Arizona Nuclear Power Project
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November 28, 1984
ANPP-31255-TDS/TRB

U. S. Nuclear Regulatory Commission
Region V
1450 Maria Lane - Suite 210
Walnut Creek, California 94596-5368

Attention: Mr. D. F. Kirsch, Acting Director
Division of Reactor Safety and Projects

Subject: Final Report - DER 84-83
A 50.55(e) Reportable Condition Relating To Cavitation In The HPSI 'A' Injection Lines.
File: 84-019-026; D.4.33.2

Reference: A) Telephone Conversation between C. Sorenson and T. Bradish on October 10, 1984
B) ANPP-31072, dated November 6, 1984 (Interim Report)

Dear Sir:

Attached is our final written report of the deficiency referenced above, which has been determined to be Not Reportable under the requirements of 10CFR50.55(e).

Very Truly Yours,

EEVanBrunt/DSK

E.E. Van Brunt, Jr.
APS Vice President
Nuclear Production
ANPP Project Director

EEVB/TRB/nj
Attachment

cc: See Page Two

IE-27

cc: Richard DeYoung, Director
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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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FINAL REPORT - DER 84-83
DEFICIENCY EVALUATION 50.55(e)
ARIZONA PUBLIC SERVICE COMPANY (APS)
PVNGS UNITS 1, 2, 3

I. Description of Deficiency

During flow verification testing of the High Pressure Safety Injection (HPSI) System per test procedure 93PE-1SA01, cavitation was detected both audibly and visually (vibration) in the vicinity of the Train "A" injection orifices and injection valves. This condition was documented by Nonconformance Report (NCR) SM-4964.

The three areas of concern associated with cavitation in the HPSI system are its effect on a) the piping system pressure integrity, b) the ability of the system to deliver the required flow, and c) the injection valve operation. The HPSI system is required to deliver water to the reactor coolant system (RCS) during a loss of coolant accident (LOCA).

Evaluation

Evaluation of this condition revealed that the root cause of cavitation was the bore size of the injection orifices 1JSIAF043, 45, 47, and 49. Each of the orifices are sized to deliver injection water to the RCS at 277 gpm.

The HPSI system was originally designed with throttling globe valves to be used for flow control. Any imbalance in the measured flow for the four (4) injection lines (per loop) due to differences in their routing configuration was to be adjusted by the addition of balancing orifices upstream of the valves. It was demonstrated during startup testing that valve limit switch settings were not reliable. Therefore, flow measurement repeatability could not be accomplished. Hence, the balancing orifice plates were resized to control the flow. This allowed the valves to be fully open in the injection mode. Changing the orifice diameter from approximately 1.35 inches for flow balancing to approximately 0.74 inch for flow control resulted in an increase of the flow velocity in the bore from 63 FPS to 209 FPS, with cavitation occurring in the downstream piping. The orifice is located upstream of a 90 degree elbow. In all eight injection lines this distance is approximately five inches, hence, the elbow is subjected to forces causing cavitation.

The above condition is generic to Train "A" and Train "B" in each unit. The subject orifices in Train "B" are 1JSIBF044, 46, 48, and 50.

Fiberscopic inspection of all eight elbows and downstream piping in Unit 1 revealed no significant cavitation damage. The most severe cavitation damage was expected to occur at the elbow. Subsequently all eight of the elbows were temporarily cut out of the system while implementing the corrective action initiated to resolve a different problem associated with the injection valves (Reference DER 84-81). Visual inspection, per NCR SM-4964, revealed slight cavitation damage in five of the elbows. Typically, the damage consisted of shallow pitting of negligible depth.

Evaluation of this condition has determined that cavitation will not impair the integrity of the system during the injection mode. This conclusion is based on:

> Cavitation damage is time-related. The material and wall thickness of the piping (Schedule 160 stainless steel pipe) and the relatively short duration that the cavitation may exist (maximum three hours, Reference CESSAR Fig. 6.3.3.4-1) would result in only minor damage.

In addition to cavitation damage, the small orifice bore results in a reduction in HPSI flow to the RCS during short-term recirculation due to choking. The required flow rate of 277 gpm has been verified during preoperational testing using relatively cool water from the Refueling Water Tank (RWT). However, under accident conditions, the HPSI pump suction transfers from the RWT to the containment recirculation sump on low RWT level. The temperature of the water is much higher in this mode (short-term recirculation). The higher temperature water and small orifice bore results in choked flow lower than 277 gpm. Combustion Engineering (C-E) has performed a detailed analysis to determine the extent of the reduction in flow. C-E's analysis indicates that the reduced flow rate would be approximately 270 gpm. This reduction does not represent a significant safety condition (Reference 3 and 4). Upon initiation of long term recirculation, the required flow through the injection orifices is reduced and cavitation/choking is not a problem.

Another area of concern is the affect of cavitation on the operation of HPSI valves. While troubleshooting the Unit 2 HPSI valves, a considerable amount of torque switch contact vibration was noticed. The contact vibration was attributed to cavitation induced vibration in the piping system. Further testing with the orifices removed revealed that the problems with the vvalves (subject of DER 84-81) were nearly the same with or without vibration. Therefore, cavitation induced vibration is not considered a major contributor to the operational problems with the HPSI valves.

II. Analysis of Safety Implications

Based on the above, this condition is evaluated as not reportable under the requirements of 10CFR50.55(e) and 10CFR Part 21; since, if this condition were to remain uncorrected, it would not represent a significant safety condition.

III. Corrective Action

Although it has been determined that this condition, if gone uncorrected, would not represent a significant safety condition, corrective actions will be taken to improve the design.

DCPs 1SM, 2SM and 3CM-SI-150 have been issued to modify the design including the addition of orifices downstream of the existing orifices and the injection valves. This modification will reduce cavitation and the pressure drop across the injection valves, thereby assisting in resolving operational problems with the valves (subject of DER 84-81).

IV. References

1. Letter V-CE-31206, October 23, 1984

2. SFR 1SI-279, October 20, 1983

3. Letter V-CE-31203, October 22, 1984

4. Letter V-CE-31392, November 16, 1984