TECHNICAL EVALUATION REPORT

ECCS REPORTS (F-47)

TMI ACTION PLAN REQUIREMENTS

INDIANA AND MICHIGAN ELECTRIC COMPANY
COOK NUCLEAR PLANT UNITS 1 AND 2

NRC DOCKET NO. 50-315, 50-316

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Prepared by

Franklin Research Center
20th and Race Streets
Philadelphia, PA 19103

Author: G. J. Overbeck
F. W. Vosbury
B. W. Ludington

FRC Group Leader: G. J. Overbeck

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: E. Chow

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Prepared by:	Reviewed by:	Approved by:
Principal Author	Group Leader	Department Director
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Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

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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.

Mr. G. J. Overbeck, Mr. F. W. Vosbury, and Mr. B. W. Ludington contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

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 Indiana and Michigan Electric Company's (IMEC) D. C. Cook 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 for which substantial outages might occur within the limits of the present technical specification. Therefore, to 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 all GE-designed plants 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 PWRs 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 January 8, 1981 [4], IMEC 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 IMEC covered the period from January 18, 1975 to April 30, 1980 for Cook Unit 1, and from March 10, 1978 to April 30, 1980 for Unit 2. IMEC stated the belief that current Technical Specifications were sufficiently restrictive to control the unavailability of ECC systems and therefore would propose no further restrictions.

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 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 IMEC's Cook Nuclear Plant Units 1 and 2 consist of the following five separate systems:

- o accumulators
- o centrifugal charging (CC)
- o safety injection system (SIS)
- o residual heat removal (RHR)
- o refueling water storage tank (RWST).

In Reference 4, IMEC also included the containment spray system. The purpose of containment spray is to spray water through the containment atmosphere following a LOCA to reduce temperature, reduce pressure, and remove fission products. While this is an engineered safety features system (ESFS), it is not considered a primary ECC system for this review.

For each ECC system outage event, IMEC provided the outage dates, the duration, and the cause, plus sufficient description to discern the corrective action taken. Maintenance and surveillance testing activities were included in the ECC system outage data, unless these activities were performed during a shutdown condition in which the affected ECC system was not required to be operational. The results of IMEC's review were provided for the period from January 18, 1975 to April 30, 1980 for Cook Unit 1 and from March 10, 1978 to April 30, 1980 for Cook Unit 2.

Based on the preceding discussion, it has been established that IMEC 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 of 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 five ECC systems (accumulators, CC, SIS, RHR, and RWST) and the standby diesel generators 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 Cook Nuclear Plant Units 1 and 2, respectively. Additional information obtained from the Licensee concerning outages of water sources is also included in the tables [9]. Outages that occurred during nonoperational periods were eliminated as were 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" [10-13], and from monthly reports, "Licensed Operating Reactors Status Summary Reports" [14]. The remaining outages were segregated into planned and unplanned outages based on IMEC's description of the causes. The outage periods for each category were calculated by summing the individual outage durations.

Observed outage times of various ECC systems at Cook Nuclear Plant 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, CC, SIS, RHR, and RWST systems has been consistent with the performance of those systems throughout the industry. The observed availability was less than the

Table 1. Planned and Unplanned (Forced) Outage Times for D. C. Cook Unit 1

Year	Days of Plant Operation	Accumulators Outage in Days		CVCS Outage in Days		SIS Outage in Days		RHR Outage in Days		Diesel Generators Outage in Days	
		Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned
1976	304.3	0.0	0.0	0.2 (0.1%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1977	277.6	0.0	0.0	6.5 (2.3%)	0.0	0.0	0.0	0.0	1.5 (0.5%)	0.8 (0.3%)	1.5 (0.5%)
1978	268.4	0.0	0.0	0.3 (0.1%)	0.3 (0.1%)	0.0	0.3 (0.1%)	0.5 (0.2%)	0.0	0.5 (0.2%)	0.9 (0.3%)
1979	236.2	0.0	0.0	1.5 (0.6%)	0.7 (0.3%)	0.0	0.5 (0.2%)	1.5 (0.6%)	0.3 (0.1%)	1.1 (0.5%)	4.8 (2.0%)
1980	103.7	0.0	0.0	1.3 (1.3%)	0.5 (0.5%)	0.0	0.2 (0.2%)	0.0	0.1 (0.1%)	0.1 (0.1%)	1.3 (1.3%)
Total	1190.2	0.0	0.0	9.8 (0.8%)	1.5 (0.1%)	0.0	1.0 (0.1%)	2.0 (0.2%)	1.9 (0.2%)	2.5 (0.2%)	8.5 (0.7%)

Table 2. Planned and Unplanned (Forced) Outage Times for D. C. Cook Unit 2

Year	Days of Plant Operation	Accumulators Outage in Days		CVCS Outage in Days		SIS Outage in Days		RHR Outage in Days		Diesel Generators Outage in Days	
		Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned	Forced	Planned
Commercial operation July 1, 1978											
1978	142.5	0.0	0.0	0.3 (<0.1%)	0.0	0.0	0.0 (0.4%)	0.5	0.0 (0.6%)	0.9 (3.4%)	4.8
1979	240.6	0.0	0.0	0.0	0.6 (0.3%)	0.0	0.0	0.0	1.8 (0.8%)	1.5 (0.6%)	1.2 (0.5%)
1980	101.6	0.1 (<0.1%)	0.0	3.0 (3.0%)	1.0 (1.0%)	0.7 (0.7%)	0.0	0.5	1.6 (0.5%)	0.0 (1.6%)	0.0
Total	484.7	0.1 (<0.1%)	0.0	3.0 (0.6%)	1.6 (0.3%)	0.7 (0.1%)	0.0	1.0 (0.2%)	3.4 (0.7%)	2.4 (0.5%)	6.0 (1.2%)

industrial mean for all ECC systems except the Unit 2 CC system, which was less than about one standard deviation above the industrial mean, assuming that the underlying unavailability is distributed lognormally. The outage times were also consistent with existing technical specifications. The outages of the standby diesel generators were not included in this comparison.

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

In Reference 4, IMEC did not propose any changes to improve the availability of ECC systems and components, stating that current Technical Specifications were sufficient to control ECC system unavailability.

4. CONCLUSIONS

Indiana and Michigan Electric Company (IMEC) has submitted a report for Cook 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 IMEC has fulfilled the requirements of NUREG-0737, Item II.K.3.17. In addition, the historical unavailability of the accumulators, centrifugal charging, safety injection, residual heat removal, and refueling water storage tank systems has been consistent with the performance of those systems throughout the industry. The observed unavailability was less than the industrial mean for all ECC systems except the Unit 2 centrifugal charging which was less than about one standard deviation above the industrial mean. The outage times were also consistent with existing 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

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