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NUCLEAR MANAGEMENT AND RESOURCES COUNCIL

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William H. Rasin
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December 22, 1992

Mr. Samuel J. Chilk
Secretary, Office of the
Secretary of the Commission
U.S. Nuclear Regulatory Commission
Mail Stop 16 G15
Washington, DC 20555

SUBJECT: Advance Notice of Proposed Rulemaking (ANPR), "Acceptability of Plant Performance for Severe Accidents; Scope of Consideration in Safety Regulations" (57 *Federal Register* 44513 of September 28, 1992)

Dear Mr. Chilk:

The Nuclear Management and Resources Council (NUMARC)[1], on behalf of the nuclear power industry, has reviewed the ANPR, "Acceptability of Plant Performance for Severe Accidents; Scope of Consideration in Safety Regulations," and offers the following comments for consideration.

The industry has long been aware of NRC consideration of the need for generic rulemaking for advanced light water reactors (ALWRs) to supplement specific design certification rulemakings. In a January 9, 1989, letter to NRC Executive Director for Operations, Victor Stello, NUMARC provided its perspective, which we have maintained consistently since, that generic Part 50 rulemaking to address severe accidents, such as that contemplated by the subject ANPR, is not necessary and, in fact, may be counter-productive. Instead, the industry has supported generic resolution of severe accident

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[1]NUMARC is the organization of the nuclear power industry that coordinates the combined efforts of all utilities licensed by the NRC to construct or operate a nuclear power plant, and of other nuclear industry organizations, in all matters involving generic regulatory policy and on the regulatory aspects of generic operational and technical issues that affect the nuclear power industry. Every utility responsible for constructing and operating a commercial nuclear facility is a member of NUMARC. In addition, NUMARC's members include major architect-engineering firms and all the major steam supply vendors.

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issues to the extent possible via the ALWR Utility Requirements Document (URD), followed by review and codification of the design specific implementation as part of the design certification process. This position was explained to the Commission and NRC staff on several occasions, including our January 27, 1992, letter to the Office of the Secretary commenting on SECY-91-262, *Resolution of Selected Technical and Severe Accident Issues for Evolutionary Light Water Reactor Designs.* We continue to feel strongly in this regard, and this letter and the enclosed responses to the fifteen ANPR questions reiterate our position and provide the basis for our conclusion.

We believe the URD/design certification process is the superior approach for the resolution of severe accident issues for ALWRs, both evolutionary and passive. A full discussion of this position is delineated in response to ANPR Question Number 1 contained in the enclosure, the key points of which are as follows:

- severe accident issue resolution via the URD and design certifications is consistent with the approach embodied by the Commission's Severe Accident Policy Statement and NRC Generic Letter 88-20, *Individual Plant Examinations for Severe Accident Vulnerabilities*;

- the URD, together with design certification reviews and rulemakings, provide the optimal approach for comprehensive, integrated and design specific resolution of all safety issues, including severe accidents, associated with individual standard plant designs;

- severe accident resolution accomplished through the URD and design certification will avoid uncertainty associated with the impact of a "competing" generic rulemaking, thus promoting predictability and stability in the Part 52 licensing process; and

- there is minimal value added by one or more generic rulemakings that produces severe accident resolution "essentially the same" as that which will be accomplished via design certification.

A separate generic rulemaking on technical issues associated with ALWR designs, such as severe accidents, is not warranted. Rather than facilitating the design certification process, as indicated in the ANPR, generic severe accident rulemaking would more likely complicate the process and unnecessarily consume significant NRC and industry resources. Further, this approach would be inconsistent with the initiatives of the NRC and the industry to identify unnecessary, contradictory and/or duplicative regulations and guidance.

We appreciate your careful consideration of these comments and urge the Commission to direct that severe accident issues be addressed via the URD/design certification process rather than move ahead with a proposed severe accident rule for future plants.

Sincerely,

William H. Rasin

WHR\RJB\ljw
Enclosure

cc: Chairman Ivan Selin
Commissioner Kenneth C. Rogers
Commissioner James R. Curtiss
Commissioner Forrest J. Remick
Commissioner E. Gail de Planque
James M. Taylor, Executive Director of Operations, NRC
Eric S. Beckjord, Director, Office of Nuclear Reactor Research
Thomas E. Murley, Director, Nuclear Reactor Regulation, NRC
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Enclosure 1

Responses to ANPR Questions

ANPR Question Number 1

Is rulemaking addressing severe accident plant performance criteria desirable? If not, why? Would such a rule provide better coherence and predictability to the design certification review and certification processes for future reactor designs or is rulemaking on these issues via individual design certification sufficient?

Industry Response

We believe that a generic Part 50 rulemaking to address ALWR technical and severe accident issues would not be appropriate and is neither necessary nor desirable.

A substantial amount of severe accident research has been accomplished by the NRC as well as the industry since the Three Mile Island Unit 2 (TMI-2) accident in 1979. Indeed, the industry has incorporated into the ALWR development the lessons learned since TMI-2 through development by EPRI of the ALWR Utility Requirements Document (URD) and vendor development of individual ALWR designs, including design specific PRAs. ALWR severe accident issues are presently being addressed by the industry and the NRC staff via complementary URD and design certification interactions. Utility requirements have been developed for both evolutionary and passive ALWRs, including explicit consideration of a wide spectrum of severe accident phenomena and potential challenges to containment [1, 2]. These challenges encompass containment bypass scenarios, random system and equipment failures which could lead to breach of the containment boundary independent of any severe accident conditions, and potential phenomena that could challenge the structural integrity of the containment as a result of a core damage accident. The challenges considered include not only those referenced in the first two alternatives of the ANPR, but also the eight groups of challenges proposed by the ACRS for inclusion in the General Design Criteria [3]. References 1 and 2 identify the extensive list of challenges considered in the evolutionary and passive ALWRs and contain a summary of the design features available in each plant to limit the potential for or accommodate each of these challenges. Design specific PRAs are being performed which evaluate the potential for significant challenges given these design features and address plant response to those challenges that dominate risk. Individual ALWR designs that implement the utility requirements and reflect the insights of a design specific PRA are being reviewed by the NRC staff and will become codified via design certification rulemakings. In sum, the industry and the NRC staff have pursued a course emphasizing generic resolution of severe accident issues to the extent possible via the ALWR URD followed by review and codification of the design specific implementation as part of the design certification process.

Consistent with this approach, the NRC staff argued persuasively in SECY-91-262 that individual design certification rulemakings provide the most efficient and effective mechanism for codifying the resolution of technical and severe accident issues. As noted in SECY-91-262, the design certification process provides for a thorough NRC staff, ACRS and Commission review of ALWR design requirements and criteria leading to their codification via the design certification rulemakings. Moreover, addressing severe accident issues in the context of the URD as well as within the overall design certification process provides greater confidence that these complex and interdependent technical issues will be coherently resolved. We concur in the essential thrust of SECY-91-262 that, considering the advanced state of the ALWR designs and associated reviews the diversity among the standard plant designs, and the potential for delaying the design certification process, generic rulemaking to address ALWR technical and severe accident issues is not necessary or desirable.

Not only is resolution of severe accident issues via design certification amenable to evolutionary designs, as recommended in SECY-91-262, we believe severe accident resolution via design certification is the appropriate, superior and most technically coherent course for passive designs as well. Indeed, an approach for passive plants that instead relies upon generic rulemaking would be contrary to the rationale behind the NRC staff issuance of Generic Letter 88-20, *Individual Plant Examinations for Severe Accident Vulnerabilities*, which recognized that severe accident challenges and resolutions are somewhat design specific. A generic rulemaking on severe accidents, especially one based principally upon evolutionary plant designs as suggested by the ANPR, may not address the particular performance characteristics of passive plant designs or allow for the realization of the full regulatory benefit in their regard. As a result, a generic rulemaking would likely not obviate the need to scrutinize severe accident issues in detail as part of a passive plant design certification. Therefore, we conclude that generic technical issues, such as severe accidents, can be most efficiently and coherently resolved for all ALWRs, including passive designs, via the URD and design certification reviews and rulemakings.

Furthermore, we are particularly concerned that promulgating a rule based upon this ANPR would likely generate uncertainty and could significantly disrupt the design certification process for both evolutionary and passive designs. Because evolutionary plant resolution of severe accident issues reflected in Part 52 design certifications and the rule envisioned by this ANPR are expected to be "essentially the same," there would seem to be minimal value added by such a generic rule for evolutionary designs. Indeed, we are concerned that issues relating to the consistency and applicability of the generic severe accident rule may be raised at a critical time in design certification proceedings with the potential for causing costly and unwarranted disruption of the certification process.

Regarding passive designs, parallel design certification reviews and severe accident generic rulemaking would add another dimension of uncertainty to an already complex undertaking. It is not clear what benefit a generic severe accident rulemaking based on evolutionary designs could add to the comprehensive and integrated resolution of all technical and severe accident issues via individual design certification rulemakings. The ANPR essentially acknowledges this by noting that, "as detailed design information becomes available and review of the passive systems is completed, further rulemaking may be necessary." Presumably, the net result of such a series of generic rulemakings would be that generic resolution of severe accident issues for passive designs would be "essentially the same" as that reflected in passive plant design certifications. As in the case of the evolutionary designs, there would seem to be no value added by a largely duplicative generic rulemaking. It is our view that the potential benefit of such generic rulemaking(s) to a passive plant certification proceeding is outweighed by the greater likelihood that a rule to resolve expressed concerns would not be timely and could generate uncertainty, rather than clarity, in the design certification process.

In the deliberations leading to publication of the Severe Accident Policy Statement, the Commission considered whether it was necessary to amend the NRC regulations. The Commission concluded that a statement of policy was more appropriate as both NRC and industry studies demonstrated that operating plants posed no undue risk to public safety and health. ALWR designs satisfy the Commission's stated expectation that future plants achieve a higher standard of severe accident safety performance. This enhanced performance is being achieved, in part, by integrating severe accident considerations throughout the utility requirements and design processes, thus providing for enhanced severe accident prevention and mitigation. While addressing severe accidents for future plants is appropriate and consistent with the Commission's Severe Accident Policy, inclusion of criteria for future plants related to severe accidents in the Commission's generic Part 50 regulations would be inconsistent with the Commission's previous conclusion that generic rulemaking was not necessary because current operating plants do not pose an undue level of risk to public health and safety. Because advanced plants achieve a higher standard of severe accident safety than the current operating plants, we would expect the Commission's previous conclusion regarding generic rulemaking to continue to be appropriate. Analogous to the plant specific approach to severe accident issue resolution for operating plants via Individual Plant Examinations, an integrated, design specific treatment of severe accident issues within design certification reviews and rulemakings is the best approach for future plants.

Finally, the industry and NRC staff are presently proceeding in efforts to take a hard look at eliminating or revising unnecessary, duplicative, or potentially confusing regulations and regulatory practices. The generic rulemaking envisioned by this ANPR would be inconsistent with that process in that it would promulgate duplicative severe accident regulation on top of comprehensive design certification rulemakings, potentially introducing technical inconsistencies, schedular disruptions and licensing uncertainty. In addition to being the most practical and efficient approach to ALWR severe accident

issue resolution, the URD/design certification process will provide for severe accident issue resolution that is clear, tailored and codified for each standard design, and reflective of integrated and coherent consideration by plant designers and NRC staff reviewers alike, of the full spectrum of safety issues associated with ALWR designs.

[1] "Matrix Approach to Evolutionary Plant Containment Performance," E.E. Kintner letter to T.E. Murley, May 9, 1991.

[2] DOE/ID-10291, "Passive ALWR Requirements to Prevent Containment Failure," December 1991.

[3] "Proposed Criteria to Accommodate Severe Accidents in Containment Design," ACRS letter dated May 17, 1991.

ANPR Question Number 2:

Would a new rule in 10 CFR Part 50 concerning plant performance for severe accidents, as discussed in the three alternatives, provide a basis for revising the requirements on Emergency Planning Zones for future LWRs? If so, why? If not, why not?

Industry Response:

Plant design to enhance performance under potential accident conditions and the improved state of knowledge regarding accident consequences provides an appropriate basis for reevaluating the requirements on Emergency Planning Zones and offsite emergency response programs. The traditional requirements should be reconsidered for ALWRs due to the enhanced plant design, including containment performance and other relevant technical criteria in the Utility Requirements Document. Reconsideration of offsite emergency planning requirements is also appropriate due to developments regarding improved understanding of, and anticipated changes to, the source term for ALWR designs. As emphasized throughout the industry response to this ANPR, the industry does not believe a generic severe accident rulemaking is necessary. However, a generic rulemaking may be necessary to accomplish ALWR emergency planning and is being considered by the industry subject to finalizing the technical basis through review and issuance of the FSER on the passive plant URD.

ANPR Question Number 3:

One option for an overall containment performance criterion that has been considered is that the conditional failure probability of the containment should be less than approximately one in ten. Two of the alternatives use a deterministic surrogate that states that the containment should remain leak tight for a period of approximately 24 hours following the onset of core damage and after that time, remain a barrier against

the uncontrolled release of radioactivity when faced with challenges from the more likely severe accident phenomena. Is this criterion a suitable substitute for the conditional containment failure probability of one in ten? If so, explain why. If not, explain why not. Is a period of approximately 24 hours an appropriate time frame? Is its degree of conservatism appropriate considering uncertainties and defense-in-depth? If not, what alternative would be appropriate? What other criteria [probabilistic or deterministic] might be considered?

Industry Response:

Deterministic containment performance criteria are a suitable substitute to a quantitative conditional containment failure probability for demonstrating containment performance for ALWR designs.

The underlying purpose of containment performance criteria is to provide defense-in-depth in the design of containment and containment systems by assuring a balance between severe accident prevention and mitigation. For a plant with highly reliable core damage prevention systems, it may be possible to show consistency with the safety goals simply by assuring an extremely low potential for core damage. The quantitative health objective, the large release guideline, and the mean core damage frequency guideline could all be achieved without the need for a containment. The intent of a containment performance criterion, either probabilistic or deterministic, is to assure that no matter how low the potential for core damage, there still will be a containment function that is available under postulated severe accident conditions. As provided for by the Commission SRM in response to SECY-89-102, the industry has pursued a deterministic approach to demonstrating ALWR containment performance. Indeed, the URD establishes design features and criteria which accomplish the containment performance objective of this ANPR, as well as that suggested by the NRC staff in SECY-90-016, thereby assuring adequate severe accident containment response for ALWRs. ALWR plant designs codified at the conclusion of the URD/design certification process will have reliable containments and containment systems capable of preventing or accommodating a wide spectrum of severe accident challenges as measured against the deterministic containment performance criteria of the URD. This deterministic approach to evaluating containment performance meets the intent of a quantitative conditional containment failure probability for demonstrating ALWR containment performance.

The time frame for containment remaining leak tight after the onset of core damage should be long enough to: (1) allow for fission product radioactive decay and aerosol settling so that if a release were to occur thereafter, the site boundary dose would be below the threshold for acute health effects when analyzed realistically; and (2) allow time for protective action as part of ALWR emergency planning. The URD establishes design features and containment performance criteria based on a 24-hour leak tight period to provide reasonable assurance that each of these objectives is

accomplished with significant margin. With these design features and using the best estimate methodology of the URD, ALWR containments can be shown to remain leak tight for at least 24 hours following core damage. In actuality, a period of 16 hours or even less, depending upon the specific plant design and site, provides ample time for meeting both of the above objectives based on the half life of noble gases, the effectiveness of fission product mitigation systems and natural removal processes, and historical emergency evacuation experience, including ad hoc evacuations. Thus, the approximately 24-hour deterministic containment performance criterion proposed by the NRC staff in SECY-90-016 and this ANPR, in the absence of a common understanding regarding realistic evaluation methods, may be overly conservative.

This conservatism is acknowledged in Question 15 of this ANPR which notes that the 24-hour containment barrier criterion provides a level of safety that is three orders of magnitude more conservative than the quantitative health objective of the Safety Goal Policy statement. While 24 hours is an appropriately challenging URD requirement to ensure that ALWR designs contain features that provide a high level of severe accident protection, codifying this deterministic criterion would be inappropriate because doing so would establish a de facto higher safety goal. That result would be contrary to Commission guidance provided in response to SECY-89-102 concerning NRC staff imposition of industry design objectives as regulatory requirements.

Based on the preceding discussion, the criterion for protection against uncontrolled fission product release after 24 hours is similarly conservative and is inappropriate to codify. As noted above, it is estimated that a controlled release that would pose no undue risk to the public could occur significantly prior to 24 hours following core damage. Controlled release from the suppression pool airspace in the form of an overpressure protection device is being considered for the advanced BWRs. Overpressure protection may also be provided by demonstrating that the size and strength of the containment allows meeting appropriate ASME limits for approximately three days, which provides adequate time for actions to bring the accident under control. This latter method of protection from uncontrolled release is being implemented for large PWR containments.

In summary, design features for overpressure protection are specified by the URD and will be codified for individual ALWRs via the design certification rulemakings. These features provide the basis for assuring substantial time for fission product removal and emergency response prior to any significant release, and their codification via design certification eliminates the need for generic severe accident rulemaking. The industry concurs in the appropriateness of deterministic performance criteria, and as discussed above, severe accident resolution for ALWRs achieved via the URD and individual design certification reviews and rulemakings will reflect use of these criteria for demonstrating ALWR containment performance.

ANPR Question Number 4:

Alternative 2 would require extensive reliance on analytical tools that calculate the effects of severe accident phenomena. Are there analytical tools that are sufficiently developed and adequate to allow effective implementation of such a phenomena-based rule? If so, what are they, and for what phenomena could they be used? How would Alternative 2 be implemented? For example, should the codes and input parameters be approved by NRC? Should acceptance criteria be codified or put in a regulatory guide?

Industry Response:

Specific response is not provided to this question relative to the implementation of Alternative 2 on the basis of the industry's overall position embodied by the response to ANPR Question 1 that generic severe accident rulemaking for ALWRs is neither necessary nor appropriate.

With respect to the URD/design certification process for implementing ALWR severe accident resolution, a combination of quantitative analyses and qualitative considerations has been used. The appropriateness of the implementation and criteria for a given ALWR will be indicated in the FSER for the design and codified via the certification rulemaking.

ANPR Question Number 5:

Should future LWR containment designs include features beyond those described in Alternative 1 to prevent/mitigate severe accidents? If so, what are they?

Industry Response:

Specific response is not provided to this question relative to the implementation of Alternative 1 on the basis of the industry's overall position embodied by the response to ANPR Question 1 that generic severe accident rulemaking for ALWRs is neither necessary nor appropriate.

As discussed in response to Question 1, ALWR designs contain features required by the URD intended to limit the potential or accommodate a wide spectrum of severe accident phenomena and containment challenges. These features include those identified in Alternative 1 of the ANPR and, together with specific insights from the design PRA, provide the basis for severe accident issue resolution for ALWRs via the URD/design certification process.

ANPR Question Number 6:

Alternatives 2 and 3 specify phenomenological severe accident challenges that should be considered in the design. Alternative 1 is based upon the same phenomena/challenges. Are there other severe accident phenomena/challenges that should be considered? Should the challenges be specified in more detail (for example, specifying the amount of hydrogen generation) or is a general statement of the challenge more desirable?

Industry Response:

Specific response is not provided to this question relative to the severe accident phenomena/challenges considered by Alternatives 1, 2 and 3 on the basis of the industry's overall position embodied by the response to ANPR Question 1 that generic severe accident rulemaking for ALWRs is neither necessary nor appropriate.

As discussed in response to Question 1, the URD identifies an extensive list of ALWR severe accident phenomena/containment challenges. These include containment bypass scenarios, random system and equipment failures, and phenomena with the potential to challenge containment integrity. For each ALWR design, features are provided to limit the potential or accommodate each of the phenomena/challenges. These features, together with specific insights from the design PRA, provide the basis for severe accident issue resolution for ALWRs via the URD/design certification process.

ANPR Question Number 7:

For what reason (e.g., not a risk significant phenomena, not a cost effective solution) would any of the criteria proposed in the three alternatives not be fully applicable to passive designed LWRs?

Industry Response:

Specific response is not provided to this question relative to the implementation of Alternatives 1, 2 and 3 for passive plants on the basis of the industry's overall position embodied by the response to ANPR Question 1 that generic severe accident rulemaking for ALWRs is neither necessary nor appropriate.

As discussed in response to ANPR Question 1, severe accident issue resolution for passive plants is being coherently addressed via the passive plant URD and passive plant design certifications. This approach thus avoids the potential problem of incongruities between passive designs and a generic severe accident rule based on evolutionary designs.

ANPR Question Number 8:

What features could an advanced LWR design include that would prevent or mitigate fuel-coolant interactions?

Industry Response:

Fuel-coolant interactions (FCI) can be postulated to occur either in-vessel or ex-vessel. The potential for in-vessel FCIs inducing containment failure (alpha-mode failure mechanism) was identified in the WASH-1400 Reactor Safety Study. ALWRs have depressurization system capabilities which could result in low enough reactor coolant system pressures such that energetic FCIs could not be excluded based on system pressure. The reactor pressure vessel, and internals, head closure, and missile barriers included in the ALWR design are similar to those employed in existing LWR plants. Thus, the same mechanisms are operable in ALWR designs that led to past conclusions that the occurrence of an energetic FCI which could lead to alpha-mode containment failure is very remote in probability.

In the unlikely event of reactor pressure vessel lower head failure, ex-vessel FCIs can result in both significant steam generation rates and shock waves induced by ex-vessel explosive interactions. In the PWR designs, any shock waves which occur will be within the thick walled reactor cavity, and the containment boundary integrity would not be challenged. Additionally, the thick walled reactor cavity provides a barrier against the generation of missiles which could impact the containment boundary and challenge its integrity. The lower drywell boundary provides the same type of barrier in evolutionary BWR designs.

In the SBWR, the lower drywell walls form the containment boundary. However, a thick walled shield is being provided to protect the lower drywell portion of the containment boundary from the effects of severe accidents. Thus, containment boundary integrity would not be challenged by shock waves or missiles.

For the AP600, the capability has been provided to externally flood the reactor pressure vessel and attached piping such that ex-vessel heat removal can be established. This feature could protect the vessel lower head and prevent its failure. Maintenance of vessel integrity serves as a preventive means of precluding ex-vessel FCIs since it avoids the discharge of molten core debris.

The above ALWR capabilities and features, which are being incorporated in the advanced LWR designs via the URD and individual design certification reviews and rulemakings, provide adequate severe accident protection relative to both prevention and mitigation of FCIs.

ANPR Question Number 9:

If a design includes the capability to rapidly depressurize the primary system, should it also be required to have a reactor cavity design and/or a reactor vessel support structure capable of mitigating and accommodating a high pressure melt ejection?

Industry Response:

The capability to reliably depressurize the primary system provides sufficient means for limiting the potential for high pressure melt ejection (HPME) events. ALWR designs include reliable means of primary system depressurization such that additional mechanisms and features, to address HPME are not required.

However, it should be noted that reactor cavity/support design has been extensively considered relative to assuring ex-vessel fuel/debris cooling under low pressure core melt scenarios. The resulting design of these features is also expected to limit the transport of fragmented core debris outside the reactor cavity region in the unlikely event of HPME.

ANPR Question Number 10:

Should future LWR designs include an on-line instrumentation system that monitors containment atmosphere for gross leakage to reduce the risk from an inadvertent bypass of containment function? Would application of this system be sufficient basis to modify leak rate testing requirements under 10 CFR 50, Appendix J?

Industry Response:

The Utility Requirements Document for advanced LWRs for both evolutionary and passive designs requires that a means be provided to enable the operator to perform a periodic check for gross leakage of containment atmosphere during normal operation. The intent is to provide the owner/operator of the plant with added assurance that penetrations connected to both the containment atmosphere and the environment are not inadvertently left open during normal operation. It was not the intent that such a system be maintained on-line continuously; instead, it would be used as a periodic check, e.g., following maintenance operations which involve opening of containment penetrations.

It is not practical to use such a system to modify the leakage rate testing requirements in 10 CFR 50, Appendix J. Testing conducted at the containment pressure which exists during normal operation would likely not be sufficiently accurate for detection of design basis leakage rates such as are detected by testing in accordance with Appendix J. Also, testing during normal operation would identify leakage in penetrations connecting the containment atmosphere to the environment, but not in

other penetrations which are covered by Appendix J testing (e.g., penetrations of lines connected to the reactor coolant system). Thus, a system for periodic checking of gross containment leakage during normal operation is a requirement of the URD. However, it is not practical or necessary to use this system to modify Appendix J leak rate testing requirements.

ANPR Question Number 11:

What design criteria should be developed that provide assurance that the containment's integrity could easily be established during certain shutdown conditions?

Industry Response:

Like severe accident issues associated with power operation, shutdown risk issues are being appropriately addressed for ALWRs via the URD/design certification process described in response to Question Number 1.

The risk associated with shutdown operations is dominated by a few key plant configurations and operator actions initiating and responding to events occurring in the plant during shutdown conditions. These conclusions are variously reflected in NUREG-1449 [1], NUREG-1410 [2], the IAEA conference report on shutdown accident sequence modeling [3] and industry initiated studies associated with shutdown risk [4, 5, 6].

ALWR designs reflect past operating experience to minimize the risks associated with the events identified in the referenced documents. The need to isolate containment during an event which might occur during shutdown conditions is dependent on the risk associated with the postulated event.

For example, for transient initiators which occur with the refueling cavity full, many hours are available prior to the beginning of bulk boiling even at the beginning of an outage, and days are required in order to boil off the inventory to the point that fuel damage would occur. This provides substantial time for operator actions to recover lost systems or mitigate the depletion by providing makeup from external sources. If the containment is open, the only risk during this period is that associated with the releases from the coolant activity. Such releases would be minimal (a small fraction of 10 CFR 100 limits), and therefore offsite consequences from this type of an event are expected to be very low. The URD specifies that the reactor designer demonstrate that the consequences of pool boiling with containment open are acceptable.

For those configurations when reactor inventory is low, such as head removal, the time available for recovery is short. Managing risk during these relatively brief and infrequent periods is best accomplished by plant system configuration control and by providing the operator with the capability to mitigate any loss of inventory. Again, the

URD specifies that sufficient water inventory be available to provide makeup for losses of reactor coolant system inventory.

Because the risk associated with shutdown operations is very low and because residual risk is best addressed through configuration control and procedures, design features intended to limit releases by isolating containment are of limited incremental benefit and have not been established as design criteria. For purposes of establishing additional margin, the ALWR URD specifies that, where practical, capability shall be provided to restore containment closure through simple manual actions.

[1] NUREG-1449, "NRC Staff Evaluation of Shutdown and Low Power Operation," February 1992.

[2] NUREG-1410, "Loss of Vital AC Power and the RHR System During Midloop Operations at Vogtle Unit 1 on March 20, 1990," June 1990.

[3] IAEA, "Modeling of Accident Sequences During Shutdown and Low Power Conditions," November 1991.

[4] "Seabrook Station Probabilistic Safety Study, Shutdown (Modes 4, 5 and 6)," May 1988.

[5] "Shutdown Risk, Prairie Island Dual Unit Shutdown," Northern States Power Co., ANS Executive Conference on IPEs, October 1992.

[6] "The Diablo Canyon Shutdown Safety Assessment," Pacific Gas and Electric, ANS Executive Conference on IPEs, October 1992.

ANPR Question Number 12:

Should equipment provided only for severe accident prevention or mitigation be subject to (a) the same requirements as design basis equipment (e.g., redundancy/diversity, power supply, environmental qualification, inclusion in plant Technical Specifications, maintenance priority, quality assurance; or (b) lesser standards (e.g., reduced design margins or the regulatory guidance found in appendices A and B of Regulatory Guide 1.155, "Station Blackout?"). If lesser standards, what standards would be appropriate?

Industry Response:

Equipment provided only for severe accident prevention or mitigation should not be subject to the same requirements as design basis equipment. This position regarding equipment survivability is consistent with that expressed by the NRC staff in SECY-90-

016 and subsequently accepted by the Commission via their SRM dated June 26, 1990. The NRC staff recently reiterated this view in SECY-92-070, which observed that applying the requirements developed for safety-related equipment to equipment provided for severe accident would amount to inclusion of severe accidents in the design basis for the plant design. The industry concurs in the NRC staff position indicated by SECY-92-070 that, "[E]xisting requirements and the high degree of pedigree associated with them provide the design basis of the plant."

As stated in SECY-90-016, equipment provided only for severe accident prevention or mitigation should be designed so that there is reasonable assurance that it performs the function for which it is intended over its mission time. However, as indicated in the SECY, the equipment pedigree requirements need not be as stringent as those for equipment credited in design basis accident analyses. Specifically, features provided for severe accident protection only, need not not be subject to: (a) 10 CFR 50.49 equipment qualification requirements, (b) all aspects of 10 CFR Part 50, Appendix B quality assurance requirements nor (c) 10 CFR Part 50, Appendix A redundancy/diversity requirements. Likewise, severe accident features would be included in Technical Specifications only to the extent that a design basis accident function is served by the same equipment.

The URD specifies that the design of equipment identified as useful for severe accident mitigation shall provide reasonable assurance that the equipment can perform its identified function during severe accident conditions. Design considerations for equipment under severe accident conditions include the circumstances of applicable initiating events and the environment (e.g., pressure, temperature, radiation) in which the equipment is expected to function. In addition, such equipment will be located and arranged, to the extent practical, to enhance its usefulness under severe accident conditions. Safety-related equipment that also serves for severe accident mitigation will be qualified and provided with quality assurance consistent with design basis requirements.

<u>**ANPR Question Number 13:**</u>

Alternative 1 discusses not exceeding ASME service level C stress limits for steel containments under certain severe accident conditions. Are these limits appropriate for severe accident conditions? If not, what limits would be appropriate? Could these same stress limits also be used for loads generated by missiles? If not, what limits would be appropriate? What equivalent limits would be appropriate for concrete containments?

<u>**Industry Response:**</u>

Adherence to the ASME service level C stress limits for steel containments under severe accident conditions provides reasonable assurance that the containment will perform its intended function as an additional barrier against potential fission product

release. The containment will perform satisfactorily if its integrity is not compromised and no unacceptable leakage develops during and after the severe accident. By limiting the stresses in the shell to the code yield, the service level C limits assure that the containment remains in the elastic domain by a margin of at least 20%. Within the stress range, the containment integrity is only minimally challenged since significant margin exists between service level C and ultimate failure. Tests and analytical modeling have shown the margin to be of the order of two or greater [1,2,3,4].

Limits less conservative than the service level C stress limits should be used for loads generated by missiles. Missiles have a local impact and do not threaten the overall integrity of the containment. Criteria based on strain limits are appropriate for this type of loading. The energy is absorbed through plastic deformations limited by functionality requirements (i.e., no leakage and no zipper effect that would compromise the overall integrity of the structure).

For concrete containments, the unity factored load combinations of Subsection CC of ASME Section III are adequate requirements for severe accidents. They are based on the same philosophy as service level C stress limits applied to Class MC components. The limits placed on stresses and strains in the reinforced concrete load resisting elements, strain in the metallic liner plate and liner plate anchorage systems and other liner design details, provide significant margin against catastrophic failure and containment pressure boundary leakage.

The containment boundary strain levels associated with service level C will be within elastic limits such that any leakage that does occur can be expected to be via penetrations through the primary steel membrane. Tests have been performed on individual penetration types including airlocks, hatches, electrical penetration assemblies, and mechanical penetrations at pressures comparable to containment ultimate capacities. Such tests have demonstrated that typical penetration designs can withstand pressures substantially greater than equivalent service level C containment pressure without loss of structural integrity or any significant degradation to their leakage barrier function.

The containment loading criteria discussed above are being incorporated into ALWR designs, as appropriate, based on utility requirements and will be codified via the design certifications. Therefore, as discussed in response to Question 1, generic rulemaking such as that envisioned by this ANPR is unnecessary.

[1] Keck, J., F. Thome, "Leak Behavior Through EPAs Under Severe Accident Conditions," Proceeding of the Third Workshop on Containment Integrity, NUREG/CP-0076.

[2] Julien, J. T., S. W. Peters, "Leak Rate Test of a Containment Personnel Airlock," Fourth Workshop on Containment Integrity, NUREG/CP-0095.

[3] Brinson, D. A., G. H. Graves, "Evaluation of Seals for Mechanical Penetrations of Containment Buildings," NUREG/CR-5096, August 1988.

[4] Crapo, H. S., R. Steele, Jr., "Containment Penetration System (CPS) Tests Under Accident Conditions," NUREG/CR-5043, August 1988.

ANPR Question Number 14:

What information is available regarding the costs (capital and operational/maintenance) of design features that would be required under these alternatives?

Industry Response:

Based on the industry position strongly preferring the URD/design certification process for accomplishing ALWR severe accident issue resolution/codification, the industry does not have the appropriate data and has not addressed the comparative costs of implementing the three alternatives outlined in this ANPR.

ANPR Question Number 15:

The containment performance objective discussed in Alternatives 1 and 2 (i.e., containment shall provide a barrier against the release of radioactive material for a period of approximately 24 hours following the onset of core damage) represents a level of safety for a 3800 MWt plant sited in accordance with 10 CFR Part 100 approximately three orders of magnitude below the Commission's quantitative health objective for prompt fatalities, as defined in the Commission's Safety Goal Policy Statement. It could be argued that a future LWR design meeting this objective through analyses and the incorporation of design features need not consider the addition of other features, since these other features would be directed at even more highly unlikely severe accident phenomena and sequences which could be considered "remote and speculative" under the National Environmental Policy Act (NEPA) and 10 CFR Part 51. Therefore, would the codification and compliance with such a containment performance objective be sufficient to also define a point of truncation and serve as the basis for an amendment to 10 CFR Part 51 eliminating the need for further review of SAMDAs for future LWRs under 10 CFR Part 51?

Industry Response:

The industry concurs in the underlying thrust of ANPR Question number 15, consistent with the intent of design certification under Part 52, that additional requirements should not be considered for ALWR designs which will have a level of safety substantially exceeding that established by the quantitative health objectives of the Safety Goal Policy Statement. In keeping with the intent to resolve all design related issues at certification, the industry and NRC are addressing the requirements under

NEPA relative to consideration of severe accident mitigation design alternatives (SAMDAs) as part of the design certification process. The staff recommendation in this regard, later concurred in by the Commission in an SRM dated October 25, 1991, was contained in SECY-91-229.

While the concept of generically eliminating NEPA/SAMDA requirements for future plant designs demonstrating a high level of safety is sound, this benefit does not outweigh the industry's substantial concerns regarding the implications of conducting a generic severe accident rulemaking that would be necessary to provide the basis for such a change. Further, as a practical matter, a generic rulemaking would likely not be timely to eliminate the NEPA/SAMDA review requirements for evolutionary plant design certifications.