effective isolation.

Recorder. An instrument capable of simultaneously recording the data versus time from acceleration sensor(s).

Remote Indicating Instruments. Instruments whose output is transmitted to a location separate from the sensor.

Safe Shutdown Earthquake Ground Motion (SSE). The Safe Shutdown Earthquake Ground Motion (SSE) is the vibratory ground motion for which certain structures, systems, and components shall be designed to remain functional. These structures, systems, and components are those necessary to assure:

(a) The integrity of the reactor coolant pressure boundary,

(b) The capability to shut down the reactor and maintain it in a safe shutdown condition, or

(c) The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures exceeding allowable amounts.

Secondary Containment. The structure surrounding the primary containment that acts as a further barrier to control the release of radioactive material.

Seismic Isolator. A device, for instance, laminated elastomer and steel, installed between the structure and its foundation to reduce the acceleration of the isolated structure, the attached equipment and components.

Seismic Trigger. A device having the function of starting the time-history accelerograph.

Time-History Accelerograph. An instrument capable of measuring and permanently recording acceleration versus time.

Triaxial. Describes the function of an instrument or group of instruments in three mutually orthogonal directions, one of which is vertical.

NRR is developing a position paper on CAV and when it is finished we will coordinate it with this Reg. Guide.

DRAFT REGULATORY GUIDE DG-1017

PLANT SHUTDOWN

DRAFT REGULATORY GUIDE DG-1017
PRE-EARTHQUAKE PLANNING AND IMMEDIATE NUCLEAR POWER PLANT OPERATOR POST-EARTHQUAKE ACTIONS

A. INTRODUCTION

Proposed Paragraph (a)(12) of §50.34, "Contents of Applications; Technical Information" to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that on or after the effective date of this regulation, applicants who apply for early site permits, design certifications, or combined licenses for nuclear power plants, as partial conformance to General Design Criteria 2, "Design Basis for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, shall implement the earthquake engineering criteria in Proposed Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," of 10 CFR Part 50. Prior to the effective date of this regulation, applicable earthquake engineering criteria for nuclear power plants are contained in Section VI of Appendix A, "Seismic and Geologic Siting Criteria," to 10 CFR Part 100, "Reactor Site Criteria." Paragraph IV(a)(4) of Proposed Appendix S to 10 CFR Part 50, requires that suitable instrumentation[1] shall be provided so that the seismic response of nuclear power plant features important to safety can be evaluated promptly. (Paragraph VI of Proposed Appendix B, "Criteria for the Seismic and Geologic Siting of Nuclear Power Plants After [Effective Date]," to 10 CFR Part 100, also cites Proposed Appendix S to 10 CFR Part 50). Paragraph IV(a)(3) of Proposed Appendix S to 10 CFR Part 50 requires that if vibratory ground motion exceeding that of the Operating Basis Earthquake occurs, shutdown of the nuclear power plant will be required. The Operating Basis Earthquake is set pursuant to Paragraph IV(a)(2)(i) or (ii) of Proposed Appendix S to Part 50. Proposed Paragraph (ee) of §50.54 to 10 CFR 50 requires licensee's of nuclear

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[1] Guidance is being developed in Draft Regulatory Guide DG-1016, Second Proposed Revision 2 to Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes," to describe seismic instrumentation acceptable to the NRC staff.

power plants that have implemented the earthquake engineering criteria in Proposed Appendix S to 10 CFR 50, to shut down the plant if the criteria in Paragraph IV(a)(3) of Proposed Appendix S are exceeded. This guide provides guidelines that are acceptable to the NRC staff for a timely evaluation of the recorded instrumentation data and to determine whether or not plant shutdown is required as satisfying the above-stated requirement of Proposed Part 50 and Proposed Appendix S to Part 50.

B. DISCUSSION

When an earthquake occurs, ground motion data are recorded by the seismic instrumentation.[1] These data are used to make an early determination of the degree of severity of the seismic event. The data from the seismic instrumentation, coupled with information obtained from a plant walkdown, are used to make the initial determination of whether the plant should be shut down, if it has not already been shut down due to operational perturbations resulting from the seismic event. If, on the basis of these initial evaluations (instrumentation data and walkdown), it is concluded that the plant shutdown criteria have not been exceeded, it is presumed that the plant will not be shut down. Post-shutdown inspections and plant restart are covered elsewhere.[2]

Working Group ANS-2.10 of Subcommittee ANS-2, Site Evaluation, of the American Nuclear Society Standards Committee has developed a standard that contains guidelines for the retrieval, and the subsequent processing, handling, storage and evaluation of data obtained from nuclear power plant seismic instrumentation. This standard was approved and designated ANSI/ANS-2.10-1979, "Guidelines for Retrieval, Review, Processing and Evaluation of Records Obtained from Seismic Instrumentation,"[3] by the American Standards Institute

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[2]. Guidance is being developed in Draft Regulatory Guide DG-1018, "Restart of a Nuclear Power Plant Shut Down Due to a Seismic Event" to describe inspections and tests acceptable to the NRC staff.

[3] Copies may be obtained from the American Nuclear Society, 555 North Kensington Avenue, La Grange Park, Illinois 60525.

on January 8, 1979.

The Electric Power Research Institute has developed guidelines that will enable licensees to quickly identify and assess earthquake effects on nuclear power plants. These reports are designated EPRI NP-5930, "A Criterion for Determining Exceedance of the Operating Basis Earthquake," July 1988, EPRI NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake," December 1989, and EPRI Report TR-100082, "Standardization of Cumulative Absolute Velocity for Use With the EPRI OBE Exceedance Criteria," November 1991[4].

This guide is based on the assumption that the nuclear power plant has operable seismic instrumentation. If the seismic instrumentation is inoperable the guidelines that will be followed by the NRC staff are identified.

Applicable portions of Proposed Appendix S to 10 CFR 50 are repeated to highlight the changes in philosophy pertaining to the Operating Basis Earthquake that were made during the creation of Proposed Appendix S to 10 CFR 50 and Proposed Appendix B to 10 CFR 100 (revision of 10 CFR 100, Appendix A).

The Regulatory Position is a combination of several items. First, information contained in ANSI/ANS-2.10-1979 pertaining to the retrieval, and subsequent processing, handling, and evaluation of data obtained from nuclear power plant seismic instrumentation. Second, the criterion for determining exceedance of the Operating Basis Earthquake contained in EPRI NP-5930 as supplemented by EPRI Report TR-100082. Third, the pre-earthquake actions, immediate post-earthquake operator actions, operator walkdown inspections, and pre-shutdown inspection contained in EPRI NP-6695.

The definitions of Safe Shutdown Earthquake Ground Motion (SSE) and Operating Basis Earthquake in EPRI NP-6695 are replaced to reflect changes that have been made during the creation of Proposed Appendix S to 10 CFR 50 and Proposed Appendix B to 10 CFR 100 (revision of 10 CFR 100, Appendix A).

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[4] Copies may be obtained from the Research Reports Center (RRC), Box 50490, Palo Alto, California 94303.

The definition of Felt Earthquake in EPRI NP-6695, is revised, deleting the phrase pertaining to "plants with operable seismic instrumentation." Nuclear power plants should have operable seismic instrumentation; further, the instrumentation shall be functioning in all modes of operation. If the seismic instrumentation is inoperable the guidelines that will be followed by the NRC staff are identified.

The staff does not support the philosophy discussed in EPRI NP-6695, Section 4.3.4 (first paragraph, last sentence), pertaining to plant shutdown considerations following an earthquake based on the need for continued power generation in the region. Decisions on continued operation will be made by the licensee in conjunction with the staff on a case-by-case basis consistent with applicable regulations.

C. REGULATORY POSITION

I. The following segments of Paragraph IV(a)(2) of Proposed Appendix S to 10 CFR 50 are repeated to highlight changes in the regulation pertaining to the Operating Basis Earthquake that are not consistent with those contained in EPRI NP-6695:

> "The Operating Basis Earthquake shall be defined by response spectra. When subjected to the effects of the vibratory motion of the Operating Basis Earthquake in combination with normal operating loads, all structures, systems, and components of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public shall remain functional, that is, within applicable stress and deformation limits.
>
> The value of the Operating Basis Earthquake shall be set to one of the following choices:
>
> (i) if the Operating Basis Earthquake is set at one-third of the Safe Shutdown Earthquake Ground Motion level, the

requirement of the Operating Basis Earthquake, as stated above, can be satisfied without the applicant performing any explicit response analyses,[5] or

(ii) if an applicant chooses an Operating Basis Earthquake greater than one-third the Safe Shutdown Earthquake Ground Motion an explicit suitable analysis and design shall be performed to demonstrate that the requirement of the Operating Basis Earthquake, as stated above, is satisfied. The design shall take into account soil-structure interaction effects and the expected duration of vibratory ground motion.*

2. Definitions

Definitions are contained in Appendix A.

3. Pre-Earthquake Planning

3.1 Seismic Instrumentation.

This guide is based on the assumption that the nuclear power plant has operable seismic instrumentation, including the equipment and software required to process the data within four hours after an earthquake. This is necessary to determine if the plant should be shut down by comparing the recorded data against Operating Basis Earthquake exceedance criteria and to evaluate the results of the operator walkdown inspections within eight hours of the event. If the seismic instrumentation is inoperable the guidelines described in Appendix B will be used to determine if the Operating Basis Earthquake has been exceeded.

see comment on DG-1016

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* A separate analyses to compute structure, equipment and piping response associated with the Operating Basis Earthquake is not required. Applicable design provisions associated with this Operating Basis Earthquake, for instance, fatigue, are discussed in regulatory guides.

3.2 Plant Instrumentation Characteristics.

A file of all seismic instrumentation should be kept at the plant. The file should include:

1. Information on each instrument type such as: make, model and serial number; manufacturers' data sheet; list of special features or options; performance characteristics; examples of typical instrumentation readings and interpretations; operations and maintenance manual; repair procedures (manufacturers' recommendations for repairing common problems); and list of any special requirements, e.g., maintenance, operational, installation.

2. Building and equipment plan views and vertical sections. These should have sufficient detail to show the location of each instrument and the orientation of the instrument axis with respect to a plant reference axis.

3. A complete service history of each seismic instrument ~~should be kept at the plant.~~ The service history should include information such as: dates of servicing, description of completed work, and calibration records and data (where applicable).

3.3 Pre-Event Actions.

The selection of equipment and structures for inspections, and base line inspections as described in Section 5.3.1 (includes Section 5.3.2.1) of EPRI NP-6695 "Guidelines for Nuclear Plant Response to an Earthquake" are acceptable to the NRC staff for satisfying the evaluation requirements indicated in Paragraph IV(a)(2) of Proposed Appendix S to 10 CFR 50 for ensuring the safety of nuclear power plants.

4. Immediate Post-Earthquake Actions

After any felt earthquake at a nuclear power plant, the licensee should take appropriate action to determine if the plant should be shut down (Regulatory Position 7).

The Definitions Section and the guidelines for immediate post-earthquake actions specified in Sections 4.3.1 and 4.3.2 (includes Section 5.3.2.1 and items 7 and 8 of Table 5-1) of EPRI NP-6695 "Guidelines for Nuclear Plant Response to an Earthquake," are acceptable to the NRC staff for satisfying the evaluation requirements indicated in Paragraph IV(a)(2) of Proposed Appendix S to 10 CFR 50 for ensuring the safety of nuclear power plants, subject to the revision or addition of the following definitions:

4.1 felt earthquake. An earthquake of sufficient intensity such that:

1. the vibratory ground motion is felt at the nuclear power plant site and recognized as an earthquake based on a consensus of the control room operators on duty at the time, or
2. the free field or foundation-level seismic instrumentation installed at the plant are activated. The seismic triggers that activate these instruments are set at a threshold ground acceleration of not more than 0.02g. Spurious activation that can be clearly related to a nonseismic event, for example, vehicular movement or construction, does not denote seismic instrumentation activation.

4.2 operating basis earthquake (OBE). The "Operating Basis Earthquake" produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public shall remain functional.

4.3 safe shutdown earthquake ground motion (SSE). The "Safe Shutdown Earthquake Ground Motion (SSE)" is the vibratory ground motion for

which certain structures, systems, and components shall be designed to remain functional. These structures, systems, and components are those necessary to assure:

1. The integrity of the reactor coolant pressure boundary,

2. The capability to shut down the reactor and maintain it in a safe shutdown condition, or

3. The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures exceeding allowable amounts.

5. Evaluation of Ground Motion Records.

5.1 Data I ntification

All data should be identifiable and traceable with respect to the following:

1. date and time of collection,

2. make, model, serial number, location and orientation of instrument (sensor) from which record was collected, and

3. a record collection log should be maintained at the plant.

5.2 Data Collection

1. Extreme caution should be exercised to prevent accidental damage to the recording media and instruments during data collection and subsequent handling.

2. As each record is collected, notes should be made regarding the condition of instrument installation; for example, instrument flooded, mounting surface tilted, fallen objects

that might have struck the instrument or instrument mounting surface.

3. For validation of collected data, instruments capable of having a post-event calibration or reference signal added to the record without affecting the previously recorded data should have such data added before removing the record medium.

4. Where an instrument appears to have changed its characteristics, the transfer function, volts per g or millimeters per g, should be measured without readjustment. This measurement should be performed in accordance with the instrument manufacturer recommendations.

5. Those instruments not capable of such reference data recording should be inspected to evaluate the record validity. Any anomalies should be noted on the record collection log.

6. Where instrument operation appears to have been normal, the instrument should be placed back in service without readjustment or change that would defeat attempts to obtain post-event calibration.

5.3 Record Evaluation

~~[redacted]~~ The instruments should be calibrated tested using the time history from the obtained earthquake which was used to establish the Records should be analyzed according to the manufacturer's specifications. The results of the analysis should be evaluated. CAV Notations should be, such as: record anomalies; and invalid data and non-pertinent signals with notes identifying causes.

6. Determining OBE Exceedance See previous Comment

The evaluation should be performed on the three free-field ground motion acceleration components (i.e., two horizontal and one vertical). The evaluation may be performed on uncorrected earthquake records. It was

found in a study of uncorrected versus corrected earthquake records (Reference 9.1) that for cases where the records are potentially damaging the use of uncorrected records is conservative. The evaluation consists of a Response Spectrum Check and a Cumulative Absolute Acceleration Check.

6.1 Response Spectrum Check

The response spectrum check is exceeded if any one of the three components (two horizontal and one vertical) of the 5 percent damped free-field ground motion response spectra is larger than:

1. the corresponding design response spectra (OBE spectra if used, otherwise 1/3 SSE spectra) or 0.2g, whichever is greater for frequencies between 2 to 10 Hz, or

2. a spectral velocity of 6 inches per second for frequencies less than ~~2 Hz~~ between 1 and 2 Hz.

6.2 Cumulative Absolute Velocity (CAV) Check

The cumulative absolute velocity (CAV) check is exceeded if any one of the three components (two horizontal and one vertical) is larger than 0.16 g-second.

The CAV has been shown in EPRI NP-5930, (Reference 9.1) to be a lower bound indicator of the damage potential of an earthquake at a specific location. The calculation of the CAV is as follows: For each direction time history, 1) the absolute acceleration (g units) time history is segmented into one second intervals, 2) each one second interval that has at least one exceedance of .025g is integrated over time, 3) all the integrated values are summed together to arrive at the CAV. Additional guidance on how to determine the CAV is provided in Reference 9.2.

7. Plant Shutdown Criteria

7.1 OBE Exceedance. If the Response Spectrum Check and the Time History (CAV) Check, performed in accordance with Regulatory Position 6.1 and 6.2 were exceeded, than the OBE was exceeded and plant shutdown is required. If either check does not exceed the criterion, the earthquake motion did not exceed the OBE.

The determination of whether or not the OBE has been exceeded should be performed even if the plant automatically trips off-line as a result of the earthquake.

What if one of the two checks is inoperable?

or

7.2 Damage. Shutdown of the plant is required if the walkdown inspections, performed in accordance with Regulatory Position 4 (Section 4.3.2 of EPRI NP-6695), discover damage.

8. Pre-Shutdown Inspections

The pre-shutdown inspections as described in Section 4.3.4 of EPRI NP-6695 "Guidelines for Nuclear Plant Response to an Earthquake," are acceptable to the NRC staff for satisfying the evaluation requirements indicated in Paragraph IV(a)(2) of Proposed Appendix S to 10 CFR 50 for ensuring the safety of nuclear power plants subject to the following:

8.1 Delete the last sentence in the first paragraph.

8.2 The following paragraph contained in Section 4.3.4 is repeated for emphasis:

"Prior to initiating plant shutdown following an earthquake, visual inspections and control board checks of safe shutdown systems should be performed by plant operations personnel, and the availability of off-site and emergency power sources should be determined. The purpose of these inspections is to determine the effect of the earthquake on essential safe shutdown equipment

which is not normally in use during power operation so that any resets or repairs required as a result of the earthquake can be performed, or alternate equipment can be readied, prior to initiating shutdown activities."

In order to ascertain possible fuel and reactor internal damage, the checks noted in Section 4.3.4 of EPRI NP-6695 should be made, if possible, before plant shutdown is initiated.

If the OBE was not exceeded and the walkdown inspection indicates no damage to the nuclear power plant, then shutdown of the plant is not required. The plant may continue to operate (or restart following a post-trip review, if it tripped off-line due to the earthquake).

9. References

9.1 Electric Power Research Institute, NP-5930, "A Criterion for Determining Exceedance of the Operating Basis Earthquake" July 1988.

9.2 Electric Power Research Institute, EPRI Report TR-100082, "Standardization of Cumulative Absolute Velocity for Use With the EPRI OBE Exceedance Criteria," November 1991.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This proposed revision has been released to encourage public participation in its development. Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of applications for

an early site permit, design certification, or combined license submittals docketed after the implementation date to be specified in the active guide.

APPENDIX B

INTERIM OPERATING BASIS EARTHQUAKE (OBE) EXCEEDANCE GUIDELINES

1. For plants at which only instrumentally determined foundation level data are available, the Cumulative Absolute Velocity (CAV) Check is not applicable, and a determination of Operating Basis Earthquake (OBE) exceedance is based on the Response Spectrum Check described in Regulatory Position 6.1 of this regulatory guide. A comparison is made between the foundation level design response spectra and those obtained from the foundation level instruments. If the Response Spectrum Check at any foundation level is exceeded, the OBE is exceeded and shutdown is warranted.

2. For plants at which no instrumental data are available, the OBE will be considered to have been exceeded and shutdown to be warranted if the earthquake:

   a. resulted in MMI VI[a] or greater within 5 km[a] of the plant or

   b. was felt within the plant and was of magnitude 6.0[a] or greater or

   c. was of magnitude 5.0[a] or greater, and occurred within 200 km[a] of the plant.

3. A post-earthquake plant walkdown should be conducted. A procedure acceptable to the NRC staff is described in Regulatory Position 4 of this regulatory guide.

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[a] In these guidelines the U. S. Geological Survey, National Earthquake Information Center determinations of epicentral location, magnitude, and intensity will usually take precedence over other estimates; however, regional and local determinations will be used if they are considered to be more accurate. Also, higher quality damage or lack of damage reports from the nuclear power plant site or its immediate vicinity will take precedence over more distant reports.

NRR is reviewing this issue in conjunction with its OBE shutdown requirements and we will coordinate our position with this Reg Guide

DRAFT REGULATORY GUIDE DG-1018

PLANT RESTART

DRAFT REGULATORY GUIDE DG-1018
RESTART OF A NUCLEAR POWER PLANT SHUT DOWN DUE TO A SEISMIC EVENT

A. INTRODUCTION

Proposed Paragraph (a)(12) of §50.34, "Contents of Applications; Technical Information" to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," requires that on or after the effective date of this regulation, applicants who apply for early site permits, design certifications, or combined licenses for nuclear power plants, as partial conformance to General Design Criteria 2, "Design Basis for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, shall implement the earthquake engineering criteria in Proposed Appendix S, "Earthquake Engineering Criteria for Nuclear Power Plants," of 10 CFR Part 50. Prior to the effective date of this regulation, applicable earthquake engineering criteria for nuclear power plants are contained in Section VI of Appendix A, "Seismic and Geologic Siting Criteria," to 10 CFR Part 100, "Reactor Site Criteria." Paragraph (IV)(a)(3) of Proposed Appendix S to 10 CFR Part 50 requires that if vibratory ground motion exceeding that of the Operating Basis Earthquake occurs, shutdown of the nuclear power plant will be required.[1] The Operating Basis Earthquake is set pursuant to Paragraph IV(a)(2)(i) or (ii) of Proposed Appendix S to Part 50. Prior to resuming operations, the licensee will be required to demonstrate to the Commission that no functional damage has occurred to those features necessary for continued operation without undue risk to the health and safety of the public. This guide provides guidelines that are acceptable to the NRC staff for performing inspections and tests of nuclear power plant equipment and structures prior to restart of a plant that has been shutdown due to a seismic event as satisfying the requirements of Proposed Part 50 and Proposed Appendix S to Part 50.

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[1] Guidance is being developed in Draft Regulatory Guide DG-1017, "Pre-Earthquake Planning and Immediate Nuclear Power Plant Operator Post-Earthquake Actions," to provide plant shutdown criteria.

B. DISCUSSION

Data from seismic instrumentation[2] and a walkdown of the nuclear power plant ~~were~~ are used to make the initial determination of whether the plant should be shut down, if it is not already shut down due to operational perturbations resulting from the seismic event. (1) Plant in Control

The Electric Power Research Institute has developed guidelines that will enable licensees to quickly identify and assess earthquake effects on nuclear power plants. This report is designated EPRI NP-6695, "Guidelines for Nuclear Plant Response to an Earthquake,"[3] December 1989. This regulatory guide ~~is~~ addresses ~~sections that relate to~~ post-shutdown inspection and tests, inspection criteria, inspection personnel, documentation, and long-term evaluations.

Applicable portions of Proposed Appendix S to 10 CFR 50 are repeated to highlight the changes in philosophy pertaining to the Operating Basis Earthquake that were made during the creation of Proposed Appendix S to 10 CFR 50 and Proposed Appendix B to 10 CFR 100, (revision of Appendix A to 10 CFR 100).

The definitions of Safe Shutdown Earthquake Ground Motion (SSE) and Operating Basis Earthquake in EPRI NP-6695 to reflect changes that have been made during the creation of Proposed Appendix S to 10 CFR 50 and Proposed Appendix B to 10 CFR 100, (revision of Appendix A to 10 CFR 100).

C. REGULATORY POSITION

1. The following segments of Paragraph IV(a)(2) of Proposed Appendix S to

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[2] Guidance is being developed in Draft Regulatory Guide DG-1016, Second Proposed Revision 2 to Regulatory Guide 1.12, "Nuclear Power Plant Instrumentation for Earthquakes," that will describe seismic instrumentation acceptable to the NRC staff.

[3] Copies may be obtained from the Research Reports Center (RRC), Box 50490, Palo Alto, California 94303.

10 CFR 50 are repeated to highlight changes in the regulation pertaining to the Operating Basis Earthquake that are not consistent with those contained in EPRI NP-6695:

> "The Operating Basis Earthquake shall be defined by response spectra. When subjected to the effects of the vibratory motion of the Operating Basis Earthquake in combination with normal operating loads, all structures, systems, and components of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public shall remain functional, that is, within applicable stress and deformation limits.
>
> The value of the Operating Basis Earthquake shall be set to one of the following choices:
>
> (i) The Operating Basis Earthquake is set at one-third of the Safe Shutdown Earthquake Ground Motion level, the requirement of the Operating Basis Earthquake, as stated above, can be satisfied without the applicant performing any explicit response analyses,[4] or
>
> (ii) if an applicant chooses an Operating Basis Earthquake greater than one-third the Safe Shutdown Earthquake Ground Motion an explicit suitable analysis and design shall be performed to demonstrate that the requirement of the Operating Basis Earthquake, as stated above, is satisfied. The design shall take into account soil-structure interaction effects and the expected duration of vibratory ground motion."

2. The Definitions Section and the guidelines for post-shutdown inspections

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[4] A separate analyses to compute structure, equipment and piping response associated with the Operating Basis Earthquake is not required. Applicable design provisions associated with this Operating Basis Earthquake, for instance, fatigue, are discussed in regulatory guides.

and tests, and long-term evaluations specified in Sections 5.3.2 (includes Tables 2-1, 2-2 and 5-1), 5.3.3 (includes Table 5-1), 5.3.4, 5.3.5, and 6.3 (all sections and subsections) of EPRI NP-6695 are acceptable to the NRC staff for satisfying the evaluation requirements indicated in Paragraph IV(a)(2) of Proposed Appendix S to 10 CFR 50 for ensuring the safety of nuclear power plants, subject to the following definitions that should be added to or supersede those in the report:

2.1 felt earthquake. An earthquake of sufficient intensity such that:

1. the vibratory ground motion is felt at the nuclear power plant site and recognized as an earthquake based on a consensus of the control room operators on duty at the time, or
2. the free field or foundation-level seismic instrumentation installed at the plant are activated. The seismic triggers that activate these instruments are set at a threshold ground acceleration of not more than 0.02g. Spurious activation that can be clearly linked to a nonseismic event, for example, vehicular movement or construction, does not denote seismic instrumentation activation.

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2.3 safe shutdown earthquake ground motion (SSE). The "Safe Shutdown Earthquake Ground Motion (SSE)" is the vibratory ground motion for which certain structures, systems, and components shall be designed to remain functional. These structures, systems, and components are those necessary to assure:

1. The integrity of the reactor coolant pressure boundary,

2. The capability to shut down the reactor and maintain it in a

safe shutdown condition, or

3. The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the guideline exposures exceeding allowable amounts.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

This proposed revision has been released to encourage public participation in its development. Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the method to be described in the active guide reflecting public comments will be used in the evaluation of applications for an early site permit, design certification, or combined license submittals docketed after the implementation date to be specified in the active guide.