

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of

METROPOLITAN EDISON COMPANY, ET AL.)

(Three Mile Island Nuclear Station,)
Unit No. 1)

Docket No. 50-289
(Restart)

NRC STAFF COMMENTS IN RESPONSE TO APPEAL BOARD
MEMORANDUM AND ORDER OF NOVEMBER 5, 1982

James M. Cutchin IV
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November 22, 1982

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I. INTRODUCTION

In a Memorandum and Order, dated November 5, 1982, the Atomic Safety and Licensing Appeal Board expressed its preliminary views and concerns regarding the posture of the evidentiary record on the issue of "feed and bleed" core heat removal capability. The Appeal Board, while cautioning that its review was not yet complete, raised the possibility that a reopening of the record may be necessary to resolve its concerns. The Appeal Board noted, however, that a more satisfactory alternative to reopening may be available. If adequate core cooling can be ensured through natural circulation then there is no need to rely on feed and bleed core cooling capability as a back-up. The Appeal Board also questioned the adequacy of the record on natural circulation core cooling, but suggested that the assignment of an individual whose sole function would be to operate the emergency feedwater (EFW) flow control valves manually if necessary, together with the installation of high point vents in the hot legs for steam removal, would ensure core cooling by natural circulation. The Appeal Board expressed its interest "in

the parties' views concerning the sufficiency of our proposed requirements or, in the absence of the proposed changes, the need for reopening the record on feed and bleed." Memorandum and Order, dated November 5, 1982, at 10-11.

For the reasons discussed at length below, the proposed requirements suggested by the Appeal Board's initial review of the record would not significantly enhance the efficacy of natural circulation as a core cooling method. This does not mean, however, that the evidentiary record must be reopened. First, a safety-grade capability to manually control EFW independent of the non-safety-grade Integrated Control System (ICS) exists at TMI-1. Second, the capability of the boiler-condenser mode of natural circulation core cooling has been adequately demonstrated in the record. Finally, contrary to views expressed by the Union of Concerned Scientists and the Appeal Board, the efficacy of feed and bleed core cooling as a back-up to natural circulation has not been called into question by the Semiscale test results discussed in Board Notifications BN-82-93 and BN-82-107. No significant safety issue has been raised by the Semiscale test results, and there is no need to reopen the record for additional test results or any other additional evidence.

II. DISCUSSION

A. The Proposed Requirements Suggested by the Appeal Board

The two proposed requirements as to which the Appeal Board requested the parties' views are: (1) the assignment of an individual to operate the EFW flow control valves manually as necessary; and (2) the installation of vents in the hot leg high points for steam removal. In

the Appeal Board's preliminary view, such requirements might ensure the adequacy of core cooling through natural circulation and render unnecessary the reliance on feed and bleed for back-up core heat removal capability.

The assignment of a dedicated operator for manual operation of the flow control valves until the EFW system is modified to full safety-grade status at the next refueling outage is feasible but unnecessary. The assignment of such an individual presents no particular difficulty in terms of control room staffing and operation or of operator capability. However, the premise relied upon by the Appeal Board in identifying the need for a dedicated operator -- the dependence of the EFW system on the non-safety-grade ICS -- is incorrect.

A safety-grade manual control capability for the EFW system is present at TMI-1. There is in the control room at TMI-1 a manual back-up control station for EFW. This station is powered independently of ICS via redundant Class IE power supplies and the ICS is completely bypassed when "manual" is selected on the control station. Licensee Ex. 1 at p. 2.1-22. This modification has been reviewed and accepted by the Staff. Staff Ex. 1 at C1-11, C8-37. The operator will also have a safety-grade level and flow indication system to monitor EFW flow and steam generator level when using the back-up control station. Staff Ex. 14 at 37-39.

Small break LOCA analyses have indicated that the operators will have at least 20 minutes to restore feedwater and manually initiate high pressure injection (HPI) in the event of a small break LOCA before inadequate

core cooling would result. Staff Ex. 1 at C1-13; Affidavit of Walton L. Jensen, Jr. dated August 6, 1982 (Jensen Affidavit #1) at ¶ 10.^{1/} The operator is instructed by emergency procedures in the event of a complete loss of all feedwater immediately to initiate HPI and then to attempt to restore feedwater flow. Id. at 3. Since all of these operations are possible from the control room, and there is ample time to initiate HPI and EFW, there is no need to assign a dedicated operator. The control room staff already has four licensed operators available.

In addition, the installation of vents in the hot leg high points is both unnecessary and ineffective for the purpose intended by the Appeal Board. Such vents are designed to remove noncondensable gas from the reactor coolant loops in accordance with 10 CFR § 50.44. Jensen, ff. Tr. 4913 at 10 and Tr. 4992 (Jensen). They are to be designed sufficiently small that their failure will not produce a LOCA. NUREG-0737, Item II.B.1. Because the vents are to be so small, if boiler-condenser natural circulation core cooling is not available, steam would be produced by boil-off of the core coolant faster than the vents could remove it during the period of most interest. Thus, the installation of high point vents in the hot legs would not materially assist the cooling of the core in the absence of reliable natural circulation cooling. Affidavit of Walton L. Jensen, Jr. dated November 22, 1982 (Jensen Affidavit #2) at ¶ 9.^{2/}

^{1/} This affidavit was attached to "NRC Staff's Response to Appeal Board's Order of July 14, 1982" dated August 9, 1982.

^{2/} This affidavit is enclosed.

The steam flow capacity of the hot leg high point vents will be approximately 15 lb/sec at 2500 psia. Shortly after reactor trip decay heat will produce steam at a greater rate than it can be removed by the high point vents. Jensen Affidavit #2 at ¶ 10. The excess steam would be removed by the safety valves on the pressurizer (or by the PORV if it were available). Eventually core decay heat will decrease such that the rate of steam production is less than the rate at which steam can be removed by the high point vents. Id. At that time the reactor coolant system could be refilled using HPI, and single-phase natural circulation could be established. Establishment of single-phase natural circulation would require that feedwater be supplied to the steam generators. Jensen Affidavit #2 at ¶ 11. But if feedwater were available heat removal in the boiler-condenser mode of natural circulation would occur long before the reactor coolant system could be refilled to establish single-phase natural circulation. Jensen Affidavit #2 at ¶ 12. If HPI were available to refill the reactor coolant system it would be available to provide the feed for "feed and bleed" cooling. Id. Either of these cooling modes could effectively remove decay heat from the reactor coolant system long before single-phase natural circulation could be established. Id. Thus, the high point vents alone could not establish single-phase natural circulation in a timely manner. Id. They would only aid in refilling the reactor coolant system. Id. In sum, in the Staff's view the proposed requirements suggested by the Appeal Board would not significantly enhance the efficacy of natural circulation as a core heat removal method, nor are they necessary to provide adequate core cooling.

B. Reopening of the Record

Despite the Appeal Board's preliminary views and concerns, closer analysis shows that there is no need to reopen the record for additional evidence on the adequacy of the boiler-condenser mode of natural circulation core cooling or the efficacy of feed and bleed capability.

The Appeal Board offered its observation that "at the present time, we do not consider the boiler-condenser mode a viable method of removing decay heat." Memorandum and Order, dated November 5, 1982, at 7.

Contrary to the suggestion of the Appeal Board, the ability of the boiler-condenser mode of natural circulation to remove enough decay heat to prevent core damage has been adequately demonstrated on the record.

Boiler-condenser natural circulation is a process by which steam produced in the core of a nuclear reactor following a small break LOCA would be condensed inside the steam generator tubes. Jensen Affidavit #2 at ¶ 3. The process requires that the exterior surface of the steam generator tubes be cooled by feedwater. Id. Boiler-condenser natural circulation involves basic concepts of heat transfer which have been used by engineers for years and which are well understood. Id. The boiler-condenser mode of natural circulation is relied upon for small break LOCA recovery in the safety analyses of all PWR's, including TMI-1. Id.

Boiler-condenser natural circulation was discussed extensively in the record of this proceeding by Licensee's witness Jones and Staff's witness Jensen. In an event involving reactor trip and loss of power to the reactor coolant pumps decay heat would be removed from the core by single-phase natural circulation. Jensen ff. Tr. 4913 at 4. The ability to remove decay heat by single-phase natural circulation has been

demonstrated at operating B&W reactors. Jensen ff. Tr. 4913 at 5. In a LOCA steam formation in the reactor coolant system could interrupt single-phase natural circulation. Jensen ff. Tr. 4913 at 6. Natural circulation is not required to remove decay heat for most LOCA break sizes because decay heat would be removed from the reactor coolant system by the loss of coolant from the break. However, for breaks smaller than about 0.02 ft.² coolant flow from the break would be insufficient to remove all of the decay heat. Jones ff. Tr. 4588 at 7 and Jensen ff. Tr. 4913 at 5. For such breaks natural circulation is required to remove some of the decay heat, and single-phase natural circulation could be interrupted by the presence of steam in the loops of the reactor coolant system. Interruption of single-phase natural circulation would cause reactor coolant system pressure and the rate of coolant loss from the break to increase. Jensen ff. Tr. 4913 at 5. Natural circulation in the boiler-condenser mode would be established and reactor coolant system pressure and the rate of coolant loss from the break would be decreased. The core would not become uncovered. Jensen ff. Tr. 4913 at 6-7.

The boiler-condenser mode of natural circulation was found by the Licensing Board to be a reliable means of heat removal. PID at ¶ 621. Moreover, the boiler-condenser mode of natural circulation has been demonstrated by LOFT and Semiscale experiments to be effective in U-tube steam generators. See Board Notification BN-82-71 at 10. The tubes in the TMI-1 steam generator are straight rather than U-shaped. However, the same basic heat transfer mechanisms (condensation of steam on the primary side tube wall, conduction of heat through the tube wall, and

removal of heat by the feedwater on the secondary side tube wall) would occur whether the tubes are straight or U-shaped. Jensen Affidavit #2 at ¶ 3. That the Staff has concluded that additional experimental data is desirable to confirm the predictive capability of computer codes used to design B & W reactors (See NUREG-0737, Item II.K.3.30), does not contradict its conclusion that the boiler-condenser mode of natural circulation will be effective in removing decay heat. The additional experimental data would be useful to an understanding of detailed realistic system response to transients and accidents including small break LOCAs. For example, an understanding of the hydraulic stability of the system during the transition from two-phase bubbly-flow natural circulation to boiler-condenser natural circulation may be useful to an operator in diagnosing the transient. However, uncertainties associated with this transition do not affect the Staff's conclusion that a condensing surface will be exposed in the steam generators and that boiler-condenser natural circulation would be established. Jensen Affidavit #2 at 4.

Finally, as the Staff argued in its October 25, 1982 response to the Appeal Board's Order of October 15, 1982 in this proceeding, the Semiscale test results reported in BN-82-93 and BN-82-107 do not call into question the efficacy of feed and bleed cooling. Although reliance on feed and bleed is not required in the Staff's view, feed and bleed is available as a back-up method of core heat removal. See generally Affidavit of Brian W. Sheron (enclosed).

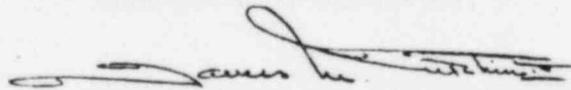
In sum, there is no basis for reopening the record. A safety-grade capability to manually control EFW exists at TMI-1 and the EFW system is

fully safety-grade for all conditions having a nexus to the TMI-2 accident and thus within the scope of this special proceeding. The boiler-condenser mode of natural circulation has been demonstrated to be an effective method of cooling the core. Feed and bleed is an effective back-up means of decay heat removal, and the adequacy of feed and bleed cooling has not been called into question by the recent Semiscale test results.

III. CONCLUSION

The proposed requirements suggested by the Appeal Board's initial review of the record -- the assignment of an operator to activate flow control valves manually as necessary and the installation of high point hot leg vents in the steam generators for steam removal -- would not significantly enhance the efficacy of natural circulation as a core heat removal method. The record need not and should not be reopened, however, because it is adequate to support findings that the EFW system is reliable for events having a nexus to the TMI-2 accident and thus within the scope of this special proceeding, and that the boiler-condenser mode of natural circulation is viable. Moreover, feed and bleed cooling capability, even though not necessary, exists and has not been called into question by recent Semiscale test results.

Respectfully submitted,



James M. Cutchin IV
Counsel for NRC Staff

Dated at Bethesda, Maryland
this 22nd day of November, 1982.

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METROPOLITAN EDISON COMPANY, ET AL

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AFFIDAVIT OF WALTON L. JENSEN, JR. CONCERNING
THE APPEAL MEMORANDUM AND ORDER OF NOVEMBER 5, 1982

1. I, Walton L. Jensen, Jr., being duly sworn, state as follows: I am a Senior Nuclear Engineer in the Reactor Systems Branch, Division of Systems Integration, Office of Nuclear Reactor Regulation. A copy of my professional qualifications is attached.
2. In its Memorandum and Order of November 5, 1982 the Appeal Board stated its tentative views that neither the boiler-condenser mode of natural circulation nor feed and bleed have been demonstrated on the record as viable means of removing decay heat at TMI-1. The Appeal Board also stated the tentative opinion that the assignment of a dedicated operator to control the emergency feedwater system together with the installation of the high point vents in the hot legs would ensure core cooling by natural circulation during the interim before the emergency feedwater system is modified to full safety-grade status at the next refueling outage.

The Appeal Board requested that the parties provide comments on the above proposals. The purpose of this affidavit is to provide comments in two areas. (1) the adequacy of the record in demonstrating that boiler