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Subject: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
Westinghouse Steam Generator Tube Mechanical Plugs

Gentlemen:

On January 31, 1995, Entergy Operations submitted an action plan to repair the Westinghouse Alloy 600 mechanical ribbed plugs installed in the Arkansas Nuclear One, Unit 1 and 2 (ANO-1 and ANO-2) steam generators. Entergy Operations committed, at that time, to complete repairs to the plugs installed in the hot legs of the Unit 1 Once Through Steam Generators (OTSGs) by 1997. Completion of repairs for the plugs located in the OTSG cold legs was to occur prior to the end of their service life, which was calculated to be year 2038 for 40 of the plugs and year 2040 for the remaining 31 plugs.

On October 10, 1995 (0CAN109503), Entergy Operations submitted a revised action plan for repairs to the Westinghouse plugs. At that time, the ANO-1 steam generators contained 12 hot leg plugs and 71 cold leg plugs and the revised plan was for completion of repairs to the hot leg plugs by the end of 1996 and the cold leg plugs by the end of 2000. Repairs to the hot leg plugs were completed during refueling outage 1R12 (1995). The purpose of this letter is to provide notification that Entergy Operations has deferred repairs to the 71 cold leg plugs that are installed in the ANO-1 steam generators. The basis for this deferral is provided in the following discussion.

All of the Westinghouse ribbed plugs on the hot legs have been machined out and repaired with a remote welded plug. There are currently 71 Westinghouse ribbed plugs located in the cold legs of the OTSGs (64 in "A" and 7 in "B"). Since primary water stress corrosion cracking (PWSCC) is initiated as a function of operating temperature, the cold leg plugs are less susceptible to cracking. Westinghouse analysis estimates that the effects of temperature on Alloy 600 material renders the cold leg plugs 6 to 10 times less

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susceptible to PWSCC than those located in the hot leg. Visual inspections performed during refueling outages 1R14 and 1R15 indicated no signs of leakage from the Westinghouse ribbed plugs.

The current repair process for a Westinghouse ribbed plug is to machine the plug/tubesheet face, then install a remote welded plug. This process is very dose intensive and requires additional personnel to support the outage due to the dose considerations. Framatome and Entergy Operations are currently qualifying a "plug a plug" (PAP) process which could reduce some of the additional support requirements and result in a substantial dose reduction benefit.

The ANO-1 OTSGs contain Westinghouse ribbed plugs manufactured from only one heat of material, NX-2387. In 1988 Westinghouse classified the microstructures of the plugs in inventory and conducted corrosion testing. It was concluded that heat NX-2387 possessed the preferred grain boundary carbide structure. Furthermore, WCAP-12245, Revision 3; Addendum 3 to Steam Generator Tube Plug Integrity Report, January 1995 identified Westinghouse ribbed plugs manufactured from heat NX-2387 as the least susceptible to PWSCC.

Only one instance of leaking plugs in cold legs has been identified. Calvert Cliffs Unit-2 observed three plugs that had boric acid build up, all were from heat NX-3513. As stated above, in 1988 Westinghouse classified the microstructures of the plugs in inventory and conducted corrosion testing on several plugs. The results were consistent with the anticipated performance based on the microstructural work. Heat NX-2387 which possessed the preferred grain boundary carbide structure, lasted over sixteen (16) times longer than heat NX-3513, which was characterized by relatively few grain boundary carbides.

Two primary plug failure considerations were evaluated for the basis of deferral of the Westinghouse cold leg plug repairs; plug end release and primary to secondary leakage. An ANO Plug End Release Engineering Evaluation and Test Program Summary report was completed by Westinghouse to aid Entergy in this evaluation. Should a circumferential crack develop in a mechanical plug, leakage is expected to occur past the plug into the inactive tube, equalizing pressure across the plug and precluding plug end release. Another primary deterrent for a plug end release to cause a gross failure is the presence of partial depth roll expansion which precludes plug end release for those plugs installed such that the expander has passed two contact lands. If plug end separation occurs at the second plug land or higher, the plug end will remain lodged within the immediate region of the roll transition depths provided. Additionally, the Westinghouse report identifies that the travel distance of any released plug end in SG's with partial depth rolled tubes is limited to approximately 1 inch under all circumstances. The energy available would be insufficient to force the plug end past the expansion transition of the tube; thus the requisite conditions for perforation of the parent tube are not present. The travel distance would be expected to be negligible owing to the roll length being only

slightly greater than the length of the first top land of the plug. The wedging effect in the expansion transition would likely limit leakage past the plug top to some small amount.

The worst case consequence would be primary-to-secondary leakage through the plug orifice. The leak rate of the expected condition has not been quantified; however, the path through the combination of the expander and a lodged plug top is tortuous and would result in a significantly reduced amount. Primary-to-secondary leakage is monitored with the N16 detectors, main steam line high range radiation monitors, condenser off-gas samples, and condenser off-gas radiation monitor. In the event leakage is detected that exceeds administrative and/or a TS limit, guidance for safe shutdown of the plant is provided in the plant Abnormal and Emergency Operating Procedures.

The integrity of the existing tubes that contain these plugs also adds assurance of small leakage rates in case the plug did fail. A review of the ANO-1 eddy current database was performed and it was observed that the majority of the indications that caused the 71 tubes to be plugged were located in the upper tubesheet. (Note: All of the upper tubesheet (hot leg) Westinghouse plugs have been replaced). Based on pulled tube results and historical information these indications are likely outer diameter intergranular attack (ODIGA). Recent evaluations for ODIGA indicate the extremely low propensity for ODIGA to propagate throughwall and an associated low likelihood of leakage. Therefore, if a cold leg plug did crack there is a low probability that it contains a tube with a 100% throughwall flaw that could challenge leakage limits.

Predictions of plug lifetimes were originally based on an algorithm which calculated the time from installation to when a 360 degree crack could proceed throughwall to a point where remaining plug ligament is sufficient to support a pressure differential of 2650 psig without relying on any support from the tube. Subsequent industry experience has resulted in a revision to the Westinghouse recommended corrective action plan. In lieu of providing estimates for remaining plug life (e.g. revising the algorithm) a ranking was provided that implemented a proactive graduated approach. Three categories were established with Category 1 plugs having a projected repair date less than or equal to the year 2000. Category 2 plugs have projected repair dates ranging from 2001 to 2005. Category 3 plugs have projected repair dates greater than the year 2005. The 71 Westinghouse ribbed plugs remaining in the ANO-1 OTSGs are classified as Category 3 plugs with projected repair dates greater than 2005 (reference WCAP-12245, Revision 3, Addendum 3 to Steam Generator Tube Plug Integrity Report, January 1995). The replacement schedule of 2000 for all Westinghouse ribbed plugs was based on the recommended schedule contained in Addendum 4 to WCAP-12245, May 1995. The more aggressive schedule was primarily due to the uncertainty in plug failure predictability. However, the report recognizes that plug replacement schedules may be revised based on continuing field observations. Even though a deferral of repairs will extend the conservative WCAP repair date, it will not extend the in-service time for the ANO-1 Westinghouse ribbed plugs beyond their predicted lifetime.

In summary, Entergy Operations regards a deferral of repairs to Westinghouse ribbed plugs to be acceptable when considering the lower susceptibility to PWSCC of plugs manufactured from heat NX-2387, their location in the lower temperature area of the OTSGs, and the low consequence in the event of a plug end release. ANO will continue to visually inspect these plugs during each refueling outage to ensure that no leakage path exists on any of the Westinghouse Alloy 600 ribbed cold leg plugs. If operational leakage is observed, actions will be taken in accordance with the ANO-1 Technical Specifications.

If you should have any questions please contact me.

Very truly yours,

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