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Alabama Power
the southern electric system

F. L. CLAYTON, JR.
Senior Vice President

November 1, 1979

Docket Nos. 50-348
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I.E. Bulletin 79-21
Effects of Reference Leg Heatup
Farley Units 1 & 2

Mr. James P. O'Reilly, Director
U. S. Nuclear Regulatory Commission
Region II - 101 Marietta Street, N. W.
Suite 3100
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

Alabama Power Company's response to the above subject bulletin is attached.

If you have any questions, please advise.

Yours very truly,

F. L. Clayton, Jr.

F. L. Clayton, Jr.

FLCjr/TNE/mmb

Attachment

cc: Mr. R. A. Thomas
Mr. G. F. Trowbridge

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POOR ORIGINAL

In response to IE Bulletin 79-21, Temperature Effects on Level Measurements, Alabama Power Company submits the following:

1. Review the liquid level measuring systems within containment to determine if the signals are used to initiate safety actions or are used to provide post-accident monitoring information. Provide a description of systems that are so employed; a description of the type of reference leg shall be included, i.e., open column or sealed reference leg.

RESPONSE:

Liquid level measuring systems inside containment at Farley Nuclear Plant - Unit 1 which initiate safety actions or provide post-accident monitoring are steam generator narrow range and wide range level and pressurizer level.
Steam generator narrow range and wide range level utilize an open column reference leg. Narrow range level provides reactor trips at:

1) Low level coincident with a feed flow-steam flow mismatch and,
2) Lo-lo level. The lo-lo level setpoint is also used to initiate auxiliary feedwater.

Narrow range level provides a high level turbine trip. Steam generator narrow range and wide range level is used for post-accident monitoring.

Pressurizer level utilizes a sealed reference leg. Pressurizer level initiates a reactor trip on high level, turns off the backup heaters and secures letdown on low level. Pressurizer level is also used for post-accident monitoring.

2. On those systems described in item 1 above, evaluate the effect of post-accident ambient temperatures on the indicated water level to determine any 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 measurement. The results of this evaluation should be presented in a tabulor form similar to Tables 1 and 2 of Enclosure 1.

RESPONSE:

A. Reference Leg Heatup

High Energy line breaks inside containment can result in heating level measurement reference legs. Increased

1387 355

reference leg water colum 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). For FNP, the steam generator narrow range reference legs have been insulated with sufficient insulation to protect them from significant short term (before auxiliary feedwater pump start and reactor trip) heatup. Long term maximum reference leg temperature following a steam line break is 269.9°F (reference Figure 6.2-- 3C15 in FNP FSAR).

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 Table I through III for steam generator narrow range level, steam generator wide range level and pressurizer level, respectively. These tables give the error (Indicated Level minus Actual Level) 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 < 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 and safety injection actuation. If such boiling were to occur, it could cause a major error in the indicated level of the affected steam generator, 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 through III.

3. Review 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. Provide a listing of these setpoints.

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 17%. (See note 1)

b) Reactor trip at a low level of 25% coincident with a feed flow-steam flow mismatch of 40%

of full steam flow at rated thermal power

c) Turbine Trip at a high level of 75%.

For the case of low or low-low water level, the trip must be actuated by the time the pressure difference between the narrow range level taps corresponds to a zero-level valve. 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 FNP have been insulated to limit the error due to reference leg heating prior to reactor trip and auxiliary feedwater pump start to less than 2% for a maximum containment temperature of 302°F (See note 1). Thus a determination of the low-low level trip setpoints is as follows:

Bottom of span (%)	0
Normal Channel Accuracy (%) (including instrument drift allowance)	±5
Post Accident Transmitter Error (%)	+10
Reference Leg Temperature Effects (%)	∓2, -0
Total Error (%)	+17,-15
Trip Setpoint (%)	17 percent of span
Allowable Setpoint (%)	16 percent of span

The low steam generator level coincident with steam/feedwater flow mismatch is not used in the transient and accident analyses but is included in table 2.2-1 of Technical Specifications to ensure the function capability of the low level trip, thereby enhancing overall reactor protection system reliability. It is redundant to the low-low level trip. The trip value of 25% includes allowance in excess of normal operating values to minimize spurious trips but, as shown in the previous calculation, will initiate a reactor trip before the steam generators are dry. 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 causes the high level turbine trip to actuate at a lower actual level, i.e., become more consecutive.

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 15%

The pressurizer high level trip ensures protection against RCS overpressurization 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 error introduced by increased reference leg temperature or by decreased pressure causes the high level trip to actuate at a lower actual level, i.e., become more conservative. The pressurizer low level function of letdown isolation and backup heaters off is a control function only. No credit is taken for this function

in the accident analyses.

4. Review and revise, as necessary, 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 a magnitude of erroneous level signals. All tables, curves, or corrective factors that would be applied to post-accident monitors should be readily available to the operator. If revisions to procedures are required, provide a completion date for the revisions and a completion date for operator training on the revisions.

RESPONSE:

Emergency operating procedure FNP-1-EOP-2.0 "Loss of Secondary Coolant" and FNP-1-EOP-1.0 "Loss of Reactor Coolant" were revised September 11, 1979, to provide the following caution:

CAUTION: Due to density changes occuring in the reference legs with increasing containment temperature, steam generator level should not be used as sole indication of adequate level in the steam generator to provide a heat sink. Parameters such as AUXILIARY FEEDWATER FLOW, STEAM PRESSURE and RCS WIDE RANGE Tc and Th should also be evaluated. Steam generator narrow range level should be maintained between 24% and 68% of span when a post accident environment exists in containment.

These procedures will be revised to include a caution regarding reference leg temperature effects on pressurizer level indication and pressure effects on both pressurizer and steam generator level indications. Graphs or tables of pressurizer and steam generator level indication error as a function of system pressures for both normal and post accident containment temperatures will be developed and placed in the control room. These actions will be completed by December 15, 1979. Licensed Operations personnel will be trained on the procedure changes by January 15, 1979.

NOTE 1 The non-conservative effect of increasing steam generator (S/G) reference leg temperature was reported to the NRC in FNP Unit 1 LER 79-023/01T-0 and 79-023/01T-1. A design change has been executed to place 2 inches of insulation on the S/G reference legs, excluding the condensate pots and the first 18 inches of leg below the pots. The low-low level S/G trip bistables have been reset from 15% to 17% to compensate for the calculated effect of a peak containment vapor temperature of 302°F on the insulated reference legs. A change to the FNP Unit 1 Technical Specifications was submitted August 30, 1979, to revise the low-low level setpoint and allowable values from 15% to 17% and from 14% to 16% respectively.

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

STEAM PRESSURE (psia)		100	300	500	700	900	1100
Reference Leg Temperature (^{0}F)	Actual Level	Error (%) = (Indicated Level - Actual Level)					
90	0%	-2	-1	-1	0	+1	+2
	100%	+15	+8	+3	-1	-5	-8
120	0%	-1	0	0	+1	+2	+3
	100%	+16	+9	+4	0	-4	-7
280	0%	+7	+7	+8	+9	+10	+11
	100%	+24	+17	+12	+8	+4	+1

Basis:

Level Calibration Pressure - 640 psia

Reference Leg Calibration Temp - 90^{0}F

Ratio of reference leg height to tap span (HL/H) $\leq$ 1.003

S/G Thermal Expansion Coef. 7.07×10^{-6} inches/inch -^{0}F

Boiling in reference leg is not assumed

1387 360

TABLE II EFFECTS OF TEMPERATURE AND PRESSURE ON STEAM GENERATOR WIDE RANGE LEVEL

STEAM PRESSURE (psia)		100	300	500	700	900	1100
Reference Leg Temperature ^0F	Actual Level	Error (%) = Indicated Level - Actual Level)					
90	0%	0	+1	+2	+2	+3	+4
	100%	-9	-15	-19	-22	-24	-27
120	0%	+1	+2	+2	+3	+4	+4
	100%	-9	-14	-18	-21	-24	-26
280	0%	+7	+8	+8	+9	+10	+10
	100%	-3	-8	-12	-15	-18	-20

Basis:

Level Calibration Pressure - 14.7 psia

Reference Leg Calibration Temp - 70^0F

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

S/G Thermal Expansion Coef. 7.07×10^{-6} inches/inch - ^0F

Boiling in reference leg is not assumed

TABLE III EFFECTS OF TEMPERATURE AND PRESSURE ON PRESSURIZER LEVEL INDICATOR

RCS PRESSURE (psig)		0	200	400	800	1200	1800	2235
Reference Leg Temperature ^0F	Actual Level	Error (%) = (Indicated Level - Actual Level)						
90	0%	-20	-18	-17	-14	-11	-6	0
	100%	+75	+56	+48	+35	+25	+11	0
120	0%	-18	-17	-16	-13	-10	-4	+1
	100%	+77	+58	+49	+37	+27	+12	+1
280	0%	___	-5	-3	-1	+2	+8	+13
	100%	___	+70	+62	+49	+39	+24	+13
300	0%	___	-3	-1	+1	+4	+10	+15
	100%	___	+72	+64	+51	+41	+26	+15

Basis:

Level Calibration Pressure - 2235 psig

Reference Leg Calibration Temp - $\approx 90^0F$ (ambient at time of calibration)

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

Saturated steam conditions assumed in Pressurizer at all pressures calculated

Boiling in reference leg is not assumed

1387 362