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**INFORMAL REPORT**

**AUDIT OF THE PUMP AND VALVE OPERABILITY  
ASSURANCE PROGRAM FOR THE SHEARON HARRIS  
NUCLEAR POWER PLANT**

C. Kido  
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*Work performed under  
DOE Contract  
No. DE-AC07-76ID01570*

Prepared for the  
**U.S. NUCLEAR REGULATORY COMMISSION**

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**AUDIT OF THE PUMP AND VALVE OPERABILITY ASSURANCE PROGRAM  
FOR THE SHEARON HARRIS NUCLEAR POWER PLANT**

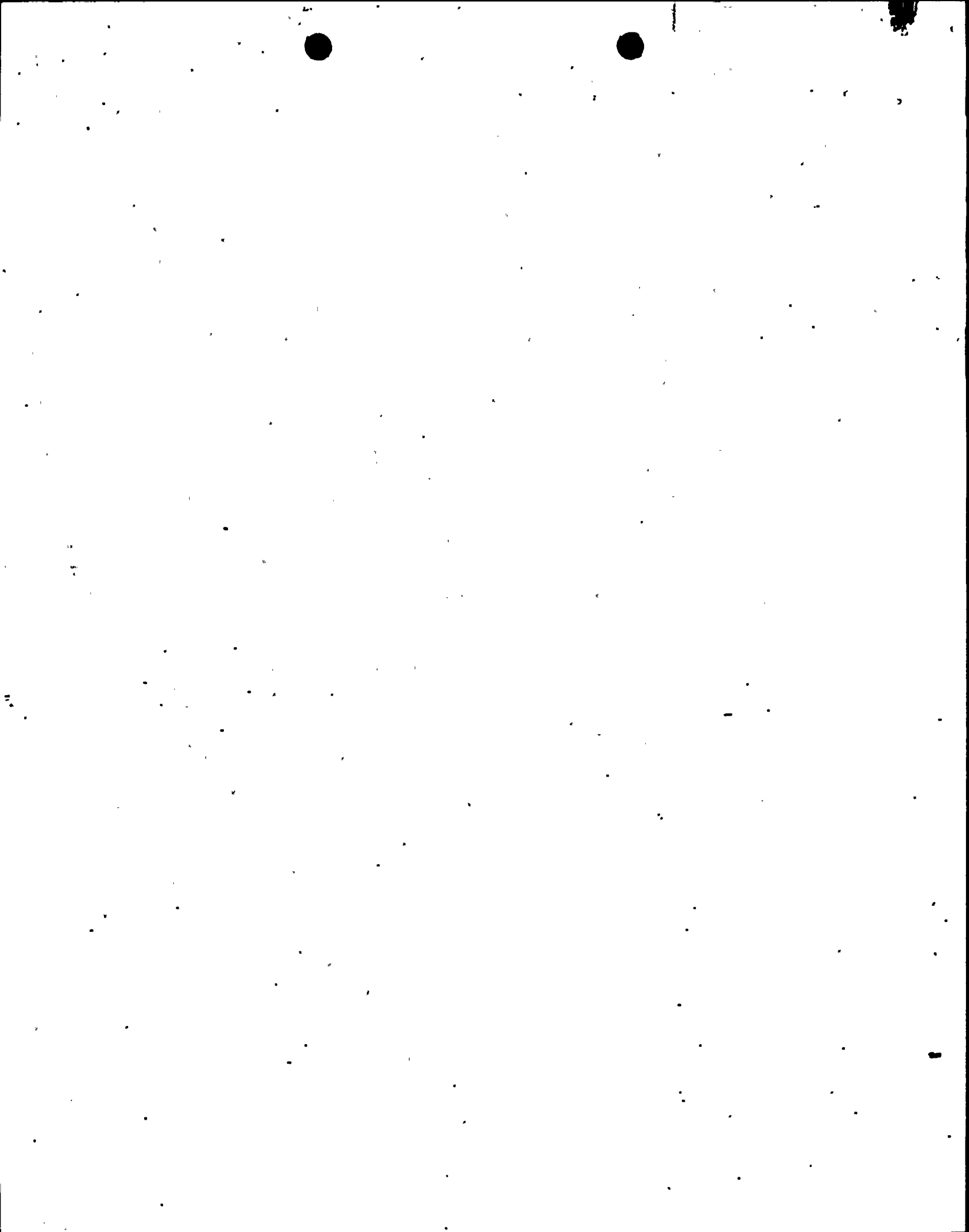
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## ABSTRACT

The Shearon Harris Nuclear Generating Station was audited December 3 to 6, 1985 to determine the adequacy of their Pump and Valve Operability Assurance Program. Four concerns (one specific and three generic), which could not be resolved by the close of the audit, were subsequently resolved by the applicant in his January 27, 1986 submittal. A new generic issue was identified involving the apparent lack of qualification test data for some safety-related equipment. The applicant has committed to address this concern prior to fuel load. The results of this audit indicate that the applicant has established and is implementing a program that will track all pumps and valves important to safety from manufacture and in-shop testing through qualification, installation, testing, maintenance, and surveillance for the purpose of assuring continued operability of these components over the life of the plant.

## FOREWORD

This report is supplied as part of the "Equipment Qualification Case Reviews" project that is being conducted for the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Engineering, Equipment Qualification Branch by the Engineering Analysis Division of EG&G Idaho, Inc.

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## SUMMARY

The Pump and Valve Operability Assurance Review Team (PVORT), comprised of one member of the Nuclear Regulatory Commission (NRC) staff and three EG&G personnel, conducted an on-site audit of the Shearon Harris Pump and Valve Operability Assurance Program during the week of December 3 to 6, 1985. A representative sample of active pumps and valves was selected for review and evaluation. These components are categorized as either Nuclear Steam Supply System (NSSS) or Balance of Plant (BOP), based upon which organization was responsible for the purchase and installation of the component. Westinghouse is Shearon Harris' NSSS vendor while Ebasco, an architectural engineering firm, is responsible for the BOP components.

The process used to evaluate the plant's overall Pump and Valve Operability Assurance Program includes: (a) becoming familiar with each selected component and the system in which it is installed, (b) understanding the component's normal and safety function, (c) visually inspecting the component's configuration and mounting, (d) reviewing those documents relating to the operability of each selected component, (e) ensuring the applicant has an adequate document retrieval system, and (f) reviewing the applicant's preoperational testing and maintenance/surveillance programs.

The results of the evaluation process are two-fold. Any component specific deficiencies or concerns are identified and documented. Of greater importance are any generic concerns, which may be identified, that could affect other components in the plant or possibly even extend to other plants.

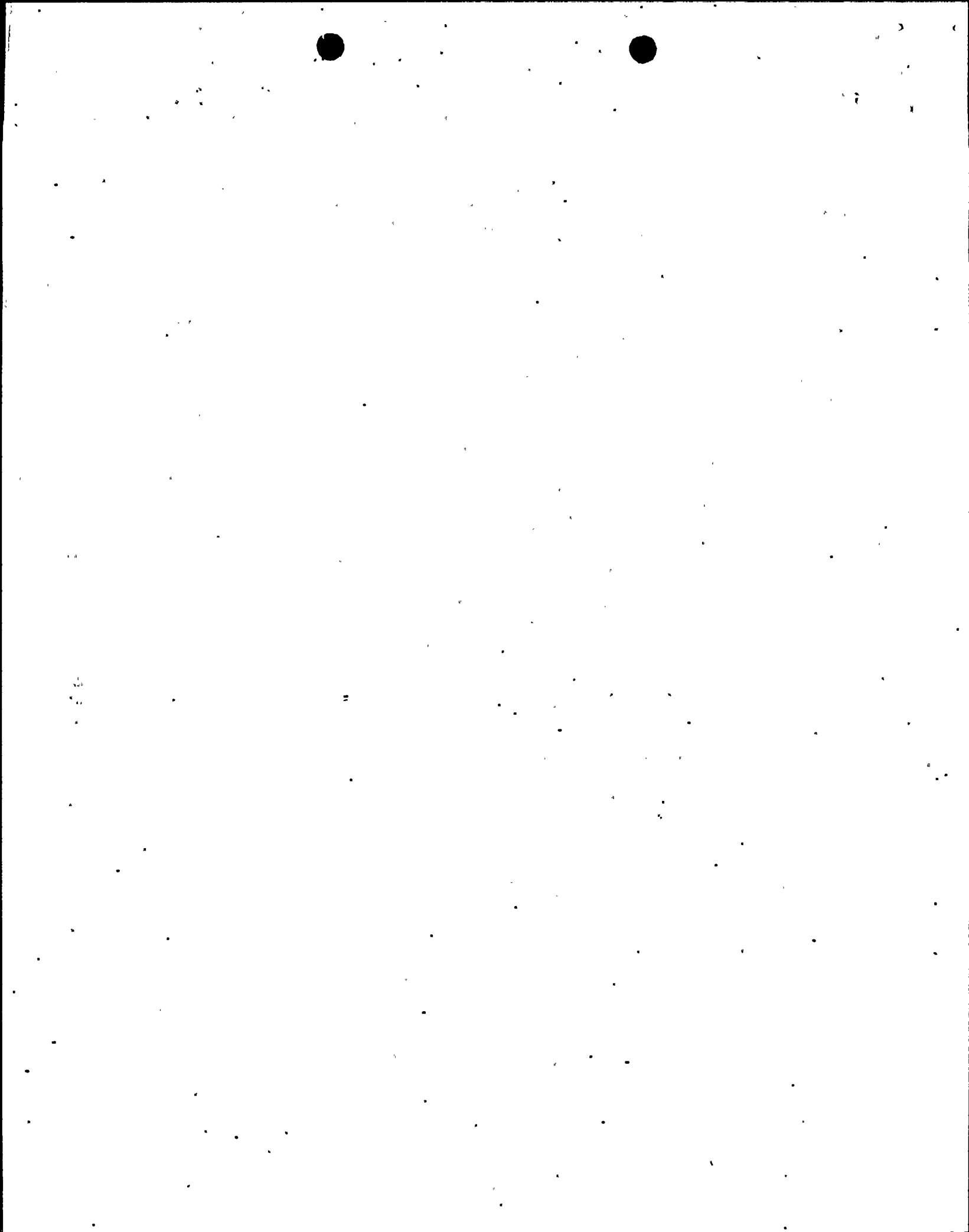
During the PVORT review, a number of component specific concerns were raised. All but one of these specific concerns was satisfactorily resolved during the audit by the applicant supplying additional information or demonstrating that administrative procedures were in place that would





address them. The applicant committed to resolve the one component specific concern prior to fuel load. In addition, the staff also requested that prior to fuel load the applicant confirm that: (a) all active valves are correctly identified in the FSAR, (b) all pre-service tests that are required before fuel load have been completed, and (c) all pumps and valves important to safety are properly qualified and installed. Shortly after the audit the applicant provided additional information and commitments, which satisfactorily resolved the one specific and three generic issues. This submittal was added to the docket file for Shearon Harris on January 27, 1986.

However, a post-audit discussion to clarify applicant's submittal raised a new generic concern. The new issue is that the qualification of some safety-related equipment does not appear to be linked to any test data. In order to resolve this concern, the staff requests that the applicant prior to fuel load (a) identify all safety-related pumps and valves qualified by analysis only, (b) justify the method of qualification, (c) describe how the analyses have been verified to demonstrate equipment operability, and (d) submit evidence showing that the Velan gate valves can be linked to qualification test data.

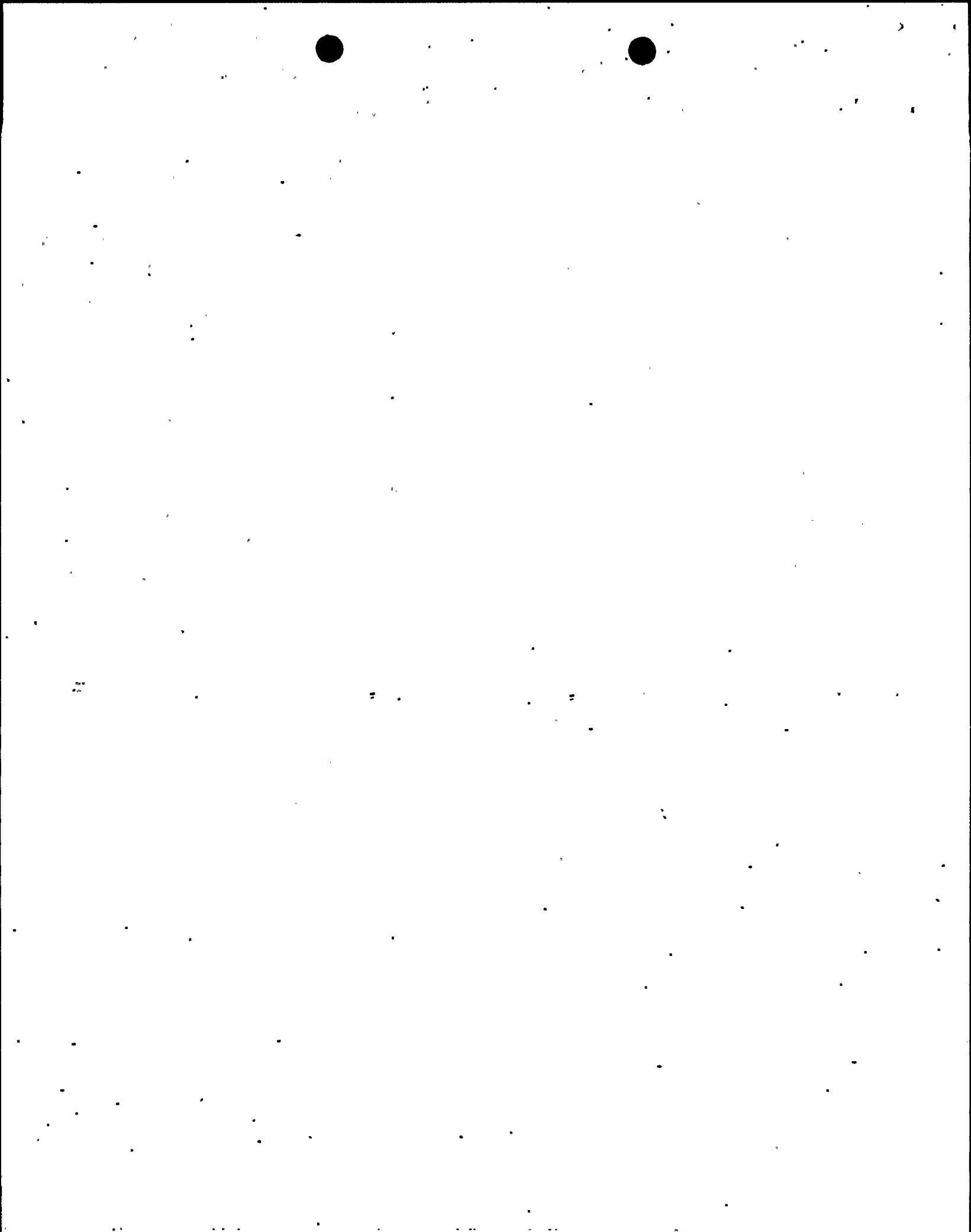


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AUDIT OF THE PUMP AND VALVE OPERABILITY ASSURANCE  
PROGRAM FOR THE SHEARON HARRIS GENERATING STATION

1. INTRODUCTION

The Equipment Qualification Branch (EQB) performed a two-step review of the Pump and Valve Operability Assurance Program being implemented by the Shearon Harris Nuclear Generating Station. The purpose of this review was to determine whether Shearon Harris' program is adequate to ensure that pumps and valves important to safety will operate when required during the life of the plant under normal and accident conditions. Shearon Harris is a 900-MWe pressurized water reactor (PWR) located 20 miles southwest of Raleigh, North Carolina.

The first step was a review of Section 3.9.3.2 of the applicant's Final Safety Analysis Report (FSAR). This information was general in nature, however, and by itself was not adequate to properly determine the scope of the applicant's overall equipment qualification program as it pertains to pump and valve operability. The results of this FSAR review appeared as input to Shearon Harris' Safety Evaluation Report (SER). The resolution of all open SER issues was accomplished prior to or concurrently with the on-site audit.

The second step of the review was an on-site audit to assess the applicant's overall program, while it was being implemented. A Pump and Valve Operability Review Team (PVORT) consisting of engineers from the EQB and the Idaho National Engineering Laboratory (INEL-EG&G) conducted an audit from December 3 to 6, 1985 of a representative sample of installed pump and valve assemblies and their supporting qualification documents at the applicant's plant site. Based upon the results of the FSAR review and the on-site audit, the PVORT was able to determine whether the applicant's overall program conforms to the current licensing criteria presented in Section 3.10 of the Standard Review Plan (SRP). Conformance with SRP 3.10 criteria is required in order to satisfy the applicable portions of General

Design Criteria (GDC) 1, 2, 4, 14, and 30 of Appendix A to 10 CFR 50 as well as Appendix B to 10 CFR 50.

Section 2 of this report presents the basic methodology used to evaluate Shearon Harris' overall equipment qualification program as well as a discussion of the concerns raised during the evaluation of the selected components and other qualification issues. Section 3 presents the staff's conclusions concerning the audit. Sections 4 and 5 present the references for the NSSS and BOP components, respectively.

## 2. EVALUATION METHODOLOGY

In order to evaluate the adequacy of Shearon Harris' Pump and Valve Operability Assurance Program and the extent to which it is being implemented, the PVORT conducted an audit at the plant site December 3 to 6, 1985. The first phase of the on-site audit consisted of the applicant presenting the major element of his overall equipment qualification applicable elements of the program had been (or would be) implemented for the set of selected components. By performing a detailed review on a diverse set of components, the PVORT is attempting to identify concerns that may be generic to the applicant's overall program. Table 1 presents a list of pumps and valves selected for the PVORT audit.

As the first step of the detailed review of the selected components, the PVORT conducted a plant walkdown of each component accompanied by cognizant licensee personnel. One purpose of this walkdown was to obtain information that could later be compared with the evidence of qualification contained in each component's document package. Some examples of walkdown information that was compared with relevant documents are: (a) name plate data versus design and purchase specifications, (b) installed configuration and mounting versus the configuration and type of mounting that was tested (or assumed in an analysis), (c) local equipment environment (including the environment that could result from an accident) versus the environment enveloped during required testing, (d) system interfaces versus energy or fluid requirements, and (e) installed functional accessories versus actual equipment tested. In addition, a second purpose of the walkdown was to evaluate each selected component in order to determine whether any operability concerns may have been overlooked up to that point in time. Examples of such concerns are: (a) the potential for flooding, (b) component misapplication, (c) the potential for pipe whip or missile damage, and (d) the potential for personnel interactions that could inadvertently cause a component to become inoperable.



TABLE 1. PUMPS AND VALVES SELECTED FOR THE PVORT AUDIT

<u>NSSS Components</u>		<u>BOP Components</u>	
3CC-V165SA	Component Cooling Water to RHR HX Isolation Valve	3CE-V43SAB-1	Turbine Driven AFW Pump Suction Line Check Valve
2WL-L600SA-1	Reactor Coolant Drain Tank Level Control Valve	3CT-V88SB-1	Containment Spray Additive Valve
APCC-1C-SAB	Component Cooling Water Pump	3SW-B1SA	Emergency Service Water Pump Isolation Valve from the Auxiliary Reservoir
2SI-V579SA <sup>b</sup>	Cold Leg Injection/RHR Return Line Isolation Valve	3AF-F3SA-1	AFW Pump Discharge Flow Control Valve
		PIA-SA <sup>a</sup>	Emergency Service Water Pump
		2MS-V95A-1 <sup>b</sup>	AFW Pump Turbine Steam Supply Isolation Valve

Note: The applicant has six weeks to prepare document packages for all but the surprise components; for those he has only a few days. The contents of the document package for the surprise components is an indicator of: (a) the applicant's ability to retrieve documents in a timely manner, and (b) the completeness of his central files.

a. The applicant provided a separate presentation concerning the deep draft pump issue (refer to IE Bulletin 79-15) for this component.

b. Surprise component--The applicant is informed of this component only a few days prior to the on-site audit.

The document review portion of the audit was conducted after the completion of the applicant's program presentation and the walkdown of the selected components. One purpose of the document review was to verify that the principles established in Shearon Harris' program had been (or would be) uniformly implemented. Therefore, the document package for each of the audit components was reviewed to ensure that, as a minimum, each package contained the following:

- o A purchase specification that reflects design and functional requirements
- o Results of applicable in-shop tests
- o Evidence that the component was subjected to a qualification plan that addressed:
  - Pre-aging
  - Significant aging mechanisms (if applicable)
  - Normal and accident loads (including seismic and hydrodynamic loads)
  - Acceptance criteria requiring operability both during and after an event
  - Identifiable safety margins (difference between design basis parameters and the test parameters used for equipment qualification)
- o Applicable preoperational test procedures
- o Similarity statements, where the qualification of a similar equipment is used to qualify the installed equipment (if applicable)

- o Evidence that maintenance/surveillance practices incorporate qualification and operability concerns.

In addition, a second purpose of the document review was to ensure that an auditable link existed between the documents in the package and that all documents had been reviewed and approved by personnel having a working knowledge of equipment qualification issues and concerns. Those documents not present in the audit component package were requested by the PVORT. Shearon Harris' timely response to these requests and their ability to compile a complete package for the surprise components were considered to be positive indicators of the acceptability of the applicant's central file system.

The remainder of Section 2 is devoted to discussing any concerns raised by the PVORT as a result of the equipment and issues reviewed during the on-site audit. Sections 2.1 and 2.2 present the evaluation of the NSSS and BOP components, respectively. Section 2.3 summarizes the status of other equipment qualification issues relating to pump and valve operability.

## 2.1 Nuclear Steam Supply System (NSSS) Components

### 2.1.1 Component Cooling Water (CCW) to RHR HX Isolation Valve, 3CC-V165 SA (Audit Status: Open, awaiting resolution by applicant)

2.1.1.1 Component Description. This component is a 12-inch gate valve manufactured by Velan (Model 12 GM32 SB) powered by a Limitorque motor operator (Model SMB-00-10). The valve is located in the auxiliary building at the 236 ft level. The valve is normally closed to isolate CCW flow from RHR Heat Exchanger 1. After the design bases event, the valve opens to pass flow through the RHR HX1.

There are redundant torque switches to prevent the actuator from exceeding the specified torque setting. Likewise, there are redundant limit switches which read the linear travel of the valve stem to ensure full open and closed positions. Upon loss of power the valve will fail as is.

2.1.1.2 Component Walkdown. The walkdown of this component revealed one minor anomaly, which was adequately resolved during the audit. The observation was that a caution tag, specifying the type of lubricant to be used, was found to be mounted upside-down on the exterior of the actuator. The applicant explained that the tag was placed there by the utility's preventive maintenance crew. It is an internally generated program which is used for assistance in the maintenance of Limitorque actuators. Regardless of its orientation, the tag will perform its function of informing the maintenance personnel of the type of grease/lubricant used within the actuator. All Limitorques have been lubricated in accordance with the environmental specifications requiring EXXON EP-0. The applicant's discussion of this procedure in this voluntary preventive maintenance program satisfactorily resolved this walkdown observation.

2.1.1.3 Document Review. The review of the qualification documents [1-15] revealed that the qualification of this component was addressed by a combination of similarity and stress analyses. The apparent lack of any qualification test data to substantiate valve operability was discussed with the applicant. Westinghouse, who supplied the Velan valve, recommended that this valve undergo additional static deflection operability testing in order to comply with the Westinghouse Pump and Valve Operability Program. The applicant declined the proposal for testing and instead instructed Westinghouse to perform a static deflection analysis. Review of the stress reports indicated that the allowable stress limits and structural clearances were not exceeded when a conservative 5 g load was applied to the valve assembly. The required design load is 3 g horizontal and 2 g vertical. The Limitorque SMB-00-10 operator was qualified by type tests using the SMB-0 and SMB-000 models. These operators met all acceptance criteria associated with the type test sequence in IEEE 323-1974. In addition the applicant provided evidence of startup tests performed at the plant to measure valve stroke times, switch settings, and motor voltage and insulation. However, these startup tests were conducted at less than design load conditions.

At the conclusion of the site audit, the PVORT identified a specific issue which the applicant must resolve prior to fuel load. The confirmatory issue is that valve 3CC-V165 has not been qualified by testing. Therefore, in lieu of testing, the applicant shall justify the ability of this valve assembly to operate as required under its design load conditions. If qualification by similarity is used, the applicant shall include a description of other tests performed as well as the basis for establishing the similarity of the installed valve with the valve tested. Evidence of test data, as well as completion of the startup and pre-operational tests, will provide confidence that the valve will operate as required.

Shortly after the audit the applicant explained in a January 27, 1986 letter\* that valve 3CC-V165 is not required to operate until approximately 20 minutes following a large LOCA. During the worst postulated event (LOCA and SSE), the valve is normally closed and will not receive any LOCA loads, only SSE loads. Since the valve disc will already be pressed firmly against its seat, the applicant predicts that the SSE loads will not adversely affect the functionality of the valve internals. This clarification of the valve's safety function plus the on-site review of the valve assembly analysis and valve actuator test reports provide confidence that valve 3CC-V165 will function as required. Therefore, the specific confirmatory issue for valve 3CC-V165 is considered to be closed.

However, a new generic open issue arose from a post-audit discussion with the applicant on February 21, 1986. The open issue is that the qualification of some safety-related equipment does not appear to be linked to any test data. In order to resolve this issue, the applicant shall submit the appropriate information requested in Section 3.

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\*Letter from A. B. Cutter, Vice President, Nuclear Engineering and Licensing Carolina Power and Light Company, to H. R. Denton, Director, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Seismic Qualification and Pump and Valve Operability Reviews, NLS-85-463, January 27, 1986.

2.1.1.4 Findings. No specific operability concerns remained after the evaluation of this component.

2.1.2, Reactor Coolant Drain Tank Level Control Valve, 2WL-L600SA-1, (Audit Status: Closed)

2.1.2.1 Component Description. This component is a three-inch air operated globe valve manufactured by Copes Vulcan (Model 3RA92 RE). The valve is located in the liquid waste process system inside the containment building at the 230 ft level. During normal operation the valve controls the level in the reactor coolant drain tank (RCDT) by diverting water to the boron recycle system. The safety function of the valve is to close for containment isolation. Upon loss of power to the operator the valve fails closed which is the fail-safe position.

2.1.2.2 Component Walkdown. The walkdown of this component revealed one anomaly, which was resolved before the close of the audit. The flow direction could not be found on the valve body or adjacent piping. The applicant presented the layout drawing and component sketch which confirmed that the valve was properly installed. In addition, since the valve had already been released for testing, an improper configuration would have been readily identified by the variance from design parameters.

2.1.2.3 Document Review. The review of the qualification documents [16-28] revealed that the qualification of this component was addressed by a combination of tests, analyses, and similarity statements. The valve assembly was analyzed using a 160 inch<sup>2</sup> operator compared to the 100 inch<sup>2</sup> operator installed. Seismic loads of 3 gH and 2 gV were applied, enveloping the 2.1 g (H/H/V) design specification value. The resulting stresses and deflections were found to be within the ASME Section III acceptance criteria. A static deflection test, performed at 5.66 g using the larger operator, yielded valve opening and closure times of 2.4 and 1 seconds compared to the specified limit of 10 seconds maximum. The test using the larger operator was considered to be acceptable since the mounting configurations of both operators are identical. The original limit switches provided for the valve were

replaced with NAMCO EA-180 series for inside containment environmental qualification requirements. The limit switches will be replaced every 20 years as specified by the plant maintenance procedures which invoke the manufacturer's technical manual. The station staff chose to seal the conduit connections of the ASCO solenoid valves in order to eliminate problems with moisture intrusion. This action was taken in lieu of the manufacturer's recommendation to use a properly vented conduit/junction box system. The applicant's decision appears to be conservative and should not detract from the qualified life of the component.

2.1.2.4 Findings. No specific operability concerns remained after the evaluation of this component.

### 2.1.3 Component Cooling Water Pump, APCCO-1C-SAB (Audit Status: Closed)

2.1.3.1 Component Description. This component is a horizontal, centrifugal, 9150 gpm pump manufactured by Pacific Pumps (Model DSK, 16 x 18 in., 1 stage) with an induction dripproof 800 h.p. electric motor driver manufactured by Westinghouse Electric (Model Life Line D, HSDP). The pump is located in the Auxiliary Building at the 236-ft level. This pump is one of three 100 percent capacity pumps in the component cooling water system all of which are in parallel with each other. Normal system operation requires only one pump in operation at a time however, two pumps must be available to meet single failure criteria. The normal operation of this system involves one pump operating to supply cooling water to NSSS heat exchangers. During cooling down of the plant, two pumps are required. The emergency function is to supply cooling water to the safeguard pumps. On the receipt of an "S" or station blackout signal two pumps start up.

2.1.3.2 Component Walkdown. The walkdown of this component identified seven concerns all of which were resolved before the close of the audit. The first concern involved what appeared to be a temporary modification that was made to the pump power supply connection box. The problems were that a temporary cover had been installed and some of the cover hold down screws had not been installed. The applicant investigated

this item and found that the original cover had been removed and a temporary installed while work was being performed in the cabinet. The applicant demonstrated that the correct cover would be installed. Second, the power cable connections at the motor did not appear to be complete because a flexible conduit was hanging free in the air. The applicant investigated the problem and found that the motor has the capability of receiving power from more than one source. At the time of the walkdown, the applicant had not decided how the motor was to be wired up. The plant engineering personnel reviewed and resolved the problem. A field change request was generated that resulted in the flexible conduit being removed and the holes capped. Third, an RTD wire on the inboard motor bearing had been broken off. The applicant investigated the broken wire and found that the deficiency had been identified earlier. The applicant also found that the wire had been repaired between the time of the audit team's tour and their investigation. Fourth, some anchor bolts on a stanchion installed in the vicinity of the pump appeared to be too long and at an uneven height. The applicant demonstrated that the bolts had been installed in accordance with design requirements. The fifth concern identified during the walkdown involved some "O" rings that had been taped to a vent pipe on the top of the pump. The concern was that the "O" rings had been taped there for use during maintenance and then had not been used. The applicant explained that the "O" rings had been taped in place so that they would not be lost during maintenance activities. However, when the maintenance had been performed the "O" rings were replaced with spares that met the same requirements. The applicant will remove the extra O-rings from the vent pipe. Sixth, a construction hold tag for vent pipe installation was found to be hung on the vent pipe. The concern was that the tag had been hung, the work performed, and the tag had not been removed. To correct this lack of tag control, the applicant processed a procedure change that required the tags to be removed prior to equipment turnover. The final problem involved locking pins that had been installed on a variable spring support on the pump suction before the pump had been tested. The concern was that with the pins installed, there was a potential for the installation to exceed its stress limits. The applicant indicated that the testing with the pins installed had been evaluated before the testing was started.



Proof that the evaluation had been performed was provided. Documentation was reviewed, which found the applicant's discussion and evaluation to be acceptable.

2.1.3.3 Document Review. The review of the qualification documents [29-48] revealed that the qualification of this component was addressed by a combination of tests, analyses and operational testing. The pump was qualified by performing shell hydrostatic, exploratory vibration, thermal and mechanical aging, bearing temperature, vibration levels, seal leakage, and flow performance testing. The seismic qualification was done by analysis. The motor was qualified for mechanical loads by analysis. The qualification for aging and environmental conditions was demonstrated by similarity using generic type test results.

During the document review, five concerns were identified. The first concern involved special pump bolt torqueing requirements that were identified in the qualification documents. It was not clear that these requirements were identified for maintenance. The applicant indicated that these requirements were identified in a corrective maintenance procedure. The second concern involved the lube oil requirements for the pump. The pump apparently required special oil but it was not clear that the correct oil had been identified for maintenance. The applicant demonstrated that the correct oil had in fact been identified. The third concern involved a pump flow curve that was not included in a qualification document package for all component cooling water pumps. The applicant indicated that the original pump design document would have allowed the pump discharge pressure to be high enough to overpressurize the component cooling water system if the pumps were deadheaded. Consequently, modification of the pump impellers was required to prevent system overpressurization. Once the impellers were changed, new pump flow curves had to be provided. The document package that was reviewed was the presentation of the new curves. The package addressed spare pumps as well. The applicant provided evidence that the pumps with flow curves had been installed and that the pump missing a curve was a spare and not required. The fourth problem involved the aging of the motor. The aging test performed on the motor identified that the motor had a lifetime of five years. It was not clear if the

maintenance specified that the motor had to be replaced at a five year interval. The applicant stated that the motor was qualified for the life of the plant. The original aging qualification was done at the most conservative condition. When the lifetime was found to be that short of the plant design life a more realistic approach was used. The requalification considered environmental and aging conditions that the motor would more likely experience. After the audit this approach was discussed with equipment qualification experts who indicated that this is an industry accepted practice. The final concern involved a discrepancy in the humidity qualification of the motor. The humidity referenced in two documents was different and it was not clear which value was the correct. The applicant determined the correct humidity and provided proof that it was within the acceptance criteria.

2.1.3.4 Findings. No other specific operability concerns remained after the evaluation of this component.

2.1.4 Cold Leg Injection/RHR Return Line Isolation Valve, 2SI-V579 SA, (Audit Status: Closed)

2.1.4.1 Component Description. This component is a 10 inch gate valve manufactured by Westinghouse (Model 10001GM99FN8020) with a motor operator manufactured by Limitorque (Model SB-2-60). The valve is located in the safety injection system inside the Auxiliary Building at the 251-ft level. The valve is normally open in the discharge line from the RHR pump downstream of the RHR heat exchanger. The normal function of the valve is to remain open for cold leg injection and recirculation. The safety function is to close for containment isolation and hot leg recirculation. There are redundant torque switches to prevent the actuator from exceeding the specified torque setting. Likewise, there are redundant limit switches which read the linear travel of the valve stem to ensure full open and closed positions. Upon loss of power, the valve will fail as is, which is the fail safe position. The valve is required to be operable for 24 hours after event initiation.

2.1.4.2 Component Walkdown. The walkdown of this component discovered an equipment modification tag in place. Upon questioning, the applicant explained that a general work order had been generated to provide external limit switches for redundant position indication on various valves. The modification was complete for the valve inspected and the tag will be removed upon completion of the modification for the remaining valves. The vendor drawing and documentation were found to be consistent with the installed valve assembly including the two new external limit switches.

2.1.4.3 Document Review. The review of the qualification documents <sup>[49-66]</sup> revealed that the qualification of this component was addressed by a combination of tests, analyses, and similarity statements. The Limitorque operator was included in the generic design group of SMB-0 operators qualified by type tests for Class 1E service outside primary containment. The static deflection test results for generic 4 and 12-inch valve assemblies were used to qualify the 10-inch valve by similarity. Startup test data of the installed valve demonstrated that the actual stroke time of 10.6 seconds satisfied the 15 second requirement. The stress analysis of the valve assembly met the criteria of the 1974 ASME code, Section III. Hydrostatic tests at 2500 psi measured 5.0 cc/hr leakage compared to the specified limit of 30 cc/hr. In addition, this valve was generically qualified to design conditions of 2500 psig and 650°F although the actual operating conditions are 100 to 400 psig and 100 to 350°F. Consequently, the valve is conservatively overqualified for its specified service conditions. Westinghouse engineers discussed their test program for evaluating the effects of differential pressure and flow rate upon the valve closure loads. Their results concluded that the required closing thrust is directly related to the differential pressure present during the closing stroke. In addition within the constraints of their test; the flow rate did not significantly affect the closing load. Westinghouse used these test results to ensure that the SB-2-60 operator was capable of overcoming valve stem friction losses during closure.

The NAMCO EA-180 limit switches completed the full IEEE 323-1974 test sequence including caustic spray environment. This degree of qualification is conservative for its intended application on valve 2SI-V579 SA, since the valve lies outside primary containment. The station staff maintenance personnel confirmed that maintenance procedures have been written which invoke the manufacturer's recommendations for replacement of limited life components.

2.1.4.4 Findings. No other specific operability concerns remained after the evaluation of this component.

## 2:2 Balance of Plant (BOP) Components

### 2.2.1 Turbine Driven Auxiliary Feedwater Pump Suction Line Check Valve 3CE-V43SAB-1 (Audit Status: Closed)

2.2.1.1 Component Description. This component is an eight-inch Duo-Wafer Check valve manufactured by TRW Mission (Model K15SPF-U12) and is located near the turbine driven auxiliary feed pump in the Auxiliary Building at elevation level 236 ft. The valve is in the line from the condensate storage tank to the suction of the steam driven auxiliary feed pump. The valve prevents backflow in the suction line of the turbine driven pump when the motor driven auxiliary feedwater pumps are operated with the turbine driven pump idle. The valve opens to allow flow in the suction line when the turbine driven pump is operated. The valve is normally closed but must open when auxiliary feedwater is to be supplied by the turbine driven pump.

2.2.1.2 Component Walkdown. The valve was verified to be an 8 in. TRW Mission valve. The valve was verified to be bolted between two mating flanges and, therefore, only subjected to compressive stress. The valve was also verified to be pipe supported. One anomaly was observed in the installation. Three plugs were observed to be in place on the top of the valve. On the bottom of the valve two plugs were in place and one hole was observed without a plug. Subsequent discussions with the licensee revealed the open hole was for a lifting eye bolt. However, with this hole located

on the bottom the drain hole would be located on the top. The licensee stated the drain is not used since the piping system is provided with low point drains and the valve is not installed at a low point. Also, the licensee stated that the either orientation was acceptable for valve operation. After studying the valve drawing the explanation was considered acceptable and the anomaly resolved.

2.2.1.3 Document Review. The review of the documents [1-11] revealed that the operability qualification of the valve was based on normal operating tests and seismic analysis. The valve design conditions were 150 psig at 140°F which exceed the most severe accident condition of 130 psig at 125°F. The seismic design requirements were for 3.0 g horizontal and 2 g verticals. The seismic analysis demonstrated the valve could stand loads much in excess of the requirement.

The review of the seismic analysis revealed that only the natural frequency of the valve body was calculated and the natural frequency of the duo-wafer discs were not addressed. The licensee reply to this question was that the check valve manufacturer does not evaluate the natural frequency of the discs since the developed stresses are extremely low. In addition, the spring and weight of the water serve to keep the discs against the seats when the valve is performing its check function. The reply was considered satisfactory and the question resolved.

The review also revealed that the design specification identified design end loads for the valve. The end loads were not considered in the analysis. The licensee reply to this question was that the check valve is bolted between two mating flanges and is, therefore, only subjected to a compressive load induced when the bolts are tightened. This load has been considered in the seismic analyses. The requirement to consider the end load should have been deleted from the general specification when the specification was utilized to purchase wafer check valves. The reply was considered satisfactory and the question resolved.

The PVORT Form reported the acceptable leak rate as 320 liters/hr. The Design Specification M-70 requires seat tightness per MSS-SP-61. The

allowable leak rate per this standard would be 320 milliliters per hr. The licensee acknowledged the error. The results of the leak test for the valve was 5.33 cc/min or 319.8 milliliters per hour which is acceptable and the question resolved.

2.2.1.4 Findings. All questions were satisfactorily resolved and no specific operability concerns remained after the evaluation of this component.

2.2.2 Containment Spray Chemical Additive Valve, 3CT-V88SB-1, (Audit Status: Closed)

2.2.2.1 Component Description. This component is a 2 inch motor operated globe valve manufactured by Yarway. (Model 5515-F316M). The operator is a gear motor operator manufactured by Philadelphia Gear Limatorque Corp. (Model SMB-00-15). The valve is located in the reactor auxiliary building at elevation 219 ft and is installed on the line from the containment spray additive tank to the eductor that adds chemicals to the containment spray water. The valve opens 100 seconds after a containment spray actuation signal. The delay allows the operator to decide if the borated NaOH from the containment spray additive tank needs to be injected into the containment spray.

2.2.2.2 Component Walkdown. The valve and operator were verified to be the size and models specified. The valve was verified to be pipe supported. The operator was verified to be supported by the valve but, in addition, the operator was found to have a brace from the operator to an anchor. There was some concern that motion of the pipe from thermal expansion, seismic loads and accident loads could introduce excessive loads on the valve operator or the valve because the brace would restrain movement of the actuator. The support identification is CT-H-497. Calculations (Number 3048-6) were provided by the applicant verifying that the valve and pipe loads were acceptable. The concern was considered resolved.

2.2.2.3 Document Review. The review of the documents [12-16] revealed that the valve assembly was qualified by a combination of tests and analysis. The valve body was qualified by stress analysis which demonstrated that the valve parts, yoke, actuator connection bolts, valve body, and valve stem had acceptable stress levels. The Limitorque operator was qualified by test. The document provided to verify the acceptance was Reference 15. The document demonstrated qualification for a series of Limitorque operators. Model SMB-00-15 was included in the series. The report indicated that the tests performed to qualify the series of operators included thermal aging, mechanical aging, radiation exposure, seismic dwell test, hydrostatic tests, seat leakage test and valve closure tests.

The design basis event conditions were identified as 10 psig and 105°F. The valve is a 1500 lb valve which is qualified for loads much in excess of these conditions. The valve was identified to be acceptable for NaOH service.

2.2.2.4 Findings. All questions were satisfactorily resolved and no specific operability concerns remained after the evaluation of this component.

2.2.3 Emergency Service Water Pump Isolation From the Auxiliary Reservoir, 3SW-B1SA (Audit Status: Closed)

2.2.3.1 Component Description. This component is a 30-in. butterfly valve manufactured by Jamesbury Corporation (Model 8229-MT) with a motor operator manufactured by Limitorque (Model SMB 00/10 H2BC). The valve is installed in the Emergency Service Water and Cooling Tower Makeup Intake Structure. There are two valves in redundant loops each capable of supplying the necessary flow. The valve's normal position is open to allow flow from the auxiliary reservoir. The safety position is open for a loss of offsite electrical power or safety injection actuation signal. This valve is closed if the Emergency Service Water Pumps take a suction from the main reservoir.

2.2.3.2 Component Walkdown. During the walkdown of this component, three operability concerns were identified all of which were resolved before the close of the audit. The first concern involved some temporary wires that had been attached to the motor operator. The applicant was asked to explain the purpose of the wires and to indicate when the installation would be made permanent. The applicant researched the installation and found that the wires were connected to motor space heaters. The space heaters are not necessary for normal operation, however, they are used during normal construction and startup. The temporary connections will be removed soon after these activities are completed. The second problem found during the walkdown was that some conduit covers had not been installed. The applicant demonstrated that the missing conduit covers would be identified and installed during the building walkdown.

The third walkdown concern involved water that had collected in the pit where the valve was installed, subsequently damaging the actuator. The applicant was asked to identify the cause of the flooding, the corrective actions taken to restore the component to a qualified state, and the protective measures taken to prevent a recurrence. The applicant explained that a large rainfall had caused a berm surrounding the auxiliary reservoir to fail. At that time the pipeline to the reservoir was still disconnected (i.e., open) due to construction activities. The rainwater then entered the valve pit through the open pipes, flooding the valve and actuator. The applicant shipped the damaged actuator to the vendor for repair and requalification, before it was reinstalled. Documentation was later reviewed which supported the applicant's discussion.

The PVORT reviewers pointed out to the applicant that some residual water still remained in the pit, although the water did not contact the valve assembly. There did not appear to be any method for removing the water nor any means of monitoring the water level to alert the plant operator of a submergence hazard. Upon investigation, the applicant explained that a portable pump will be used to remove all water from the pit. Normal plant operating procedures require an auxiliary operator to perform a daily walkdown of the Emergency Service Water and Cooling Tower



Makeup Intake Structure. Furthermore, the scenario for a recurrence of flooding has been eliminated, because the pipes have been connected up as specified and the berm has been reinforced. The corrective and preventive measures taken by the applicant appear to be adequate to address the operability concerns discussed above.

2.2.3.3 Document Review. The review of the qualification documents<sup>[17-31]</sup> indicated that qualification of this component was addressed by a combination of tests, analyses and similarity. The valve was qualified for seismic loads by analysis. The Limitorque was qualified by similarity using the results of seismic tests performed on a similar unit. Additional vendor testing was performed on the valve and actuator. The testing included aging, accident environment operation, hydrostatic, seat leakage and environmental testing. All vendor testing was completed satisfactorily without any anomalies.

The Limitorque actuator was qualified for environmental conditions by similarity. The Limitorque actuator environmental qualification report was prepared covering a family of actuators that shared the same design features, materials, standards, and tolerances. The discussion presented in the qualification report adequately addressed similarity qualification.

2.2.3.4 Findings. No specific operability concerns remained after the evaluation of this component.

#### 2.2.4 Auxiliary Feedwater Control Valve 3AF-F3SA-1, (Audit Status: Closed)

2.2.4.1 Component Description. This component is a 3 inch globe valve with a electro-hydraulic actuator. The valve is manufactured by Masoneilen (Model 50-41412). The operator is a Milliampere Hydramotor Actuator and is manufactured by ITT General Controls (Model NH92J8002F). The valve is located in the discharge line of the 1B-SB motor driven auxiliary feedwater pump in the auxiliary building at elevation 261 ft. The valve is used to regulate flow from the 1B-SB motor driven pump to provide a regulated flow balanced with the flow from the other motor driven pump. Auxiliary feedwater is normally provided by the motor driven pumps during

start-up, hot-standby and cold shutdown. Auxiliary feedwater is also required for accidents such as loss of main feedwater, steamline rupture and loss of coolant accident. The valve must function for all of these events. Also the valve must be able to close to protect against feedwater header or mainsteam header rupture. Upon loss of power the valve will fail open to ensure an auxiliary feedwater path.

2.2.4.2 Component Walkdown. The walkdown of this component verified that the installed valve assembly is the same as the equipment purchased. The valve was verified to be mounted in and supported by a horizontal pipe. There was one anomaly discovered during the walkdown, which was adequately resolved by discussions with the applicant. A flow direction tag, which was spot welded to the valve body, was observed to be installed upside down. If the tag was turned upright, the flow arrow would point in the opposite direction, indicating that the valve was installed backwards. Upon review of the system drawings, the applicant confirmed that the observed orientation of the valve body is correct. The applicant originally intended to mount the tag upright on the other side of the valve body to indicate the proper flow direction. However, access to that side was limited. Therefore, the tag was mounted in its present location to indicate the proper flow direction, although the valve manufacturer's trademark is now upside down. This explanation adequately resolved the walkdown concerns.

2.2.4.3 Document Review. The review of the documents [32-35] revealed that the valve assembly was qualified by a combination of analyses and test. A mathematical model was made of the valve and operator assembly and the fundamental natural frequency was computed to be 15.57 Hz. The fundamental frequency measured from the strike test was 19.14 Hz. The agreement was considered to sufficient to verify the acceptability of the model. The assembly was analyzed for the specified seismic motion at the 261 ft level in the auxiliary building. The computed stresses were acceptable and the maximum load was calculated to be 1.5 g. Static tests were run with a conservative 4 g load and the stroke time met the acceptance criteria.

The system accident conditions were specified as 1275 psig and 100°F. The valve design conditions were 1600 psig at 125°F. The maximum ΔP for the valve was stated as 5 psi on the Operability Assurance Review Form (Reference 33) but the Design Specification (Reference 34) required 1085 psig. The applicant indicated the 5 psi was an error and the valve did meet the 1085 psig requirement. This contention was verified since the valve passed the required leak test with a ΔP of 1600 psig.

During the environmental qualification tests after exposure to temperature, radiation, steam and pressure, the valve did not function properly. Several modifications were made to the operator and the valve successfully passed the tests. In response to our request for verification that these modifications had been made to the operators of the valves that are installed in the plant, a Certification of Conformance was provided that certified that the ITT General Controls NH90 actuators had been retrofitted in accordance with the Operator Qualification Report.

2.2.4.4 Findings. All questions were satisfactorily resolved and no specific operability concerns remained after the evaluation of this component.

#### 2.2.5 Emergency Service Water (ESW) Pump, P1A-SA, (Audit Status: Closed)

2.2.5.1 Component Description. This component is a centrifugal, vertical "deep draft" 21500 GPM pump manufactured by Hayward Tyler (Model 32x42VS01) and is driven by a vertical induction, 1300 HP motor manufactured by General Electric Company (Model 5K6356XC21A). The pump is located in the Emergency Service Water Intake Structure at the 262-ft level. There are two 100 percent capacity pumps, only one which is needed to satisfy the water requirements for plant shutdown. Normally, the ESW pumps draw suction from the Auxiliary Reservoir, although the main reservoir can be used if necessary. The normal state of the ESW pump is standby for auto-start. The safety function is to start automatically on loss of offsite power or in the event of a safety injection signal. The lineup of valves required for the switchover from the normal service water

pumps to the ESW pumps is automatic following the startup of the ESW pumps. The ESW pump is required to remain operable for 30 days post accident.

2.2.5.2 Component Walkdown. The walkdown of this component revealed two anomalies, both of which were satisfactorily explained by plant personnel. First, a deficiency tag was attached to the pump motor. Plant maintenance personnel explained that a temporary gasket had been installed in the motor terminal box while awaiting the qualified replacement gasket. When the work request is completed, the deficiency tag will be removed and attached to the completed work request. Documentation was reviewed, which substantiated this explanation in a satisfactory manner.

Second, the seal water supply line was found to be slightly rusted and partially immersed in a pool of water created by the pump cover plate. The Ebasco engineers explained that this problem was previously identified earlier by the vendor. As recommended by the vendor, a design change has been initiated to provide a 1/2 inch hole in the pump base plate, permitting drainage to the pump suction bay below. The pipe will be carefully examined and repaired or replaced as necessary. Documentation was reviewed, which substantiated the explanation. However, the PVORT noticed that the work order was written the day after the on-site walkdown. Upon questioning, the maintenance engineer speculated that the pump vendor did not consider this modification to be a high priority item, possibly accounting for the "less-than-prompt" action taken to process the work order. The PVORT mentioned the possibility that the work order would not have been written if the PVORT had not raised the concern during the walkdown. This matter was discussed privately with other PVORT reviewers. Although, there were other isolated cases of recently dated work orders, the PVORT did not consider this observation to be a licensing issue because (1) the overall qualification program is very comprehensive tying together the responsibilities of many disciplines and (2) the generation of the work orders as well as prompt document retrieval typifies the ability of the applicant to implement his program. The PVORT did remind the applicant that his program must be vigorously pursued by knowledgeable personnel on all levels for the life of the plant.

2.2.5.3 Document Review. The review of the qualification documents <sup>[36-56]</sup> revealed that the qualification of this component was addressed by a combination of tests, analysis, and operating experience. The motor was qualified for mechanical loads by analysis. Qualification of the motor for aging and environmental conditions was demonstrated by similarity, using generic type test results. The pump was qualified by analysis, shop tests, and pre-operational tests. The pump performance curves were still being developed from the pre-operational test data and will be compared with the design specification.

The ESW pumps 1A and 1B experienced material failures to the bearings resulting from inadequate seal water injection. The loss of pump discharge pressure and flow occurred during operation of the 1A ESW pump on September 5, 1985. Subsequent inspection by the applicant revealed that the pump shaft sheared at the pump upper bearing due to extreme overheating. The bearing and shaft sleeve were destroyed and no further conclusions could be drawn from their failure. Subsequent inspections of the 1B ESW pump revealed overheating damage to the upper pump bearing which could have lead to a similar pump failure.

Upon reassembly of pump 1A the bearing housing was discovered to be slightly "hour-glass" shaped by 30 mils compared to the nominal diameter of 6.623 inches. Due to the absence of any metal discoloration, the "hour-glass" shape was considered to be a construction anomaly rather than the result of overheating. The problem was corrected by honing the inside diameter of the housing.

Upon further investigation, the applicant determined that prior to the reported failure neither pump had been operated with seal injection flows specified by the pump manufacturer. Pending the design and construction of the permanent seal water piping system, seal injection water was provided by a temporary configuration using the fire protection water system. This temporary system failed to deliver the stated cooling needs of 10 GPM at 125 psig required by the bearing. This configuration was used for over approximately 12 months of intermittent pump operation.

The final design for seal injection relied upon a booster pump when the ESW pump was in standby or starting and an ESW screen wash pump when the ESW pump was running. A relief valve set at 118 psig upstream of the cyclone separator lifted whenever the booster pump was used. In order to prevent the relief valve from lifting, the reduced ESW pump discharge pressure (100 psig) was used as the sole source of seal injection flow. The 1A pump failure occurred during this interval.

The corrective action taken by the applicant was to remove the relief valve and qualify the seal injection line to the design pressure (225 psig) of the booster pump. The final report on this matter will be issued by March 1, 1986 upon completion of the testing of both ESW pumps as required by IE bulletin 83-05. The PVORT requested a copy of the final report as confirmation that the pump failure problem has been addressed in a satisfactory manner.

The applicant's response to IE Bulletin 79-15 "Long-Term Operability of Deep Draft Pumps" was reviewed. Long-term operation was demonstrated by a 78 hour continuous run after the modification to the seal injection system was completed. By also implementing the vibration analysis program and maintenance/surveillance program, the applicant has satisfied the Licensing-Review Group II guidelines, endorsed by NRC-EQB staff.

The favorable results of the walkdown and document review, as well as the on-going discussions and clarifications with station staff, provide confidence that the component will function as required for the life of the plant.

2.2.5.4 Findings. No specific operability concerns remained after the evaluation of this component.

2.2.6 Auxiliary Feedwater (AFW) Pump Turbine Steam Supply Isolation Valve, 2MS-V95A-1 (Audit Status: Closed)

2.2.6.1 Component Description. This component is a 6-inch gate valve manufactured by Anchor Darling Valve Company (Model SC-2) with a Limitorque

motor operator (Model SMB-00-15). Valve 2MS-V95A-1 is located in the Reactor Auxiliary Building/Main Steam Tunnel at the 261 foot elevation. This valve is an isolation in the steam supply line from steam generator "1 C" to the auxiliary feedwater pump turbine. The normal position for this valve is closed. There are two safety positions associated with this valve; one open and the other closed. The open position is provided when the valve is required to open on the receipt of an AFW actuation signal. The closed position is provided when the valve receives an isolation signal on a main steam line break.

2.2.6.2 Component Walkdown. The walkdown of this component led to two concerns, both of which were satisfactorily addressed before the close of the audit. The first concern involved an actuator that had a plastic tag mounted that indicated only Mobil Type 28 grease could be used. The concern was that the correct grease would not be identified in the lubrication procedures. The applicant demonstrated that lubrication was being performed in accordance with manufacturer's requirements and IEB 79-03. The lubrication procedures had not been completed yet, however, the procedure that will be used in their preparation was presented. It was determined that the procedure should be adequate enough to determine the necessary lubrication requirements. The second concern involved a blue RFT (Released For Transfer) which had been altered by having RFT crossed out and ET (Equipment Transfer) penciled in. The concern was that the tag was being used for purposes for which it was not intended. The applicant demonstrated that the changes had been made in accordance with the startup manual which was found acceptable.

2.2.6.3 Document Review. The review of the qualification documents<sup>[57-74]</sup> indicated that qualification of this component had been addressed by a combination of tests, analyses, and similarity. Seismic tests were performed on the actuator and analysis on the valve. Vendor tests included aging accident environment, hydrostatic and seat leakage.

It was found that all vendor testing was completed satisfactorily without any anomalies. It was noted that the Limitorque actuator was qualified by similarity. The Limitorque actuator environmental

qualification report was prepared covering a family of actuators that shared the same design features, materials, standards, and tolerance. The documentation presented adequately addressed qualification by similarity.

There were three concerns identified during the document review, all of which were resolved before the close of the audit. The first concern involved a document change notice which had been initiated to change the safety train designation. It was not clear why this had been done. The applicant researched the issue and determined that the change was made to meet the requirements of a cold shutdown within 36 hours in accordance with the limiting single failure criteria identified in Shearon Harris document RSB-B-1. The second concern involved a non-conformance report (NCR) which had been generated against some material specifications. There were two problems associated with this NCR. One was that the NCR in the package had not been reviewed and signed off. The applicant found that although the NCR had been completed and signed off, the wrong copy had been included in the qualification package. The signed off copy will be restored to its proper location. The other problem was that the vendor deviated from the specification during component manufacture. It was not clear why the deviation was acceptable. The applicant researched the problem and determined that the specifications had been upgraded to a new version of the ASME Code which superseded the old requirements. Since the requirements were deleted from the new specifications, the vendor's deviation was found acceptable.

2.2.6.4 Findings. No specific operability concerns remained after the evaluation of this component.

### 2.3 Other Equipment Qualification Issues

This section summarizes the status of other issues relating to pump and valve operability that were addressed by the PVORT. The following discussions combined with the detailed review of selected equipment provide additional basis for PVORT's conclusions concerning the applicant's overall program.



### 2.3.1 Safety Evaluation Report (SER) Items (Status: Closed)

The PVORT reviewed the Shearon Harris FSAR and formulated questions and concerns that appeared in the preliminary SER dated October 6, 1983. At that time the PVORT requested the applicant to provide additional information in order to better clarify his program as well as to detect and address any major deficiencies. Additional comments were discussed at a pre-audit meeting held March 21, 1984. Table 2 summarizes the status of the five SER items. Two of these issues (Items 1 and 2) were addressed adequately by the applicant in a response dated May 29, 1984.<sup>a</sup> In this letter, the applicant committed to provide the requested information in the form of new or amended tables and expanded discussion in the appropriate sections of the FSAR. The maintenance program was also discussed during the audit from an overall programmatic level as well as from the component level. The remaining three items (3, 4, and 5) were addressed during the site audit December 3 to 6, 1985.

SER Items 3, 4, and 5 were resolved by the applicant's discussions and clarifications of his equipment qualification program. Regarding Item 3, the applicant pointed out that the load conditions and acceptance criteria are already described in the FSAR for general categories of equipment. However, the specific load and conditions must be examined on a component level. The results of the component reviews indicated that the applied conditions and criteria were consistent with the FSAR. Regarding Item 4, the applicant indicated that he did not use the guidelines of the draft standards, but would consider them when they are approved. It is the PVORT's belief that Shearon Harris' pumps and valves do meet the requirements of the codes and standards that were in effect at the time of purchase, and that the applicant's reluctance to review draft standards does not constitute a licensing issue. Regarding Item 5, the information requested is indirectly referenced in the FSAR Appendix 3.9 D (Inservice

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a. Letter from S. R. Zimmerman, General Manager, Nuclear Licensing Section, Carolina Power and Light Company, to H. Denton, Director, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Hope Creek Generating Station, Equipment Qualification, May 29, 1984.

TABLE 2. STATUS OF SER ITEMS FOR PUMP AND VALVE OPERABILITY ASSURANCE

SER Items <sup>a</sup>	Finding/ Resolution	Status
1. All active safety-related valves including those valves smaller than two inches in size, should be included in the Shearon Harris pump and valve operability program.	Satisfactory	Closed <sup>b</sup>
2. Clarification of how aging was incorporated in the qualification process should be contained in the FSAR. In addition, the applicant should commit to establish a maintenance and surveillance program to maintain equipment in a qualified status throughout the life of the plant. The criteria for the maintenance and surveillance program should be contained in the FSAR.	Satisfactory	Closed <sup>b</sup>
3. The FSAR should be amended to clearly show the loads and conditions considered in the qualification of safety related pumps and valves.	Satisfactory	Closed <sup>c</sup>
4. The extent to which draft standards ANSI/ASME QNPE-1 (N551.1), QNPE-2 (N551.2) QNPE-3 (N551.3), QNPE-4 (N555.4) and issued standard ANSI/ASME B.16.41 are used needs to be clearly stated in the FSAR. In addition, the applicant's position with respect to Regulatory Guide 1.148 must also be indicated in the FSAR.		

TABLE 2. (continued)

SER Items <sup>a</sup>	Finding/ Resolution	Status
5. The FSAR should be amended to show the extent to which operational testing is being used to meet the requirements of SRP Section 3.10. The extent to which operational testing is performed at full flow and temperature conditions should be shown.	Satisfactory	Closed <sup>c</sup>

a. The Shearon Harris Preliminary Safety Evaluation Report (PSER) items for pump and valve operability assurance were identified in a PSER dated October 6, 1983 and were supplemented by specific comments discussed at a pre-audit meeting held March 21, 1985.

b. This item was adequately resolved based on information submitted by the applicant in a letter "Shearon Harris Nuclear Power Plant Unit No. 1, Docket No. 50-400--Equipment Qualification," letter from S. R. Zimmerman, Manager, Nuclear Licensing Section, Carolina Power and Light, Serial No. NLS-84-201, to H. R. Denton, Director, Office of Nuclear Reactor Regulation, USNRC, May 29, 1984.

c. This item was adequately resolved based on information reviewed by the staff during the site audit December 3 to 6, 1985. The applicant committed to close out this item in a manner and time frame that is acceptable to the staff.

Pump and Valve Testing Program), Chapter 14 (startup testing) and Chapter 16 (Plant Technical Specifications). The PVORT reviewed the pre-operational test procedures for selected components within the context of the audit. Drafts of the IST procedures were reviewed briefly to confirm that the IST program will comply with the ASME Section XI requirements. In addition the applicant discussed his maintenance surveillance program which ensures that each component will be maintained in its qualified state for the life of the plant. In summary, the PVORT believes that the applicant has, by way of appropriate commitments and clarifications, adequately addressed all five SER items as they relate to pump and valve operability.

### 2.3.2 Long Term Operability of Deep Draft Pumps, (Status: Closed)

IE Bulletin 79-15 was issued July 11, 1979 as the result of industry-wide problems associated with the long term operation of deep draft pumps. Plants under construction were required to identify such pumps, provide operating history, and verify the pump's ability to operate without incurring vibration-induced problems. At the time of the bulletin, Shearon Harris was in a position only to identify the types of pumps used, since operating history was unavailable. As a followup to their original response, the PVORT asked the applicant to review and compare his deep draft pump qualification program to the NRC's suggested guidelines contained in a memorandum regarding the Licensing Review Group-II Issue 9-RSB. The application stated that long-term operability of the service water and cooling tower pumps is demonstrated by (1) using the vendor recommended installation procedures; (2) testing and verifying design features; (3) over 12 months of intermittent operation and (4) the ability to perform maintenance and repair of the pumps. Maintenance of the pump was evident. In the work done to investigate a pump shaft failure due to overheating of the bearings (see discussion in Section 2.2.5). The subsequent modification to the seal water injection system restored design flow to the bearings. Continuous runs up to 78 hours have since been achieved without any evidence of abnormal performance.

The vendor sketch and discussions with the station staff indicate that vibration of the pump has been addressed. The pump shaft has bearings located every 8 feet within the pump column. The column is laterally braced every 15 feet by four pinned connections mounted to the structural wall. The applicant's vibration analysis program for rotating equipment includes the ESW pumps. Vibration measurements are taken at the top and bottom of the pump motor on a schedule that is consistent with ASME Section XI requirements. Vibration test data, taken with the motor loaded and unloaded, did not change significantly and were significantly less than the manufacturer's acceptance criteria.

Debris is controlled by screens in the main and auxiliary reservoirs, which supply water to the pump suction bay. There is no debris screen on the suction bell of the ESW pump. However, the pump suction bay can be drained if necessary to perform maintenance activities.

In summary, the PVORT believes that the program described by the applicant meets the intent of the NRC's suggested guidelines for long term operability of deep draft pumps.

### 2.3.3 Operability of Turbine-Driven AFW Pump PIX-SAB (Status: Closed)

NUREG 1154 was issued as the result of an investigation of a loss of main and auxiliary feedwater event experienced at the Davis Besse plant on June 9, 1985. A contributing factor to this event was excessive moisture content in the driving steam to the AFW pump turbine, as well as the difficulty of re-establishing steam flow following the turbine overspeed trip. The report implied that the operability of turbine-driven AFW pumps could be similarly affected at other nuclear plants. Consequently, the PVORT audited AFW pump PIX-SAB in order to investigate the plant specific features and preventive measures in place at Shearon Harris. The review of this component focussed primarily on NUREG 1154 related concerns, since a detailed review of a similar component had been performed by the PVORT reviewers at another plant in November 1985.

2.3.3.1 Component Description. This component consists of a centrifugal pump manufactured by Ingersoll Rand with a Terry Turbine manufactured turbine drive (Model GS-N2). The auxiliary feedwater pump is located in the Auxiliary Building at the 236 foot elevation. This pump is part of the Auxiliary Feedwater (AFW) System which supplies feedwater to the steam generators during emergency situations. There are three redundant loops in the AFW System; one loop has a steam turbine driven feed pump and the other two loops have electric motor driven feed pumps. All three pumps are normally in standby. The safety function of this pump is to start and provide feedwater to the steam generators in the event of a line break, loss of main feedwater or reactor-turbine trip.

2.3.3.2 Component Walkdown. During the walkdown of the turbine driven auxiliary feedwater pump, three operability concerns were identified, all of which were adequately addressed before the close of the audit. The first problem found during the walkdown was that the trip and throttle valve installation did not appear to be adequate to allow easy operation after an overspeed trip. The applicant demonstrated operation was assured by using a safety grade motor operator and electrical power supply both of which have been designed to provide sufficient force to open the valve with full differential pressure.

The second issue was to determine the ease with which the valve could be reset after a turbine trip. The applicant demonstrated that there are two overspeed trips associated with the auxiliary overspeed turbine; one mechanical and one electronic as well as other trips. The applicant also demonstrated that all trips except the mechanical trip causes the trip and throttle valve to trip in a way that it can be reset and opened from the control room. The mechanical overspeed trip causes a latch mechanism to operate which requires an operator to reset it locally. After the trip mechanism is reset, the trip and throttle valve can be operated locally or from the control room. The design of this installation appears to be adequate to assure easy valve operation after any type of trip.

The third issue was to determine if the applicant could assure turbine operation when the turbine driving steam includes moisture. The applicant

studied the problem and demonstrated that (a) sufficient protections had been designed into the piping to prevent any moisture from reaching the turbine and (b) sufficient loop redundancy has been designed into the auxiliary feedwater system to prevent system failure in the event there is moisture in the steam. The applicant also demonstrated that the Westinghouse Owner's Group is reviewing the Davis Besse incident and that any problem areas identified would be reviewed for applicability at Shearon Harris.

2.3.3.3 Document Review: The only documents reviewed for this component were the maintenance requirements. During the seismic testing of the Terry turbine, trouble was experienced with some turbine casing bolts coming loose. Terry Turbine Company performed a study and determined that it was necessary to put Loktite on the bolts and torque them periodically. Originally the torqueing was to be performed annually. The applicant was asked about this requirement. The applicant reviewed this requirement and discussed it with Terry Turbine personnel. The applicant's conclusion was that a second seismic test had been performed in 1978 and that the torqueing requirements for the turbine installed at Shearon Harris should be interpreted as a requirement to test annually a sampling of accessible turbine bolts with particular attention given to pressure-retaining bolts. If a number of bolts prove to be loose, then all turbine bolting, accessible and inaccessible, would require retorquing. The torqueing frequency was identified in the vendor technical manual which the applicant had committed to invoke for performance of the maintenance. This explanation was found to be acceptable.

2.3.3.4 Findings. No specific operability concerns remained after the evaluation of this component.

#### 2.3.4 Implementation of the Overall Program, (Status: Closed Pending Resolution by Applicant)

The PVORT's evaluation of the applicant's overall qualification program was based on many factors, including the FSAR review, resolution of SER items, pre-audit correspondence, and the on-site review of selected

equipment. Another important factor was the follow-up evaluation of the applicant's administrative programs that are linked to equipment qualification. The PVORT evaluated these programs during the on-site audit. This evaluation enabled the PVORT to gain a better perspective of the programmatic scope and implementation of the applicant's overall equipment qualification program. For example, the PVORT's concern about deep draft pump operability led to discussions of the applicant's vibration analysis program, in-service test procedures, preventive maintenance procedures, and quality control program. Throughout the audit, it was apparent that the applicant's document control system was sufficiently complete and organized to retrieve the documents necessary to support these discussions. The programs mentioned above enhance the PVORT's confidence the applicant's overall program can ensure that all pumps and valves important to safety will operate as required for the life of the plant.

The PVORT's evaluation of the applicant's overall program was not entirely absent of qualification issues, however. The PVORT did identify three generic issues, which were discussed with the applicant at the exit meeting. Shortly after the audit the applicant submitted a letter dated January 27, 1986\* which resolved these three issues. The three generic issues as well as their resolutions are discussed below.

At the conclusion of the audit, it was apparent that the Shearon Harris list of active valves was not totally up-to-date. In preparation for the site audit the PVORT used the FSAR tables of active pumps and valves, supplemented by information contained in the master equipment list. A number of discrepancies were discovered in the FSAR tables. The applicant provided annotated pages of the FSAR to represent

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\*Letter from A. B. Cütter, Vice President, Nuclear Engineering and Licensing Carolina Power and Light Company, to H. R. Denton, Director, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Seismic Qualification and Pump and Valve Operability Reviews, NLS-85-463, January 27, 1986.



the complete lists of pumps and valves. However, the master list was not updated in a similar manner. For example, the flow control valve 2RH-F500SN-1 was listed as an active valve on the master list, yet Westinghouse and CP&L considered this valve as non-active. The PVORT investigated their reasons for claiming this valve as non-active.

The valve 2RH-F500SN-1 is an 8 inch butterfly manufactured by Fischer Continental (Model 7613) with an integral actuator. The valve is located on the bypass line around the RHR HX1, and is normally closed. The valve is opened to balance the flow and prevent initial thermal shock to the heat exchanger. As thermal equilibrium is reached the valve gradually closes directing all the flow through the heat exchanger. Upon loss of power, the valve will fail closed which is the fail safe position. Westinghouse engineers stated the 2RH-F500SN-1 is not active because the design basis for Shearon Harris is hot shutdown. The hot shutdown temperature and pressure conditions is above the 350°F and 425 psig level at which the RHRS is placed into operation. The cooling capacity of the RHR system is 50°F per hour which is less than the allowable limit of 100°F per hour for the reactor coolant system. Containment isolation in the event of an RHR line break is provided by safety-related active valves. Redundancy is provided by a duplicate RHR train.

The PVORT accepted the applicant's reason for declaring valve 2RH-F500 SN as non-active. However, it was apparent that a complete list of active valves has not been docketed in the FSAR. Therefore, the first generic issue presented to the applicant at the exit meeting was to confirm that all active valves are correctly identified in the FSAR.

In his January 27, 1986 letter the applicant committed to revise the FSAR tables upon completion of the staff reviews. This commitment satisfactorily resolved the first generic issue.

The staff requires that all equipment important to safety be properly qualified prior to fuel load. However, the PVORT audit was conducted months in advance of the expected fuel load date before the applicant had been able to qualify, test, and install all of his equipment. The

applicant did provide evidence that the documentation and installation was complete for approximately 85 percent of the Shearon Harris equipment at the time of the audit. The remaining 15 percent is scheduled to be completed prior to fuel load. Similarly, some preoperational tests remain to be completed. The hot functional tests were scheduled to commence later in the month.

Therefore, the second generic issue presented to the applicant at the exit meeting was to confirm that all pre-service tests required to be completed before fuel load have been performed.

In his January 27, 1986 letter the applicant committed to complete the pre-service testing prior to power operation. This commitment satisfactorily resolved the second generic issue.

Finally, the third generic issue was that all pumps and valves important to safety are properly qualified prior to fuel load. Complete qualification includes, but it is not limited to, confirmation that (a) the associated documentation is complete and readily accessible, (b) the equipment is properly installed, and (c) the appropriate administrative procedures have been performed as required.

In his January 27, 1986 letter the applicant committed to complete the qualification of all safety-related pumps and valves prior to fuel load. This commitment satisfactorily resolved the third generic issue.

However, during a telephone conference held February 21, 1986, it was apparent that the qualification of some safety-related equipment might not be linked to any test data. The staff consider this concern to be a new generic issue, which the applicant must resolve by submitting the appropriate information for staff review and approval.

Section 3 summarizes the three generic issues mentioned above, the one specific concern mentioned in Section 2.1.1, the resolutions of these items, as well as the new generic issue involving qualification test data.

### 3. CONCLUSION

The Equipment Qualification personnel for Shearon Harris are dealing with the equipment qualification issue in a positive manner. The PVORT has reached this conclusion because the applicant has: (a) provided adequate documentation to demonstrate qualification of a representative sample of pumps and valves important to safety, (b) established administrative programs to determine, monitor, and maintain equipment operability for the life of the plant, (c) demonstrated an adequate central file system by the timely retrieval of information requested by the staff, (d) demonstrated that he corresponds closely with the NSSS vendor, architect-engineer, and equipment suppliers concerning details of construction, design, maintenance, utility policy, and plant operation, and (e) demonstrated overall accountability by committing the appropriate personnel to implement these policies and programs.

Based on the results of the on-site audit, the PVORT concludes that an appropriate Pump and Valve Operability Assurance Program has been defined and is being implemented at Shearon Harris. The continued implementation of this program should provide adequate assurance that all pumps and valves important to safety will perform their safety-related functions as required for the life of the plant.

Table 3 presents a summary of the audit results. By the close of the on-site audit, all but one specific and three generic concerns had been resolved. These concerns were resolved by the applicant in a January 27, 1986 letter. However, a new generic issue was subsequently identified. The following is a status of all unresolved pump and valve operability concerns and the applicant's commitments:

#### Specific Confirmatory Issue:

1. The 12-inch Velan gate valve (3cc-V165) was qualified by analysis only. The applicant should provide test data demonstrating the ability of this valve assembly to operate as required under its

TABLE 3. SUMMARY OF PVORT AUDIT FOR THE SHEARON HARRIS NUCLEAR POWER PLANT

Plant I.D. Number	Description	Component Function	Findings	Resolutions	Status	Remarks
3CE-V43SAU-1 (BOP)	Auxiliary feed pump suction check valve (TRW mission 8 inch wafer check).	Valve is normally closed. Valve opens when auxiliary feedwater is supplied by steam driven feed pump.	--	--	Closed	Specific concerns were resolved during the audit.
3CT-V885B-1 (BOP)	Containment spray additive valve. (Yarway 2 inch motor operated globe).	Valve normally closed. Valve opens to allow borated sodium hydroxide solution to go the containment spray water. Valve fails as is.	--	--	Closed	Specific concerns were resolved during the audit.
3SW-B1SA-1 (BOP)	Emergency service water intake screening structure isolation valve. (Jamesbury 30 inch motor operated butterfly).	Valve is normally open to allow flow from auxiliary water reservoir to ESW pump. Valve closes if main Reservoir is used as water source. Valve fails as is.	--	--	Closed	Specific concerns were resolved during the audit.
3AF-F3SA-1 (BOP)	Aux FW pump discharge flow control valve (Masoneilan 3 inch electro-hydraulic globe).	Valve is normally open. Valve closes to isolate S.G. FW header in event of rupture of FW header or main steam header. Valve fails open.	--	--	Closed	Specific concerns were resolved during the audit.
PIA-SA (BOP)	Emergency service water pump (Hayward Tyler 30 VSN vertical centrifugal 21500 GPM).	Pump is normally at standby. Pump starts automatically on loss of offsite power or upon safety injection signal. Pump supplies cooling water to equipment required for safe plant shutdown.	--	--	Closed	Specific concerns were resolved during the audit.

TABLE 3. (continued)

Plant I.D. Number	Description	Component Function	Findings	Resolutions	Status	Remarks
2MS-V95A (BOP)	Auxiliary feed pump turbine steam supply isolation valve (Anchor Darling 6 inch motor operated flex-wedge gate).	Valve is normally closed. Valve opens for operation of AFH pump turbine upon initiation signal. Valve fails as is.	--	--	Closed	Specific concerns were resolved during the audit.
3CC-V165 SA (NSSS)	Component cooling water to RIR IX isolation valve (Velan 12 inch motor operated gate).	Valve is normally closed to isolate CCH flow from RIR IX 1. Valve opens after event to pass flow through RIR IX. Valve fails as is.	Note <sup>a</sup>	Note <sup>b</sup>	Closed	Valve was qualified by analysis only. Applicant shall provide test data demonstrating the ability of this valve assembly to operate as required under its design load conditions. This issue was resolved by the applicant's letter dated January 27, 1986.
2WL-L600SA (NSSS)	Reactor coolant drain tank (RCDT) control valve (Copes-Vulcan 3 inch air operated globe).	Valve is normally open and controls level in RCDT by diverting water to boron recycle system. Valve closes to isolate the RCDT for its safety function. Valve fails closed.	--	--	Closed	Specific concerns were resolved during the audit.
APCC-1C-SAB (NSSS)	Component cooling water pump (Pacific DSK centrifugal 11000 GPM).	Pump is normally operating. Pump supplies component cooling water to various NSSS heat exchangers.	--	--	Closed	Specific concerns were resolved during the audit.
2SI-V579A (NSSS)	Cold leg injection and RIR return line isolation valve (Westinghouse 10 inch motor operated gate).	Valve is normally open in discharge line from RIR pump downstream of RIRX for cold leg injection and recirculation. Valve closes for containment isolation and hot leg recirculation. Valve fails as is.	--	--	Closed	Specific concerns were resolved during the audit.

TABLE 3. (continued)

Plant I.D. Number	Description	Component Function	Findings	Resolutions	Status	Remarks
--	ALL PUMPS AND VALVES IMPORTANT TO SAFETY	Operate as required during the life of the plant under normal and accident conditions	Note <sup>d,e,f,g</sup>	Note <sup>b</sup>	Open <sup>c</sup>	Generic issues "d, e, and f" were resolved by the applicant's letter dated January 27, 1986.

- a. (SPECIFIC ISSUE) The applicant did not provide any test data to qualify the valve. The applicant shall provide test data demonstrating the ability of this valve assembly to operate as required under its design load conditions.
- b. At the conclusion of the site audit, the PVORT summarized the specific and generic confirmatory issues, as well as the actions necessary to resolve them prior to fuel load.
- c. The qualification status will be "closed," upon resolution of the specific and generic confirmatory issues.
- d. (GENERIC ISSUE) At the conclusion of the PVORT audit, it was apparent that a complete list of active valves had not been provided in the FSAR. The applicant shall confirm that all active valves are correctly identified in the FSAR.
- e. (GENERIC ISSUE) Some pre-service tests required to be completed prior to fuel load have not yet been performed. The applicant shall confirm that all appropriate pre-service tests have been completed prior to fuel load.
- f. (GENERIC ISSUE) Some pumps and valves important to safety have not been completely qualified and installed. The applicant shall confirm that all pumps and valves important to safety are completely qualified and installed prior to fuel load. Also, the applicant shall confirm that the original loads used in tests and analyses to qualify pumps and valves important to safety are not exceeded by any new loads (i.e. design load reconciliation).
- g. (GENERIC ISSUE) The qualification of some safety-related equipment does not appear to be linked to any test data. The applicant shall (1) identify all safety-related pumps and valves qualified by analysis only; (2) justify the method of qualification; (3) describe how the analyses can demonstrate equipment operability, and (4) submit evidence that the Velan gate valves can be linked to qualification test data.

design load conditions. The applicant shall include a description of the test performed as well as the basis for establishing the similarity of the installed valve with the valve tested.

Resolution: Shortly after the audit the applicant explained in a January 27, 1986 letter that valve 3CC-V165 is not required to operate until approximately 20 minutes following a large LOCA. During the worst postulated event (LOCA and SSE), the valve is normally closed and will not receive any LOCA loads, only SSE loads. Since the valve disc will already be pressed firmly against its seat, the applicant predicts that the SSE loads will not adversely affect the functionality of the valve internals. This clarification of the valve's safety function plus the on-site review of the valve assembly analysis and valve actuator test reports provide confidence that valve 3CC-V165 will function as required. Therefore the specific confirmatory issue for valve 3CC-V165 is considered to be closed.

Generic Open Issue:

1. The applicant has not been able to provide qualification test data for Velan valves (12GM32SB and 6GM62FB) and Fisher Valve 18BM32. The staff suspect that the qualification of other safety-related equipment might not be linked to any test data as well. In order to resolve this issue, the applicant shall submit the appropriate information for staff review prior to fuel load.
  - a. Identify all safety-related pumps and valves that have been qualified by analysis only.
  - b. Justify the method of qualification, in lieu of providing verification by test.
  - c. Describe how the qualification analyses have been verified to demonstrate equipment operability.

- d. Submit evidence that the qualification of Velan gate valves can be linked to test data.

Evidence of qualification by testing can be submitted in the form of actual test reports for prototype equipment, or similarity analyses which reference existing test data. A copy of the test reports being cited by the applicant should be included for staff review.

Generic Confirmatory Issues:

1. At the conclusion of the PVORT audit, it was apparent that a complete list of active valves had not been provided in the FSAR. The applicant shall confirm that all active valves are correctly identified in the FSAR.

Resolution: In the January 27, 1986 letter the applicant committed to revise the FSAR table when the staff reviews are complete.

2. At the time of the audit, most construction tests had already been completed. However, the hot functional tests were scheduled to commence later in the month. The applicant shall confirm that all pre-service tests that are required before fuel load have been completed.

Resolution: In the January 27, 1986 letter the applicant committed to complete pre-service testing prior to power operation.

3. At the time of the audit, approximately 10 to 15 percent of all pumps and valves important to safety had not been qualified. The applicant shall confirm that all pumps and valves important to safety are properly qualified and installed. In addition, the applicant shall provide written confirmation that the original loads used in tests or analyses to qualify pumps and valves important to safety are not exceeded by any new loads, such as those imposed by a LOCA (Hydrodynamic loads) or as-built conditions.



Resolution: In the January 27, 1986 letter the applicant committed to complete the qualification of all safety-related active pumps and valves prior to fuel load.

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13. ABSTRACT (200 words or less) <p style="text-align: center;">           The Shearon Harris Nuclear Generating Station was audited December 3 to 6, 1985 to determine the adequacy of their Pump and Valve Operability Assurance Program. Four concerns (one specific and three generic), which could not be resolved by the close of the audit, were subsequently resolved by the applicant in his January 27, 1986 submittal. A new generic issue was identified involving the apparent lack of qualification test data for some safety-related equipment. The applicant has committed to address this concern prior to fuel load. The results of this audit indicate that the applicant has established and is implementing a program that will track all pumps and valves important to safety from manufacture and in-shop testing through qualification, installation, testing, maintenance and surveillance for the purpose of assuring continued operability of these components over the life of the plant.         </p>								
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