UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CAROLINA POWER AND LIGHT COMPANY AND	)	
NORTH CAROLINA EASTERN MUNICIPAL	)	Docket Nos. 50-400 OL
POWER AGENCY	)	50-401 OL
	)	
(Shearon Harris Nuclear Power Plant,	)	
Units 1 and 2)	)	

AFFIDAVIT OF ALECK W. SERKIZ IN SUPPORT OF NRC STAFF RESPONSE TO APPLICANTS' MOTION FOR SUMMARY DISPOSITION ON EDDLEMAN CONTENTION 45 (WATER HAMMER)

I, Aleck W. Serkiz, being duly sworn, state the following:

1. I am a Senior Task Manager in the Generic Issues Branch, in the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission.

2. I have held the above described position since April 1981 and have been responsible for managing efforts related to the resolution of the Unresolved Safety Issue A-1, Water Hammer.

3. I received my Bachelor or Science Degree in Mechanical Engineering from Clarkson College of Technology in 1956 and attended the University of Cincinnati graduate school in 1958-1960. I am also a registered Professional Engineer in Ohio and Pennsylvania.

4. Prior to joining the Generic Issues Branch, I was employed in Division of Reactor Safety Research, Office of Nuclear Reactor Research, NRC for 7-1/2 years in the position of Senior Nuclear Engineer, Section Leader and Branch Chief (Acting). During those years I planned and supervised experimental research programs directed at resolving thermal

hydraulic questions associated with the loss-of-coolant accident phenomena. I joined the Atomic Energy Commission in 1973, being employed by the Division of Reactor Licensing. Prior to government employment I was employed by Battelle Memorial Institute - Columbus Laboratories and by the General Electric Company. I have accumulated 27 years of experience in engineering, project management and supervision; 17 of those years have been in the private sector. Most of my experience has been related to power systems (both nuclear and non-nuclear), nuclear safety related research and reactor licensing.

5. I have been the Task Manager for the Unresolved Safety Issue (USI) A-1, Water Hammer for the past several years. In that capacity I have been responsible for directing technical evaluation activities regarding water hammer occurrences in nuclear power plants and for developing a Staff position regarding the safety implications associated with such water hammers. The Staff's technical findings are reported in NUREG-0927, Revision 1, "Evaluation of Water Hammer in Nuclear Power Plants," March 1984. These technical findings were used to revise portions of the Standard Review Plan to ensure continuance of established plant design features and operational procedures that have demonstrated the capability to minimize or avoid water hammer occurrence and severity. Implementation of these SRP changes will be for new CP's, current licensing reviews will be concluded through plant specific Staff evaluations in progress (see also NUREG-0993, Revision 1, "Regulatory Analysis for USI A-1, Water Hammer," March 1984.)

The Staff's findings can be summarized as follows:

(a) Total elimination of water hammer is not feasible due to the possible coexistence of steam, water, and voids in various subsystems. Experience shows that design inadequacies and operator- or maintenance-related actions have contributed about equally to water hammer occurrences. BWRs are intrinsically more susceptible to water hammer occurrence than PWRs.

(b) Reported damage has been principally confined to piping support systems, and none of the reported water hammer occurrences has resulted in any radioactive release.

(c) Frequency and severity of water hammer can be reduced and maintained low through the continued use of proven effective design features.

(d) Additional operator awareness and training could lead to a further reduction of water hammer occurrence. Use of void detection instrumentation to alert operators to voided conditions would also help.

6. I provide this affidavit in Response to the Applicant's Motion for Summary Disposition of Eddleman Contention 45 dated May 25, 1984. I have reviewed the Applicant's "Statement of Material Facts as to Which There Is No Genuine Issue to be Heard on Eddleman Contention 45" and the supportive affidavits. My comments which follow address the generic aspects of the Applicant's Motion.

7. With respect to the Applicant's selective quotations from NUREG-0927, Revision 1, the citations are correct; these were the Staff's findings. However to state: "The Staff does not, however, recommend the imposition of any new design or operational requirements for existing plants or plants under construction" (see p. 6) and to continue with: "The Staff further recommends some revisions to the Standard Review Plans for applications for construction permits docketed after publication of NUREG-0927, NUREG-0993 at 5." is an oversimplification, and overstatement of the results of the Regulatory Analysis contained in NUREG-0993, Revision 1. The Staff's recommendation regarding

the need for SRP revisions (see p. 5 of NUREG-0993, Revision 1) is as follows:

> "Issue the following revisions to Standard Review Plan (SRP) Sections: 3.9.3, ASME Code Class 1, 2, and 3 Components, Component Supports, and Core Support Structures; 3.9.4, Control Rod Drive Systems; 5.4.6, Reactor Core Isolation Cooling System (BWR); 5.4.7, Residual Heat Removal (RHR) System; 6.3 Emergency Core Cooling System; 9.2.1 Station Service Water System; 9.2.2, Reactor Auxiliary Cooling Water Systems; 10.3, Main Steam Supply Systems; and 10.4.7, Condensate and Feedwater Systems reflect current water hammer findings and will ensure continued use of design features which have eliminated or minimized water hammer occurrence. Public comments received have been reflected in these SRP revisions (see Appendix A). The revised SRPs would be used for reviews of "custom plant" Construction Permit (CP) applications and for reviews of Standard Plant applications docketed after issuance of the revision and which are intended for referencing in CP applications."

8. The principal safety significance rests primarily on the continuance of established plant design features and operational procedures which have evolved and demonstrated the capability to minimize or avoid water hammer occurrence and severity, thereby avoiding damage which might lead to radioactive release. The Staff concluded that such design features and procedures were being utilized and that plant specific reviews underway by the Staff would provide the means to conclude licensing evaluations -- thus there was not a need to "back fit" revised review procedures, such as the revised SRPs noted above. The Staff did not feel that the potential for water hammer occurrence should be left unaddressed.

9. The principal Shearon Harris plant systems (and components) which should have been designed with water hammer considerations in mind

are the: main steam (particularly the steam generator), the main and auxiliary feedwater systems (and their control systems), the ECCS and pressurizer relief valve design. The design of such systems has been addressed to varying degrees in the Applicant's submittal and supporting Affidavits.

10. The Shearon Harris steam generators (SGs) are Westinghouse Model D-4 SGs and are characteristically called "bottom feed," or "preheat" steam generators. The occurrence of water hammer in "top feed ring" SGs is not uncommon and the underlying cause is drain down of the feed ring, filling of the feed ring with steam followed by injection of cold FW or AFW which results in rapid condensation and a steam-water hammer. The SHNPP SGs are not susceptable to such feed ring drainage since the main FW entry is at the preheater located at the bottom. AFW is provided through a AFW nozzle above the U-tubes (see Attachment 1 of the Carlson Affidavit). Thus, if the boundary is drawn around <u>just</u> the SGs, water hammer occurrence is unlikely.

11. However, any SG in a PWR configuration is supplied with makeup water by the FW and AFW systems, and thus the potential interaction of steam with cold water is possible. Operation of the SHNPP SGs relies on AFW flow up to approximately 15% full power, at which time main FW (through the preheater) is established. It is following this transfer from AFW to main FW that the potential for setting up water hammer conditions in the AFW could occur. The use of continuous warming flow (through the AFW line) can prevent buildup of steam. Although no such water hammer has occurred in U.S. plants with preheat SGs, the KRSKO plant in Yugoslavia (which has Westinghouse D-type SGs) experienced a

water hammer in July 1981 during preoperational testing. The cau[illegible] attributed to back leakage of steam through faulty check valves i[illegible] feedwater systems and possibly poor operational controls.

12. The SHNPP has both design features and operational proc[illegible] to minimize, or prevent water hammer in the SG and FW systems; these are:

a. Operating criteria for controlling AFW and main FW during power ascension and during plant unloading (see page 2 of J. M. Collins' affidavit).

b. Design features such as temperature sensors located on the AFW piping to monitor any leakage in the AFW system from the main FW systems, plus the alarming of such sensors in the control room (see Paragraph 17 of D. Shah's affidavit).

c. Westinghouse recommends (see Paragraph 42 of R. W. Carlson's affidavit) that during heatup, cooldown and hot standby conditions, relatively small amounts of feedwater be supplied to the SG by the AFW system through the auxiliary nozzle.

13. The avoidance of steam and cold water in the AFW system will minimize or preclude occurrence of any water hammers; the above features appear capable of achieving this goal.

14. The NRC does view the potential for water hammer in the SG/feedwater systems as real and does require a preoperational test to verify the absence of water hammer under simulated plant upset conditions, or power transfer transients. The Staff's views are contained in Branch Technical Position ASB 10-2, "Design Guidelines for Avoiding Water Hammers in Steam Generators," SRP Section 10.4.7, "Condensate and Feedwater System."

15. The Applicant has agreed to follow the guidance in BTP ASB 10-2 as indicated in Section 10.4.7 of the Shearon Harris SER. In

addition, the Applicant (in response to Staff question 410.19, 10.4.7) added a Steam Generator test, for Condensation Induced Water Hammer (see FSAR Amendment No. 4, Item 14.2.12.2.31). Thus, the Applicant's statement on page 7 of this Motion: "that there have been no NRC requirements with respect to design or testing for water hammer." is incorrect. The Staff views the Applicants submittal in Amendment 4 to the FSAR as a commitment and will follow the results of that test address the potential for water hammer in the SHNPP steam generators and feedwater systems. Item 22 of C. S. Hinnant's Affidavit, appears to also support the Applicant's commitment.

16. Therefore, it appears that the Applicant has taken the necessary design and operational steps to minimize condensation-induced water hammer in the SG/Feedwater systems based on NRC's generic evaluation of water hammer occurrences.

17. The design of main steam systems and feedwater systems should include consideration of water hammer loads. Main steam stop valve and turbine stop valve closures can lead to significant dynamic loads on piping supports. Water hammers have occurred in PWR main steam systems.

18. Feedwater and feedwater control systems also require dynamic load considerations. Feedwater control valve (FCV) flow instabilities and flow control controller mismatches have resulted in water hammer occurrences in PWRs in the early and mid-1970's.

19. The SHNPP design has considered both dynamic and water hammer loads as evidenced by D. Shah's affidavit. The design and analysis considerations noted do address the more probable water hammer events in main steam and feedwater systems and this approach is consistent with

NRC's guidance provided in SRP Section 3.9.3; that is the use of design specifications (for the various systems) identify the major dynamic loads to include in the system design specifications.

20. The probability of water hammer occurrence in PWR ECC systems is very low. Only four such occurrences have been reported for PWRs. Those water hammers occurring between 1968 and 1973. Pump startup into voided lines and improper operating procedures were the underlying causes; damage was limited to pipe hangers and restraints. Only in 1 of the 4 occurrences was the plant in the normal operating state; none have been reported since.

21. The need to design for potential voided line conditions and for venting provisions are addressed in the supportive affidavit of R. W. Carlson (see paragraphs 47 and 48) and D. Shah (paragraph 18). Mr. Shah states that Westinghouse design recommendations have been implemented in the SHNPP ECCS. Therefore it appears that the applicant has taken the necessary design considerations and precautions to prevent, or minimize the formation of voids in the ECCS systems; these design precautions being consistent with NRC's generic assessment of water hammer occurrence and prevention thereof.

CONCLUSION

22. In conclusion, the generic findings resulting from USI A-1 support the Applicant's motion for summary disposition of Eddleman Contention 45 provided that the plant design features and operational

procedures identified in the Applicant's submittal and supportive Affidavits are incorporated in the SHNPP design and operation.

Aleck W. Serkiz

Subscribed and sworn to before
me this 2nd of July, 1984

Notary Public

My commission expires: 7/1/86