TECHNICAL EVALUATION REPORT

ECCS REPORTS (F-47)

TMI ACTION PLAN REQUIREMENTS

GEORGIA POWER COMPANY
EDWIN I. HATCH NUCLEAR PLANT UNITS 1 AND 2

NRC DOCKET NO. 50-321, 50-366

NRC CONTRACT NO. NRC-03-81-130

FRC PROJECT C5506

FRC ASSIGNMENT 7

FRC TASKS 191, 192

Prepared by

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

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

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

FRC Group Leader: G. J. Overbeck

Lead NRC Engineer: E. Chow

February 8, 1983

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A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

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Prepared by:	Reviewed by:	Approved by:
Principal Author	Group Leader	Department Director (Acting)
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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 Georgia Power Company's (GPC) Edwin I. Hatch 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, to assure 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 December 31, 1980 [4], GPC submitted the final draft of 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 GPC covered the period from December 1, 1975 to December 1, 1980 for Edwin I. Hatch Nuclear Plant Unit 1, and from July 1, 1978 to December 1, 1980 for Edwin I. Hatch Nuclear Plant Unit 2. GPC indicated that the report was under review to determine whether any possible modifications would improve the availability of ECC system components. In addition, GPC indicated that completion of the review and the submittal of a final report was expected by January 12, 1981. GPC stated that "the recommendations which result from that review, if any, will be submitted for NRC information as soon as they are available."

On January 16, 1981 [5], GPC resubmitted the final report for review without revision or any recommendations to improve the availability of ECC system components.

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 [6] outlining Tentative Work Assignment F. Provided as review criteria in Reference 6, 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 [7]. 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 [8], 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 GPC's Edwin I. Hatch Nuclear Plant Units 1 and 2 consist of the following four separate systems:

- o high pressure coolant injection (HPCI) system
- o automatic depressurization system (ADS)
- o core spray (CS) system
- o low pressure coolant injection (LPCI) mode of the residual heat removal (RHR) system.

In Reference 5, GPC also included systems and components that support the ECC systems in carrying out their design functions under various accident conditions. The support systems are:

- o containment cooling mode of the RHR system
- o RHR service water system
- o plant service water system
- o standby diesel generators
- o equipment area coolers for HPCI and RHR pumps.

The purpose of the containment cooling mode of the RHR system is to limit temperature and pressure in the torus and drywell after a LOCA. The RHR service water system provides a reliable supply of cooling water for decay heat removal from the RHR system. The purpose of the plant service water system is to provide a reliable supply of cooling water to systems and equipment required for accident conditions. The equipment area coolers for the HPCI and RHR pumps maintain the environment for the respective electrical components at temperature within their maximum allowable operating limits. However, none of these systems are primary emergency core cooling systems, and hence are not considered in this review.

In establishing the type of events that constitute an ECC system outage, GPC considered an outage to be any event that results in a Limiting Condition of Operation (LCO) as defined by the technical specifications. The ECC system outage data were extracted from the following plant records:

- o records for LCOs cumulative downtime and equipment operating times
- o daily operating reports
- o deviation reports
- o maintenance requests
- o design change requests
- o Licensee Event Reports (LERs)
- o shift foreman and operator log books.

For each ECC system outage event, GPC 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 GPC's review were provided for the period from December 1, 1975 to December 1, 1980 for Unit 1, and from July 1, 1978 to December 1, 1980 for Unit 2. The period for Unit 2 represents the plant operating time since fuel loading.

Based on the preceding discussion, it is concluded that GPC 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 [9], 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 four ECC systems (HPCI, ADS, CS, and LPCI) and the standby diesel generators were identified from the outage information in Reference 5 and are shown in number of days and as percentage of plant operating time per year in Tables 1 and 2 for Hatch Units 1 and 2, respectively. Outages that occurred during nonoperational 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" [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 GPC'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 Hatch Units 1 and 2 were compared with those of other BWRs. Based on this comparison, it was concluded that the historical unavailability of the ADS and LPCI system for both units and of the HPCI system for Unit 1 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 plus about one standard deviation for the above systems, assuming that the underlying unavailability is distributed lognormally. The remaining ECC systems, CS for both units and the HPCI for Unit 2, exhibited unavailabilities significantly higher than those observed in other plants. They exceeded the industrial mean by greater than about one standard deviation, again assuming that the underlying unavailability is distributed lognormally. The outages of the standby diesel generators were not included in this comparison.

A detailed review of the three systems exhibiting higher than normal unavailability was performed in order to ascertain the contributing factors to

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Table 1. Planned and Unplanned (Forced) Outage Times for Hatch Unit 1

Year	Days of Plant Operation	HPCI Outage in Days Forced	HPCI Outage in Days Planned	ADS Outage in Days Forced	ADS Outage in Days Planned	Core Spray Outage in Days Forced	Core Spray Outage in Days Planned	LPCI Outage in Days Forced	LPCI Outage in Days Planned	Diesel Generator Outage in Days Forced	Diesel Generator Outage in Days Planned
1976	304.17	0.53 (0.2%)*	0.0	0.0	0.0	0.51 (0.2%)	0.0	0.77 (0.3%)	0.03 (0.1%)	2.39 (0.8%)	4.30 (1.4%)
1977	242.17	2.71 (1.1%)	0.19 (0.1%)	0.0	0.0	0.65 (0.3%	1.03 0.4%)	2.42 (1.0%)	1.46 (0.6%)	6.84 (2.8%)	13.01 (5.2%)
1978	265.67	3.67 (1.4%)	0.77 (0.3%)	0.0	0.05 (<0.1%)	17.16 (6.5%)	0.0	0.26 (0.1%)	1.59 (0.6%)	7.22 (2.7%)	5.33 (2.0%)
1979	199.37	4.27 (2.1%)	2.26 (1.1%)	0.0	0.0	0.0	0.25 (0.1%)	2.08 (1.1%)	0.64 (0.3%)	5.65 (2.8%)	3.00 (1.5%)
1980	323.35	2.13 (0.7%)	2.88 (0.9%)	0.0	0.0	0.79 (0.2%)	0.18 (0.1%)	2.70 (0.8%)	1.27 (0.4%)	0.84 (0.3%)	7.20 (2.2%)
Total	1334.73	13.31 (1.0%)	6.10 (0.5%)	0.0	0.05 (<0.1%)	19.11 (1.4%)	1.46 (0.1%)	8.23 (0.6%)	4.99 (0.4%)	22.94 (1.7%)	32.84 (2.5%)

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

Table 2. Planned and Unplanned (Forced) Outage Times for Hatch Unit 2

Year	Days of Plant Operation	HPCI Outage in Days Forced	HPCI Outage in Days Planned	ADS Outage in Days Forced	ADS Outage in Days Planned	Core Spray Outage in Days Forced	Core Spray Outage in Days Planned	LPCI Outage in Days Forced	LPCI Outage in Days Planned	Diesel Generator Outage in Days Forced	Diesel Generator Outage in Days Planned
1979	100.58	15.66	1.58	0.0	0.0	0.0	2.90	2.47	0.31	0.61	6.76
		(15.6%)*	(1.6%)	0.0	0.0		(2.9%)	(2.5%)	(0.3%)	(0.6%)	(6.7%)
1980	232.10	6.75	3.11	0.0	0.0	0.0	4.10	0.88	0.97	0.48	5.25
		(2.9%)	(1.3%)	0.0	0.0		(1.8%)	(0.4%)	(0.4%)	(0.2%)	(2.3%)
Total	332.68	22.41	4.69	0.0	0.0	0.0	7.10	3.35	1.28	1.09	12.01
		(6.7%)	(1.4%)	0.0	0.0		(2.1%)	(1.0%)	(0.4%)	(0.3%)	(3.6%)

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

the high unavailability. This review was based on a detailed examination of the Licensee's submittals [4] and [5], LER information from the Nuclear Safety Information Center [15], and telephone contact with the Licensee through the NRC Project Manager [16].

Most of the unavailability of the Unit 2 HPCI system was due to problems with actuators on the motor-operated valves (MOV) and with system instrumentation. These outages can be divided into two categories: isolated failures and a series of apparently related motor burnup failures. There were three isolated failures that accounted for 50% of the HPCI unavailability during the reporting period. The first occurred on October 25, 1979, when the HPCI steam line inboard valve failed to isolate. The HPCI steam line outboard isolation valve was closed and secured rendering the HPCI system unavailable. Nine days later, on November 3, 1979, the reactor was shut down for 48 hours to effect repairs. It was determined that the failure to close was due to an overly conservative setting on the motor torque limit switch. The torque setting was increased and the valve then operated properly.

The second isolated failure occurred on January 30, 1980, when minimum flow valve F012 failed to close during a HPCI pump operability test. F012 ensures that a minimum flow is allowed from the HPCI pump to avoid damaging the pump. The failure to close was due to sticking switch contacts on flow switch N006. The contacts were cleaned and the pump test was successfully completed.

The third isolated failure occurred on June 26, 1980, when a low suction pressure indication for the HPCI pump was obtained. The cause was suction pressure transmitter N019 having drifted out of tolerance. The transmitter was recalibrated and the HPCI system returned to service.

The investigation of the motor burnup failures revealed nine related incidents listed in Table 3, though only two of these outages contributed significantly to HPCI system unavailability. The other seven either occurred during non-mode 1 operation, prior to commercial startup on September 5, 1979, or were very short. Several different causes of failure are listed, but the overall impression was a combination of environment and operating conditions

Table 3. MOV Motor Failure, Unit 2 HPCI

Date	Valve	Power Level	Duration (hr)	Reference [15]	Description
10/22/78*	F001	9%	21.5	N/A	Motor shunt field insulation failure probably due to excessive duty cycle.
06/09/79*	F041	1%	N/A	LER 79-050	Motor failed due to loose shunt field circuit which caused overheating.
07/07/79*	F001	12%	N/A	LER 79-067	Motor failed, apparent cause excessive duty cycle.
07/30/79*	F041	99%	7.8	LER 79-086	Pinion key slipped allowing motor to run long beyond 5-minute duty cycle on close signal.
10/15/79	F041	93%	58.8	LER 79-114	Motor windings failed, cause unknown.
05/07/80	F006	76%	0.5	LER 80-079	Steam leak around defect seal allowed water to enter and collect in motor shorting windings.
05/30/80	F041/ F042	99%	59.2	LER 80-089	Motor shorted out due to excessive condensation in HPCI room.
07/11/80	F006	0%	0.0	LER 80-101	Motor winding failure due to exceeding motor duty cycle.
08/09/80	F041	99%	N/A	LER 80-109	Motor failure due to excessive temperature/ humidity in HPCI room. Investigation will continue with followup report.

*Outages prior to commercial operation on September 5, 1976.

that were too harsh for the successful functioning of the motors. The LER description for the last motor failure outage on August 9, 1980 concluded with the statement that the failure investigation would continue and a followup report would be submitted. The Licensee was contacted to determine what conclusion had been reached. GPC stated that an HPCI improvement program had been initiated to deal with these problems. Specific improvements impacting MOV reliability were new motors, better temperature and humidity conditions in the HPCI room, and improved testing procedures. The NRC indicated that they were aware of the problems with MOV reliability and had approved of the modifications implemented by GPC. These modifications were completed in the summer of 1982.

The outages described in the preceding discussion account for approximately 68% of the total unavailability shown in Table 2 for the Unit 2 HPCI system. Reduction of the listed HPCI unavailability by this amount results in an unavailability of approximately 2.6%. This percentage is less than the HPCI industrial mean unavailability plus about one standard deviation, assuming that the underlying unavailability is distributed lognormally.

Most of the unavailability of the Unit 1 core spray system, 83%, was due to four outages of the air circuit breaker on the core spray pump motor C002A during a 2-month period in latter 1978. The Licensee was contacted for additional information concerning these outages as there was no clear indication of the cause or repair in either the ECCS report [4, 5] or the LER descriptions [15]. In a telephone conversation [16], GPC stated that the problem had been with the core spray motor itself. The motor was rebuilt, which finally resolved the problem; however, no specific cause was ever identified. No further problems of this type have recurred with the core spray motor.

Elimination of these four outages from the total core spray unavailability listed in Table 1 reduces the unavailability to approximately 0.3%. This percentage is less than the HPCI industrial mean unavailability plus about one standard deviation, assuming the underlying unavailability is distributed lognormally.

Most of the unavailability of the Unit 2 core spray system, 52%, was due to a single planned maintenance outage to perform modifications to the torus. The Licensee was contacted to obtain more information concerning the nature of the modifications and reasons for it. The modification consisted of installation of a torus water cleanup system and required welding of a bypass line into the torus. The purpose of the cleanup system is to remove contamination from the torus water to allow other NRC-required modifications to take place in the vicinity of the torus. Removal of the torus modification outage from the total Unit 2 core spray unavailability listed in Table 2 reduces the unavailability to approximately 1.0%. This percentage is less than the core spray industrial mean plus about one standard deviation, assuming the underlying unavailability is distributed lognormally.

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

In Reference 4, GPC indicated that recommendations, if any, to improve the availability of ECC systems and components would be submitted to the NRC. In Reference 5, the final report was submitted without any such recommendations. This review did identify three individual ECC systems at Hatch Units 1 and 2 that exhibited unavailabilities significantly higher than those found in other plants. However, based on the discussion in Section 3.2, these unusual unavailabilities can be attributed to either isolated failures, problems that have since been corrected, or required maintenance modifications. Hence, no modifications to ECC systems or components to improve availability are recommended.

4. CONCLUSIONS

GPC has submitted a report for Edwin I. Hatch Units 1 and 2 which contains (1) outage dates and duration of outages, (2) causes of the outages, (3) ECC systems or components involved in the outages, and (4) corrective action taken. It is concluded that GPC has fulfilled the requirements of NUREG-0737, Item II.K.3.17.

In addition, the historical unavailability for the automatic depressurization system (ADS) and low pressure coolant injection (LPCI) system for both units, and the high pressure coolant injection (HPCI) system for Unit 1, 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 plus about one standard deviation, assuming the underlying unavailability is distributed lognormally. The remaining ECC systems, the core spray (CS) system for both units and the HPCI system for Unit 2, exhibited unavailabilities significantly higher than those observed in other plants. However, based on the discussion in Section 3.2, these unavailabilities have been satisfactorily accounted for, and no recommendations to improve ECC system or component availability are warranted.

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