

Central file

July 30, 1981

The Honorable Morris K. Udall, Chairman
Subcommittee on Energy and the Environment
Committee on Interior and Insular Affairs
United States House of Representatives
Washington, D.C. 20515



Dear Mr. Chairman:

This letter is in response to your inquiry of May 1, 1981 regarding the question of nuclear reactor pressure vessel integrity when subjected to thermal shock and subsequent repressurization during an overcooling transient.

Pressure vessel thermal shock has been considered for many years in the context of assuring integrity of the vessel when subjected to cold emergency core cooling water during a large loss of coolant accident (LOCA). Based on a series of thermal shock experiments (unpressurized) conducted at Oak Ridge National Laboratory (ORNL) beginning in 1976 and fracture mechanics analyses, it was concluded that a postulated flaw would not propagate through the vessel wall during a large LOCA and that the vessel integrity would therefore be maintained during subsequent repressurization.

As the result of operating experience and further analysis, it was subsequently recognized that there could be transients in pressurized water reactors (PWRs) in which the vessel could be subjected to overcooling (thermal shock) at the same time that primary system pressure remained high. In those pressurized thermal shock transients, the vessel would be subjected to pressure stresses superimposed upon the thermal stresses resulting from the temperature difference across the vessel wall. In order to define what conditions would be necessary to propagate a flaw through the entire vessel thickness under those conditions, a number of investigations were initiated by the staff beginning in early 1980 including defining the cooldown transients of interest and their respective probability, development of a computer code to perform the thermal transients and fracture mechanics analyses and planning for pressurized thermal shock tests in the Heavy-Section Steel Technology Program at ORNL.

The staff evaluations of this analytical work are summarized in a recent Commission Paper (copy enclosed). In this paper the staff indicated that there could be a problem if pressure vessels having initial material properties (fracture toughness) less favorable than those fabricated more recently were subjected to severe cooldown transients after many years of neutron irradiation. In order to assess the need for any immediate action,

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the PWR industry Regulatory Response Groups (RRGs) and PWR reactor manufacturers were briefed on this issue by the staff on March 31, 1981. In a progress briefing on April 29, 1981, the PWR Owners' Group asserted that there was no need for immediate corrective action. On May 15, 1981, the Westinghouse, Combustion Engineering and Babcock & Wilcox Owners' Groups filed written responses supporting and reiterating their conclusion that no immediate action was required on any operating reactor.

Based on our independent review, the Office of Nuclear Reactor Regulation (NRR) staff concluded, as discussed in the enclosed paper dated May 4, 1981, that no immediate licensing actions are required for operating reactors because there is no evidence indicating that the radiation damage to these reactor vessels has reached an extent that requires such actions. Please also note that the probability of such an event occurring in a B&W reactor is estimated to be about 10^{-3} per reactor per year and for Westinghouse and Combustion Engineering designed reactors, it is lower, perhaps by an order of magnitude. However, the staff has been performing a detailed review of the problem and will report its recommendations to the Commission in about five months. As a result of this review, equipment and/or procedural changes may be required.

A number of efforts are now underway by NRC to develop a full understanding for this problem. These programs may show the need for more extensive corrective action. A new project has been initiated at ORNL to bring together a comprehensive evaluation of the many aspects of this problem in order to define the best course of regulatory action toward its understanding and resolution. The Heavy-Section Steel Technology Program at ORNL is continuing, and first tests using a new pressurized thermal shock test facility are scheduled for FY 1982. The development of a computer code for probabilistic analysis of reactor pressure vessel failure utilizing fracture mechanics and Monte Carlo simulation techniques is continuing.

Several potential corrective actions are possible, and will be considered. These include:

1. Reducing the neutron irradiation of the pressure vessel by replacing some or all of the outer row of fuel elements in the core with partially loaded or reflector elements;
2. Annealing the reactor pressure vessel in-situ to restore a major fraction of the fracture toughness which was lost due to neutron irradiation. Annealing is feasible from a metallurgical standpoint, but practical application is difficult and potentially expensive;
3. Reducing the thermal shock by raising the temperature of the emergency core cooling system (ECCS) injection water; and
4. Reducing the probability of the event by control system designs that would prevent repressurization, and/or by operator actions to prevent repressurization.

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The NRC staff and its contractors have been, and will continue to be, extensively involved in the development of the technology of this issue. The independent capability of the staff and its contractors is briefly summarized in Enclosure 2.

The Commission regards pressurized thermal shock as a serious problem. Any significant possibility of reactor pressure vessel failure has to be regarded as serious because there are no engineered safety systems designed to deal with a large pressure vessel rupture. The Commission has directed the staff to continue close involvement with the affected licensees on this issue. The staff will be conducting meetings with the PWR Owners Groups during the week of July 27 to discuss current and future activities. In the near future, the staff will be issuing letters to several licensees requiring the submittal of an action plan within 90 days for dealing with this problem. The plan must consider at least the corrective actions listed earlier.

The NRC staff and its contractors have the capability to evaluate and resolve this issue. Any specific regulatory guidance that is needed as a result of our ongoing evaluations will be promulgated promptly so that any potential threat can be adequately addressed and the required integrity of pressure vessels in operating facilities can be assured for their remaining lifetime.

Sincerely,

Original signed by
Nunzio J. Palladino

Nunzio J. Palladino
Chairman

Enclosures:

1. SECY-81-286, dated May 4, 1981, "Pressurized Thermal Shock"
2. Summary of the Independent Capability of the NRC Staff and its Contractors in the Technology Related to Pressurized Thermal Shock

cc: Representative Manuel Lujan (w/encs.)

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The Honorable Morris K. Udall

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The NRC staff and its contractors have been, and will continue to be, extensively involved in the development of the technology of this issue. The independent capability of the staff and its contractors is briefly summarized in Enclosure 2.

In summary, the NRC staff and its contractors have the capability to evaluate and resolve this issue. Any specific regulatory guidance that is needed as a result of our ongoing evaluations will be promulgated promptly so that any potential threat can be adequately addressed and the required integrity of pressure vessels in operating facilities can be assured for their remaining lifetime.

Sincerely,

Nunzio J. Palladino
Chairman

Enclosures:

1. SECY-81-286, dtd May 4, 1981, "Pressurized Thermal Shock"
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cc: Rep. Manuel Lujan (w/encls)

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The NRC staff and its contractors have been, and will continue to be, extensively involved in the development of the technology of this issue. The independent capability of the staff and its contractors is briefly summarized in Enclosure 2.

In summary, the NRC staff and its contractors have the capability to evaluate and resolve this issue. Any specific regulatory guidance that is needed as a result of our ongoing evaluations will be promulgated promptly so that any potential threat can be adequately addressed and the required integrity of pressure vessels in operating facilities can be assured for their remaining lifetime.

Sincerely,

Joseph M. Hendrie
Chairman

Enclosures:

1. SECY 81-286 dated May 4, 1981, "Pressurized Thermal Shock"
2. Summary of the Independent Capability of the NRC Staff and its Contractors in the Technology Related to Pressurized Thermal Shock

cc: w/enclosures
Representative Manuel Lujan

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I believe it is clear from the above discussion that the NRC staff and its contractors have been and will continue to be, extensively involved in the development of the technology of this issue. The independent capability of the staff and its contractors is briefly summarized in Enclosure 2.

In summary, I believe the NRC staff and its contractors have the capability for the appropriate resolution of this issue and that this will readily follow from the base already established. I expect that specific regulatory guidance will be forthcoming so that any potential threat can be blunted and the required integrity of pressure vessels in operating facilities can be assured for their remaining lifetime.

Sincerely,

Joseph M. Hendrie
Chairman

Enclosures:

1. SEC 81-266 dated May 4, 1981, "Pressurized Thermal Shock"
2. Summary of the Independent Capability of the NRC Staff and its Contractors in the Technology Related to Pressurized Thermal Shock

cc: w/enclosures
Representative Manuel Lujan

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