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NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

GEORGIA POWER COMPANY, ET AL.

VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2

DOCKET NOS. 50-424 AND 50-425

1.0 INTRODUCTION

1.1 Alternate Miniflow System Design

By letter dated November 18, 1992, the NRC requested that Georgia Power Company (GPC) meet with the NRC staff to provide information concerning the operability of the Vogtle Electric Generating Plant (Vogtle), Units 1 and 2, high head safety injection (HHSI) system alternate miniflow (AMF) relief/ control valves. The staff's concerns were based on the circumstances of a potential loss of HHSI at the Shearon Harris Nuclear Power Plant (SHNPP), as reported in Licensee Event Report (LER) 50-400/91-008 on May 3, 1991, and supplemented October 13, 1992. The further purpose of this meeting was to discuss similarities of the Vogtle and SHNPP designs to determine if a similar problem could exist at Vogtle. At this meeting, GPC provided information to describe its past operability determinations for Vogtle, and stated that it has determined that the Vogtle Units 1 and 2 AMF systems have always been, and are currently, operable. Further information was provided by GPC to the staff by letters dated February 18 and October 11, 1993.

Several Westinghouse plants, including Vogtle Units 1 and 2, feature charging pumps which, in addition to their charging function during normal plant operation, also serve as part of the emergency core cooling system (ECCS) high pressure injection (HPI) system. The design provides a minimum recirculation flow (miniflow) path to protect the charging pumps from deadheading when trying to inject into the primary system when pressure is higher than the shutoff head of the pumps. For some of these plants, this miniflow function is satisfied by a non-safety grade path through the reactor coolant pump seal cooling system. This path allows sufficient flow during normal plant operation such that the charging pumps will not overheat or be damaged by some other deadheading consequence.

However, during a SBLOCA event, the safety injection signal would cause isolation of the normal miniflow path, and if the reactor coolant system were at a pressure higher than the pump shutoff head, the charging pumps would deadhead. Another concern associated with the miniflow design for some plants was that the normal miniflow line could divert enough flow from the HPI discharge that the remaining injected flow would not satisfy licensing basis accident analysis assumptions.

A number of plants with this design, including both the Shearon Harris Nuclear Power Plant (SHNPP) and Vogtle Units 1 and 2, addressed these concerns by altering the charging/HPI system design to include a safety related alternate miniflow system (AMF) which would be made available whenever the normal miniflow path is isolated (see Figure 1, attached). The AMF design features one path from the discharge piping of each charging/HPI pump back to the refueling water storage tank (RWST), consisting of two series motor operated isolation valves, a spring loaded relief/control valve set slightly below the shutoff pressure of the pump, and associated piping. Functionally, the system was intended to be available when the charging/HPI pumps were called upon to operate in their ECCS mode and to permit adequate flow only when needed to protect the charging/HPI pumps from deadheading. The closure function of the relief/control valve was intended to prevent unnecessary diversion of ECCS water, and to prevent return of contaminated ECCS water to the RWST during the ECCS recirculation mode.

1.2 Shearon Harris Operating Experience

The SHNPP HPI design consists of two charging/SI pumps which perform the charging function during normal plant operation and the HPI function when the ECCS is actuated. A third charging/SI pump is available as a "swing" pump which may be aligned to either of the power trains and either of the AMF paths by manual action. Table 1, attached, and Figure 1 provide design information for the SHNPP HPI and AMF systems.

Tests conducted at SHNPP during a March 1991 refueling outage discovered significant damage to both AMF paths. The damaged equipment and estimated associated diverted flow rates are: 1) first path - failed relief/control valve actuation components, setpoint drift to 1100 psi and flow of 275 gpm, 2) other path - relief/control valve seat leakage, 50 gpm; broken drain line, 500 gpm. An NRC special team inspection report (50-400/92-201, dated August 27, 1992) attributed the damage to waterhammer in the AMF system, and to a design deficiency consisting of excessive piping length (up to 60 ft.) associated with oversized relief/control capacity (275 gpm). A study by the NRC Office of Analysis and Evaluation of Operational Data (AEOD) identified the design as suspect, and associated a conditional probability of core damage of 6.3×10^{-3} with the as-found AMF system.

The licensee for SHNPP modified the AMF at SHNPP to eliminate the relief/control valve. The modified system was reviewed and approved by the NRC. The licensee provided its own probabilistic assessment of the impact of the as-found degraded HPI (including updated input parameters and taking credit for alternate mitigation processes) which identified an estimated conditional probability of core damage of 1.28×10^{-5}. Prior to modifying the AMF, the licensee tested the AMF an additional time with a water-filled system and found damage. The licensee concluded that the damage originally attributed to waterhammer may have been due to other hydraulic forces as well.

2.0 EVALUATION

2.1 VOGTLE HPI/AMF OPERABILITY DETERMINATION

Similar to SHNPP, the Vogtle charging pumps serve two functions which include charging during normal operation and HPI during the ECCS mode. The Vogtle HPI system also includes two intermediate head pumps with a lower shutoff head (about 1535 psid) and higher maximum flow (about 650 gpm) than the charging pumps (two pumps, about 2685 psid shutoff, 550 gpm maximum flow). Important design parameters for these systems are compared in Table 1.

The Vogtle AMF system is similar to the SHNPP AMF in concept and objectives. Table 1 provides important design parameters for the two plants' AMF systems. In a letter dated February 18, 1993, Georgia Power Company, et al. (the licensee), identified differences between the Vogtle AMF system and the SHNPP AMF system which the licensee used to show that Vogtle is not vulnerable to the AMF damage experienced at SHNPP. The licensee identified oversized relief/control valve and excessive AMF flow as causes of the damage at SHNPP. These diagnoses agree with NRC inspection findings for SHNPP. The licensee presented information about the Vogtle AMF showing that its relief/control valve has a much lower capacity (rated at 96 gpm) than that for the damaged SHNPP system. The licensee stated that this lower flow was not excessive and that the resulting hydraulic loads would not cause significant valve damage or piping damage. According to calculations done by the licensee, significant valve chatter is not expected in its lower flow AMF system.

In the letter dated February 18, 1993, the licensee stated that a review of past operating experience indicated that, although there has been valve setpoint drift, it would never have prevented the valve from carrying out its intended safety function. At a meeting on January 7, 1992, attended by representatives of Westinghouse and four other licensees with plants having AMF designs similar to Vogtle's, the Texas Utilities' Comanche Peak plant representative referenced the cumulative AMF experience of the attending owners and a special test of the AMF run at the Comanche Peak Unit 2 plant. With regard to experience, none of the owners of the lower capacity AMF systems has experienced significant AMF damage. Surveillance and maintenance information shows minor relief/control valve damage (e.g., bellows failure which would result in slight valve leakage, but would not impact HPI performance) and setpoint drift which are corrected when found.

The licensee concluded that the Vogtle AMF systems, for both units, are operable. Because this determination is consistent with AMF experience and related NRC diagnoses, the licensee's finding is reasonable and appropriate.

2.2 Analysis of Postulated Failures in the Vogtle AMF System

As discussed above, analytical and empirical information presented by the licensee indicate that the Vogtle AMF is not vulnerable to the damage producing phenomena that were experienced at SHNPP. Since the damage producing phenomena are not present, it is expected that the AMF would normally perform its intended function in a highly reliable manner. However, if it were postulated that the AMF relief/control valves for the charging/HPI pumps fail in the fully open position permitting rated flow to be diverted (96 gpm each), the resulting charging/HPI flow (454 gpm from each pump) would be sufficient to meet SBLOCA analysis assumptions. In addition, if it were postulated that one or both AMF relief/control valves were to fail fully open permitting rated flow (96 gpm each), and/or if it were further postulated that the drain lines in both AMF paths were to completely fail (about 500 gpm each), the resultant HPI injection flow, even with an added single failure, would still exceed that assumed in licensing basis LOCA analyses, because flow from the intermediate head HPI pumps to the reactor would not be diverted.

2.3 Surveillance

The AMF system is part of the safety-related high pressure injection system, and as such must be safety grade, with commensurate surveillance. The safety nature of this system is a position of the NRC and is implicitly accepted by industry by its very provision. Therefore, for the conclusions regarding continued operability determinations made by the licensee for the Vogtle AMF system (and for similar AMF systems at other plants) an acceptable surveillance program for the AMF system must exist. The type and frequency of the required surveillance should satisfy the positions being developed by the Mechanical Engineering Branch, Division of Engineering, NRC, for safety-related control valves.

2.4 Relief/Control Valves Surveillances

By letter to the licensee dated August 26, 1993, the staff identified a concern regarding the appropriate valve surveillances for the Vogtle high head safety injection (HHSI) system AMF relief/control valves. Each train of the AMF lines in the HHSI system contains a spring-actuated valve that is designed to self-actuate when AMF flow is required. The normal practice for valves of this general design would be to categorize them as relief type valves and, as such, to test their set pressure at a nominal 5-year or 10-year testing frequency in accordance with Section XI of the ASME Code. However, the NRC staff has determined that these valves perform safety functions by opening to assure adequate flow in the AMF lines, and by closing to assure integrity of the HHSI system. Moreover, the valve's control functions of (1) opening to prevent the HHSI pumps from deadheading following a safety injection signal, and (2) closing to assure adequate HHSI flow for emergency core cooling, have a significant effect on overall plant safety.

Because these relief/control valves have performed poorly at some plants during various system actuations and tests, the NRC staff has determined that in order to assure these safety functions, testing should be performed more frequently than would be required for relief valves whose function is that of system overpressure protection. Moreover, the NRC staff has determined that, as a minimum, these valves should be tested to ensure operational readiness as follows:

(1) At least one of the valves should be set pressure tested each fuel cycle. Both valves should be tested within two fuel cycles.

(2) If one valve fails a set pressure test, the other valve should be tested.

(3) An immediate assessment of valve operability should be made following any system actuation requiring valve discharge, including a visual inspection and verification of reseating. Both valves should then be set pressure tested, inspected and refurbished as necessary at the next shutdown of sufficient duration to perform these activities.

The licensee responded to the above staff concerns by letter dated October 11, 1993, wherein the licensee committed to perform testing of the Vogtle AMF relief/control valves (PSV-8510A and B) in agreement with items (1), (2), and (3) above, until these valves are permanently removed from service and a pressure control is added to motor-operated valves HV-8508A and B. The licensee further stated that the Unit 2 AMF relief/control valves are being removed during the fall 1993 refueling outage and that the Unit 1 valves are scheduled to be removed during the next Unit 1 refueling outage, presently scheduled to begin September 1994. The interim testing proposed by the licensee will provide reasonable assurance of adequate valve performance until these valves are removed. Therefore, the staff has determined that the licensee's response is sufficient to resolve the staff concerns regarding the testing, inspection, and refurbishment necessary to assure adequate performance of the AMF relief/control valves.

2.5 Vogtle HPI System Design Conclusions

Based on the staff's assessment of the impact of AMF failures on performance of the Vogtle HPI system, as discussed in Section 2.2, and with the implementation of an acceptable AMF system surveillance program as discussed in Section 2.3, the staff concludes that the Vogtle HPI system continues to meet applicable criteria and continues to be acceptable as previously found in the Vogtle Safety Evaluation Report, NUREG-1137.

3.0 CONCLUSIONS

Based on the staff's audit of the Vogtle history of operability determinations, as discussed in Section 2, the staff concludes that the licensee's finding of past and present AMF operability is reasonable and appropriate. Based on the staff's reassessment of the Vogtle HPI design, as further discussed in Section 2, the staff concludes that the HPI system continues to be acceptable.

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TABLE 1

COMPARISON OF HPI AND AMF DESIGN PARAMETERS

VOGTLE VS. SHNPP

	Vogtle	SHNPP
High Pressure Safety Injection		
Charging Pumps		
Number	2	2 (also 1 in reserve)
Shutoff Pressure, psid	2685	about 2600
Maximum Flow, gpm	555	650
SI Pumps		
* Number	2	0
Shutoff Pressure, psid	1535	N/A
Maximum Flow, gpm	660	N/A
Alternate Miniflow		
Number of Lines per Charging Pump	1	1
Line Size, in.	2	2
* AMF Line Length, ft.	15-20 (estimated)	30 - 60
Number of Flow Path Turns	several	several
MOV Isolation Valves per Line	2	2
Relief/Control Valves per Line	1	1
R/C Valve Size, in.	1-1/2 x 2	1-1/2 x 2-1/2
R/C Valve Orifice Area, sq. in.	.129	.222
R/C Valve Bellows	Yes	Yes
R/C Valve Set Pressure, psi	2200	2300
* R/C Valve Stamped Capacity, gpm	96	277
Drain Line Diameter, in.	3/4	3/4
Broken Drain Line Postulated Flow, gpm	500	500

* - most important items for comparison

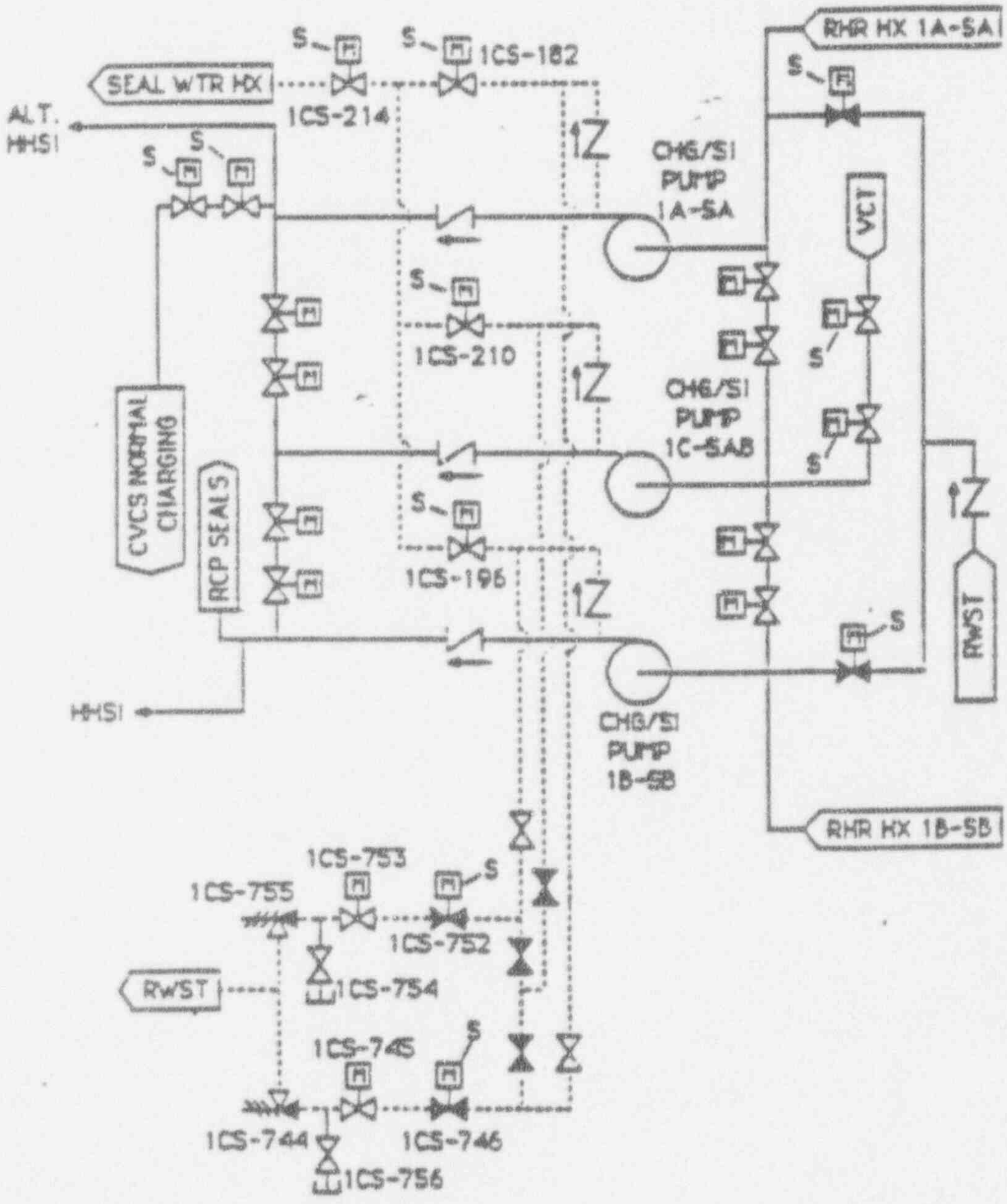

Fig. 1. charging/safety injection system