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The Honorable Lando W. Zech, Jr.
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Chairman Zech:

SUBJECT: BOILING WATER REACTOR CORE POWER STABILITY

During the 350th meeting of the Advisory Committee on Reactor Safeguards, June 8-10, 1989, we discussed the issue of core power stability in boiling water reactors (BWRs). We had the benefit of presentations by representatives of the BWR Owners Group (BWROG), the General Electric Company, the NRC staff, and contractors to the NRC. This topic was also discussed at a meeting of the combined Thermal Hydraulic Phenomena/Core Performance Subcommittees on May 23, 1989. Attention has been drawn to this issue by an event which occurred in March 1988 at the LaSalle County Station, Unit 2. The chief purpose of our recent meetings was to review the general program outlined by the BWROG and the staff to address this issue. The Committee had previously considered this matter during its meeting on December 15-16, 1988. We also had the benefit of the documents referenced.

Although it is well known that BWRs can experience core power oscillations under certain conditions, the magnitude and divergent nature of the oscillations during the LaSalle event were unexpected. BWRs have inherent feedback mechanisms that tend to constrain power increases. But, if the feedback becomes out of phase with power generation, as can occur under certain operating conditions, this inherent constraint can be lost. Core power oscillations can involve the entire core behaving as a whole, or behaving in a manner where one region is increasing in power while another region is decreasing.

Such oscillations pose two threats to reactor safety. First, if peak local power becomes great enough during an oscillation, local fuel damage from overheating can occur because of a local loss of effective heat transfer through the phenomenon known as Departure from Nucleate Boiling (DNB). Substantial numbers of fuel pins could fail in such an event. This can occur even if total reactor power has not increased significantly. In the LaSalle event, the peak local neutron power exceeded 300 percent of rated core average although there was no evidence of fuel overheating or damage. A second class of threat is, we believe, of greater significance. If core power oscillations are large and continue for an extended period, the suppression pool may become overheated and the integrity of the containment might be threatened.

Because a reactor scram terminates oscillations, the latter threat exists only if the scram fails; for example, if an anticipated transient without scram (ATWS) event triggers a severe power oscillation. Local damage from DNB could result following the onset of large oscillations if the capability for making the reactor subcritical is lost.

Following the LaSalle Station event, the staff issued two generic letters to

BWR licensees. These letters endorsed a series of actions that had already been proposed by the BWROG and added some additional short-term requirements. For the longer term, it was agreed that the BWROG would develop further actions that would be reviewed by the staff and implemented on a schedule to be agreed upon later this year.

The initial BWROG action was the imposition of new administrative controls at operating BWRs that define power/flow regions of unacceptable operation. These are regions where analysis or experience has indicated potential for oscillations. The administrative controls provide that these operating regions be avoided completely, or that special actions be taken if such a region is entered during operating maneuvers. We were told that these administrative controls are now in place at all operating BWRs. The staff has added a requirement that a manual scram be initiated in certain classes of BWRs upon occurrence of an inadvertent loss of operation of two reactor recirculation pumps.

For the longer term, the BWROG and the General Electric Company have developed a provisional list of alternatives that will be made available to individual licensees. This approach is intended to recognize that differences exist among the plants and that an optimal solution will be based on plant-specific parameters. These proposed alternatives range from further administrative controls to the addition of new automatic shutdown circuits that would detect the inception of oscillations or the entry into potentially unstable regions of operation. Our understanding is that the staff will review and approve proposals developed for each individual plant.

We believe that the general program outlined by the BWROG and the staff is sound and represents an adequate response to the issue. Local fuel damage, caused by DNB, is most certainly something plant owners will want to avoid, but the safety implications are limited. In general, the potential for power oscillations of the sort being considered does not represent a significant risk to public health and safety, except in combination with an ATWS, as we have discussed above.

We believe it is important that considerable attention be given in the longer term to the development of an improved understanding of the conditions that can lead to an ATWS compounded by core power oscillations. We are disappointed, given the many years that BWRs have been operating in this country, with the present limited state of knowledge and the inadequacy of existing analytical tools. We note that in European BWR programs a more aggressive approach seems to have been taken to studies of core power instabilities and to incorporation of provisions for monitoring and controlling them.

Sincerely,

Forrest J. Remick
Chairman

References:

1. U.S. Nuclear Regulatory Commission, NRC Bulletin Number 88-07: "Power Oscillations in Boiling Water Reactors (BWRs)," June 15, 1988

2. U.S. Nuclear Regulatory Commission, NRC Bulletin Number 88-07, Supplement 1: "Power Oscillations in Boiling Water Reactors (BWRs)," December 30, 1988

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