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May 7, 1980

Mr. H. R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. Robert L. Baer, Chief
Light Water Reactors Branch No. 2

Subject: McGuire Nuclear Station
Docket Nos. 50-369, 50-370

Dear Mr. Denton:

As requested by Mr. R. L. Baer's letter of February 29, 1980, please find attached additional information concerning steam generator level measurement errors. This information supplements my letter of December 18, 1979 on this subject.

Very truly yours,

William O. Parker, Jr.

LJB:scs

Attachment

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MCGUIRE NUCLEAR STATION

Additional Information
on
Steam Generator Level Measurement Errors

In regard to Question 3 of Mr. R. L. Baer's October 15, 1979 request for information, the determination of the low-low steam generator level trip setpoint has been revised. This revision incorporates a change from a statistically determined channel accuracy to a direct summation error analysis for channel accuracy. This represents a more conservative approach in that all identified errors are arithmatically combined assuming all existed simultaneously in the worst possible direction. In addition, the Barton Lot 1 transmitters currently installed to measure steam generator levels will be replaced with Barton Lot 2 transmitters. The Barton Lot 2 transmitters will be temperature compensated statically to achieve transmitter errors of +5%, -15% of span. The error has also been incorporated into the low-low steam generator level trip setpoint.

Therefore, our December 18, 1979 response to Question 3 is revised as follows:

Bottom of Span	0
Normal Channel Accuracy	$\pm$ 5%
Transmitter Errors Due to Adverse Environment	$\pm$5, -15%
Reference Leg Heatup Effects	+2%
Total Errors	+12, -20% of Span
Trip Setpoint	+12%

The following answers are provided to the questions outlined in your February 29, 1980 letter:

Question 1

Your response provided an analysis to show how the steam generator low-low level trip setpoint is to be determined as a result of temperature induced errors resulting from accident environmental (heatup) effects on the reference leg. You calculated a maximum error of "+12.2% of span" and propose to use this as the setpoint (upward from zero percent of span) for the low-low level trip point. We have the following concerns and request action to be taken as described:

A. The basis setpoint for the low-low level trip at "zero percent of span" corresponds to a water level exactly at the height even with the lower narrow range sensing tap. This setpoint does not provide an adequate margin to ensure that the instrument channel will initiate safety actions since the level transmitters do not respond to a reduction of water below this point in the steam generator. Therefore, we require that a margin of safety of at least 3% be used in addition to the value of the accumulated errors to establish a minimum allowable setpoint.

B. We question the basis for your use of an environmental allowance error which you state as being 7%. We assume that this error is an allowance for the level transmitter. Based on our review of the Westinghouse tests of Barton Lot 1 transmitters, we conclude that the results do not demonstrate accuracies less than the acceptance criteria which is $\pm$10%. Therefore, this evaluation should be based upon $\pm$10% errors or a basis should be provided for using a lower value.

Response

1.A. The errors that were incorporated into the low-low steam generator water level setpoint are discussed above. Since negative errors would provide an earlier trip, only the positive errors need be considered in specifying the normal trip setpoint. Based upon the above breakdown, the low-low level trip setpoint was set at 12 percent of narrow range span. No margin of safety above the bottom of the narrow range trip was incorporated into the setpoint due to the conservative nature in which the errors were combined. This approach is justified since all identified error sources were arithmatically combined assuming all existed simultaneously in the worst possible direction.

1.B. The Barton Lot 1 transmitters on McGuire Unit 1 will be replaced with Barton Lot 2 transmitters. The accuracy requirement for steam generator water level (NR) on plants employing split flow preheat steam generators has been placed at +5% for improved operational flexibility. To support this requirement Lot 2 Barton transmitters for this application on McGuire Nuclear Station will be temperature compensated statically to +5, -15% of span. The temperature selected for this static compensation is the temperature expected inside the electronics housing at five minutes into the event, which corresponds to the trip function requirement.

Question 2

Your response indicates that reference legs will be insulated to limit the error due to reference leg heatup. Provide the following additional information pertaining to the use of insulation:

A. A basis should be provided for the 2% error assumed due to insulation addition. A description of how the 2% reference leg error is determined should be provided.

B. Provide an analysis of the impact that the level measurement errors, due to reference leg heatup, will have on the post-accident monitoring (PAM) functions required of the steam generator narrow range and pressurizer level instruments.

C. The reference leg should not be insulated immediately adjacent to the condensing pot because the pot must be allowed to cool to perform its function, and the reference leg must be able to cool to ambient before it enters the insulated portion. Please describe how your design addresses these concerns.

D. Identify what precautions are to be taken to ensure that the operators are aware of the possibility of erroneous indications that could result from flashing of the reference leg water to steam.

E. Describe any long-term solutions that are being investigated that will provide reference leg temperature compensation for the level transmitters.

Response

2.A. A calculation was performed to determine the amount of heatup an insulated reference leg would experience subjected to an adverse environment following a postulated high energy line break. Sufficient insulation will be added to minimize the amount of instrument error as a result of this heatup.

The TAP-A computer code was used to model the reference leg with varying thickness of insulation. This code performs a two dimensional heat transfer calculation through a cylindrical model of the insulated reference leg. The model consists of composite layers of conducting slabs in the direction of the shortest heat transfer path from the equipment surface to the internal point where the heatup is of concern. This model then provides the thermal response of the reference leg when exposed to the adverse environment. TEMP-MAT was the insulating material used with the following thermophysical properties:

$$K = 0.33 \text{ BTU/HR Ft}^2 \text{ }^{\circ}\text{F}$$

$$\rho = 11. \text{ lb}_m/\text{ft}^3$$

$$Cp = 0.18 \text{ BTU/lb}_m \text{ }^{\circ}\text{F}$$

The adverse environment of interest is that which will exist during the interval that the trip function is needed from this instrumentation.

The design basis of the required installed 2 inches insulation thickness which results in less than 2 percent of span error is the WCAP-8587 containment temperature envelope. With this boundary condition and a conservatively high surface heat transfer coefficient of 1000 BTU/hr-ft^2-$^{\circ}$F, the reference leg heatup was calculated to be less than 2 percent of span for 5 minutes following a secondary high energy line rupture.

2.B. A potential exists that the adverse environment inside containment following a high energy line rupture will impact the post accident monitoring functions by causing a significant error contribution in the indicated steam generator and pressurizer indicated water level. An error lookup table provided in our December 18, 1979 response will be used by the operators to determine the error in the indicated levels based upon containment temperature and system pressure. The tables were developed based on the following evaluation of the effect of post-accident conditions on indicated water level.

A bias in indicated water level may be introduced by changes in pressurizer or steam generator pressure, due to changes in the density of the saturated water and steam within those vessels. The errors, as presented in the tables, which would exist at low power under quiescent conditions were calculated directly, using the following formula:

$$E = \frac{H_L}{H} \left(\frac{\rho_L,\text{cal} - \rho_L - \rho_g,\text{cal} + \rho_g}{\rho_f,\text{cal} - \rho_g,\text{cal}}\right) + \frac{L}{H} \left(\frac{\rho_f - \rho_g}{\rho_f,\text{cal} - \rho_g,\text{cal}} - 1\right)$$

where:

E = level error due to density changes in both the vessel and the reference leg, as a fraction of level span,

L = true water level in the vessel, above the lower level tap,

ρ_f = saturated water density at the pressure of interest,

ρ_g = dry saturated steam density at the pressure of interest,

H = level span = vertical distance between narrow range taps on steam generator.

H_L = height of reference leg = maximum vertical distance from lower tap to water level in condensing pot on upper tap.

$\rho_{L,cal}$ = water density at containment temperature and steam generator or pressurizer pressure for which the level indication system was calibrated.

2.C. In order to avoid heatup of the reference leg during normal operation, a distance of 12 inches is not insulated down line of the condensate pot. This uninsulated length will be exposed to the adverse environment and will be a contributor to the total heatup error. The total error resulting from the heatup of both the insulated and uninsulated region subject to the adverse environment is less than 2 percent of span for 5 minutes following the accident.

2.D. A caution will be included in the plant operating instructions to alert the operators to the possibility of erroneous water level indications of any depressurized steam generators due to reference leg flashing.

2.E. Westinghouse is in the process of developing a system to provide compensation for density changes in the steam generator reference legs to reduce the water level measurement errors that could occur due to a post accident environment. At present, the effort is directed toward a mechanical scheme which involves installing a sealed reference leg with a proper spring arrangement, which would provide the necessary compensation without external hardware. This effort will not be completed unitl late 1980 and hardware will not be available until mid-1981.

Question 3

You state that the pressurizer low level signal is used for a control function only and that no credit is taken for this function in the accident analyses. The FSAR states that the pressurizer low level signal is used to: 1) actuate an alarm when the level falls to a fixed setpoint, 2) trip the pressurizer heaters "off" (to protect from overheat), and 3) close the letdown line isolation valves.

We are concerned that the impact of level measurement errors due to reference leg heatup in an accident environment would give erroneous high water level indication which could prevent the pressurizer low level control functions. Therefore, please revise your response to address the impact that the level measurement errors will have on the pressurizer low level control functions and describe any corrective actions to be taken.

Response

The pressurizer low level signal is used to perform the following control functions:

1. actuate an alarm when the level falls to a fixed setpoint
2. trip the pressurizer heaters "off"
3. close the letdown line isolation valves.

Even though the above three functions are control functions, consideration has been given to each area.

Item 1 is not considered a problem with or without reference leg errors. No safety function is performed based upon the low pressurizer level alarm.

Furthermore, if a post-accident adverse environment results in a higher indicated than actual pressurizer level, the alarm will not be actuated since the same signal that supplies the alarm also supplies the level instrumentation. Therefore, the worst situation that could occur is that a low level actually exists in the pressurizer but the operator will not receive a low level alarm.

The above described situation is also applicable to Item 2. The most severe situation that could occur is that the actual level in the pressurizer may be very low even though the indicated level may be above the heaters due to reference leg heatup. This concern has been addressed in the plant Emergency Operating Procedures. The operator is not directed to terminate high head charging flow until the indicated pressurizer water level is greater than 50 percent of span. By requiring this high level ensures that the operator does not terminate high head charging flow until the heaters are covered by water.

Closure of the letdown isolation valves mentioned in Item 3 is also guaranteed by a redundant safety function. Pressurizer letdown isolation valves are also closed on an "T" signal. Following any high energy line rupture that results in a severe containment environment, the "T" signal will be generated by a containment pressure signal. For all cases in which an adverse environment exists, the letdown isolation valves will be closed.