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May 16, 1972

No UER

Mr. E. J. Bloch, Director
Directorate of Licensing
United States Atomic Energy Commission
Washington, DC 20545

Re: Docket No 50-255
License No DPR-20

Dear Mr. Bloch:

This letter is written to provide information, in addition to that submitted by TWX dated May 15, 1972, concerning the discovery of a portion of a shoulder bolt in the No 2 steam generator at the Palisades Plant on May 7, 1972.

The piece of the bolt was discovered in the hot leg side of the primary side of the steam generator during an inspection of the steam generator partition bolting. At this time, the plant was in a cold shutdown condition with the primary coolant system at refueling boron concentration and the water level lowered to a point below the center line of the hot leg pipe between the reactor vessel and the steam generator. Required core cooling was being provided by the shutdown cooling system.

The portion of the bolt found was identified at the plant as being identical to the compensating ring shim bolts. The piece of the bolt, when cleaned of loose material, read approximately 15 mRem/h on contact. It was shipped to the nuclear steam supply system supplier for further examination and identification.

The bolt was the portion above the threads of a 5/8-inch diameter shoulder bolt. The head of the bolt is round, 7/8-inch in diameter and 3/8-inch thick with a socket for a 5/16-inch allen wrench. The shank, or shoulder, is 5/8-inch in diameter and 3/4-inch long. The bolt head was stamped B8M infinity and also had the numeral 1 stamped in it. The bolt exhibited almost no evidence of tumbling and had obviously been inactive in the steam generator primary head.

A review of the components within the primary system which could have been the source of the bolt revealed that the only component utilizing a 5/8-inch shoulder bolt is the compensating ring shim; therefore, assuming that the bolt came from within the primary system, it would be a compensating ring shim bolt. This theory is reinforced

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by the fact that the internals manufacturer used this type of shoulder bolt from the H. M. Harper Company, Morton Grove, Illinois, the manufacturer of the bolt as indicated by the symbol "infinity" on the bolt head.

During shipment of the upper guide structure (UGS) to the plant, it was involved in an accident in which the upper portion of the UGS shipping container struck the lower portion of a highway underpass. Some damage to the UGS occurred, which was subsequently repaired. Scattered scratches and gouges were noted on the compensating ring shim. In addition, the compensating ring shim was determined to be slightly out of round.

We have concluded that the cause of the failure of this compensating ring shim bolt was due to a series of events, starting with the accident during shipment of the UGS in which the UGS and the compensating ring shim were struck radially. While the impact was not sufficient to sever the bolt, it could have deformed the shoulder section and initiated a crack at the root of the upper thread. Because the bolt is contained within a counterbore in the ring shim, the deformation and/or crack would not be visible.

Upon arrival at Palisades, all bolts were torque tested in place to determine if they had sheared. Since the only function of the bolts is to hold the compensating ring shim in place on the UGS flange during shipment and handling of the UGS during refueling operations and would not normally be stressed or even required during reactor operation, the above check was considered adequate. The bolts were not removed for inspection since the lower end is pinned with a dowel to the UGS flange and the dowel is plug welded.

The appearance of the portion of the bolt recovered from the steam generator indicates that it was highly loaded radially at the shoulder, probably from the impact and subsequent bearing against the shoulder by the ring shim. During normal heatup and cooldown cycles, the force of the ring shim against the shoulder bolt introduced sufficient loading in the already weakened bolt which eventually caused its failure.

The purpose of the compensating ring shim is to permit differential expansion between the 304 stainless steel core barrel and upper guide structure flanges and the low alloy carbon steel reactor vessel and closure head flanges. Since the bolts are used only to hold the compensating ring shim on the upper guide structure flange during shipping and handling, there are large clearances between the bolts and the bolt holes in the ring shim. In the reactor, the ring shim is positioned by the four core barrel alignment pins which engage slots in the ring shim. If all eight of the bolts were to be removed, the ring shim would still be properly positioned and there would be no effect on the function of the ring and correspondingly no effect on other internal components.

Should further bolts fail under full flow conditions, the bolts would be carried by the flow stream down through the upper guide structure and the core barrel and passed out through the outlet nozzles into a steam generator. The head of the bolt prevents its passage through the steam generator.

Based on appearance of the bolt portion, and steam generator from this incident, we would not expect any damage to the steam generator to occur.

Under partial flow or if the flow were shut off with a bolt in transit to the outlet nozzles, the bolt could drop down and rest on the top of the core shroud or the top of fuel assemblies. It is possible that a bolt could drop down between an opening in the core shroud lateral support plates and lie trapped between the core shroud and core barrel. In no case could a bolt drop below the top plate of a fuel assembly in the core region because there are no openings large enough to permit passage of a 5/8-inch shoulder bolt.

Assuming a bolt were to reach the top of a fuel assembly and if the adjacent control blade was fully inserted, it is possible for a bolt to fit past the post and guide rod nut of a fuel assembly and get into the center portion of a control rod shroud, but this is unlikely because of the tortuous path to get into the channel and the fact that the flow velocity required to move the bolt would tend to lift it rather than push it laterally. If this were to occur, difficulty would be experienced when attempting to withdraw the control blade. If it were to come to rest atop a fuel assembly, it would be carried upward and out of the reactor into the steam generator when flow was restarted. This possibility is the only way that portions of compensating ring shim hold-down bolts could interfere with control rod drive mechanism operation. It is considered extremely unlikely.

The possibility of vibration causing the failure of this shoulder bolt was investigated. The precritical vibration monitoring program conducted at Palisades was reviewed. The object of the vibration monitoring program was to provide confirmation, based upon experimental evidence, that excessive vibrations of the core internals do not exist. To this end, a vibration monitoring program was developed to determine the extent of core support barrel motion in various modes of reactor operation. This portion of the program was performed in four phases; ie, pre- and post-core, both hot and cold. Also included in the program was a procedure for visual inspection of the core support barrel, UGS and pressure vessel interface surfaces to determine their condition after pre-core operation. It was concluded from this program that vibrations of the reactor internals are well within design allowables. The visual inspection performed included the upper and lower surfaces of the compensating ring shim, the upper and lower surfaces of the UGS support flange, and the underside of the reactor vessel head. The visual inspections revealed normal indications of differential thermal growth, installation scratches and bearing markings.

There were no significant indications of relative vibratory motion. Based on this review and a review of the construction of the reactor vessel and its internals, it was concluded that vibration was not the cause of the failure of the shoulder bolt. It was further concluded that the absence of the shoulder bolts would not introduce a vibration problem.

Based on our review of this incident, we have concluded that if future incidents of this nature were to occur, they would have no detrimental effects on reactor safety or plant operations. We plan to resume operation Wednesday, May 17, 1972. During the next refueling outage, a modification will be made that will prevent escape of the upper portion of a failed bolt from the compensating ring shim bolt.

Yours very truly,

Ralph B. Sewell

RBS/map

Ralph B. Sewell
Nuclear Licensing Administrator

CC: Boyce H. Grier,
USAEC