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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

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1. INTRODUCTION

1.1 PURPOSE OF REVIEW

This technical evaluation report (TER) documents an independent review of the outages of the emergency core cooling (ECC) systems at Wisconsin Electric Power Company's (WEPC) Point Beach Nuclear Plant Units 1 and 2. The purpose of this evaluation is to determine if the Licensee has submitted a report that is complete and satisfies the requirements of TMI Action Item II.K.3.17, "Report on Outages of Emergency Core-Cooling Systems Licensee Report and Proposed Technical Specification Changes."

1.2 GENERIC BACKGROUND

Following the Three Mile Island Unit 2 accident, the Bulletins and Orders Task Force reviewed nuclear steam supply system (NSSS) vendors' small break loss-of-coolant accident (LOCA) analyses to ensure that an adequate basis existed for developing guidelines for small break LOCA emergency procedures. During these reviews, a concern developed about the assumption of the worst single failure. Typically, the small break LOCA analysis for boiling water reactors (BWRs) assumed a loss of the high pressure coolant injection (HPCI) system as the worst single failure. However, the technical specifications permitted plant operation for substantial periods with the HPCI system out of service with no limit on the accumulated outage time. There is concern not only about the HPCI system, but also about all ECC systems where substantial outages might occur within the limits of the present technical specification. Therefore, ensure that the small break LOCA analyses are consistent with the actual plant response, the Bulletin and Orders Task Force recommended in NUREG-0626 [1], "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in GE-Designed Operating Plants and Near-Term Operating License Applications," that licensees of General Electric (GE)-designed NSSSs do the following:

> "Submit a report detailing outage dates and lengths of the outages for all ECC systems. The report should also include the cause of the outage (e.g., controller failure or spurious isolation). The outage data for

> ECC components should include all outages for the last five years of operation. The end result should be the quantification of historical unreliability due to test and maintenance outages. This will establish if a need exists for cumulative outage requirements in technical specifications."

Later the recommendation was incorporated into NUREG-0660 [2], "NRC Action Plan Developed as a Result of the TMI-2 Accident," for GE-designed NSSSs as TMI Action Item II.K.3.17. In NUREG-0737 [3], "Clarification of TMI Action Plan Requirements," the NRC staff expanded the Action Item to include all light water reactor plants and added a requirement that licensees propose changes that will improve and control availability of ECC systems and components. In addition, the contents of the reports to be submitted by the licensees were further clarified as follows:

> "The report should contain (1) outage dates and duration of outages; (2) cause of the outage; (3) ECC systems or components involved in the outage; and (4) corrective action taken."

1.3 PLANT-SPECIFIC BACKGROUND

On March 31, 1981 [4], WEPC submitted a report in response to NUREG-0737, Item II.K.3.17, "Report on Outages of Emergency Core-Cooling Systems Licensee Report and Proposed Technical Specification Changes." The report submitted by WEPC covered the period from January 1, 1976 to December 31, 1980 for Point Beach Units 1 and 2. WEPC did not provide any recommendations to improve and control availability of ECC systems.

2. REVIEW CRITERIA

The Licensee's response to NUREG-0737, Item II.K.3.17, was evaluated against criteria provided by the NRC in a letter dated July 21, 1981 [5] outlining Tentative Work Assignment F. Provided as review criteria in Reference 5, the NRC stated that the Licensee's response should contain the following information:

1. A report detailing outage dates, causes of outages, and lengths of outages for all ECC systems for the last 5 years of operation. This report was to include the ECC systems or components involved and corrective actions taken. Test and maintenance outages were to be included.

2. A quantification of the historical unavailability of the ECC systems and components due to test and maintenance outages.

3. Proposed changes to improve the availability of ECC systems, if necessary.

The type of information required to satisfy the review criteria was clarified by the NRC on August 12, 1981 [6]. Auxiliary systems such as component cooling water and plant service water systems were not to be considered in determining the unavailability of ECC systems. Only the outages of the diesel generators were to be included along with the primary ECC system outages. Finally, the "last five years of operation" was to be loosely interpreted as a continuous 5-year period of recent operation.

On July 26, 1982 [7], the NRC further clarified that the purpose of the review was to identify those licensees that have experienced higher ECC system outages than other licensees with similar NSSSs. The need for improved reliability of diesel generators is under review by the NRC. A Diesel Generator Interim Reliability Program has been proposed to effect improved performance at operating plants. As a consequence, a comparison of diesel generator outage information within this review is not required.

3. TECHNICAL EVALUATION

3.1 REVIEW OF COMPLETENESS OF THE LICENSEE'S REPORT

The ECC systems at WEPC's Point Beach Nuclear Plant Units 1 and 2 consist of the following five separate systems:

- o accumulators
- o safety injection system (SIS)
- o residual heat removal system (RHR)
- o boric acid storage tanks (BST)
- o refueling water storage tanks (RWST).

In Reference 4, WEPC also included the containment spray system, auxiliary coolant system, and service water system. The containment spray system is a containment heat removal system as well as a fission product cleanup system. The auxiliary coolant system is an intermediate closed-loop cooling system that removes heat from the RHR system. The service water system removes heat from the auxiliary cooling system. Because the containment spray system is not an emergency core cooling system, its outages are not considered in this review. Similarly, the auxiliary coolant and service water systems are essential support systems for long-term cooling; however, none of those systems is considered a primary EEC system for this review.

For each ECC system outage, WEPC provided the date, the duration, a brief description, and the cause, with sufficient details to indicate the corrective action taken. Information on routine preventive maintenance and surveillance testing was also included.

WEPC's review encompassed the period from January 1, 1976 to December 31, 1980 for Point Beach Units 1 and 2.

Based on the preceding discussion, it has been established that WEPC has submitted a report which fulfills the requirements of review criterion 1 without exception.

3.2 COMPARISON OF ECC SYSTEM OUTAGES WITH THOSE OF OTHER PLANTS

The outages of ECC systems can be categorized as (1) unplanned outages due to equipment failure or (2) planned outages due to surveillance testing or

preventive maintenance. Unplanned outages are reportable as Licensee Event Reports (LERs) under the technical specifications. Planned outages for periodic maintenance and testing are not reportable as LERs. The technical specifications identify the type and quantity of ECC equipment required as well as the maximum allowable outage times. If an outage exceeds the maximum allowable time, then the plant operating mode is altered to a lower status consistent with the available ECC system components still operational. The purpose of the technical specification maximum allowable outage times is to prevent extended plant operation without sufficient ECC system protection. The maximum allowable outage time, specified per event, tends to limit the unavailability of an ECC system. However, there is no cumulative outage time limitation to prevent repeated planned and unplanned outages from accumulating extensive ECC system downtime.

Unavailability, as defined in general terms in WASH-1400 [8], is the probability of a system being in a failed state when required. However, for this review, a detailed unavailability analysis was not required. Instead, a preliminary estimate of the unavailability of an ECC system was made by calculating the ratio of the ECC system downtime to the number of days that the plant was in operation during the last 5 years. To simplify the tabulation of operating time, only the period when the plant was in operational Mode 1 was considered. This simplifying assumption is reasonable given that the period of time that a plant is starting up, shutting down, and cooling down is small compared to the time it is operating at power. In addition, an ECC system was considered down whenever an ECC system component was unavailable due to any cause.

It should be noted that the ratio calculated in this manner is not a true measure of the ECC system unavailability, since outage events are included that appear to compromise system performance when, in fact, partial or full function of the system would be expected. Full function of an ECC system would be expected if the design capability of the system exceeded the capacity required for the system to fulfill its safety function. For example, if an ECC system consisting of two loops with multiple pumps in each loop is designed so that only one pump in each loop is required to satisfy core

cooling requirements, then an outage of a single pump would not prevent the system from performing its safety function. In addition, the actual ECC system unavailability is a function of planned and unplanned outages of essential support systems as well as planned and unplanned outages of primary ECC system components. In accordance with the clarification discussed in Section 2, only the effects of outages associated with primary ECC system components and emergency diesel generators are considered in this review. The inclusion of all outage events assumed to be true ECC system outages tends to overestimate the unavailability, while the exclusion of support system outages tends to underestimate the unavailability of ECC systems and components. Only a detailed analysis of each ECC system for each plant could improve the confidence in the calculated result. Such an analysis is beyond the intended scope of this report.

The planned and unplanned (forced) outage times for the ECC systems (accumulators, SIS, RHR, BST, and RWST), were identified from the outage information in Reference 4 and are shown in number of days and as percentage of plant operating time per year in Tables 1 and 2 for Point Beach Units 1 and 2, respectively. Outages that occurred during non-operational periods were eliminated as well as those caused by failures or test and maintenance of support systems. Data on plant operating conditions were obtained from the annual reports, "Nuclear Power Plant Operating Experience" [9-12], and from monthly reports, "Licensed Operating Reactors Status Summary Reports" [13]. The remaining outages were segregated into planned and unplanned outages on the basis of WEPC's description of the cause. The outage periods for each category were calculated by summing the individual outage durations.

Observed outage times of various ECCS systems at Point Beach Units 1 and 2 were compared with those of other PWRs. Based on this comparison, it was concluded that the historical unavailability of the accumulators, BST, and RWST for both units has been consistent with the performance of those systems throughout the industry and consistent with existing technical specifications. The observed unavailability was less than the industrial mean for the accumulators, RST, and RWST for both units. The SIS and RHR systems, however, require further investigation since their observed unavailability is significantly higher than

Table 1. Planned and Unplanned (Forced) Outage Times for Point Beach Unit 1*

Year	Days of Plant Operation	Accumulator Outage in Days		SIS Outage in Days		RHR Outage in Days		BIT Outage in Days		RWST Outage in Days	
		Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned
1976	301.7	0.0	0.0	0.6 (0.2%)	1.4 (0.5%)	0.2 (0.1%)	0.2 (0.1%)	0.0	0.0	0.2 (0.1%)	1.2 (0.4%)
1977	322.3	0.0	0.0	0.0	0.3 (0.1%)	0.4 (0.1%)	1.5 (0.5%)	0.0	0.0	0.2 (0.1%)	0.0
1978	327.9	0.0	0.0	0.0	6.9 (2.1%)	0.0	7.5 (2.3%)	0.0	0.0	0.3 (0.1%)	0.0
1979	269.1	0.0	0.0	0.0	5.8 (2.2%)	0.2 (0.1%)	5.7 (2.1%)	0.0	0.0	0.2 (0.1%)	0.3 (0.1%)
1980	288.3	0.0	0.0	0.0	6.1 (2.1%)	0.6 (0.2%)	6.0 (2.1%)	0.0	0.0	0.4 (0.1%)	0.0
Total	1509.3	0.0	0.0	0.6 (<0.1%)	20.5 (1.4%)	1.4 (0.1%)	20.9 (1.4%)	0.0	0.0	1.3 (0.1%)	1.5 (0.1%)

*Numbers in parentheses indicate system outage time as a percentage of total plant operating time.

Table 2. Planned and Unplanned (Forced) Outage Times for Point Beach Unit 2*

Year	Days of Plant Operation	Accumulators Outage in Days		SIS Outage in Days		RHR Outage in Days		BIT Outage in Days		RWST Outage in Days	
		Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned
1976	331.8	0.0	0.0	1.0 (0.3%)	1.7 (0.5%)	0.0	0.2 (0.1%)	0.0	0.0	0.0	0.0
1977	312.5	0.0	0.0	0.0	0.3 (0.1%)	0.2 (0.1%)	0.6 (0.2%)	0.0	0.0	0.4 (0.1%)	0.0
1978	335.0	0.0	0.0	0.0	6.5 (1.9%)	0.0	7.1 (2.1%)	0.0	0.0	0.0	0.0
1979	322.2	0.0	0.0	0.6 (0.2%)	6.7% (2.1%)	0.2 (0.1%)	7.5 (2.3%)	0.0	0.0	0.0	0.0
1980	318.9	0.0	0.0	1.4 (0.4%)	6.1 (1.9%)	0.2 (0.1%)	7.6 (2.4%)	0.0	0.0	0.0	0.0
Total	1620.4	0.0	0.0	3.0 (0.2%)	21.3 (1.3%)	0.6 (<0.1%)	23.0 (1.4%)	0.0	0.0	0.4 (<0.1%)	0.0

*Numbers in parentheses indicate system outage time as a percentage of total plant operating time.

that observed in other plants and has exceeded the industrial mean by greater than about one standard deviation, assuming that the underlying unavailability is distributed lognormally.

A detailed review of the SIS and RHR system outages was performed in order to ascertain the contributing factors to the high system unavailability. For both the SIS and RHR systems at both units, the high unavailability was solely due to surveillance testing. The monthly testing of the safety injection system contributes a minimum of 125 hours (1.4%) annually to system unavailability. The monthly testing of the RHR system also contributes a minimum of 125 hours (1.4%) annually to the system unavailability. The monthly tests are required by the plant technical specifications.

3.3 REVIEW OF PROPOSED CHANGES TO IMPROVE THE AVAILABILITY OF ECC EQUIPMENT

In Reference 4, WEPC did not propose any changes to improve the availability of ECC systems and components.

4. CONCLUSIONS

Wisconsin Electric Power Company (WEPC) has submitted a report for Point Beach Nuclear Plant Units 1 and 2 that contains (1) outage dates and durations (2) causes of the outages, (3) ECC systems or components involved in the outages, and (4) corrective actions taken. It is concluded that WEPC has fulfilled the requirements of NUREG-0737, Item II.K.3.17. In addition, the historical unavailability of the accumulators, BST, RWST, SIS and RHR system at both units has been consistent with the performance of those systems throughout the industry and consistent with existing technical specifications. The observed unavailability was less than the industrial mean for the accumulators, BST, and RWST. However, the observed unavailability of the SIS and RHR system was significantly higher than the industrial mean. The high unavailability was directly attributed to surveillance testing required by the plant's technical specifications.

5. REFERENCES

1. NUREG-0626
   "Generic Evaluation of Feedwater Transients and Small Break Loss-of-Coolant Accidents in GE-Designed Operating Plants and Near-Term Operating License Applications"
   NRC, January 1980

2. NUREG-0660
   "NRC Action Plan Developed as a Result of the TMI-2 Accident"
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3. NUREG-0737
   "Clarification of TMI Action Plan Requirements"
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