DOCKET NO. 50-29

HAZARDS ANALYSIS BY THE RESEARCH AND POWER REACTOR SAFETY BRANCH

DIVISION OF LICENSING AND REGULATION

IN THE MATTER OF

YANKEE ATOMIC ELECTRIC COMPANY

PROPOSED CHANGE NO. 10

Yankee Atomic Electric Company's license presently provides that the reactor will not be operated above 15 Mw electric unless the boron concentration in the main coolant system is less than 80 ppm. Yankee, pursuant to paragraph 3.A. of License No. DPR-3, has requested authorization to perform a test demonstration of the use of boric acid at higher concentrations while operating the reactor at full power. This test would continue for a period of from two to six weeks, with continuation of the test beyond the initial two week period depending on Yankee's evaluation of data obtained during the first two weeks.

During the test, the concentration of boron in the system would be limited to values less than 400 ppm. The negative reactivity which would be provided by 300 to 400 ppm of boron in the coolant is approximately equivalent to that of the reactivity worth of the equilibrium xenon concentration in the reactor, i.e., 2.5% delta k/k. The ability to operate the reactor for short periods of time with boric acid present would allow a portion of the excess reactivity to be poisoned out during startup operations until xenon equilibrium is established. This might permit an increase in the initial reactivity of subsequent core loadings with a consequent increase in core lifetime.

Boric acid has been used in the main coolant system during initial testing of the Yankee reactor and is injected into the system during the process of cooldown. During the first year of operation, Yankee has had considerable experience in the use of boric acid and has reported that it has had no problems with boron injection, residence or dilution. One phenomenon which has been observed during operations at Yankee involving boric acid is that the acid acts as a mild decontaminant and solvent of the established corrosion product film, and tends to increase the crud level in the coolant. However, this has resulted in a beneficial effect in that the crud level after cleanup of the borated system has been found to be lower than before the shutdown, and a lower crud equilibrium level has persisted for a period of time following a subsequent startup. Although there is no conclusive evidence to indicate whether or not the crud released as a consequence of boric acid injection tends to deposit on heat transfer surfaces, Yankee intends to operate a cation purification system during the proposed tests in order to hold the crud concentration to 10 ppm, and to minimize this effect should it occur.

The (n,alpha) reaction which would take place with boron present in the coolant with the reactor at power will result in some disassociation of water as a result of the ionization produced by the alpha particles. Yankee has considered the increased disassociation which might result from operation under the conditions of the proposed tests. They have concluded, and we agree, that such an increase is not a cause for concern, since it would not be significant in relation to the disassociation normally taking place which has been adequately controlled during previous operations.

There has been concern expressed in the past that initially dissolved boron in the coolant might react under irradiation with other chemicals present in the primary system. Should this occur, the boron might initially be deposited on surfaces in the reactor (boron hideout), and then suddenly "fall out" and cause a step increase in reactivity. There has been some experimental evidence that lithium metaborate is one such insoluble compound that might be formed if lithium is present in the reactor coolant. However, since the only additive which Yankee plans to have present in the primary system is the boric acid, there seems to be no possibility of a sudden removal of boron from the Yankee reactor due to possible chemical reactions. Although it is conceivable that other phenomena might also cause boron hideout, there is no known mechanism for such an occurrence in the Yankee reactor. Accordingly, Yankee believes, and we agree, that the only indisputable means of proving or disproving this possibility is to conduct a test demonstration under carefully controlled conditions of the use of boron in the coolant with the reactor at power.

Yankee has stated that chemical analysis will be routinely performed during the proposed tests which will define the boron concentration in the main coolant within 1% of the actual concentration present. In addition, by monitoring control rod withdrawal rates, any losses in reactivity greater than .43% delta k/k can be detected. The .43% delta k/k, therefore, represents an upper limit on the uncertainty in measuring reactivity. Yankee has stated that the test will not be continued past the initial two week period if the value of the uncertainty in reactivity plus any unexplainable reactivity change exceeds .8% delta k/k. Thus, the largest unexplainable change which could be present at the end of the two weeks, and the test still be allowed to continue, is .37% delta k/k.

In order to estimate the upper limit of hazard from these proposed tests, Yankee has analyzed the consequences of an instantaneous insertion of 1.5% delta k/k of reactivity into the reactor. They have concluded, and we agree, that the resulting excursion would peak at about 200% of the steady state power, with a minimum DNB ratio greater than 1 at the time of the peak due to the inherent negative power coefficient of the reactor. The reactor would automatically be scrammed on high neutron flux (any two of three independent channels could cause such a scram) and the integrity of the fuel would not be impaired. As noted previously, Yankee has stated that the test would not be extended past the initial two week period if the value of the uncertainty in reactivity measurement plus any unexplainable reactivity change exceeds .8% delta k/k. Since the resulting excursion following the instantaneous insertion of this amount of reactivity would be less severe than that caused by the 1.5% step which was analyzed, we believe that the .8% delta k/k limit is adequate to determine if the test should be permitted to continue at the end of the initial two week period. Further, we believe that an additional condition should be imposed that will require that the tests be discontinued if at any time during the testing period the sum of uncertainty plus unexplainable reactivity values exceeds .8% delta k/k. An existing license condition requires that Yankee provide the Commission with a complete report on the results and significance of these tests after they have been completed.

Based on the foregoing analysis, we have concluded that Yankee should be authorized to perform the proposed tests with the additional restriction that the test be discontinued if at any time the sum of uncertainty plus the unexplainable reactivity values exceeds .8% delta k/k. With this restriction, it is our opinion that the proposed tests do not present significant hazards considerations not described or implicit in the license application and there is reasonable assurance that the health and safety of the public will not be endangered by operation of the facility as described above.

Original Signed by
E. G. Case

Edson G. Case, Chief
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Date: SEP 1 2 1961