Met-Ed / GPU

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March 14, 1979
GQL 0364

Director of Nuclear Reactor Regulation
Attn: R. W. Reid, Chief
Operating Reactors Branch No. 4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Sir:

Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR-50
Docket No. 50-289
Out-of-Core Detector Information

By letter of November 13, 1978, you requested certain additional information concerning out-of-core detector calibration. In your letter of February 6, 1979, you indicated that more information than was submitted by our December 26, 1978 (GQL 2040) response was required.

Attached, please find the questions and Met-Ed's responses. Our NSSS supplier, Babcock & Wilcox, has begun an investigation into this concern on a generic basis. Should the results of that investigation conflict with what is submitted herewith, we will revise our responses as appropriate.

This letter is submitted on this date per March 13, 1979 telecon between your Mr. G. B. Zwetzig and our Mr. R. J. Stevens.

Sincerely,

J. G. Herbein
Vice-President Generation

JGH:WSS:mrm
Attachment

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Response to Additional Information Request

on

Power Range Nuclear Instrumentation Calibration

The response to Question 1 below addresses the magnitude of the difference between indicated and actual reactor thermal power during transients which may result in a reactor trip and its effect on trip setpoints. The responses to Questions 2, 3 and 4 below address the magnitude of the difference between indicated and actual reactor thermal power during steady state operation and following typical (non-trip) transients, since these differences determine recalibration frequency.

Question 1

Provide an analysis which shows how the power indicated by the nuclear instruments will differ from the actual reactor thermal power as a function of time after various typical and limiting power transients.

Response

The accidents analyzed in Chapter 14 of the TMI-1 FSAR that rely on a high flux trip are as follows: start-up accident, rod withdrawal accident at a rated power, rod ejection accidents, and steam line failure.

A test was conducted by B&W to attempt to quantify the magnitude of the error between the power level indicated by a heat balance and the power level as indicated by the out-of-core detectors (OCD's). Starting at 95% power and decreasing to 30% power yielded an error of about 12% in the conservative direction. On the increase from 30% to 95%, the error was about 8% in the non-conservative direction. The error tended to fade away at a rate of approximately 2%/hour. An approximate conservative correlation between power level change and OCD error is thus 12/65 or 0.18% (error) /% (power change). This rate will be used in evaluating the effect of out-of-calibration OCD's on the accidents discussed below.

During a startup accident, neutron power rises to 275% in about 0.5 seconds, or 550%/second (see FSAR Figure 14-2). With a trip setpoint of 105.5%, the error would amount to approximately 19%. For a power ramp rate of 550%/second, this amounts to a delay of about 0.035 seconds. This is roughly 12% of the trip delay time assumed in the accident analysis. The additional delay has a negligible effect on the consequences of the accident.

It should be noted that a high pressure trip may be the result of a startup accident for a specific range of reactivity insertion rates (see FSAR Figure 14-3).

For a rod withdrawal or rod ejection accidents from rated power, the transient-induced error would only be about 1%, which is already accounted for in the trip setpoint.

A rod ejection accident is characterized by an extremely fast rise in neutron power which initiates a high flux trip before the full worth of the ejected rod has been inserted. Ejection time is 0.15 seconds, thus with FSAR Figure 14-22, a minimum power ramp rate of 1000%/second can be inferred for the nominal case starting from 0.1% power at end-of-life.

For rod ejection accidents from startup, the nominal case at beginning-of-life terminates as a result of a high pressure trip. Neutron power for the nominal case at end-of-life peaks at approximately 160%. The delay attributable to transient-induced error calculated as above, amounts to 0.02 seconds. FSAR Figure 14-29 shows that peak thermal power is relatively insensitive to such a short delay.

During an overcooling transient in which the inlet temperature decreases, the leakage flux decreases due to an increase in moderator density. Thus the neutron power indicated by the OCD's will decrease. This phenomena was confirmed during a test at an operating B&W reactor. The magnitude of the change was approximately 0.5% (power)/$^{\circ}$F (temperature change).

The steamline break is the only overcooling transient that is terminated by a high flux trip: depending on the size of the break, it may end with a RCS low pressure trip. FSAR Figure 14-21 shows that the RCS coolant temperature has decreased by about 10°F at the time of the trip. This would imply a 5% flux measurement error. However, the flux increases so rapidly (see FSAR Figure 14-21) that the additional error has an insignificant effect on the time to trip and resultant peak core thermal power.

Therefore, this additional transient-induced error has an insignificant effect on the consequences of accidents analyzed in the TMI-1 FSAR.

Question 2

Based on the above analysis, describe rational criteria for performing heat balance checks and calibrating the nuclear instrumentation such that the consequences of possible accidents remain within the bounds calculated in the TMI-1 FSAR.

Response

The additional transient-induced error has an insignificant effect on accident analyses. However, during 1975 to 1977, B&W undertook a comprehensive study of operating plant data to determine the adequacy of the required heat balance checks. Factors that can cause calibrated upset were found to be:

- Changes in T_{cold}
- Changes in boron concentration
- Changes in rod position
- Depletion (burnup, slow effect)

The first three items are primarily due to changes in power level, such as load following. The last item is an extremely slow effect and would place no restriction on periodicity of calibration. It was found that following significant changes in power level, the measured versus actual thermal power would differ by greater than 10%, changing at a rate of 2% per hour. It was also found that for steady-state operation, no changes occurred in the heat balance error and a once-per-shift check and/or calibration was sufficient to assure <2% difference between indicated and actual reactor thermal power.

Using the results of this study, a recommended change to the Technical Specifications and operating instructions was sent to TMI-1. TMI-1 changed both its Tech. Specs. to require a heat balance check and calibration, if necessary, once per shift and its operating instructions as follows:

1) For power level maintained within a 5% RTP band and no changes in rod index > 15% since last calibration, check OCD power range calibration once per shift and recalibrate, if necessary, in accordance with Tech. Spec. limits.

2) For power level change > 5% RTP and/or changes in rod index > 15% since the last calibration, (a) check OCD power range calibration after reaching desired power level and recalibrate, if necessary, in accordance with Tech. Spec. limits, and (b) in addition to the first check, a minimum of two additional checks should be performed at 2 or 3 hour intervals to confirm that the calibration has stabilized.

Thus, heat balance checks and OCD calibrations once per shift are sufficient during steady state operation. During transient operation, more frequent checks and calibrations are performed as described above to maintain the error within 2%.

Question 3

If the criteria presented in Item 2, above, are more restrictive than the criteria you have already proposed (heat balance once per shift) revise your March 13, 1978 submittal to reflect these more restrictive criteria.

Response

Met-Ed has incorporated the more restrictive criteria necessary to account for transient-induced effects into its operating procedures. The criteria proposed by our March 13, 1978 submittal (Technical Specification Change Request No. 75) have been incorporated into the TMI-1 Technical Specifications by Amendment No. 46 of November 22, 1978. Met-Ed believes that the procedural guidance for checks and calibrations following transients is sufficient.

Question 4

In LER 78-01/01T you committed to make certain changes in the overpower trip bistable settings following certain changes in power level. Discuss why these changes were needed, why they are adequate to assure safety of operations and why they were not included as part of the proposed change in the technical specifications.

Response

The commitment to reduce the overpower bistable trip setpoint to 95% following power reductions to less than 90% was made as a conservative response based on the limited information available at the time LER 78-01/1T was submitted. As a result of the investigation and analysis described above, it was determined that this measure was not needed to assure safe operation of TMI-1 and has therefore been deleted from the TMI-1 operating procedures.