February 16, 1983

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY	)	Docket No. 50-289
	)	(Restart)
(Three Mile Island Nuclear Station, Unit No. 1)	)	

LICENSEE'S TESTIMONY OF

ROBERT C. JONES, JR. AND LOUIS C. LANESE

IN RESPONSE TO ALAB-708 ISSUE NO. 2

(USE OF HOT LEG VENTS IN PROMOTING NATURAL CIRCULATION)

SUMMARY

This testimony responds to the Appeal Board's request for information concerning the usefulness of the hot leg high point vents in promoting or restoring natural circulation in the event of a small-break loss of coolant accident.

Based upon a review of the size of the hot leg vents to be installed at TMI-1 (and therefore their capability to relieve steam) and of the reactor coolant system response during various small-break scenarios, it is concluded that opening of these vents provides very little benefit during the early stages of a small-break LOCA. The vents would provide some assistance in recovering natural circulation during the refill stage, when the HPI flow has matched the leak flow. While the vents may provide some incremental assistance in recovering natural circulation at this latter phase, Licensee has determined that this limited benefit does not outweigh the complexities associated with determining the conditions under which the vents may be opened. Licensee will instruct the TMI-1 operators to utilize the vents under inadequate core cooling conditions.

INTRODUCTION

This testimony, by Robert C. Jones, Jr., Supervisory Engineer, Operational Analysis Unit, Babcock & Wilcox Company, and Louis C. Lanese, Senior Safety Analysis and Plant Control Engineer, GPU Nuclear Corporation, is in response to Issue No. 2 of the Appeal Board's Memorandum and Order of December 29, 1982 (ALAB-708), which states:

> 2. When and under what circumstances such vents would or would not be useful to promote natural circulation, including reasons for the conclusions reached (from the staff).

This testimony will also address the concerns expressed by the Appeal Board at pp. 22-23 and n. 40 of ALAB-708, regarding the procedural guidelines for use of the hot leg high point vents.

BY WITNESS JONES:

High point vents in the hot legs were designed and are being installed in the reactor coolant system (RCS) as a means for control of non-condensible gases. To assure that a failure of this vent system does not result in a LOCA, the vents have been sized such that the leak flow rate could be compensated by the makeup system. The size of the vents limits their usefulness for recovery of natural circulation for a small break LOCA.

Before examining the potential usefulness of the vents for recovery of natural circulation for a small break, I would like to review briefly the several different RCS responses as a function of break size. For larger-sized small breaks, greater than approximately 0.02 ft2, energy removal via the break alone is sufficient to remove all the core decay heat. For very small breaks, less than approximately 0.005 ft2, a high pressure injection (HPI) or make-up (MU) pump provides sufficient flow to assure that the RCS remains full of liquid. Therefore, natural circulation will be continually maintained. What remains is the break size range between 0.005 and 0.02 ft2. For this range of small breaks, energy removal from the system is accomplished by a combination of the break flow and steam generator (SG) heat removal; natural circulation is not continuously maintained. Opening of the vents could possibly aid in the restoration of natural circulation for these transients, but for the reasons provided below, usefulness of the vents is severely limited.

A brief discussion of the RCS response for this break size range is necessary to understand the potential usefulness of high point vents. Within this break size range, the HPI flow is not able to match the inventory being lost through the break, and the RCS will depressurize and evolve to saturated fluid conditions. Energy removal via the SG will first be by all-liquid phase natural circulation and then by two-phase natural circulation. Continued energy additions from the core decay heat will result in boiling within the vessel and subsequent formation of pure steam regions within the primary system. These pure steam regions will interrupt the two-phase natural circulation. System pressurization will then occur due to the loss of SG heat removal. Once sufficient primary system inventory has been lost to establish a condensing surface within the steam generator, boiler-condenser cooling will be established. This will terminate the system pressure increase and a depressurization of the RCS will commence. Ultimately, the primary system pressure will settle at a condition where mass and energy flow added to the system is balanced by mass and energy flow through the break.

Opening of the high point vents, as a means of recovering natural circulation, has been examined at various points in the sequence of RCS response for the break sizes between 0.005 and 0.02 ft2 where the conditions described above will occur. Obviously, opening of the vents would serve no use so long as liquid single-phase natural circulation is maintained. Therefore, the earliest situation of interest is during the two-phase natural circulation period of the transient.

Opening of the vents during the two-phase natural circulation period of the transient could be useful if by doing so the depressurization rate of the primary system was materially increased, thereby aiding HPI injection flow. Opening of the vents when the system is in two-phase natural circulation would provide an additional energy removal path from the RCS and lead to some increase in the depressurization rate. Since the RCS is saturated during this phase of the transient however, liquid in the RCS would flash, retarding the depressurization rate.

Additionally, because of the small size of the vent, which is the equivalent of only a .00085 ft2 break in the RCS, the addition to the depressurization rate would be small in any event. Thus, while some additional HPI flow could be obtained as a result of the depressurization, the incremental effect would be minimal and not sufficient to cover the large range of leak flows expected over the break size range of 0.005 to 0.02 ft2.

Opening of the vents after natural circulation is lost would also not result in a recovery of natural circulation. The steam flow through the vents (approximately 3 lb/sec total) is only 4 percent of the steam production rate from the core at one-half hour, for example. Thus, unless the combination of the break flow and the HPI were nearly sufficient alone to provide the necessary energy relief (a situation which only occurs for the larger small-break sizes), opening of the vents would not provide sufficient additional energy relief to prevent pressurization of the system. However, for these breaks, the HPI flow is small relative to the break flow. Thus, recovery of the system inventory, and thereby natural circulation, would not occur.

Opening of the vents would provide a means of recovering natural circulation only when two conditions are met. First, the HPI flow has matched the leak flow; and second, the energy flow through the leak is sufficient to remove essentially all of the energy being added to the system. The vent path would result in additional energy removal with a subsequent decrease in RCS pressure and increased HPI flow. Since the HPI flow rate would then be greater than the leak flow, RCS refill would commence. Refill times for this mode of recovery could be expected to be on the order of one to two hours, assuming core boiling is suppressed by the incoming HPI.

In summary, opening of hot leg high point vents would provide virtually no benefit for recovering natural circulation during the early phases of a small break LOCA. Thus, the vents are not capable of replacing the role of the steam generators for small-break LOCAs. In the long term, however, the vents could provide a means of recovering the system inventory and thereby reestablish natural circulation.

BY WITNESS LANESE:

The hot leg high point vents will be used during situations of inadequate core cooling. Guidelines have been developed and included in the abnormal transient operating guidelines (ATOG) program and are undergoing review by the NRC Staff.

Proposed guidelines for utilizing the hot leg high point were first submitted by the B&W Owners Group for NRC Staff review in mid-1981. These guidelines addressed two conditions for opening the hot leg vents: (1) during inadequate core cooling conditions, and (2) during the refill phase of a small-break LOCA. However, the vent guidelines for use during the refill phase a small break LOCA have been withdrawn by the B&W owners from NRC Staff consideration. This was done after the initial submission of the guidelines because the owners and NRC Staff agreed that certain questions raised about the guidelines could not be resolved without an extensive testing and analytical effort to demonstrate to the NRC Staff that use of the vents under certain conditions would not be detrimental to plant safety. Since the use of the vents during the refill phase was considered to be of marginal benefit, the owners decided to withdraw the refill guidelines in April of 1982. GPU Nuclear made a plant-specific notification of this decision by letter to the Staff dated August 23, 1982.

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Education: B.S., Nuclear Engineering, Pennsylvania State University, 1971. Post Graduate Courses in Physics, Lynchburg College.

Experience: July 1982 to present: Supervisory Engineer, Operational Analysis Unit, B&W. Responsible for the performance of plant transient analyses and analyses used in the development of operator guidelines. During this period, has continued as Project Engineer for B&W analyses performed in response to NUREG-0737 Item II.K.3.30.

June 1975 to July 1982: Acting Supervisory Engineer and Supervisory Engineer, ECCS Analysis Unit, B&W. Responsible for calculation of large and small break ECCS evaluations, evaluations of mass and energy releases to the containment during a LOCA, and performance of best estimate pretest predictions of LOCA experiments as part of the NRC Standard Problem Program. Involved in the preparation of operator guidelines for small-break LOCA's and inadequate core cooling mitigation.

June 1971 to June 1975: Engineer, ECCS Analysis Unit, B&W. Performed both large and small break ECCS analyses under both the Interim Acceptance Criteria and the present Acceptance Criteria of 10 CFR 50.46 and Appendix K.

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Education: B.S., Engineering Science, Newark College of Engineering, 1970, M.E., Nuclear Engineering, New York University, 1972. Nuclear Engineering courses, Polytechnic Institute of New York, 1975 to 1980. Completed course work for Degree of Engineer.

Experience: Senior Safety Analysis and Plant Control Engineer, GPU Nuclear Corporation, 1979 to present. Responsibilities include the performance of the TMI-1 Restart Safety Analysis; TMI-1 Emergency Feedwater design, design review of TMI-1 restart and long-term modifications. Member of TMI-2 Generation Review Committee (GRC), 1979 through June 1982. Member of TMI-1 GRC, 1979 to present.

Chairman of the Babcock & Wilcox Owners Group Analysis Subcommittee from May 1981 to July 1982. Currently a member of the Analysis Subcommittee. Member of the GPUNC inhouse committee responsible for implementing the Abnormal Transient Operating Guidelines (ATOG) at TMI-1. Currently working on improvement of steam generator tube rupture emergency procedures, including analyses of tube rupture events using the RETRAN computer code. Working with EPRI in benchmarking RETRAN with RELAP 5 for tube rupture events. Independent safety reviewer for emergency procedures from August 1982 to present.

Control and Safety Analysis Engineer, GPU Service Corporation, 1978 to 1979. Responsibilities included the performance of containment analyses in support of plant operation; developing analyses in support of the TMI-2 feedwater system modification; preparation of the TMI-1 restart safety analysis.

Lead Nuclear Licensing Engineer, GPU Service Corporation, 1977 to 1978. Primary responsibility for TMI-2 licensing activities and for licensing matters involving generic safety issues affecting all GPU system plants.

Safety and Licensing Engineer, GPU Service Corporation, 1974 to 1977. Responsibilities included technical resolution of TMI-2 licensing open items; conformance of Forked River systems design to licensing criteria; and, safety review of Oyster Creek radwaste facility.

Assistant Safety and Licensing Engineer, Ebasco Services, Inc., Performed licensing and safety review of St. Lucie Units 1 and 2 Safety Analysis Report pertaining to instrumentation and power systems; cooling water and HVAC systems, radwaste systems; and, accident analysis. Performed dose analyses and developed secondary system source terms.