ARKANSAS POWER & LIGHT COMPANY
POST OFFICE BOX 551 LITTLE ROCK, ARKANSAS 72203 (501) 371-4000

November 27, 1984

1CAN118413

Director of Nuclear Reactor Regulation
ATTN: Mr. J. F. Stolz, Chief
Operating Reactors Branch #4
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
ANO-1 Reactor Vessel
Internals Bolting

Gentlemen:

This letter is to apprise you of the results of reactor vessel internals bolting inspections and replacements completed during the sixth ANO-1 refueling outage which is currently nearing completion. During the current outage AP&L completed UT inspections of the core guide block bolting and the five reactor vessel internals bolting rings, including the upper and lower thermal shield bolts, accessible flow distributor bolts, and the upper and lower core barrel bolts. In addition to these inspections, the upper core barrel (UCB) bolt ring was replaced with bolts of an improved design. These inspections and replacements were a result of bolt failures observed at other Babcock and Wilcox plants and previous ultrasonic testing (UT) indications on seven (7) of the one hundred twenty (120) upper core barrel bolts at ANO-1. These actions were consistent with the recommendations of the Babcock and Wilcox Owners Group (BWOG) Bolting Task Force previously established to deal with this issue. Further details of these previous events are discussed in AP&L letter 1CAN058302 dated May 11, 1983, and BWOG Bolting Task Force reports BAW-1174 dated May 1983 and BAW 1789 dated August 1984.

The UT examinations conducted during the current outage resulted in no indications with the exception of the seven (7) UCB bolt indications previously observed. AP&L chose, however, to proceed with replacement of the entire UCB bolt ring in order to completely preclude concerns for future bolt failures. One hundred fourteen (114) of the one hundred twenty (120) UCB bolts were successfully replaced with bolts of an improved design;

8412100035 841127
PDR ADOCK 05000313
P PDR

A001

however, due to difficulties during the replacement effort, new bolts were not installed in six bolt locations. One bolt location was left vacant due to extensive thread damage and the remaining five (5) locations have original bolt shanks left in place. Details of the status of each of these six (6) locations are provided in Attachment I. In those cases where a bolt shank was left in place, the locking clips have been modified to provide required locking capability and ensure the remaining portion of the stuck bolts will be retained in the bolt holes.

As indicated in earlier analysis (BAW-1789) the UCB joint was originally very conservatively designed, requiring only forty-two (42) of the original one hundred twenty (120) bolts to maintain joint integrity during faulted conditions (LOCA combined with SSE). Based on this margin the NRC, by letter dated May 13, 1983, (1CNAØ583Ø4), approved operation of ANO-1 during the previous cycle with seven (7) UCB bolts having UT indications and assumed to be failed. Although similar margins were maintained in the design of the replacement bolting and the replacement bolting has eliminated the only known failure mechanism, AP&L has completed a new analysis of the final configuration of the UCB joint to confirm that adequate design margins remain given the slightly reduced number of bolts. This analysis is summarized in Attachment II. As discussed in the attachment, even assuming up to twenty-four missing bolts and conservatively accounting for uneven bolt distribution, this analysis demonstrates that large design margins are maintained in the UCB joint. Therefore, based on this analysis and the improved design of the UCB bolts, it is concluded that the existing configuration of the UCB joint is fully adequate for all normal and faulted conditions.

Based on the results of the study of reactor vessel internal bolting by the BWOG Bolting Task Force and the additional inspections and bolting replacements completed during the current refueling outage, AP&L considers the core internals bolting issue to be satisfactorily resolved for ANO-1.

Very truly yours,

Dan Howard

for J. Ted Enos
Manager, Licensing

JTE:DRH:lw

Attachments

Attachment I

SUMMARY RESULTS OF UPPER CORE BARREL BOLT REPLACEMENT

During the current refueling outage 114 of the 120 UCB bolts have been replaced with bolts of an improved design. Due to difficulties during the replacement effort, six bolts were not replaced. These are described below.

BOLT #	STATUS
21*	The bolt head separated from the shank during locking clip removal. Efforts to remove the bolt shank failed and the shank has been left in place.
25	The bolt head was repeatedly rounded at very high torque. The bolt head was cut away and the shank left in place.
88	Subsequent to bolt removal a thread chaser became stuck in the bolt hole. Initial efforts to back the tool out failed, resulting in rounding of the tool head. A metal disentegration machine was then used to machine a new head and the tool removed using a hydralic wrench. This resulted in thread damage and precluded installation of a new bolt.
91*	The bolt head separated from the shank during clip removal. The shank was later partially backed out before becoming stuck. The protruding shank has been cut away and the remainder left in place.
96 & 97	The bolt heads separated from the shanks at very high torque. Efforts to remove the shanks failed. The shanks were left in place.

* Bolts with previous UT indications

Attachment II

SUMMARY OF STRESS ANALYSIS OF UPPER CORE BARREL JOINT WITH REDUCED NUMBER OF BOLTS

METHOD

The method of analysis consisted of extracting operating and faulted stresses from the previous ANO-1 Upper Core Barrel (UCB) bolt stress analysis for the full 120 bolt case and applying an appropriate peaking factor to these stresses to account for the reduced number of bolts and nonuniformity of the bolt distribution. Stresses from flow induced vibration (FIV) were extracted from a finite element analysis of 177FA internals with the appropriate peaking factor applied.

ASSUMPTIONS

As discussed in Attachment I, the UCB joint now contains 6 ineffective bolts of the original 120. For conservatism, 6 ineffective bolts were assumed in each of four quadrants. To develop the maximum load on the bolts, the maximum prestress of 25000 psi is combined with the operating loads from a low prestress analysis and a peaking factor is then applied. The operating loads were based on an analysis using a lower prestress to account for the lower joint clamping force due to the reduced number of effective bolts.

PEAKING FACTOR

For the reduced number of bolts:

$$K1 = (\text{original \# bolts})/(\text{effective \# bolts}) = 120/96 = 1.25$$

For increased loads on bolts adjacent to vacant bolt holes:

$$K2 = 1.07$$

K2 was calculated conservatively based on 5 consecutive vacant holes.

The total peaking factor becomes:

$$K = K1 * K2 = 1.35$$

NORMAL OPERATING STRESSES (INCLUDING UPSET)

For primary and secondary membrane stresses and defining a Design Factor (DF) as the Code allowable stresses divided by the calculated stresses:

DF = 72900 psi/40600 psi = 1.8

For primary and secondary membrane plus bending stresses:

DF = 96950 psi/42000 psi = 2.3

SHEAR AND BEARING STRESSES

Acceptability of the bolts due to shear and bearing with the increased loading is calculated by adjusting the previously calculated DFs to account for the increased load.

Increase in load factor (membrane) = 40600 psi/35740 psi = 1.14

where 35740 psi is extracted from the original 120 bolt analysis. Adjusting the DFs from the original 120 bolt analysis to account for the increased load factor yields:

Shear DF = original DF/increased load factor = 1.85/1.14 = 1.62

Bearing DF =original DF/increased load factor = 1.63/1.14 = 1.43

FAULTED CONDITIONS

For faulted conditions the peaking factor was applied to the maximum stress obtained from the original 120 bolt analysis and this stress compared to the Code allowable.

DF = 86600 psi/48600psi = 1.78

FATIGUE

A previous low prestress 120 bolt analysis using a prestress of 8680 psi and the applied peaking factor provides a conservative analysis to model the lower clamping force expected from the 24 missing bolts. Zero fatigue usage is determined by comparing alternating stressed and design cycled to ASME Section III, Appendix I, Figure I - 9.2.2, Fatigue Curve C. All alternating stresses fall below Curve C. Inputs to the fatigue analysis include:

Heatup and cooldown (70F to 8% power), 240 cycles

Gamma heating (8% power to 100% power), 4800 cycles

Flow induced vibration, 2.5E10 cycles

Operating Basis Earthquake, 650 cycles

JOINT TIGHTNESS

A previous finite element analysis for the conservative end of life prestress of 8670 psi was used to confirm joint tightness. This is a conservatively lower prestress than that provided by the 96 bolts assumed. The analysis showed that the joint would not open at the bolt hole locations. Therefore, the joint is considered adequately tight.

CONCLUSION

The 114 installed bolts at ANO-1 are fully adequate for the balance of the unit life based upon a conservative analysis demonstrating the adequacy of 96 installed bolts. The conservative analysis demonstrates that 96 bolts meet all applicable stress limits for ASME, Subsection NG, 1983 and are structurally adequate for the balance of the unit life.