



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

July 21, 1993

OFFICE OF THE
SECRETARY

MEMORANDUM FOR: James M. Taylor, Executive Director
for Operations

FROM: Samuel J. Chilk, Secretary

SUBJECT: **SECY-93-087 - POLICY, TECHNICAL, AND
LICENSING ISSUES PERTAINING TO EVOLUTIONARY
AND ADVANCED LIGHT-WATER REACTOR (ALWR)
DESIGNS**

This is to advise you that the Commission (with all Commissioners agreeing) has approved the items for which the staff requested a decision as follows:

1. I.E. Fire Protection:

The Commission approves the staff's position that the passive plants should also be reviewed against the enhanced fire protection criteria approved in the Commission's SRM of June 26, 1990.

The Commission would like to be kept informed of the staff's resolution of the issue related to common-mode failures through common ventilation systems.

2. I.F. Intersystem Loss-of-Coolant Accident:

The Commission approves the staff's position that the passive plants should also be reviewed for compliance with the intersystem LOCA criteria approved in the Commission's SRM of June 26, 1990.

The staff should clarify the intent of the phrase "could not practically be designed to meet such a criterion."

3. I.G. Hydrogen Control:

The Commission approves the staff's position that the passive plants should be designed, as a minimum, to the same requirements applied to evolutionary designs. Specifically, passive plants must:

SECY NOTE: This SRM and the vote sheets of all Commissioners will be made publicly available in 10 working days from the date of this SRM. (SECY-93-087 was previously released to the public).

- o accommodate hydrogen generation equivalent to a 100% metal-water reaction of the fuel cladding;
- o limit containment hydrogen concentration to no greater than 10%; and
- o provide containment-wide hydrogen control (such as igniters or inerting) for severe accidents.

The Commission approves the staff's clarification, as expressed at the Commission briefing, that the possible use of passive autocatalytic hydrogen recombiners should not be precluded from consideration a priori. The staff is cautioned to consider carefully the relatively slow time response of autocatalytic recombiners as a possible impediment to their efficiency.

The staff's resolution of the issue of the placement of hydrogen control devices should be provided to the ACRS and the Commission for information.

4. I.H. Core Debris Coolability:

The Commission approves the staff's position that both the evolutionary and passive ALWR designs meet the following criteria:

- o Provide reactor cavity floor space to enhance debris spreading.
- o Provide a means to flood the reactor cavity to assist in the cooling process.
- o Protect the containment liner and other structural members with concrete, if necessary.
- o Ensure that the best estimate environmental conditions (pressure and temperature) resulting from core-concrete interactions do not exceed Service Level C for steel containments or Reactor Load Category for concrete containments, for approximately 24 hours. Ensure that the containment capability has margin to accommodate uncertainties in the environmental conditions from core-concrete interactions.

With regard to the 0.02m²/Mwt reactor vessel cavity floor area, the staff should continue its research activities and supporting analyses, as documented in its May 19, 1993 letter to the ACRS.

With respect to the containment response to ex-reactor vessel core debris, the staff should not limit licensees to

only one method for addressing containment responses to severe accident events but also permit other technically justified means for demonstrating adequate containment response.

5. I.I. High Pressure Core Melt Ejection:

The Commission approves the staff's position for the general criteria that the evolutionary and passive LWR designs:

- o provide a reliable depressurization system; and
- o provide cavity design features to decrease the amount of ejected core debris that reaches the upper containment.

6. I.J. Containment Performance:

The recommendations on containment performance, as outlined in SECY 93-087, could be read to imply that the staff is no longer proposing to use the concept of conditional containment failure probabilities (CCFP). However, based on discussions held during the Commission meeting on this subject, the staff informed the Commission that it intends to continue to apply the 0.1 CCFP in implementing the Commission's defense in depth regulatory philosophy and the Commission's policy on Safety Goals.

Therefore, the Commission approves the staff's position to use the following deterministic containment performance goal in the evaluation of the passive ALWRs as a complement to the CCFP approach approved by the Commission in its SRM of June 26, 1990:

"The containment should maintain its role as a reliable, leak-tight barrier (for example, by ensuring that containments stresses do not exceed ASME Service Level C limits for metal containments, or Factored Load Category for concrete containments) for approximately 24 hours following the onset of core damage under the more likely severe accident challenges and, following this period, the containment should continue to provide a barrier against the uncontrolled release of fission products."

The Commission approves the staff's interim approach subject to the staff's review and recommendations resulting from public comments on the "Advance Notice of Proposed Rulemaking on Severe Accident Plant Performance Criteria for Future ALWRs."

7. I.K. Dedicated Containment Vent Penetration:

The Commission approves the staff's position that the need for a containment vent for the passive plant designs should be evaluated on a design-specific basis.

8. I.L. Equipment Survivability:

The Commission approves the staff's position that the passive plant design features provided only for severe-accident mitigation need not be subject to the environmental qualification requirements of 10 CFR Section 50.49; quality assurance requirements of 10 CFR Part 50, Appendix B; and redundancy/diversity requirements of 10 CFR Part 50, Appendix A.

9. I.M. Elimination of Operating-Basis Earthquake (OBE):

The Commission approves the staff's recommendation to account for earthquake cycles in the fatigue analyses of piping systems performed until the new guidance is issued, using two SSE events with 10 maximum stress cycles per event (20 full cycles of the maximum SSE stress range). Alternatively, the number of fractional vibratory cycles equivalent to that of 20 full SSE vibratory cycles may be used (but with an amplitude not less than one-third of the maximum SSE amplitude) when derived in accordance with Appendix D of IEEE Standard 344-1987.

The Commission approves the staff's recommendation that the effects of anchor displacements in the piping caused by an SSE be considered with the Service Level D limit.

The Commission approves the staff's recommendation to eliminate the OBE from the design of systems, structures, and components. When the OBE is eliminated from the design, no replacement earthquake loading should be used to establish the postulated pipe rupture and leakage crack locations.

The Commission approves the staff's recommendation that the mechanistic pipe break and high-energy leakage crack locations determined by the piping high stress (without the OBE) and fatigue locations may be used for equipment environmental qualification and compartment pressurization purposes.

The Commission agrees that with the elimination of the OBE, two alternatives exist that will essentially maintain the requirements provided in IEEE Standard 344-1987 to qualify equipment with the equivalent of five OBE events followed by

one SSE event (with 10 maximum stress cycles per event). Of these alternatives, the equipment should be qualified with five one-half SSE events followed by one full SSE event. Alternatively, a number of fractional peak cycles equivalent to the maximum peak cycles for five one-half SSE events may be used in accordance with Appendix D of IEEE Standard 344-1987 when followed by one full SSE.

The Commission agrees that the above requirements should also apply to passive ALWRs.

The Commission understands that the OBE will continue to be used as a threshold criterion for conducting inspections following an earthquake event. The staff should keep the Commission and the ACRS informed as the staff's further analysis and review proceed.

10. I.N. Inservice Testing of Pumps and Valves:

The Commission has no objection to the staff's position, but understands that further elaboration on this issue will be forthcoming from the staff.

11. II.A. Industry Codes and Standards:

The Commission approves the staff's position that consistent with past practice, that staff will review both evolutionary and passive plant design applications using the newest codes and standards that have been endorsed by the NRC. Unapproved revisions to codes and standards will be reviewed on a case-by-case basis.

12. II.D. Leak Before Break:

The Commission approves the staff's recommendation that the leak before break approach should be applied to both the evolutionary and the passive ALWRs seeking design certification under 10 CFR Part 52. This approval should be limited to instances in which appropriate bounding limits are established using preliminary analysis results during the design certification phase and verified during the COL phase by performing the appropriate ITAAC.

13. II.E. Classification of Main Steamlines in Boiling Water Reactors:

The Commission approves the staff's position that neither the main steam drain and bypass lines from the first valve up to the condenser inlet, nor the piping between the turbine stop valve and the turbine inlet should be classified as safety-related or as seismic Category I. Rather, these lines should be analyzed using a dynamic

seismic analysis to demonstrate structural integrity under SSE loading conditions. The turbine stop, control, and bypass valves and the main steam lines from the turbine control valves to the turbine shall meet all of the quality group and quality assurance guidelines specified in SRP Section 3.2.2, Appendix A. Further, that seismic analyses be performed to ensure that the condenser anchorages and the piping inlet nozzle to the condenser are capable of maintaining their structural integrity during and after the SSE.

The Commission approves the above-described approach to resolve the main steamline classification for both evolutionary and passive ALWRs.

14. II.F. Tornado Design Basis:

The Commission approves the staff's position that a maximum tornado wind speed of 482 km/hr (300 mph) be used in the design-basis tornado employed in the design of evolutionary and passive ALWRs.

15. II.H. Containment Leak Rate Testing:

The Commission approves the staff's position that until the rule change proceedings for Appendix J of 10 CFR Part 50 are completed, the maximum interval between Type C leakage rate tests for both evolutionary and passive plant designs should be 30 months, rather than the 24 months maximum interval currently required in Appendix J to 10 CFR Part 50.

16. II.I. Post-Accident Sampling System (PASS):

The Commission approves the staff's position as modified below.

The Commission approves the staff's recommendation that the post-accident sampling systems for evolutionary and passive ALWRs of the pressurized water reactor type be required to have the capability to analyze determine the gross amount of dissolved gases (not necessarily a pressurized sample) and chloride in accordance with the requirements as an acceptable means of satisfying the intent of 10 CFR 50.34(f)(2)(viii) and Item II.B.3 of NUREG-0737.

The Commission agrees that the time for taking these samples can be extended to 24 hours following the accident.

The Commission agrees that for evolutionary and passive ALWRs of the boiling water reactor type, there would be no need for the post-accident sampling system to analyze dissolved gases.

The Commission **approves** the deviation from the requirements of Item II.B.3. of NUREG-0737 with regard to requirements for sampling reactor coolant for boron concentration and radioactivity measurements using the post-accident sampling system in evolutionary and passive ALWRs. The modified requirement would require the capability to take boron concentration samples and radioactivity measurements 8 hours and 24 hours, respectively, following the accident.

The Commission **approval** is based on the fact that the PASS system is an existing requirement and on the belief that a relatively simple system can be designed to meet the modified requirement. It is the Commission's understanding that a system can be designed which is simple, does not require chemical analysis of the gases in solution, and will provide the reactor operator information as to whether significant amounts of non-condensable gases exist in the reactor coolant.

17. **II.N. Site-Specific Probabilistic Risk Assessments and Analysis of External Events**

The Commission **approves**, in part, and **disapproves**, in part, the staff's position on site-specific probabilistic risk assessment and analysis of external events, as listed below.

The Commission **approves** the position that the analyses submitted in accordance with 10 CFR 52.47 should include an assessment of internal and external events.

The Commission **disapproves** the staff's recommendation to use two times the Design Basis SSE for margins-type assessment of seismic events.

The Commission **approves** the use of 1.67 times the Design Basis SSE for a margin-type assessment of seismic events.

The Commission **approves** the following staff recommendation, as modified:

PRA insights will be used to support a margins-type assessment of seismic events. A PRA-based seismic margins analysis will consider sequence-level High Confidence, Low Probability of Failures (HCLPFs) and fragilities for all sequences leading to core damage or containment failures up to approximately **one and two-thirds the ground motion acceleration of the Design Basis SSE.**

The Commission **approves** the staff's position that the simplified probabilistic methods, such as **but not limited to** EPRI's FIVE methodology, will be used to evaluate fires.

The Commission approves the staff's position that traditional probabilistic techniques should be used to evaluate internal floods.

The Commission approves the staff's position that the ALWR vendors should perform bounding analyses of site-specific external events likely to be a challenge to the plant (such as river flooding, storm surge, tsunami, volcanism, high winds, and hurricanes).

The Commission approves the staff's position that when a site is chosen, its characteristics should be compared to those assumed in the bounding analyses to ensure that the site is enveloped.

The Commission approves the staff's position that if the site is enveloped, the COL applicant need not perform further PRA evaluations for these external events. The COL applicant should perform site-specific PRA evaluations to address any site-specific hazards for which a bounding analysis was not performed or which are not enveloped by the bounding analyses to ensure that no vulnerabilities due to siting exist.

18. II.Q. Defense Against Common-Mode Failures in Digital Instrumentation and Control Systems:

The Commission approves, in part, and disapproves, in part, the staff's recommendation. The Commission has approved a revised position, as follows:

1. The applicant shall assess the defense-in-depth and diversity of the proposed instrumentation and control system to demonstrate that vulnerabilities to common-mode failures have adequately been addressed.
2. In performing the assessment, the vendor or applicant shall analyze each postulated common-mode failure for each event that is evaluated in the accident analysis section of the safety analysis report (SAR) using best-estimate methods. The vendor or applicant shall demonstrate adequate diversity within the design for each of these events.
3. If a postulated common-mode failure could disable a safety function, then a diverse means, with a documented basis that the diverse means is unlikely to be subject to the same common-mode failure, shall be required to perform either the same function or a different function. The diverse or different function may be performed by a non-safety system if the system

is of sufficient quality to perform the necessary function under the associated event conditions.

4. A set of ~~safety-grade~~ displays and controls located in the main control room shall be provided for manual, system-level actuation of critical safety functions and monitoring of parameters that support the safety functions. The displays and controls shall be independent and diverse from the safety computer system identified in items 1 and 3 above.

The staff's position has been modified in essentially two respects:

First, inasmuch as common mode failures are beyond design-basis events, the analysis of such events should be on a best-estimate basis.

Second, the staff indicates in its discussion of the third part of its position that "The diverse or different function may be performed by a non-safety system if the system is of sufficient quality to perform the necessary function under the associated event conditions." Therefore, this clarification has been added to the fourth part of the staff's position (which refers to a subset of the safety functions referred to in the third part) by removing the safety grade requirement. Further, the remainder of the discussion under the fourth part of the staff position is highly prescriptive and detailed (e.g., "shall be evaluated," "shall be sufficient," "shall be hardwired," etc.). The Commission approves only that such prescriptiveness be considered as general guidance, the practicality of which should be determined on a case-by-case basis.

19. II.R. Steam Generator Tube Ruptures:

II.R.1. Multiple Steam Generator Tube Ruptures:

The Commission approves the staff's position to require that analysis of multiple steam generator tube ruptures (STGRs) involving two to five steam generator tubes be included in the application for design certification for the passive PWRs. The Commission understands that, as discussed in the Commission meeting on this SECY paper, since the steam generator multi-tube rupture event is beyond the design basis requirements for PWRs, realistic or best-estimate analytical assumptions may be used to assess plant responses.

II.R.2. Containment Bypass Potential Resulting From SGTRs:

The Commission approves the staff's recommendation that the applicant for design certification for a passive or evolutionary PWR assess design features to mitigate the amount of containment bypass leakage that could result from steam generator tube ruptures.

20. **II.T. Control Room Annunciator Alarm) Reliability:**

The Commission approves the staff's recommendation that the alarm system for ALWRs should meet the applicable EPRI requirements for redundancy, independence, and separation. In addition, alarms that are provided for manually controlled actions for which no automatic control is provided and that are required for the safety systems to accomplish their safety functions, shall meet the applicable requirements for Class 1E equipment and circuits.

21. **III.H. Role of the Passive Plant Control Room Operator:**

The Commission approves the staff's recommendation that sufficient man-in-the-loop testing and evaluation must be performed. In addition, a fully functional integrated control room prototype is likely to be necessary for passive plant control room designs to demonstrate that functions and tasks are properly integrated into the man/machine interface.

Finally, the staff and industry should meet to ensure a common understanding of the requirements such that industry's design activities are appropriately directed to comply with the requirements.

The Commission commends the staff for a job well done on the highly complex technical issues presented in this paper.

cc: The Chairman
Commissioner Rogers
Commissioner Remick
Commissioner de Planque
OGC
IG
ACRS
OCA
OPA