D900426

The Honorable Kenneth M. Carr
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Chairman Carr:

SUBJECT: EVOLUTIONARY LIGHT WATER REACTOR CERTIFICATION ISSUES AND THEIR RELATIONSHIP TO CURRENT REGULATORY REQUIREMENTS

During the 358th, 359th, and 360th meetings of the Advisory Committee on Reactor Safeguards, February 8-10, March 8-10, and April 5-7 and 18-19, 1990, we discussed with representatives of the NRC staff their positions and recommendations concerning the evolutionary light water reactor (ELWR) certification issues contained in SECY-90-016 (Ref. 1). During some of these meetings, we had the benefit of discussions with representatives of the Electric Power Research Institute (EPRI) and the General Electric Company. We also had the benefit of the documents referenced.

We were told by the staff that the positions for which they are seeking Commission approval are described in the underlined portions of the enclosure to SECY-90-016, entitled "Evolutionary ALWR Certification Issues." Unless indicated otherwise, our comments relate to these staff positions. Our comments and recommendations on the staff positions are given below.

I. GENERAL ISSUES

1. Evolutionary LWR Public Safety Goals

The NRC staff has concluded that the quantitative goals submitted for Commission consideration in draft SECY-89-102 (Ref. 2) are acceptable for ELWRs. The staff notes that both public safety goals in the EPRI ALWR Requirements Document (Ref. 3) and the ABWR Licensing Review Basis Document (Ref. 4) are considerably more restrictive than the large-release guideline defined in draft SECY-89-102. The staff further notes that additional Commission guidance on quantitative safety goals will assist the staff in its continuing assessment of ELWRs.

We believe, as stated in our previous reports (e.g., ACRS report on Key Licensing Issues Associated With DOE Sponsored Reactor Designs, dated July 20, 1988), that the Commission's Safety Goal Policy is appropriate guidance for regulatory decisions relating to ELWRs, other advanced reactors, and the operating plants. We regard it as not inappropriate that applicants should work to tighter standards when it serves their purposes, but we do not believe it is appropriate that the NRC should require such standards. In its Safety Goal Policy the Commission, in effect, said it would regulate to a level of safety that is adequate, not to the highest level that is possible.

2. Source Term

This issue is dealt with by a proposal to assure that evolutionary designs meet the requirements of 10 CFR 100 (Reactor Site Criteria). The requirements of this regulation include a limit on doses experienced by an individual at the exclusion area boundary, and at the boundary of the low population zone during the course of an accident. In calculating these doses, the instructions in 10 CFR 100 prescribe that the fission products released to the containment must be those which would be expected from accidents which "result in substantial meltdown of the core with subsequent release of appreciable quantities of fission products." For plants currently operating, regulatory guides have delineated specific, but somewhat arbitrary, quantities of fission products that are acceptable to the staff in calculating the leakage from containment and the resultant doses at the specified boundaries.

In contrast, for the ELWRs, the staff proposes to explore the specification of a source term on a case-by-case basis, rather than using the arbitrary source term prescribed in the past. Since the issue of siting of these plants is not yet resolved, and since revisions to 10 CFR 100 are being considered, there may be no alternative to proceeding as the staff proposes, however awkward it may seem.

However, we can make no informed judgment concerning the appropriateness of the procedure until we know more about the criteria to be used in the selection of a source term, and the results of its application.

II. PREVENTATIVE FEATURE ISSUES

3. Anticipated Transients Without Scram (ATWS)

The staff recommends that the Commission approve the staff's position that diverse scram systems be required for the ELWRs.

It appears to us that a design that can ride out an ATWS without serious damage is feasible for PWRs and is preferable to a scram system with diverse logic, which has a reliability calculable, at best, with large uncertainty. We recommend that the staff permit demonstration that the consequences of an ATWS are acceptable as an alternative to a diverse scram logic. The uncertainty in such a demonstration is probably considerably less than that in demonstrating that the contribution of an ATWS to risk is made accept-

able by installation of a diverse scram logic system.

4. Mid-Loop Operation

We have been told previously of evidence that events initiated during mid-loop operations may be major contributors to risk in PWRs. However, shutdown operations are generally not accounted for in PRA studies, such as those reported in NUREG-1150 (Ref. 5), so the risks are not well quantified. For the operating plants, this issue has been dealt with through resolution of Generic Issue 99 (Improved Reliability of RHR Capability in PWRs). For the ELWRs, the staff recommends that PWR applicants propose design features to ensure high reliability of the shutdown decay heat removal system.

We agree with the staff's proposal, but recommend that more specific requirements be considered for mid-loop operation:

Design provisions to help ensure continuity of flow through the core and residual heat removal system with low-liquid levels at the junction of the DHR system suction lines and the RCS

Provisions to ensure availability of reliable systems for decay heat removal

Instrumentation for reliable measurements of liquid levels in the reactor vessel and at the junction of the DHR system suction lines and the RCS

Provisions for maintaining containment closure or for rapid closure of containment openings

5. Station Blackout

The Station Blackout Rule (10 CFR 50.63) requires that each light-water nuclear power plant licensed to operate must be able to withstand for a specified duration, and then recover from, a station blackout as defined in 10 CFR 50.2. This rule permits the utilities to submit alternative methods for coping with station blackout. This rule also states that a method based on an alternate ac power source, as defined in 10 CFR 50.2, will constitute an acceptable capability.

For the ELWRs, the staff recommends that the Commission require the installation of an alternate ac power source as the only basis taken to demonstrate compliance with 10 CFR 50.63. The staff recommends that the alternate ac source have capacity to supply power for one safety train, including one complete set of normal safe shutdown loads, and that it be of diverse design. The alternate ac power supply must be designed to serve any safety train when needed, thereby serving as an additional backup power supply for the Class IE power supplies. The staff has stated that the diversity requirement will not preclude use of diesel generators, even though diesel generators are used for the Class IE emergency power supplies.

Although taken by itself this may seem to be desirable, it has not been demonstrated that it is required to conform to the safety goal. Nevertheless, we endorse the staff's recommendation.

6. Fire Protection

The staff concluded that the fire protection issues raised through operating experience and the Individual Plant Examination for External Events (IPEEE) Program (Ref. 6) must be resolved for the ELWRs. To accomplish this, the staff is proposing that the current NRC guidance for fire protection be enhanced as described by the staff during the March 27, 1990, meeting of our Subcommittees on Extreme External Phenomena and Severe Accidents. The enhancements proposed by the staff when combined with the requirements of 10 CFR 50.48 (Fire Protection) without exception and the guidance provided by the Standard Review Plan Section 9.5.1 (Fire Protection Program) should constitute an acceptable basis for prescribing fire protection features for the ELWRs.

The proposed enhancements represent a significant improvement in physical separation requirements and in the need to consider the effects of smoke, heat, and fire suppressant migration into other areas. In particular, redundant train separation is likely to be the most significant feature leading to reduced fire risk. We recommend that the proposed enhancements include separation of environmental control systems.

The fire-risk issues that were examined in the Fire Risk Scoping Study (Ref. 7), however, are not fully addressed in SECY-90-016. They should be.

We agree with the staff's recommendation for resolution of this issue with the above caveats.

7. Intersystem LOCA

The staff's position is that designing low-pressure systems to withstand full RCS pressure (to the extent practicable) is an acceptable means for resolving this issue. For those systems that have not been designed to withstand full RCS pressure, the staff indicates that other measures will be required. We recommend approval of the proposed staff resolution, provided consideration is given to all elements of the low pressure piping system (e.g., instrument lines, pump seals, heat exchanger tubes, and valve bonnets).

III. MITIGATIVE FEATURE ISSUES

8. Hydrogen Generation and Control

The staff recommends that the ELWR designs provide a system for hydrogen control that can safely accommodate hydrogen generated by the reaction of water with 100% of the fuel cladding surrounding the active fuel. (Note: This is not 100% of the fuel rod cladding, nor does it include other metal in the core which could produce hydrogen if it were heated to a red heat in the presence of steam.) There is substantial uncertainty in establishing the

amount of hydrogen that might be formed in a severe accident. We support the staff's recommendation.

The staff also recommends that the system be capable of precluding uniform concentrations of hydrogen greater than 10%. The EPRI ALWR Requirements Document specifies 13%. We are not aware of any experimental or analytical work that demonstrates that the detonation of hydrogen at the 10%, 13%, or some other level could damage the integrity of the containment and essential components. It is our impression that the effect, if any, is something that experts dealing with gas explosions can calculate with reasonable confidence. We suggest that the staff seek further technical information on possible effects, including stratification, before establishing a limit for the average hydrogen concentration.

9. Core-Concrete Interaction - Ability To Cool Core Debris

The staff proposes that the ELWR designs provide sufficient reactor cavity floor space to enhance debris spreading, and provide for quenching of the debris in the reactor cavity. Quantification of what constitutes sufficient reactor cavity floor space is still an open question, as is the means by which one quenches the core debris. The resolution of this issue will require engineering judgment as many of the physical processes are not fully understood. We agree with the staff's recommendation.

10. High-Pressure Core Melt Ejection

To cope with the possible effects of direct containment heating (DCH), the staff concludes ". . . that ALWR design should include a depressurization system and cavity design features to contain ejected core debris."

This is an extremely improbable event, and we see no need to require two modes of coping with the possibility. Either depressurization or cavity design provisions alone should be adequate. Because of possible safety benefits for other events, reliable depressurization is probably the preferred approach.

11. Containment Performance

The staff recommends that a containment performance guideline, expressed as a conditional containment-failure probability (CCFP) of 0.1, be used in evaluation of the ELWR designs. As an alternative, the staff proposes a deterministic performance goal that it believes would offer comparable protection.

We have recommended previously (ACRS Comments on An Implementation Plan For The Safety Goal Policy, dated May 13, 1987) such a quantitative guideline for containment performance as a part of the implementation of the Safety Goal Policy. However, this should be regarded as guidance to the NRC staff in its development of requirements for applicants. Merely passing on this guidance to applicants is not enough because the definition of CCFP is too imprecise. The deterministic performance criterion for containment systems suggested by the staff is also difficult to interpret.

We have undertaken an effort (ACRS report on Containment Design Criteria, dated March 15, 1989) to propose containment design criteria for future plants. But, as we said at the beginning of our study, we did not expect that it would directly affect the certification of the ELWR designs. This was, to some extent, because we recognized that our study would take some time to complete, but principally because the ELWR designs are now essentially complete and have been for some time.

We understand that the staff, assisted by the Brookhaven National Laboratory, is developing a regulatory guide that would serve as a basis for review of ELWR containment performance. We believe that the staff proposal will be adequate for ELWR review if it is supported by an appropriate regulatory guide developed on a timely schedule, and if it can be reasonably demonstrated that a containment that meets this guidance has a CCFP of not more than 0.1.

12. ABWR Containment Vent Design

During our April 5-7, 1990 meeting, we heard presentations from the staff and the General Electric Company regarding the staff's proposal that the Commission approve the use of severe accident design features that include a containment overpressure protection system in the ABWR design. We recommend that use of a containment overprotection system be approved subject to the results of the regulatory review.

13. Equipment Survivability

The staff recommends that features provided in the ELWR designs that are intended only for severe accident protection (prevention and mitigation) need not be subject to 10 CFR 50.49 (Environmental Qualification Requirements), 10 CFR 50, Appendix A (Redundancy and Diversity Requirements), and 10 CFR 50, Appendix B (Quality Assurance Requirements). However, the staff will require that mitigation features must be designed so there is "reasonable assurance" that they will perform their intended function in the severe accident environment and over the time span for which they are needed. Further, the staff proposes that at least one train of features provided for design basis accident protection, but also relied upon for severe accident protection, must be able to survive severe accident conditions for the time period that is needed to perform its intended function with "high confidence." In addition, the staff proposes to require that severe accident mitigation equipment be capable of being powered from an alternate power supply, as well as from the normal Class IE on-site systems.

To accomplish "reasonable assurance" and "high confidence," the staff will require that severe accident protective features use high quality industrial grade components which will be selected for the service intended and qualified by analysis or tests.

We endorse the staff's position. We note, however, that in this instance the staff's position includes much more than the underlined portions of the enclosure to SECY-90-016.

IV. NON-SEVERE ACCIDENT ISSUES

14. Operating Basis Earthquake (OBE)/Safe Shutdown Earthquake (SSE)

The staff states that it has not yet developed a position on this issue that can be applied generically to all future designs and recommends that the Commission approve a design-specific approach. We have no objection to the staff considering exemptions to the requirement that the OBE be at least one-half the SSE, where this can be justified. We note that this has been done in the past for 14 plants at 9 sites, but in each case using site-specific data. Other bases for justification may have to be provided for un-sited standard plant designs.

In the longer term, we recommend that the staff and the industry attempt to develop a position that can be defined generically. One approach worthy of study would be to abandon the use of two earthquake levels for the design of structures, systems, and components. Instead, the design could be based only on the SSE, with appropriate load factors and limit states, and a smaller but more likely earthquake could be established as a threshold for plant shutdown and inspection.

15. Inservice Testing of Pumps and Valves

The staff proposes that certain aspects of the testing and inspection of pumps and valves be enhanced to ensure the necessary level of component operability for the ELWR designs. We endorse the staff's proposal with the following clarification and additions:

Although not stated explicitly, we were told during the March 7, 1990 meeting of our Subcommittee on Mechanical Components that the staff intends to apply the requirements of Generic Letter 89-10 (Ref. 8) to the ELWR plants as well. We endorse this intention.

We recommend that the staff's requirement for full-flow testing capability be extended to other safety-related valves (e.g., MOVs) not just check valves. The requirement for flow testing of MOVs is included in Generic Letter 89-10.

We recommend that the staff resolve the issue of check valve testing and surveillance requirements for existing LWR plants and indicate how it is to be applied to the ELWRs prior to issuing the FDAs.

We recommend that the staff be encouraged to entertain proposals from the FDA applicants regarding alternative ways of meeting the in-service testing and surveillance requirements.

Additional comments by ACRS Members Harold W. Lewis and James C. Carroll and ACRS Members William Kerr, David A. Ward, and James C. Carroll are presented below.

Sincerely,

Carlyle Michelson
Chairman

Additional Comments by ACRS Members Harold W. Lewis and James C. Carroll

Apart from one paragraph submerged as part of Item 1, this letter endorses the scattershot approach the staff has taken to the important question of regulation of new reactors. It therefore deserves to be called Camel II, in deference to the Committee's similar letter of January 15, 1987. The differences are that this list has in fact had more careful consideration, and that its elements originated with specific staff proposals. Indeed, in many cases the genealogy can be traced to industry initiatives, and the staff is simply proposing to make mandatory those things that the industry has previously proposed to do on its own. None of this pays the slightest attention to the Commission's Safety Goal Policy, nor is there any hint of an effort to seize this opportunity to move the regulatory process in the direction of coherence and consistency. This is a pudding without a theme.

Let us then try to provide some perspective, since the Committee has chosen not to do so.

The Committee has often commented on the central role of the Safety Goals in providing a focus and objective for the body of regulation. Since this list sets the tone for the licensing of the next generation of light-water reactors, it is particularly important that its relation to Commission policies, especially the Safety Goal Policy, be clear. At the risk of repetition, we, and we believe the Committee, have never urged that specific regulatory decisions (such as these) be judged individually in the context of the Safety Goals, but only that the body of regulation be judged in that light. Individual decisions must still be made deterministically, with expertise and good judgment, but as part of a coherent overall body of regulation. Still, fifteen items come close to being a "body", and it is informative to see the role of the Safety Goals in the formulation of the staff recommendations. The Safety Goal policy, and other commission policies, are supposed to provide the glue that binds the whole structure together.

In effect, the staff says that it has proposed to the Commission a set of new safety goals (SECY-89-102), the Commission has not acted on them, either way, and therefore the staff will use them as if the Commission had approved. While we sympathize with the staff predicament, we think that is entirely inappropriate. The staff proposals include such things as a core-damage probability of 1E-5 per reactor-year, a "large accident" probability of 1E-6 per reactor year (with a bizarre definition of large accident), and a so-called conditional containment-failure probability. Not one of these has been approved by the Commission, yet the staff has used them in formulating its proposed policies on these items. It has rationalized this usurpation of power by asking for Commission action on SECY-89-102, and by stating that its own safety goals are "consistent" with those of the Commission. Of course any set of

goals more stringent than yours will be consistent with your own, and acceptance of this argument will mean that the staff can regulate beyond your policies, more or less at will. That is precisely the situation your original goals were intended to foreclose. The Committee has often recommended that your Safety Goals be used as a final statement of "how safe is safe enough", not as a rigid minimum level of safety, beyond which the sky is the limit. Of course the industry may well have good reason to go further, but that is another matter.
In addition, as your own OGC has pointed out in SECY-90-016, this has the potential to open a Pandora's box, in which each party to a licensing proceeding may be able to claim the rights the staff claims--to insist on improvements beyond the rules. You will have to face this problem at some time, and the sooner the better.

We do not wish to understate the difficulty involved in translating a safety-goal policy into a workable body of regulation. The Committee has written you of its own recommendations for an organized approach to that problem, but we believe it can and should do more. Nuclear safety is not helped by letting that problem fester--the fact that it is difficult is no excuse for inattention. It is too much to expect regulation to be coherent and rational in the absence of an objective for that regulation.

We do think it was useful for the Committee to respond to your specific request for technical help on the fifteen questions posed, but you should recognize that this was done in the absence of a measuring rod. Each item was therefore judged on its own, and the Committee has turned its back on the opportunity to respond in a structured and coherent way. Any one of these items might have come out differently if it had been measured against an underlying rationale. In our view, the Committee has forfeited a chance to be of real service to both you and the public.

Additional Comments by ACRS Members William Kerr, David A. Ward, and James C. Carroll

By the "rulemaking" approach to design certification the Commission has sidestepped the development of revisions to regulations that would reflect knowledge gained from experience and research over the last ten or more years. As a result, important new requirements are being imposed on applicants through a variety of staff actions and reactions. This is a loosely controlled process in which major policy decisions are made without an appropriate intensity of review. Contributing to the lack of discipline is what we believe to be a serious ambiguity in the Commission's policy on advanced reactors. The Commission has said it expects future reactors to be safer. But, whether this is a mandate or simply an expectation that a maturing industry will produce safer plants is not clear. The staff has interpreted it as a mandate and has translated this into an unauthorized extension of the safety goals. This is despite the statement in NUREG-1226, "Development and Utilization of the NRC Policy Statement on the Regulation of Advanced Nuclear Power Plants," published June 1988 (p. 4-1) that "the Commission expects but does not require enhanced safety margins other than those that may be required by the Safety Goal Policy." The Commission should not indefinitely postpone the

development of a modern set of regulations. Only in this way will a proper balance be struck between adequate protection of the

public health and safety and the advantages to the public that can come from efficient development of the nuclear power option.

References:

1. SECY-90-016, memorandum dated January 12, 1990, from J. Taylor, Executive Director for Operations, NRC, to the Commissioners, Subject: Evolutionary Light Water Reactor (LWR) Certification Issues and Their Relationship to Current Regulatory Requirements

2. Draft SECY-89-102, memorandum dated March 30, 1989, from V. Stello, Jr., Executive Director for Operations, NRC, to the Commissioners, Subject: Implementation of Safety Goal Policy

3. Electric Power Research Institute (EPRI), Advanced Light Water Reactor Requirements Document (Chapters 1 through 13), issued December 1987

4. General Electric Company, Advanced Boiling Water Reactor Licensing Review Basis Document, issued August 1987

5. U. S. Nuclear Regulatory Commission, NUREG-1150, "Severe Accident Risks: An Assessment for Five U. S. Nuclear Power Plants," Volumes 1 and 2, dated June 1989

6. Memorandum dated March 8, 1990 from W. Minners, Office of Nuclear Regulatory Research, NRC, to R. Fraley, ACRS, Subject: Proposed Generic Letter on Individual Plant Examination for Severe Accident Vulnerabilities Due to External Events (IPEEE) and Supporting Documents (Predecisional)

7. Sandia National Laboratories, "Fire Risk Scoping Study: Investigation of Nuclear Power Plant Fire Risk, Including Previously Unaddressed Issues," NUREG/CR-5088, published January 1989

8. Generic Letter 89-10, "Safety-Related Motor-Operated Valve Testing and Surveillance," issued on June 28, 1989 to licensees for all power reactors, BWRs, PWRs, and vendors in addition to General Codes applicable to generic letters.