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October 22, 1974

Mr. D. L. Ziemann, Chief
Operating Reactors - Branch 2
Directorate of Licensing
Office of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Subject: Dresden Station Units 2 and 3 and Quad-Cities Station Units 1 and 2 Proposed Changes to Facility Operating Licenses DPR-19, DPR-25, DPR-29 and DPR-30, AEC Dkts 50-237, 50-249, 50-254 and 50-265.

Dear Mr. Ziemann:

Your letter dated September 16, 1974, requested additional information concerning proposed changes to the Technical Specification submitted May 15, 1974 for Quad-Cities and May 27, 1974 for Dresden Unit 3. A similar change was requested as part of the Technical Specification change associated with the Dresden Unit 2 Reload No. 1 Licensing Submittal which was submitted August 27, 1974. The following additional information is applicable to the referenced submittals for all four units. The purpose of the proposed changes was threefold:

1. Changes to peaking factor definition to a generalized form so as to incorporate fuel of more than one design.

2. Update the APRM Limiting Safety System Setting calculation and surveillance reflecting operating limits for both 7x7 and 8x8 fuel types.

3. Provide wider flexibility on peaking factor at low powers when conditions are quickly changing and wide safety margin exists.

Attached is a more detailed discussion of the safety evaluation of the proposed changes.

One signed original and 79 copies of this additional information is submitted for your use.

Very truly yours,

J. S. Abel
Nuclear Licensing Administrator
Boiling Water Reactors

Attachment

October 21, 1974

DISCUSSION AND SAFETY EVALUATION

The neutron monitoring system is interfaced to the Reactor Protection System to maintain margin to two steady state and transient fuel failure modes.

The first of these failure modes is burnout. Margin to burnout is monitored primarily in terms of fuel rod surface heat flux with respect to in-channel coolant quality and flow rate. Margin to burnout is maintained by monitoring Minimum Critical Heat Flux Ratio.

The second failure mode is fuel cladding strain due to fuel pellet thermal expansion. Margin to cladding 1% plastic strain is maintained by monitoring LHGR.

Margin to each of these two failure modes for the anticipated transient condition is maintained by a steady state operating limit.

The licensed operating limit of a given fuel type is expressed in terms of Linear Heat Genration Rate (LHGR). The working units of this expression are kilowatts of thermal power transferred per foot of active fuel rod (kw/ft) through the cladding. During early reactor operation all fuel bundles were of a similar (7x7) fuel rod and heat transfer geometry. At that time a single conversion could be made from LHGR (kw/ft) to surface heat flux (w/cm^2 or $Btu/hr/ft^2$).

With the introduction of mixed 8x8 and 7x7 matrix reloads a single conversion from LHGR to surface heat flux can no longer be made for all fuel in the core.

The specific difference preventing the single conversion is the reduced fuel rod diameter of the 8x8 bundle.

The appropriate expression to monitor mixed reload cores with respect to the fuel type operating limit now becomes LHGR.

Thus the existing Peaking Factor definition in terms of peak to average surface heat flux is proposed to be deleted. Existing references to "peak heat flux" are proposed to read "peak LHGR." In addition, the units of Figure 2.1-2 are proposed to be changed to reflect fractions of the operating limit LHGR.

Analyses of operating transients from full power assume that each fuel type analyzed is operating at both its operating limits. For Dresden Units 2 and 3 and Quad-Cities, those limits are MCHFR of 1.9 and LHGR of 17.5 kw/ft (7x7) and 13.4 kw/ft (8x8). These steady state limits may not be knowingly exceeded at any time.

Also assumed for the analyses were APRM trip settings of 120% power for HI HI scram and 108% power for the HI rod withdrawal block.

The equations for the APRM settings are basically -

$$S_s = 0.65W + 55$$

for the scram and

$$S_{RB} = 0.65W + 43$$

where W is % recirculation pump flow. Thus when recirculation pump flow (and reactor power) is reduced, the APRM trips are also reduced.

At recirculation flows less than 100% of rated, conditions may exist which would permit a 1.9 MCHFR and 100% LHGR limits. If then recirculation (and core flow) were increased to 100%, both MCHFR and LHGR operating limts would be violated. The margin of safety would be reduced to a state not analyzed for assumed transients. In order to regain the same margin of safety for the case of local power too high for less than rated conditions, an additional APRM setpoint reduction factor is needed. This additional factor must assure that, at least for LHGR, APRM setpoints are properly reduced in case a fuel type would be above its operating limit if 100% reactor power were to be obtained by flow increase.

The proposed Technical Specification uses a power distribution descriptive term, Limiting Total Peaking Factor, to monitor that the fraction of a fuel type's operating limit does not exceed the present fraction of rated core thermal power. If greater than a Limiting Total Peaking Factor exists then either the power distribution is changed to correct the problem, or the intercept of APRM flow biased trip is reduced. The amount of the reduction becomes the ratio of the measured Total Peaking Factor to the LTPF.

The proposed Figure 2.1-2 describes a Limiting Total Peaking Factor as the fraction of operating limit LHGR permitted at that same fraction of rated reactor power, except below 20% reactor power.

Below 20% of rated reactor power a fixed value of peak LHGR corresponding to 20% of the operating limit is permitted. The recirculation system is interlocked such that the recirculation pumps are limited to minimum speed until feedwater flow is above 20% of rated. The proposed specification retains the protection against high power operation with power distributions that are worse than analyzed.

The margin to the fuel safety limit is not reduced below that previously analyzed. This can be seen by studying Figure "A" (on page 18) of the (Quad-Cities) specifications.

The boiling water reactors of this type exhibit strong natural circulation at low power. The power vs. flow relationship plotted in the figure, compared to the safety limit line, shows wide margin to the safety limit because flow quickly increases above a few percent power. The margin may be graphically demonstrated by dividing the distance from the operating point to the safety limit line by increments of LTPF, using the distance between the design flow control line and the safety limit line as one increment of LTPF.

Normally both recirculation pumps are operating at minimum speed during power ascension. Flow to power increase is enhanced beyond that of natural circulation significantly at minimum pump speed, enhancing the margin to safety.

Power increase during startup in the RUN mode is slowly accomplished by rod withdrawal. The total peaking factor below 20% of rated power depends on the number of control rods withdrawn to a high degree. The more control rods withdrawn at a given power level, the flatter the power distribution.

During normal startups the total peaking factor will be below LTPF before 20% reactor power is reached. The proposed specification eliminates the need to reduce APRM setpoints at low power due to total peaking when absolute values of LHGR are low. Continued rod withdrawal raises more of the fuel to similar levels and lowers total peaking in a short (about one hour) period of time.

The entire proposed technical specification provides for improved fuel surveillance and LSSS evaluation so that previously analyzed safety margins may be maintained.