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# SEVERE ACCIDENT POLICY IMPLEMENTATION EXTERNAL EVENTS

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## ABSTRACT

In 1985, the NRC issued a severe accident policy statement that calls for a systematic examination of existing plants for severe accident vulnerabilities. The staff intends to proceed with the implementation of that policy using Individual Plant Examinations for internal events at the present time. The Individual Plant Examinations for external events will proceed later. This delay will allow the NRC to assess and identify areas where examinations for external event vulnerabilities are needed, to develop the guidance for the examination, and to integrate related ongoing programs.

## INTRODUCTION

On August 8, 1985, the Commission issued a policy statement on severe accidents (Ref. 1). The policy statement does not differentiate between events initiated within the plant and events caused by external initiators. Current risk assessments indicate that the risk from external events could be a significant contributor in some instances, although a distinct possibility exists that the risk from external events has been over estimated because of conservatisms used in the analyses.

The staff intends to proceed with the implementation of the Severe Accident Policy outlined in SECY-88-205 (Ref. 2) and GL 88-20 (Ref. 3) using Individual Plant Examinations (IPE) for internally initiated events. The assessment methods and plan for Individual Plant Examinations for External Events (IPEEE) requires more development. Hence the evaluation of external events will proceed on a schedule different from that for internal events. Delaying severe accident reviews for external events will not result in unacceptable public risk because design provisions for protecting nuclear power plants from external events are known to be conservative. The procedures and criteria outlined in industry codes and standards and specified in NRC Regulatory Guides and Standard Review Plans result in substantial inherent margins in the design. However, the staff believes that plant- and site-specific conditions and design and construction errors can decrease these inherent margins. In addition, use of maximum expected events has not always been developed using probabilistic bases. Therefore, it is appropriate that an IPEEE be conducted to identify and correct plant-specific vulnerabilities that could reduce the inherent margin.



The staff, as stated in SECY-86-162 (Ref. 4), is proceeding with the evaluation of severe accidents initiated by external hazards in two phases. The first phase program, which has been completed, consisted of a Lawrence Livermore National Laboratory (LLNL) study to assess the margins that past design bases provide relative to external events and to identify areas where an examination for external vulnerabilities may be needed. The second phase of the external events evaluation program will consist of developing specific guidance and criteria for each external hazard to be considered in the IPEEEs.

Based on the results of the LLNL study (Ref. 5) and information gained during an external events workshop held August 4-5, 1987, some external events such as earthquakes and internal fires may be significant risk contributors at some plants. Also, the design bases for some other external events such as tornadoes and external floods may be sufficiently conservative that they do not pose a significant risk at most plant sites. However, there may be some structures or facilities at some sites that were not designed to current criteria and may pose some risk at those plants. These studies provide insights to assist in developing review guidance for the IPEEEs.

There are many ongoing NRC programs addressing the potential threat of external events to the safety of nuclear power plants. It became evident that, to avoid any unnecessary duplication of effort, an integrated approach is absolutely essential for NRC to address these external events. On December 21, 1987, NRC established an External Events Steering Group (EESG) to make recommendations to senior management regarding the degree to which external events need to be considered in the context of the Severe Accident Policy Implementation and to determine the scope and identify the methods for such an evaluation. The EESG established three subcommittees to carry out its charter.

## EXTERNAL EVENTS PHASE I PROGRAM

Under the auspices of the NRC, the Lawrence Livermore National Laboratory (LLNL) made a study of the risk of core damage and large release due to externally initiated events at nuclear power plants. These events included internal fires, high winds/tornadoes, external floods, transportation, seismic events, and others.

Two figures-of-merit were used in the LLNL study as evaluation criteria to discriminate between the significant and the less significant levels of risk. These two figures-of-merit are defined as 1E-5 / reactor-year for a core damage accident and 1E-6 /reactor-year for a large release of radioactive materials to the environment.

The results of LLNL's study (Ref. 5) showed that those external initiators (seismic, internal fires, external floods, and high winds/ tornadoes) can be important (exceed the figure-of-merit) with respect to core damage frequency (Table 1). The results also showed that the current design bases for some external events, such as high winds/tornadoes and external floods, may be sufficiently conservative that they do not pose any significant risk at most plant sites. However, there may be some structures or facilities at some sites that were not designed to current criteria and may pose some risk at those plants (Table 2). The seismic initiator was found to have frequencies of large releases exceeding the figure-of-merit while the internal fires were found to have frequencies of large releases less than the figure-of-merit. Internal fires and seismic events may be of importance to all plants, while other external events are site specific.

These results, along with other considerations discussed below, will assist the staff in developing the scope and content of the IPEEE program.

## EXTERNAL EVENTS PHASE II PROGRAM

To address the many external events and to avoid any duplication, the NRC established the External Events Steering Group (EESG) in December 1987 to coordinate the effort. The EESG established three subcommittees (1. Seismic, 2. Internal Fires, and 3. High Winds, Floods, and Others) to carry out its mission. Specifically, each subcommittee is to recommend a potential regulatory framework with respect to the implementation of the severe accident policy. This effort included consideration of the various issues and integration of other existing programs (Table 3) into a consistent approach for an Individual Plant Examination for External Events (IPEEE).

The scope and the approach of the examination for each individual event may differ. More detailed guidance and criteria need to be developed for the IPEEE. This guidance should enable the licensees or the NRC, as appropriate to:

1. Determine which external hazards need to be included in IPEEE programs based on specific site and plant conditions.

2. Systematically assess plant-specific vulnerabilities to severe accidents initiated by those external hazards.

3. Integrate NRC's ongoing safety programs that are related to external events.

4. Establish criteria to resolve external event issues.

Programs are being conducted at LLNL and Sandia to assist the staff to (1) develop IPEEE guidance and procedures for operating plants, (2) develop review plans and acceptance criteria, (3) extend the Seismic Design Margins Program methodology, (4) integrate ongoing safety programs, and, (5) assess the impact of separating examinations for internal and external events. These programs are scheduled to be completed by next fall. Since the industry has sponsored numerous safety programs, NRC will continue to encourage industry participation to identify needs, scope, and methods for IPEEE and to develop or review guidance and procedures. Ultimately, the industry needs to be familiar with the IPEEE in order to carry out the program to identify plant-specific vulnerabilities at each plant.

## CONCLUSION

Based on NRC and industry experience with plant-specific PRAs, the Commission has recognized that systematic examinations are beneficial in identifying plant-specific vulnerabilities to severe accidents that could be fixed with low-cost improvements. The Commission, therefore, calls for each existing plant to perform such an examination to identify plant-specific vulnerabilities. At the present time, licensees are requested to proceed with examination for internal events only. The external event examination will proceed separately on a later schedule. This delay allows the staff (1) to identify which external events need an examination, (2) to develop examination guidance and procedures, and (3) to integrate other ongoing programs that deal with external events to ensure that there is no duplication of efforts. Programs are being conducted at LLNL and Sandia to assist the staff in accomplishing the above by next fall. The staff encourages the industry to propose methodologies for examining external events that meet the intent of the severe accident policy.

## REFERENCES


1. "Policy Statement on Severe Reactor Accident", USNRC, Federal Register, Vol. 50, pg. 32138, August 8, 1985.

2. USNRC Policy Paper SECY-88-205, "Generic Letter for the Implementation of the Severe Accident Policy Statement", memorandum from V. Stello, July15, 1988.

3. USNRC Generic Letter 88-20, "Individual Plant Examination for Severe Accident Vulnerabilities - 10 CFR 50.54(f)", November 23, 1988.

4. USNRC Policy Paper SECY-86-162, "Treatment of External Events in the Implementation of the Severe Accident Policy Statement", memorandum from V. Stello, May 22, 1986.

5. NUREG/CR-5042, "Evaluation of External Hazards to Nuclear Power Plants in the United States", C. Y. Kimura and R. J. Budnitz, LLNL, December, 1987.

TABLE 1
CORE DAMAGE FREQUENCIES FROM EXTERNAL EVENTS

| PRA | ALL INITIATORS | FIRES | SEISMIC | EXTERNAL FLOODS | HIGH WINDS TORNADOES |
|---|---|---|---|---|---|
| Zion 1 & 2 | 5.7E-5 | 1.8E-6 | 5.6E-6 | Insign. | N.A. |
| Indian Pt. 2 | 4.7E-4 | 1.4E-4 | 1.4E-4<br>4.8E-5R | Extre.<br>Small | 2.5E-5 (Median)<br>4.3E-5 (Mean) |
| Indian Pt. 3 | 2.3E-4 | 9.6E-5 | 3.1E-6<br>2.5E-5R | Extre.<br>Small | 4.9E-8 (Median)<br>1.3E-6 (Mean) |
| Big Rock Pt. | 9.8E-4 | 2.3E-4 | N.A. | N.A. | N.A. |
| Limerick | 4.4E-5 | 2.3E-5 | 4.0E-6 | Negl. | 9.0E-9 |
| Seabrook | 2.3E-4 | 2.5E-5 | 2.9E-5 | N.A. | 2.1E-9 |
| Oconee 3 | 2.5E-4 | 1.0E-5 | 6.3E-5 | 2.3E-5 | <1.0E-9 |
| Millstone 3 | 7.0E-5 | 4.8E-6 | 9.4E-5<br>8.8E-6R | Insign. | <1.0E-7 |
| Point Beach | 3.1E-4 | 3.3E-5 | 6.0E-5 | 1.9E-8 | 4.0E-6 |
| Turkey Pt. | 2.4E-4 | 7.5E-5 | 7.8E-6 | 4.6E-5 | 2.4E-5 |
| St. Lucie 1 | 7.5E-5 | 4.4E-5 | 1.3E-5 | 3.2E-6 | 1.6E-8 |
| Quad Cities | 2.0E-4 | 1.3E-5 | 8.3E-5 | 1.0E-7 | 1.4E-7 |
| ANO-1 | 1.8E-4 | 5.8E-6 | 7.3E-5 | 7.2E-6 | 5.3E-6 |
| Cooper | 4.4E-4 | 1.1E-5 | 8.1E-5 | 5.0E-5 | 3.8E-6 |

TABLE 2
PRA INSIGHTS ON HIGH WINDS/TORNADOES RISK

| PLANT NAME | TOTAL HIGH WINDS/ TORNADOES CDF | VULNERABLE STRUCTURES | AFFECTED STRUCTURES/ COMPONENTS |
|---|---|---|---|
| Indian Point 2 (66/71) | 2.5E-5 (Median)<br>4.3E-5 (Mean) | Unit 1 Superheater Stack | Unit 2 DG Bldg. & Control Bldg. |
| Arkansas Unit 1 (68/74) | 2.6E-4 w/o Recovery<br>5.3E-6 w/ Recovery | DG Exhaust Stack | Fail Both DGs |
| Point Beach 1&2 (67/70, 68/71) | 6.0E-5 w/o Recovery<br>4.0E-6 w/ Recovery | DG Exhaust Stack | Fail Both DGs |
| Turkey Point 3 (67/72) | 3.6E-5 w/o Recovery<br>2.4E-5 w/ Recovery | Unit 2's 400' Concrete Stack | DG Bldg., Fuel Oil Pumps Switchgear Bldg, Unit 3 RWST DG Fuel Tank, CST Intake Pumps |

TABLE 3
ONGOING NRC PROGRAMS AND RELATED UNRESOLVED
SAFETY ISSUES/GENERIC ISSUES (USIs/GIs)

(1) USI A-46, "Seismic Qualification of Equipment in Operating Plants", is developing an alternative method and acceptance criteria to verify the seismic adequacy of operating plants equipment with construction permits before about 1972 against the current safe shutdown earthquake (SSE). Although not intended to examine seismic margins beyond the SSE, this effort is expected to provide some insights on equipment capacity beyond the SSE level.

(2) USI A-45, "Shutdown Decay Heat Removal Requirement", has examined the ability of the decay heat removal systems of six operating plants to perform its function during and after seismic events up to and beyond the SSE, with internal flooding, internal fires and high winds. USI A-45 is now subsumed in the IPE program.

(3) USI A-17, "System Interactions in Nuclear Power Plants", addresses ACRS concerns regarding the interactions of various systems with regard to whether actions or consequences could adversely affect the redundancy and independence of safety systems. The spatial system interaction during a seismic event is now included in USI A-46.

(4) USI A-40, "Seismic Design Criteria, A Short-Term Program", investigated selected areas of the seismic design process, and is proposing alternate approaches to part of the design sequences, as well as modifying the NRC criteria in the Standard Review Plan to reflect the current state of the technology and industry practice. The concern of the seismic design of safety-class tanks is now included in USI A-46.

(5) "Seismic Hazard Characterization of the Eastern United States Project" has developed a method to assess the seismic hazard for the region east of the Rocky Mountains. This will provide a better means of assessing the seismic hazards used in the plant design.

(6) "Seismic Design Margins Program" has developed a simplified method to estimate available seismic margins in operating plants at a predetermined seismic level above the current SSE. The method draws on the insights gained from completed seismic PRAs to focus on those plant functions that contribute most to seismic risk. Screening guidance has been established for earthquakes up to several times above the SSE level.

(7) "Fire Risk Scoping Study" was performed to: (a) review and re-quantify certain past fire risk scenarios in light of updated data bases and updated computer fire modeling capabilities, (b) identify potentially significant fire risk issues which have not previously been addressed and to quantify the potential impact of those identified fire risk issues, and (c) review current fire regulations and plant implementation practices for relevance to the identified unaddressed fire risk issues. It was found that application of a more extensive operational experience data base resulted in an increase to the estimated fire risk as compared to previous fire PRAs. Six fire risk issues were also identified which had not previously been addressed in the fire risk context.

(8) NUREG-1150, "Reactor Risk Reference Document", has performed external event analyses for the Surry and Peach Bottom nuclear power plants. Earthquakes, internal fires, and other specific external events were included in the analyses. The approach uses event trees and fault trees derived from internal event analyses. This allows some direct comparison between external and internal events.

(9) "Robust Techniques for Estimating the Probabilities of Extreme Floods" identified and reviewed various approaches to estimate extreme flood probabilities. It recommends two general approaches, a statistical technique and a runoff model technique to estimate extreme flood frequencies.