APR 5 1977

Docket No. 50-346

MEMORANDUM FOR: T. M. Novak, Chief
Reactor Systems Branch
Division of Systems Safety

FROM: S. S. Pawlicki, Chief
Materials Engineering Branch

SUBJECT: OVERPRESSURIZATION SAFETY MARGIN FOR FIRST FUEL CYCLE FOR DAVIS-BESSE UNIT NO. 1

Plant Name: Davis-Besse Unit No. 1
Suppliers: Babcock and Wilcox; Bechtel Associates
Licensing Stage: OL
Docket Number: 50-346
Responsible Branch and Project Manager: LWR 1; L. Engle
Reviewer: C. D. Sellers
Description of Task: Overpressurization Safety Margin for First Fuel Cycle
Review Status: Complete

In response to your request of March 17, 1977, the Materials Integrity Section of the Materials Engineering Branch, Office of Nuclear Reactor Regulation has performed an evaluation of the safety margin for overpressurization transients during the first fuel cycle of Davis-Besse Unit No. 1. Our presentation of this evaluation is enclosed.

S. S. Pawlicki, Chief
Materials Engineering Branch
Division of Systems Safety
Office of Nuclear Reactor Regulation

Enclosure:
As stated

For cc's, see
attached sheet

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DATE ▶	4/12/77	4/12/77	4/13/77			

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OVERPRESSURIZATION SAFETY MARGIN FOR FIRST FUEL CYCLE FOR DAVIS-BESSE UNIT NO. 1

The NRC staff program to consider reactor vessel pressure transients was intensified beginning in 1975 when the number of such events began to increase. The overpressurization events that have occurred to date have caused no damage that would affect the integrity of the reactor pressure vessels over their lifetime. Continued operation is permissible because of the small effects of radiation early in life. New plants, such as Davis-Besse Unit No. 1 can be permitted to be licensed under existing safety criteria because appropriate corrective measures will be developed and implemented before significant irradiation embrittlement can occur.

Additionally, operating procedures for Davis-Besse Unit No. 1 preclude operation in a water-solid condition (other than system hydrostatic tests) by requiring that a steam bubble or nitrogen gas bubble be present in the pressurizer. This feature provides additional time for operator action to take place in the event of a pressure transient in that the rate of pressure increase is much less than would exist in a water-solid condition. The incorporation of the nitrogen bubble scheme is currently part of the Davis-Besse Unit No. 1 system design.

If the nitrogen bubble is lost the system could be subjected to an over-pressurization. We have evaluated the consequences of exceeding pressure-temperature limits of the reactor vessel beltline in the unlikely event that this should occur at Davis-Besse Unit No. 1 during the first fuel cycle. We have performed the evaluation assuming the most unfavorable (conservative) circumstances for the overpressurization event: (a) that this event occurs at the end of the fuel cycle when the reactor vessel has accumulated maximum neutron damage and (b) that the event occurs at ambient temperature when the vessel material is in the most brittle condition.

We find that, under these circumstances, the maximum reactor pressure permitted under 10 CFR Part 50, Appendix G rules is approximately 750 psi. These rules, however, contain considerable margins of safety against brittle failure. One of these is a safety factor of two which is applied to stresses resulting from internal pressure loading. Another safety margin results from the fact that the Appendix G limits are calculated assuming that a surface flaw to the depth of ¼ of the vessel wall thickness is present.

Based on the sensitivity of nondestructive examinations conducted during the vessel fabrication and preservice volumetric inspection conducted in accordance with Section XI of the ASME Code, we can expect that much smaller flaws in the reactor vessel beltline would have been detected and repaired. By making a conservative assumption that maximum

undetected flaw size in the vessel beltline is ½ inch (about two times Section XI acceptance criteria) we can realize an additional safety factor of more than two in comparison with the Appendix G flaw size assumptions resulting in a combined safety margin greater than four.

Considering the above assumptions, the Davis-Besse Unit No. 1 vessel could be pressurized to over 3000 psi at ambient temperature without failure. Since the primary pressure relief valves are set to open at 2500 psi the above pressure can not be realized under any circumstances making brittle failure of the Davis-Besse Unit No. 1 vessel during the first fuel cycle a highly incredible event.

Additional safety margins against failure are known to exist but were not specifically considered in the above evaluation. One of these is the fact that material toughness which is assumed for Appendix G pressure limit calculations is based on lower bound values of rapid loading tests which are typically about 25% lower than the expected material toughness values. Another is data from the Heavy Section Steel Technology intermediate test vessel experiments which were flawed and pressurized to failure at temperatures ranging from 32 to 190°F. In all cases, pressures higher than two times the design pressure were required to produce failure.

It is also noted that after fabrication the Davis-Besse Unit No. 1 pressure vessel was hydrostatically tested at 1.25 times the design pressure (3180 psi) at 250°F thus assuring leak tightness and freedom from structurally significant material or manufacturing defects.