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WILLIAM O. PARKER, JR.  
VICE PRESIDENT  
STEAM PRODUCTION

December 13, 1979

TELEPHONE AREA 704  
373-4083

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 October 15, 1979 please find attached additional information concerning steam generator level measurement errors.

Very truly yours,

*William O. Parker, Jr.*  
William O. Parker, Jr. *By [Signature]*

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Attachment

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## MCGUIRE NUCLEAR STATION

### Additional Information on Steam Generator Level Measurement Errors

1. Describe the liquid level measuring systems within containment that are used to initiate safety actions or are used to provide post-accident monitoring information. Provide a description of the type of reference leg used i.e., open column or sealed reference leg.

#### RESPONSE:

Liquid level measuring systems inside containment at McGuire Nuclear Station which initiate safety actions or provide post-accident monitoring are steam generator narrow range and pressurizer level. Both the steam generator and pressurizer level utilize an open column reference leg.

The steam generator narrow range instruments initiate reactor trip and auxiliary feedwater actuation at the low-low level setpoints. Steam generator narrow range level is also used for post-accident monitoring.

Pressurizer level is used for post-accident monitoring.

2. Provide an evaluation of the effect of post-accident ambient temperature on the indicated water level to determine the change in indicated level relative to actual water level. This evaluation must include other sources of error including the effects of varying fluid pressure and flashing of reference leg to steam on the water level measurements.

#### RESPONSE:

##### A. Reference Leg heatup

High energy line breaks inside containment can result in heating level measurement reference legs. Increased reference leg water column temperature will result in a decrease of water column density with a consequent apparent increase in the indicated water level (apparent level exceeding actual level. Long term maximum reference leg temperature following a steam line break is approximately 275°F.

##### B. Water Density Changes

An error in indicated water levels may also be introduced by changes in pressurizer or steam generator pressure due to changes in the density of the saturated water and steam within the vessels. The error which would exist at low power under quiescent conditions is described in Tables I and II for steam generator narrow range level and pressurizer level, respectively. These tables give the error (as a fraction of span) for a given vessel pressure and reference leg temperature.

C. Reference Leg Boiling

Boiling could conceivably occur in the reference leg in a single steam generator (affected by the break) with high containment temperature and depressurization of the steam generator to  $\leq 42$  psia. This condition could only occur following a steam line or feedline rupture inside containment and would be immediately detected by low steam line pressure indication with subsequent safety injection actuation. If such boiling were to occur, it could cause a major error in the indicated level of the affected steam generator for a short time period, in the extreme case indicating 100% level when the vessel is actually empty. Due to the extremely low probability of reference leg boiling, it is not included on Tables I or II.

3. Provide an analysis of the impact that the level measurement errors in control and protection systems (2 above) have on the assumptions used in the plant transient and accident analysis. This should include a review of all safety and control setpoints derived from level signals to verify that the setpoints will initiate the action required by the plant safety analyses throughout the range of ambient temperatures encountered by the instrumentation, including accident temperatures. If this analysis demonstrates that level measurement errors are greater than assumed in the safety analysis, address the corrective action to be taken. The corrective actions considered should include design changes that could be made to ensure that containment temperature effect are automatically accounted for. These measures may include setpoint changes as an acceptable corrective action for the short term. However, some form of temperature compensation or modification to eliminate or reduce temperature errors should be investigated as a long-term solution.

RESPONSE:

Steam Generator Narrow Range Level

Steam generator level initiates the following actions:

- a. Reactor trip and initiation of auxiliary feedwater at a low-low level of 12%.
- b. Turbine Trip at a high level of 84%.

For the case of low-low water level, the trip must be actuated when the pressure difference between the narrow range level taps corresponds to a zero-level value. Thus the trip setpoints must be at or above the value that would be indicative of zero true level. Because large steam generator pressure changes are not expected before the reactor trip, only the reference leg heatup effects need be considered.

The narrow range reference legs at McGuire will be insulated to limit the error due to reference leg heating prior to reactor trip and auxiliary feedwater pump start. For purposes of this calculation, an error due to reference leg heating was assumed to be 2% due to insulation addition.

RESPONSE to Question 3 (Continued)

Westinghouse is currently reviewing the addition of insulation on the reference legs for steam generator and pressurizer level instruments to verify that this error is appropriate.

A determination of the low-low level trip setpoint is as follows:

|   |          |
|---|----------|
| Bottom of span  | 0        |
| Statistically Determined Channel Accuracy (%)<br>(Including instrument drift allowance) | 3.2      |
| Environmental Allowance (%)   | 7        |
| Reference Leg Temperature Effects (%)   | <u>2</u> |
| Total Errors (%)  | 12.2     |
| Trip Setpoint (%)   | 12.2     |

Note that the current McGuire Technical Specification setpoint for the steam generator low-low level trip (which does not consider reference leg temperature effects) is 12%. This figure was obtained using a direct summation (arithmetic) error analysis. A statistical analysis of the errors associated with the RPS/ESF setpoints is being performed by Westinghouse but has not yet been completed. Preliminary results of this analysis indicate that the figures provided above will accurately represent the allowable error.

Any adjustments to the McGuire Technical Specifications or other documents due to the steam generator level measurement error will be made after completion of the review of the RPS/ESF setpoints and the reference leg heatup error are finalized.

The high steam generator level turbine trip is not included in the Technical Specifications or plant safety analyses since it is for turbine protection only. The error introduced by reference leg temperature effects caused the high level turbine trip to actuate at a lower actual level, i.e., become more conservative.

Pressurizer Level

Pressurizer level initiates the following actions:

- a. Reactor trip at high level of 92%.
- b. Letdown isolation and backup heaters off at low level of 17%.

The pressurizer high level trip ensures protection against RCS over-pressurization by limiting the water level to a volume sufficient to retain a steam bubble and prevent water relief through the pressurizer safety valves. No credit is taken for operation of this trip in the safety analyses. The pressurizer low level function (i.e. letdown isolation and backup heater control) is a control function only. No credit is taken for this function in the accident analyses.

4. Review and indicate the required revisions, as necessary, of emergency procedures to include specific information obtained from the review and evaluation of Items 1, 2, and 3 to ensure that the operators are instructed on the potential for and magnitude of erroneous level signals. Provide a copy of tables, curves, or correction factors that would be applied to post-accident monitoring systems that will be used by plant operators.

RESPONSE:

Information obtained from the evaluation of errors associated with steam generator level instrument reference legs will be incorporated, as appropriate, into the following procedures:

|                |                                   |
|----------------|-----------------------------------|
| EP/1/A/5000/03 | Loss of Reactor Coolant           |
| EP/1/A/5000/07 | Steam Line Rupture                |
| EP/1/A/5000/14 | Loss of Steam Generator Feedwater |
| EP/1/A/5000/19 | Feedwater Line Rupture            |
| EP/1/A/5000/20 | Inadequate Core Cooling           |

Correction factors that would tentatively be applied to post-accident monitoring systems are provided in Tables I and II. These factors will be revised, as necessary, after completion of the review of this problem.

TABLE I

EFFECTS OF TEMPERATURE AND PRESSURE ON STEAM GENERATOR NARROW  
RANGE LEVEL INDICATION

| STEAM PRESSURE (psia)                   | 100             | 300                      | 500  | 700  | 900  | 1100  |       |
|---|-----------------|--------------------------|------|------|------|-------|-------|
| Reference<br>Leg<br>Temperature<br>(°F) | Actual<br>Level | Error (fraction of span) |      |      |      |       |       |
| 90                                      | 0%              | -.05                     | -.04 | -.03 | -.02 | -.01  | -.002 |
|   | 100%            | .24                      | .16  | .11  | .06  | .02   | -.012 |
| 120                                     | 0%              | -.04                     | -.03 | -.02 | -.01 | -.004 | -.01  |
|   | 100%            | .25                      | .17  | .12  | .07  | .03   | -.004 |
| 280                                     | 0%              | .05                      | .05  | .06  | .07  | .08   | .09   |
|   | 100%            | .33                      | .25  | .20  | .15  | .11   | .08   |
| 340                                     | 0%              | 1.37                     | .10  | .11  | .12  | .13   | .14   |
|   | 100%            | 1.66                     | .30  | .25  | .20  | .16   | .13   |

## Basis:

Level Calibration Pressure = 1050 psia

Reference Leg Calibration Temp = 110°F

Ratio of reference leg height to tap span (HL/H) = 1.00

Calibrated span = 233.79" @ 1050 psia, 110°F

Boiling in reference leg is not assumed

TABLE II

## EFFECTS OF TEMPERATURE AND PRESSURE ON PRESSURIZER LEVEL INDICATOR

| RCS PRESSURE (psia)                   |                 | 15                       | 200  | 400  | 800  | 1200 | 1800 | 2250  |
|---------------------------------------|-----------------|--------------------------|------|------|------|------|------|-------|
| Reference<br>Leg<br>Temperature<br>°F | Actual<br>Level | Error (fraction of span) |      |      |      |      |      |       |
|                                       |                 |                          |      |      |      |      |      |       |
| 90                                    | 0%              | -.20                     | -.19 | -.18 | -.15 | -.12 | -.06 | -.008 |
|                                       | 100%            | .75                      | .57  | .58  | .35  | .25  | .31  | -.008 |
| 120                                   | 0%              | -.19                     | -.18 | -.16 | -.13 | -.11 | -.05 | .005  |
|                                       | 100%            | .76                      | .58  | .60  | .36  | .26  | .32  | .005  |
| 280                                   | 0%              |                          | -.05 | -.04 | -.01 | .015 | .07  | .13   |
|                                       | 100%            |                          | .71  | .72  | .49  | .385 | .24  | .13   |
| 340                                   | 0%              |                          | .01  | .02  | .05  | .08  | .13  | .19   |
|                                       | 100%            |                          | .77  | .78  | .55  | .45  | .30  | .19   |

## Basis:

Level Calibration Pressure = 2250 psia

Reference Leg Calibration Temperature = 110°F

Ratio of reference leg height to tap span (HL/H) = 1.00

Calibrated span = 521.73" @ 2250 psia, 110°F

Boiling in reference leg is not assumed

Saturated steam conditions assumed in pressurizer at all pressures calculated