D860319

Honorable Nunzio J. Palladino
Chairman
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Dr. Palladino:

SUBJECT: ACRS COMMENTS ON PROPOSED BROAD SCOPE RULE REVISION TO GENERAL DESIGN CRITERION 4

During its 311th meeting, March 11-13, 1986, the Advisory Committee on Reactor Safeguards met with representatives of the NRC Staff and reviewed the proposed changes to General Design Criterion 4 (GDC 4). The ACRS Subcommittee on Metal Components held a meeting on this subject on February 27-28, 1986 with representatives of the NRC Staff and the nuclear industry. We also had the benefit of the document referenced.

While the assumption of an instantaneous double ended pipe break in large high energy lines has provided a convenient way to bound the loads that might result from a pipe rupture, it bears little or no relationship to the way in which such pipes have actually developed leaks, and has led the Commission to require massive structures to protect against the consequences of these hypothetical breaks. It has also led to systems which are expensive to build, difficult to inspect, and arguably more prone to failure than those without the large restraints.

In looking for a more rational yet safe approach to pipe breaks, the research of the last decade on elastic-plastic fracture mechanics has presented a means to justify a more reasonable alternative. This work had shown how to calculate when a large through-wall crack in a high energy line will be stable instead of leading to sudden failure; that is, when "leak-before-break" will occur. The formalism has been well proven as a means for determining how fast a crack will grow and when these cracks will become unstable. In addition to work in the nuclear industry, this technology has been applied for many years in aircraft structures and in large structures like off-shore drilling platforms.

The proposed revision of GDC 4 would allow the use of leak-before-break methodology to exclude dynamic effects associated with postulated pipe ruptures. We believe that this is an appropriate approach and that the proposed rule change should be allowed to go out for public comments. Subsequent to the public comment period, we expect to review this rule together with the public comments and the NRC Staff's response to them. We also wish to be kept informed of the detailed acceptance criteria developed by the NRC Staff for the selection of piping systems to which this revision will be applied. We give below some comments on this proposed revision.

The proposed change to GDC 4 would add two sentences, as follows:

> "However, dynamic effects associated with postulated pipe ruptures in nuclear power units may be excluded from the

design basis when analyses demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping. These analyses must include, as a minimum, a deterministic fracture mechanics evaluation of the piping, and an evaluation of corrosion, water hammer, fatigue, leakage detection, and indirect sources of pipe rupture."

We recommend that the second (last) sentence be deleted. The requirement in the first sentence that "... analysis demonstrate that the probability of fluid system pipe rupture is extremely low ..." covers all that should be said in a general rule. To attempt to spell out detailed requirements in this way:

- leads to an incomplete list, for example, creep, creep-fatigue, and erosion are credible but are omitted,

- brings into question whether the rule would apply to some additional failure mechanism that might be found to be important in the future, and

- leads to possible contradictions such as requiring a "deterministic fracture mechanics analysis" on a pipe with an "extremely low probability of rupture."

The rule should not be applied in the foreseeable future to piping operating at temperatures above 750~F. The criteria that the NRC Staff is considering to evaluate piping deals primarily with the development of fatigue cracks. This mechanism of failure gives a clearly defined crack which grows slowly with time and is detectable with the NDE techniques used. At higher temperatures creep damage causes more homogeneous deterioration of the metal. This deterioration is not detectable with the nondestructive examination techniques commonly used by the industry and can lead to sudden failures which give little warning. It is believed that the recent sudden failures in fossil plant steam lines operating at 1000~F were of this type.

The text introducing the rule change brings up other concerns, the primary one being that in attempting to formulate "rigorous acceptance criteria" the NRC Staff may impose requirements at least as onerous as those now required. Though rigor has its place, judgment might be more appropriate in the evaluation of potential problems with corrosion, water hammer, indirect sources of pipe rupture, etc. In a similar vein, the package of materials properties for the various joints could balloon out of all proportions.

Additional comments by ACRS Members David Okrent and Glenn A. Reed and ACRS Members Paul G. Shewmon and David A. Ward are presented below.

Sincerely,

David A. Ward
Chairman

Additional Comments by ACRS Members David Okrent and Glenn A. Reed

We disagree with the proposed modification at this time. Although we can see the economic and safety benefits from removal of pipe restraints, we do not believe that the NRC Staff has made a case for going beyond what the regulatory authorities currently allow for PWRs in the Federal Republic of Germany (FRG) nor have they defined the detailed conditions of design, fabrication, inspection, and monitoring for reactors in operation or under construction that would be equivalent to the requirements imposed in the FRG, where the FRG permits use of leak-before-break.

In addition, it appears that the proposed modification of GDC 4 might encourage licensees with nonqualifying situations to pursue relaxation and might permit undesirable relaxation in subcompartment pressurization capabilities as well as undesirable routing of high energy lines.

We suggest that the NRC Staff be asked to resubmit a revised broad scope approach.

Additional Comments by ACRS Members Paul G. Shewmon and David A. Ward

We believe it is illogical to apply an argument to one aspect of nuclear power plant design without applying it to other aspects where it equally applies. Therefore, we believe the NRC Staff should begin to consider whether leak-before-break analysis could also be usefully applied to questions of emergency core cooling, containment design, and environmental equipment qualification with an accompanying potential for reduction in both risk and restrictive regulations.

Reference:

1. Letter from G. A. Arlotto, Office of Nuclear Regulatory Research, to R. F. Fraley, Advisory Committee on Reactor Safeguards, Subject: Updated Broad Scope GDC 4 Rule, dated February 9, 1986

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