UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO CODE ALTERNATIVE TO SECTION III OF THE ASME CODE

ARIZONA PUBLIC SERVICE COMPANY

PALO VERDE NUCLEAR GENERATING STATION, UNITS 1, 2 AND 3

DOCKET NOS. STN 50-528, STN 529, AND STN 530

1.0 INTRODUCTION

By letter dated June 25, 1998, as supplemented by letters dated July 10 and July 17, 1998, and March 5, 1999, Arizona Public Service Company (APS or the licensee) requested NRC approval of a proposed alternative to Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code in accordance with 10 CFR 50.55a(a)(3) for Palo Verde Nuclear Generating Station (PVNGS), Units 1, 2 and 3.

The licensee's proposed alternative is part of a design modification to the chemical and volume control system (CVCS) to improve overall system performance. To accomplish this, the licensee plans to replace the existing flow sensors with Coriolis type flow detectors, which are capable of reliably measuring low flow rates. Because the design of this type of flow measurement device involves 100 percent of line flow passing through the instrument, the proposed flow measurement instrument will also have a pressure retaining function.

2.0 DISCUSSION

The CVCS allows the operator to control reactor coolant system (RCS) inventory and adjust RCS boron concentration. While the system has generally performed as designed, several operational problems have occurred with this equipment in the past. Most of the problems were attributed to an original design limitation that neither the borate nor non-borate flow control loops can reliably control the process at flow rates below approximately 17 gpm. As a consequence, operators have had difficulty establishing a smooth power ascension rate after refueling because fuel preconditioning limits typically require dilution flow rates less than 10 gpm. In addition, at end of cycle, RCS boron concentration is so low that boration flow rates of less than 5 gpm are needed to prevent reactivity excursions during automatic makeup to the volume control tank (VCT). The licensee proposes to replace the existing flow sensors with Coriolis type flow sensors, which are capable of reliably measuring low flow rates.

The new flow detection instruments were purchased as commercial grade because there are no equivalent flow sensors available for purchase that are designed and manufactured in accordance with ASME Code, Section III requirements. The licensee has taken steps to ensure that the level of quality associated with the Coriolis type flow detector design, manufacture, and testing is comparable with ASME Code, Section III, Class 3 requirements. The licensee's basis for requesting staff approval pursuant to 10 CFR 50.55a(a)(3) is that the proposed alternative provides an acceptable level of quality and safety.

3.0 EVALUATION

The existing 2-inch piping line in which each flow sensor will be installed (two flow sensors per unit) was designated as ASME Code, Section III, Class 3 component, with a design pressure rating of 150 psig. The existing piping will be cut, allowing approximately a two-foot gap for the flow meter to be installed. The pipe ends will be modified to allow flanged fittings. Pipe flanges and associated bolting will be ASME Code, Section III qualified material and the flow sensors will be installed per PVNGS' ASME Code, Section XI Repair and Replacement Program, 1992 Edition, 1992 Addenda. The licensee stated in its submittals that the appropriate editions of the ASME Code, Section XI will be used to install the proposed flow sensors, ASME Code, Section IX will be used to perform and control all welding activities, and ASME Code, Section V will be used to conduct the required non-destructive examination (NDE). No staff evaluation of these activities is required, since compliance with these ASME sections meets 10 CFR 50.55a requirements.

Section 50.55a(e)(1) of Title 10 of the Code of Federal Regulations requires components classified as Quality Group C meet the requirements for Class 3 components in Section III of the ASME Code. However, the licensee cannot meet the requirements of Section III of the ASME Code for the Coriolis type flow instruments because the flow sensor is available only as commercial grade. The staff's evaluation focused on the activities conducted by the licensee to show that an adequate level of quality and safety exists in the design and manufacturing of the proposed flow sensors to perform their intended safety function. Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee requests staff approval of the new flow instrument based on it providing an acceptable level of quality and safety.

The only reason why the section of 2-inch piping where the proposed flow sensors will be installed was classified as an ASME Class 3 component was because of its RCS pressure boundary integrity function. Both the original and the proposed design have the same function of providing a flow path for borated water through the normal reactor coolant makeup system. This portion of the makeup system performs no active safety-related function and under emergency conditions, this section containing the flow sensor is bypassed and alternate emergency boration paths are used to supply borated water to the suction of the charging pumps.

The consequences of a postulated break in this portion of the makeup system are not changed by the installation of the new flow sensor, since the maximum break size and actions needed to isolate this section of piping remain the same. The effect of a break in this portion of the makeup system on plant safety is minimal since 1) the plant operators have redundant and diverse methods of detecting and isolating a break in this section of piping, 2) the amount of reactor coolant that could be lost before the system can be isolated is relatively small and

bounded by the design basis Loss-of-Coolant Accidents evaluated in the Updated Final Safety Analysis Report and 3) the temporary loss of one or two charging pumps would not adversely impact plant safety. The charging pumps are not credited in the short-term for any design basis event, and the staff concludes that sufficient time is available to restore the charging pumps to support its function in the long-term recovery from a natural circulation event.

Since this portion of the makeup system has no active safety function and the consequences of a break in the 2-inch piping or flow sensor is minimal, the staff considers this system to be of low safety significance.

The actions taken by the licensee to establish an acceptable level of quality in the design and manufacturing of the flow sensors are intended to demonstrate that the likelihood of a postulated break in this portion of the makeup system is not significantly increased. The staff's review of the material selection, reconciliation and dedication processes used by the licensee to demonstrate the adequacy of the flow sensors' pressure boundary function is listed below.

The material specifications selected by the licensee for the flow sensor's pressure boundary material are as follows:

> Flow tubes – ASTM A269-96, Grade 316L, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service. The manufacturer only uses seamless tubing.
>
> Manifold – ASTM A351-94a, Grade CF3M, Standard Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure Containing Parts.

The staff compared these ASTM standards to the ASME material standards that would be used if the flow sensor was constructed in full conformance with ASME Section III. This comparison reveals that the ASTM chemical composition requirements are identical to the appropriate ASME material specifications. ASTM A269-96, Grade 316L corresponds to ASME SA-213, Grade TP316L, and ASTM A351-94a, Grade CF3M corresponds to ASME SA-351, Grade CF3M. The staff concludes that the materials selected by the licensee are appropriate for the service conditions the flow sensors will be exposed to, and therefore are acceptable materials to perform the pressure boundary safety function of the instruments.

The differences between compliance with the ASTM standards and the ASME standards are that the ASME material traceability requirements are more rigorous. In lieu of meeting the additional ASME material traceability requirements, the licensee has taken a number of steps to dedicate the pressure boundary portions of the flow sensors in order to demonstrate that an acceptable level of quality is assured in the final product.

The dedication process utilized by the licensee was reviewed for acceptability in accordance with 10 CFR Part 21. Section 21.3, "Definitions," of 10 CFR Part 21, "Reporting of Defects and Noncompliances," provides discussion on the appropriate methodology for the dedication of commercial grade items used as basic components in nuclear power plants licensed pursuant to 10 CFR Part 50. Further, 10 CFR Part 21 states, in part, that dedication is an acceptable process undertaken to provide reasonable assurance that a commercial grade item to be used as a basic component will perform its intended safety function and, in this respect, is deemed

equivalent to an item designed and manufactured under a 10 CFR Part 50, Appendix B, quality assurance program. This assurance is achieved by identifying the critical characteristics of the item and verifying their acceptability by inspections, tests, or analyses performed by the purchaser or third party dedicating entity after delivery, supplemented as necessary by one or more of the following: commercial grade surveys; product inspections or witness at holdpoints at the manufacturer's facility, and analysis of historical records for acceptable performance. In all cases, the dedication process must be conducted in accordance with the applicable provisions of 10 CFR Part 50, Appendix B. The process is considered complete when the item is designated for use as a basic component.

Listed below are the relevant steps taken by the licensee to show compliance with the dedication requirements of 10 CFR Part 21.

1. Material of Construction

The following actions will be taken to verify that the material specifications of the flow sensor are in compliance with the subject ASTM standards. APS plans to obtain original Certified Material Test Reports (CMTRs) for the replacement instrument's pressure boundary parts and to maintain traceability of the material at the facility fabricating the replacement instrument. For the castings used, APS plans to (a) purchase an additional casting from the same heat and lot as those used to construct the instrument, and perform physical tests and chemical analyses on this item; (b) perform alloy analyzer analysis on the castings to be used; (c) perform a liquid penetrant examination of each casting used; (d) obtain the manufacturer's CMTRs for the castings; and (e) have a knowledgeable and experienced metallurgical engineer review this data to verify that the material complies with the material specification, that the items are from the same heat and lot, and that there are no "outliers" which exist that are suspect of not being from the same material heat. For the instrument tubing used, APS has stated that the flow tube material will be verified by chemical testing and hardness tests, and will subject the tube material to a hydrostatic test pressure of 2175 psig. The other tests required by ASME Standard SA-213 are not considered necessary by the staff because the end-use of the tubing is in a low-safety-significant application. A second pressure test will be conducted after the flanges are attached at twice the flange rating, or 300 psig, to ensure the flange welds are acceptable per ASME Code, Section III requirements. In addition, APS has stated that all pressure boundary material (flow tube and manifold castings) will be supplied from the same heat and lot number and that material heat marking will be verified. APS has verified, by performing a commercial grade survey of the materials manufacturer's facility, that the manufacturer adequately maintains material traceability. The testing and analyses will be performed at an APS approved laboratory having an approved 10 CFR Part 50, Appendix B quality assurance program. Acceptance criteria for all NDE shall be per 1974, Winter 1975 Addenda, ASME Code, Section III, requirements. NDE procedures and qualifications will be per ASME Code, Section V.

NCA-3800, "Metallic Material Organization's Quality System Program," of ASME Code, Section III contains provisions for upgrading material and permits, in part, the acceptance of the non-qualified manufacturer's certification for material. The dedication methodology and controls proposed by APS are not equivalent to the methodology and

controls contained in NCA-3800 of ASME Code, Section III because the material used to construct the pressure boundary portion of the instrument is not subjected to all of the tests and analyses contained in NCA-3800. However, the staff considers the activities performed by APS to be acceptable. Based on the earlier discussion of the safety function of the flow sensors, it has been determined that the pressure boundary function of the replacement instrument is of low safety significance and therefore the graded quality assurance controls addressed in NRC Regulatory Guide 1.176, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Graded Quality Assurance," can be applied. Although the technical requirements (such as the identification of critical characteristics) are not subject to grading, the verification of critical characteristics may be graded for items of low safety significance. Therefore, because the instrument's pressure boundary function has been identified as low safety significance, the staff considers the methods proposed by APS to verify the critical characteristics to be acceptable and provides reasonable assurance that the instrument will perform its pressure boundary function.

2. General Configuration

Verification will be by a combination of methods such as by commercial grade survey, source inspection, and receipt inspection.

3. Welding of Pressure Boundary Components (by the manufacturer)

APS will supply the weld filler material to the instrument manufacturer for welding the pressure boundary items in accordance with the licensee's 10 CFR Part 50, Appendix B, quality assurance program and will conduct source inspection for the welding activities. APS has stated that the welding procedure specifications (WPS) and welders will be qualified in accordance with Section IX of the ASME Code. Additionally, APS will review and approve all WPSs, the procedure qualification records for the WPSs, and the welder's qualification records. APS plans to verify this critical characteristic by a combination of methods including a commercial grade survey and source inspection.

4. NDE (Liquid Penetrant and Radiography)

APS has stated that the flow sensor tubing welds will be full penetration butt-welds and will be radiographed by the manufacturer and accepted using the acceptance criteria for Class 3 components contained in ASME Code, Section III, 1974, Winter 1975 Addenda. Additionally, surface liquid penetrant examinations will be required to be performed on all welded surfaces. This testing will be performed by the manufacturer with APS surveillance. Further all nondestructive examination procedures will be qualified in accordance with Section V of the ASME Code and personnel performing NDE will be qualified in accordance with ASNT-TC-1A-1992 Edition. As previously stated, APS plans to perform a surface liquid penetrant examination on all castings used to fabricate the instrument. APS plans to verify this critical characteristic by a combination of methods including a commercial grade survey and source inspection.

5. Hydrostatic Testing, Including Water Quality and Cleaning

   APS plans to subject the flow meters to two hydrostatic tests. The first test is without the flanges at 1.5 times the flow tube pressure rating (2175 psig) for 10 minutes and the second time after the flanges are attached at 1.5 times the flange rating (minimum of 300 psig). APS has previously performed independent water quality verification for halogens for the hydro-test and found the water quality to be acceptable. The water to be used for hydrostatic testing during the manufacturing process will also be tested. APS plans to verify this critical characteristic by a combination of methods including commercial grade survey, source inspection, and testing.

6. Design Control Process, Nonconformance Control, and Metrology

   The design control, nonconformance control, and metrology processes and associated activities for the construction of the replacement instrument were evaluated during the performance of a commercial grade survey. APS found that the manufacturer of the instrument adequately implemented controls in accordance with its QA program and implementing procedures, and that the level of detail in the procedures was satisfactory. The commercial grade survey concluded that the involvement of the supervisory and engineering support personnel resulted in an adequately controlled system for these activities and produced reliable quality results.

The staff has evaluated APS's proposed commercial grade item dedication methodology and controls and concludes that they meet the applicable requirements contained in 10 CFR Part 21.

Further, by letter dated March 5, 1999, APS has indicated that no technical specifications are affected by this modification, and that no unreviewed safety question exists as defined in 10 CFR 50.59; accordingly, a license amendment is not required.

4.0 CONCLUSION

The staff concludes that the licensee has provided an acceptable alternative to the replacement requirements of Section III of the ASME Code. Therefore, the licensee's proposed alternative provides an acceptable level of quality and safety and is authorized pursuant to 10 CFR 50.55a(a)(3)(i).

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