September 6, 1988

POLICY ISSUE
(Notation Vote)

SECY-88-248

For: The Commissioners

From: Victor Stello, Jr., Executive Director for Operations

Subject: IMPLEMENTATION OF THE SEVERE ACCIDENT POLICY FOR FUTURE LIGHT WATER REACTORS

Purpose: To propose a means of implementing the Commissions's Severe Accident Policy Statement (50 FR 32138) for future Light Water Reactors (LWRs) including those evolutionary standard reactor designs currently under staff review.

Summary: The staff proposes initiation of rulemaking to amend 10 CFR 50.34 to require that technical information on severe accidents be included in future applications. In addition to these procedural requirements, we are recommending that general performance requirements be promulgated addressing severe accident prevention and mitigation. These requirements could be promulgated as a single Rule or as two separate Rules and would only be applicable to future LWR designs not significantly different than current generation LWRs. Requirements for LWR designs that are significantly different than current generation LWRs would be developed, as appropriate, if and when such designs are presented for review. The Rules would be supplemented by two Regulatory Guides and new Standard Review Plan sections. The staff's intent is to clarify severe accident requirements for future LWRs (including the evolutionary LWR standard plant designs currently under review) prior to initiation of Design Certification rulemakings. Existing plants would not be affected by the new requirements.

Background: The designs of current engineered safety features for present LWRs are set by the requirement that the consequences of postulated design basis accidents be less than specified radiological dose levels. The most severe of these design basis accidents is the loss-of-coolant accident, which typically serves to set the required strength of the plant's containment building. In conjunction with this accident, a fission product release

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into containment is assumed to occur and is used to set the leak tightness of the containment and the capabilities of other engineered safety features. 10 CFR 100.11 requires that site characteristics be such that doses at two off-site locations, the exclusion area and low population zone outer boundaries, be limited to less than 10 CFR 100 dose values. In addition to the site characteristics, 10 CFR 100.10 directs that the containment leak tightness and the fission product retention capabilities of other engineered safety features be used in the off-site dose calculations, and 10 CFR 100.11 refers to TID-14844 for an example of how these calculations are to be done.

The temperature and pressure conditions associated with some severe accidents are expected to be more of a challenge to a reactor containment than design basis loss-of-coolant accidents. Selected accidents more severe than the design basis accidents have, in the past, been treated as generic safety issues. Examples include the ATWS Rule (10 CFR 50.62), the Hydrogen Rule (10 CFR 50.44), and the Station Blackout Rule (10 CFR 50, Appendix A and 10 CFR 50.63). In addition, 10 CFR Part 100 requires generally that the doses from any credible accident not exceed the specified dose guideline values.

10 CFR 50.34 (f) required that a probabilistic risk assessment (PRA) be performed for a specified list of plants, but adequate requirements for future applications have not yet been placed in the regulations. The proposed Rule on design certification (10 CFR 52) requires certain information identified in the Severe Accident Policy Statement be included in future plant applications; however, Part 52 does not address severe accident issues in any detail, and it does not apply to future plant applications that utilize the old Part 50 two-step licensing process. Both the Safety Goal and the Severe Accident Policy deal broadly with severe accidents, and serve to set a direction for the staff to take in the use of probabilistic risk assessments. However, they do not supply specific regulatory requirements or detailed technical guidance that could be applied in future plant licensing applications.

A requirement for the staff to develop additional guidance was included in the Severe Accident Policy Statement "...the staff will issue guidance on the form, purpose and role that PRAs are to play in severe accident analysis and decision making for both existing and future plant designs and what minimum criteria of adequacy PRAs should meet "and stated the expectation that "new standard (or custom) plants will achieve a higher standard of severe accident safety performance than their prior designs."

In accordance with the direction given in the Severe Accident Policy Statement, the Individual Plant Examination process is being proposed to address severe accidents in existing plants. The staff proposals in this paper represent the corresponding activity for those LWR designs that are currently being developed for near term application. These include the evolutionary designs currently under review - the ABWR, CE Sys80+, and SP/90 and also the 600 MWe designs currently included in the Electric Power Research Institute's (EPRI) Advanced Light Water Reactor Program (which are not expected to differ radically from the evolutionary designs). For designs having radically different design features and expected performance as compared to current generation LWRs, we would propose that new regulations be developed, as appropriate, if and when such designs are presented for review.

Discussion: The Severe Accident Policy Statement's main objective is to establish stability in the design, licensing and operation of new standard plants. In keeping with this objective, the staff considers that the Policy Statement provides guidance to formulate a systematic approach for treating severe accidents, including the development of guidelines and procedural criteria. The NRC staff is presently involved in the review of three evolutionary LWR designs. Design Certification rulemaking is expected to start for the first of these plants in mid to late 1990. The nuclear industry's proposed design requirements for future applications are in the process of being documented in the EPRI Advanced LWR (ALWR) Requirements Document which is currently being submitted chapter by chapter for NRC review. Also, the related DOE sponsored Advanced Reactor Severe Accident Program (ARSAP) is directed toward the resolution of outstanding severe accident issues. The outcome of the staff review of the ALWR and ARSAP programs will set the trend for the next generation of U.S. LWRs. It is our intent to utilize available information from our review of the ALWR and ARSAP programs, as well as other information, to develop guidance for future LWRs on the treatment of severe accidents. The effort described in this paper is intended to support the licensing of the three evolutionary LWRs, as well as other near-term future LWRs, by providing the guidance referred to in the Severe Accident Policy Statement.

The staff has considered four options for providing further guidance on the treatment of severe accidents. These options are summarized below with additional detail provided in Enclosure 1:

Option 1 This option would utilize the general statements on severe accident requirements proposed in the Rule on design certification, 10 CFR 52. Additional guidance would be provided in Regulatory Guides, and severe accident issues would be resolved during each of the individual Design Certification rulemakings for the three evolutionary LWRs currently under review.

Option 2 This option would utilize a general Rule or Rules requiring a PRA and an assessment to identify and correct any significant severe accident vulnerabilities, including both accident prevention and mitigation aspects. It is envisioned that a revised form of 10 CFR 50.34(f) would be used. General performance requirements would be included in the Rules(s) and detailed guidance would be provided in supporting Regulatory Guides. The need for design or operational changes would be determined by cost/benefit considerations.

Option 3 This option would be similar in form to Option 2 except that in addition to the general requirements given in the Rule(s), more specific performance goals and acceptance criteria would be included in the Regulatory guides and cost/benefit would not be the primary means for determining acceptability.

Option 4 This option would include specific performance requirements and acceptance criteria in the Rules(s), rather than the general requirements of the three previous options. It would be the most prescriptive option. Regulatory Guides would be provided to give additional guidance, as necessary.

In comparing these four options, the staff concludes that options 2 and 4 are not as attractive as options 1 and 3. Option 2 relies too heavily on the use of cost/benefit for decision making and would be subject to the inherent difficulties associated with that process. Option 4 could be overly prescriptive, limiting flexibility in reactor design and analysis approaches. Option 1 is considered to be workable; however, it is believed that is has some disadvantages, namely: it lacks focus on the importance of severe accidents in future reactor designs; it emphasizes procedural requirements and is lacking on performance aspects; and it is only applicable to designs which utilize 10 CFR 52. On the other hand, Option 3 is stronger in all of the above aspects.

Accordingly, the staff recommends the approach described under Option 3, since we believe that this type of approach offers the best means for identifying useful design goals for severe accidents while retaining sufficient flexibility to deal with uncertainties. It is also believed that promulgating a separate severe accident Rule before the three planned Design Certification rulemakings would facilitate the certification process and make the outcome more predictable.

In a public meeting (in Rockville, Maryland on June 9, 1988), held to discuss the staff's plans to develop further regulatory guidance on severe accidents, members of the industry expressed a desire to have such additional guidance. Discussions with OGC have also reinforced our conviction that the promulgation of separate severe accident Rules could aid future licensing actions. Therefore, we have established a schedule for a rulemaking (Enclosure 6) that is consistent with the needs of the ABWR Design Certification rulemaking schedule. This is expected to be the first of the evolutionary LWR designs to go through the Design Certification process (mid to late 1990). It would also be our aim to ensure consistency between the new regulatory guidance and key licensing decisions arrived at during the review of the GE ABWR.

In summary, the staff proposes to implement the Commission's severe accident policy for future LWRs by establishing at this time requirements for the consideration of severe accidents applicable to those LWR designs which do not differ significantly from current generation LWR designs. The most recent research insights, in conjunction with past experience in severe accident assessments, would be used to derive future plant regulatory requirements, augmenting or revising certain existing requirements. The basic objective of this activity would be to ensure that the insights regarding the prevention and mitigation of accidents, gained to date from the evaluation of postulated severe accidents in operating plants, are factored into the design and review of future plants. Emphasis would be placed on the use of realistic analysis approaches and deterministic acceptance criteria supplemented by probabilistic risk analysis and engineering judgement. To accomplish the above, the staff proposes to take the following steps:

1. Procedural requirements would be established in a Rule, currently envisioned as an updated version of 10 CFR 50.34(f). The Rule would contain the requirement that future applications include a PRA and that supplementary information be provided to demonstrate

that pertinent TMI and generic issues have been adequately addressed by the proposed designs. Enclosure 2 is a sample of the features that are being considered for this Rule that apply specifically to severe accident concerns. Additional revisions would also be made to 10 CFR 50.34(f) to make it consistent with current practices.

2. In addition to the procedural requirements, we propose that performance oriented requirements be implemented to require that future plants be designed, operated and maintained to provide assurance of preventing and mitigating severe accidents. This would implement the statement in the Severe Accident Policy which says that the Commission fully expects vendors engaged in designing new standard (or custom) plants will achieve a higher standard of severe accident safety performance than their prior designs. The performance requirements would be written to be concise and general in nature and would not be expected to need future updating. The performance requirements could be included with the procedural requirements in a single Rule or there could be two Rules. Enclosure 3 is a sample of the features that are being considered for the performance requirements.

3. Two Regulatory Guides would be provided to expand on, and support the general requirements given in the Rules and would be consistent with the Commission's Severe Accident Policy Statement. Included in the first Regulatory Guide would be detailed guidance regarding the scope and content of probabilistic risk assessments for future plants. Appropriate material for this exists in various other documents, but it needs to be assembled and revised for this use. Enclosure 4 is a representative sample of the procedural type of material being considered for the first Regulatory Guide. This Regulatory Guide would utilize information from the BNL draft report "Content of PRA Submittals for Future LWRs," NUREG/CR-4812. In addition to this procedural guidance, acceptable means of demonstrating sufficient capability to prevent and mitigate severe accidents would also be included. Enclosure 5 provides some sample information about this guidance as it is envisioned. It is expected that the first Regulatory Guide would need periodic updating to incorporate improved data and understanding of severe accident behavior. The second Regulatory Guide would provide guidance on demonstrating adequate technical resolution of applicble TMI and generic issues. For those issues which are

not amenable to a generic resolution within the time constraints of the ongoing evolutionary LWR design review, the resolution would be achieved during the design specific certification rulemaking.

The technical bases for the Rules and the Regulatory Guides would be developed in report form as supplementary documentation and would be issued concurrent with the Rules and the Regulatory Guides.

Development of the Rules and Regulatory Guides would occur in parallel with the staff Final Design Approval (FDA) reviews of the three evolutionary LWR plant designs. Public meetings in the form of workshops are planned, with participation by the staff, DOE, the public, industry representatives involved in the EPRI ALWR and the ARSAP programs and others involved in developing designs for future plants. The purpose of these meetings is to ensure that the affected parties are aware of our proposed requirements as they are being developed and to solicit their comments.

The staff does not view the proposed treatment of severe accidents as being an extension of the plant Design Basis. Instead, the staff views the imposition of severe accident requirements as being directed toward assuring that sufficient margin exists to prevent or accommodate the more likely severe accident events. Accordingly, we do not propose to change the traditional treatment of the Design Basis Accidents as described in the LWR Standard Review Plan and will make clear in the proposed rulemaking that the analysis of severe accidents can be based on a realistic evaluation of plant performance.

We also do not propose to redefine the required level of adequate protection for future LWRs, as compared to existing plants. It is our view that as long as future LWRs, of a design not significantly different than current generation LWR designs, meet existing regulations, adequate protection will be achieved. The purpose of the proposed Rules and Regulatory Guides is to ensure an adequate and consistent assessment of severe accidents on future plants. Such an assessment will help ensure that significant vulnerabilities to severe accidents are identified and that future reactors provide enhanced safety, consistent with the Commission's Severe Accident Policy Statement.

The proposed Rules and Regulatory Guides would be submitted for review by the CRGR and ACRS Committees and to the Commission prior to the formal public comment process.

Coordination: The Offices of Nuclear Reactor Regulation and Nuclear Regulatory Research concur with this paper. The Office of the General Counsel has no legal objection to this paper.

Recommendation: (1) The Commission endorse the staff's plan to develop a new Rule or Rules applicable to future LWR designs which do not differ significantly from current generation LWR designs to implement the procedural requirements set forth in the Severe Accident Policy Statement, including general severe accident performance requirements and modification of 10 CFR 50.34(f).

(2) The Commission endorse the staff's plan to develop Regulatory Guides and other documentation in support of the Rule(s).

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Enclosures:
1. Rule/Regulatory Guide Options
2. Sample Revised 10 CFR 50.34(f)
3. Sample New Performance Requirements
4. Sample Procedural Reg. Guide Material
5. Sample Performance Reg. Guide Material
6. Schedule

Commissioners' comments or consent should be provided directly to the Office of the Secretary by c.o.b. Wednesday, September 21, 1988.

Commission Staff Office comments, if any, should be submitted to the Commissioners NLT Wednesday, September 14, 1988, with an information copy to the Office of the Secretary. If the paper is of such a nature that it requires additional time for analytical review and comment, the Commissioners and the Secretariat should be apprised of when comments may be expected.

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ENCLOSURE 1

FUTURE PLANT SEVERE ACCIDENT RULE/R.G. OPTIONS

OPTIONS	RULES	REG GUIDES	COMMENTS
1	UTILIZE GENERAL STATEMENTS IN PROPOSED 10CFR52.*	R.G. ON STD. FORMAT AND CONTENT OF PRA. R.G. ON HOW TO TREAT TMI, USIs, GSIs, RANGE OF SAs OR OTHER PHENOMENA/EVENTS/ VULNERABILITIES TO BE CONSIDERED, SPECIFIC PERFORMANCE/ACCEPTANCE CRITERIA AND DOCUMENTATION TO BE SUBMITTED.	LET CERTIFICATION HEARINGS TREAT SEVERE ACCIDENT (SA) ON A CASE-BY-CASE BASIS USING 10CFR52, R.G. AND SEVERE ACCIDENT POLICY STATEMENT (SAPS) AS GUIDANCE.

*PART 52 EXCERPT: "THE APPLICATION SHALL ALSO INCLUDE... DESIGN-SPECIFIC PROBABILISTIC RISK ASSESSMENT (PRA), TOGETHER WITH A CONSIDERATION OF ANY SEVERE ACCIDENT VULNERABILITIES THAT THE PRA EXPOSES AND A REALISTIC ASSESSMENT OF THE DEGREE TO WHICH THE DESIGN CONFORMS TO THE COMMISSION'S SAFETY GOALS FOR PLANT OPERATIONS..."

FUTURE PLANT SEVERE ACCIDENT RULE/R.G. OPTIONS (CONTINUED)

OPTIONS	RULES	REG. GUIDES	COMMENTS
2	- RULE TO IMPLEMENT PROCEDURAL STEPS IN SAPS (REVISED 10CFR50.34(F))	- R.G. ON STD. FORMAT AND CONTENT OF PRA.	
	- GENERAL PERFORMANCE REQUIREMENT TO INCLUDE MARGIN IN THE DESIGN TO PREVENT/ ACCOMMODATE SAS. (10 CFR 50.XXX)	- R.G. ON RANGE OF SAS TO BE CONSIDERED, GUIDANCE ON USING COST/BENEFIT TO DECIDE WHEN A CHANGE IS NEEDED AND DOCUMENTATION TO BE SUBMITTED.	COST/BENEFIT USED TO DECIDE WHEN A DESIGN/PROCEDURE CHANGE NEEDS TO BE MADE TO PROVIDE MORE MARGIN. SOME QUESTIONS EXIST REGARDING FEASIBILITY.
			ONLY WORKABLE IF TREATMENT OF SEVERE ACCIDENT IS CONSIDERED AS ENHANCED SAFETY.

FUTURE PLANT SEVERE ACCIDENT RULE/R.G. OPTIONS (CONTINUED)

OPTIONS	RULES	REG. GUIDES	COMMENTS
3	- RULE TO IMPLEMENT PROCEDURAL STEPS IN SAPS (REVISED 10 CFR 50.34(F)	- R.G. ON STD. FORMAT AND CONTENT OF PRA.	
	- GENERAL PERFORMANCE REQUIREMENT TO INCLUDE MARGIN IN THE DESIGN TO PREVENT/ ACCOMMODATE SAS. (10 CFR 50.XXX)	- R.G. ON HOW TO TREAT TMI, USIS, GSIS, RANGE OF SAS OR OTHER PHENOMENA/EVENTS/ VULNERABILITIES TO BE CONSIDERED, SPECIFIC PERFORMANCE/ACCEPTANCE CRITERIA AND DOCUMENTATION TO BE SUBMITTED.	DEGREE TO WHICH IDENTIFIED VULNERABILITIES HAVE BEEN ELIMINATED AND SPECIFIC PERFORMANCE/ ACCEPTANCE CRITERIA IN R. G. MET USED TO EVALUATE WHETHER OR NOT THERE IS AN ACCEPTABLE MARGIN IN THE DESIGN FOR SEVERE ACCIDENT PREVENTION/MITIGATION.

FUTURE PLANT SEVERE ACCIDENT RULE/R.G. OPTIONS (CONTINUED)

OPTIONS	RULES	REG. GUIDES.	COMMENTS
4	- RULE TO IMPLEMENT STEPS IN SAPS	- R.G. ON STD. FORMAT AND CONTENT OF PRAS.	
	- SPECIFIC PERFORMANCE/ ACCEPTANCE CRITERIA ON THE MARGIN REQUIRED IN THE DESIGN TO PREVENT/ ACCOMMODATE SAS.	- R.G. ON RANGE OF SAS TO BE CONSIDERED AND DOCUMENTATION TO BE SUBMITTED.	COULD REQUIRE AN INCREASED EFFORT TO COMPLETE IN TIME TO SUPPORT CERTIFICATION OF ALWRS. WOULD REDUCE FLEXIBILITY FOR CHANGES IN TECHNICAL POSITIONS AS NEW INFORMATION DEVELOPS FROM ONGOING RESEARCH ON SEVERE ACCIDENT PHYSICAL PHENOMENA AND PLANT BEHAVIOR.

Enclosure 2

SAMPLE OF REVISION TO 10 CFR 50.34(F)

SEVERE ACCIDENT REQUIREMENTS

Each application for a CP, OL, Combined CP/OL, PDA, FDA or Design Certification for an LWR having a design similar to those currently under consideration by the Commission at the time these regulations are enacted and submitted after February 1982 shall provide:

(1) Sufficient information to demonstrate adequate technical resolution of all applicable TMI and generic issues.

(2) A plant/site specific probabilistic risk assessment, the aim of which is to identify significant plant vulnerabilities to severe accidents. This assessment shall include supplementary information as needed to demonstrate that the design provides adequate margin for protection of public health and safety and of the environment for a range of severe accidents. This information is to be used to seek improvements in the plant to reduce the identified vulnerabilities. The supplementary information is to include:

(a) A plan for accident management which includes appropriate procedures to recover heat removal capability, to minimize environmental releases, and to predict the probable future course of the event, for the potential accident sequences predicted to be the greatest contributors to plant risk.

(b) A discussion of measures taken in the proposed design to reduce the likelihood or mitigate the consequences of the potential accident sequences predicted to be the greatest contributors to plant risk.

(c) The basis for selection of the strengths, capacities or locations of equipment and materials of construction used in the facility that might be required to perform service under severe accident conditions.

(d) A discussion of the probable performance of the containment building and its penetrations and supporting systems at temperatures and pressures predicted during the more likely-severe core damage accidents.

Enclosure 3

SAMPLE NEW PERFORMANCE ORIENTED SEVERE ACCIDENTS REQUIREMENTS FOR NEAR-TERM LWRs

(1) Provisions to minimize the probability of severe core damage shall be included in plant design, operation and maintenance. Structures, systems, and components shall be designed, operated, and maintained with sufficient margin to provide reasonable assurance that neither single nor multiple failures (including those caused by internal and external events, common failure modes, or fault propagation among systems) have more than a very low likelihood of resulting in severe core damage.

(2) Containments shall be designed, maintained and operated with sufficient margin to provide reasonable assurance that in the event of a severe core damage event and the likely consequential phenomena (e.g., molten core dispersal from the vessel and containment pressurization), sufficient retention of fission products would be maintained. This requirement is applicable only to those severe accident events considered to be significant potential contributors to risk to the public health and safety.

Enclosure 4

DESCRIPTION AND SAMPLE CONTENTS FOR PROCEDURAL REGULATORY GUIDE INFORMATION

The purpose of this Regulatory Guide information would be to provide detailed guidance on what should be included in probabilistic risk assessments (PRAs) for near-term future plant applications. Both the scope and content would be covered. The procedural content will by necessity be closely tied to the safety performance goals included in the Regulatory Guide that, in turn, support the general severe accident performance requirements in the Rule(s). The scope and content of the PRA documentation will have to be consistent with the information needs dictated by the performance requirements and acceptance criteria in order that judgements can be made regarding acceptability.

Following is a sample outline of the procedural contents of this Regulatory Guide.

1. Design Characterization

    1.1 Initiating Events Considered

    1.2 The Following Information for Criticality Control, Decay Heat Removal, Inventory Control and Containment Performance

        1.2.1 System Notebook for Front-Line Systems Involved

        1.2.2 Logical Definition of Function Success in Terms of Front-Line System Success

        1.2.3 Characterization of Front-Line/Support System Interfaces

        1.2.4 Fully-Linked Model for Front-Line System Failure

        1.2.5 Fully-Linked Model for Functional Failure

        1.2.6 Treatment of Common Cause Failure

        1.2.7 Physical Analysis Demonstrating That Functional Performance Goal is Met

    1.3 Analysis of Support Systems

        1.3.1 System Notebook for Support Systems Involved

        1.3.2 Logical Definition of Support Train Success Characterization of Front-Line/Support System Interfaces

1.3.3 Fully-Linked Model for Functional Failure (that is, linked to other support systems as necessary)

1.3.6 Physical Analysis Demonstrating That Functional Performance Goal is Met (if regulatory standards have been set for support systems)

2. Delineation of Accident Sequences

2.1 Functional Event Trees

2.2 Systemic Event Trees

2.3 Accident Sequence Diagrams

2.4 Characterization of Operators' Role in Each Accident Sequence

2.5 Accident Management Considerations

2.6 Identification of Emergency Action Levels

3. Quantification of Accident Sequence Frequency

3.1 Sequence-Specific Data Development

3.1.1 Treatment of Human Actions

3.1.2 Treatment of Common Cause Initiators (idealy, a demonstration that they are not important because of train separation and system ruggedness)

3.2 Leading Minimal Cut Sets for Each Core Damage Plant Damage State

3.3 Frequencies for Each Core Damage Plant Damage State

3.4 Demonstration that Core Damage Frequency Goal is Met

4. Development of Containment Event Trees: Analysis of Accident Sequence Phenomenology

4.1 Definition of Plant Damage States at Core Damage Stage

4.2 Containment Event Trees for Each Plant Damage State

5. Quantification of Containment Event Trees

    5.1 Frequencies of Each Release Category

    5.2 Demonstration That Frequency-Of-Release Goal Is Met

6. Consequence Analysis

    6.1 Evaluation of Specified Consequences for Each Release Category (prototypical site assumptions to be prescribed)

    6.2 Demonstration That Consequence Goal (if any) Is Met

7. Sensitivity, Uncertainty, Importance Analyses

    7.1 Sensitivity Analysis

        7.1.1 Identification of Parameters/Assumptions Which Are Essential To Compliance (key reliability parameters, other significant quantities)

        7.1.2 Formulation of Interface Requirements To Be Passed On To Construction Phase/Operational Phase (train level reliability targets, key operating procedures, etc.)

    7.2 Uncertainty Analysis

        7.2.1 Uncertainty In:

            Total Core Damage Frequency

            Core Damage Frequency Of Each Plant Damage State

            Frequency Of Each Release Category

        7.2.2 Uncertainty Due To:

            Modelling

            Parametric Uncertainty

        7.2.3 Importance Analysis

8. Documentation

8.1 Summary Information To Be Documented in SAR

8.2 Information To Be Maintained At the Plant Site

8.3 Information To Be Documented and Maintained By the Licensee in Auditable Form

Enclosure 5

SAMPLE PERFORMANCE GOALS FOR THE REGULATORY GUIDE

The purpose of this Regulatory Guide information would be to provide detailed guidance on acceptable means for demonstrating that near-term future LWR designs have sufficient capability to both prevent and mitigate severe accidents. This information would support and expand on the general performance requirements stated in the proposed Rule(s).

Severe accident studies of past reactor designs have provided an extensive resource of knowledge of potential severe accident vulnerabilities. A goal of this Regulatory Guide would be to ensure that this knowledge is reflected in the new design goals for future LWRs so that past problems are eliminated as well as is possible. A number of these past problems are associated with uncertainties in our ability to predict plant behavior under certain severe accident conditions (e.g., direct containment heating). Future plants should, preferably, incorporate design features that drastically reduce the likelihood of an accident progressing to a specific behavior state that is either undesirable or not well understood. In lieu of being able to do this, analysis must be provided to demonstrate that the specific remaining risk contribution under consideration is acceptable. Accordingly, it is expected that this Regulatory Guide would include specific performance goals in two basic categories. The first category would be an identification of certain past perceived severe accident problems with a requirement that these problems be addressed in some manner in the new design. The manner of resolution would not be specified, but examples of acceptable design approaches might be included. The second category would be in the area of analysis methods. Guidance on acceptable analytical tools (computer codes), analytical assumptions, methods and data would be given.

In developing this Regulatory Guide information, extensive use would be made of available references from both the NRC and industry past and present activities in the severe accident area. Within the NRC, information from the programs discussed in the report "Integration Plan for Closure of Severe Accident Issues," SECY-88-147, is being considered. The industry's EPRI Advanced Light Water Reactor (ALWR) Program and the DOE sponsored Advanced Reactor Severe Accident Program (ARSAP) are also useful resources.

While the development of this Regulatory Guide information is still in a preliminary stage, following are two examples of the types of performance goals that could be included in such a guide.

The examples are in the form of functional performance goals rather than requirements for explicit design features. It is our intent that the designers should have as much flexibility as possible to meet the design goals.

1. SAMPLE FUNCTIONAL PREVENTION PERFORMANCE GOAL

DECAY HEAT REMOVAL

Redundant and diverse systems for core decay heat removal shall be provided that are capable of operating in the event of a severe accident. These systems shall be capable of operating during an X-hour station blackout.

An example of a system aimed at satisfying this goal is an Emergency Feedwater (EFW) System with the following characteristics:

The Emergency Feedwater System (EFW) is able to perform its function given an X-hour station blackout.

The EFW has two divisions with each division having two diverse means for supplying cooling water. Pump capacity is such that a single pump is sufficient to maintain adequate core cooling.

The plant has feed and bleed capability. This requires systems for safety depressurization, venting and safety injection. Two-out-of-four safety injection pumps and one-out-of-two bleed paths are sufficient for this function.

2. SAMPLE FUNCTIONAL MITIGATION PERFORMANCE GOALS (CONTAINMENT PERFORMANCE)

DIRECT CONTAINMENT HEATING

Design features shall be provided aimed at preventing or mitigating the potential effects of direct containment heating postulated for severe accident conditions during which there could be a high pressure expulsion of molten materials from the reactor vessel. These features could be in the form of a highly reliable means for depressurizing the reactor coolant system, a cavity design to retain the energy from the dispersed materials in the cavity region to prevent containment heatup, or containment free volume and strength sufficient to absorb the released energy.

Another example of a mitigation performance goal is:

HYDROGEN COMBUSTION

Design features shall be provided aimed at preventing containment failure from overpressurization, excessive high temperatures or detonations (local or global) due to the potential effects of hydrogen combustion. This might be accomplished by restricting the quantities of hydrogen generated during an accident, containment inerting, provision for controlled hydrogen burning (e.g., igniters), or containment volume and strength sufficient to survive such pressure increases.

An example of a containment design aimed at satisfying the performance goal regarding the effects of hydrogen combustion is given below. This design may or may not satisfy the goal to mitigate the potential for direct containment heating. To determine this, additional information would be needed.

The containment has sufficient free internal volume to ensure that the concentration of hydrogen inside containment is less that X-percent by volume, based on uniformly distributed concentrations of hydrogen generated by the equivalent of a Y-percent metal-water reaction during an accident.

The containment internal design pressure is sufficiently high that the calculated pressure resulting from adiabatic combustion (including detonations) of the available hydrogen is less than the ultimate pressure capability.

Equipment necessary for achieving and maintaining safe shutdown of the plant and maintaining containment integrity should perform its safety function during and after being exposed to the environmental conditions attendant with the release of hydrogen generated by the equivalent of X-percent fuel-clad metal-water reaction including the environmental conditions created by activation of the hydrogen control system.

The two example prevention and mitigation performance goals given above were derived from the EPRI ALWR Requirements Document, Chapter 5: Engineered Safety Systems. Chapter 5 is currently under review by the staff, and as yet, no conclusions have been reached regarding the acceptability of the performance goals proposed in Chapter 5. We do believe, however, that the above examples are representative of the types of performance goals that are appropriate for future LWRs. Given below is a partial list of examples of other performance goal criteria that are being considered:

- reactor shutdown system
- emergency core cooling systems
- equipment qualifications for severe accident conditions
- DC power supplies
- containment cooling
- prevention of containment bypass
- cavity floor area for molten core debris dispersal

Enclosure 6

SCHEDULE

TASK	PROPOSED RULE	FINAL RULE
WORKSHOP	12/88	11/89
ACRS LTR	3/89	1/90
CRGR LTR	4/89	2/90
TO COMMISSION	5/89	3/90
ISSUE	6/89	5/90