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September 14, 1979

Mr. Boyce H. Grier, Director
U. S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Region I
631 Park Avenue
King of Prussia, Pennsylvania 19406

Subject: IE Bulletin No. 79-21, Temperature Effects on Level Measurement
R. E. Ginna Nuclear Power Plant, Unit #1
Docket No. 50-244

Dear Mr. Grier:

In response to Inspection and Enforcement Bulletin 79-21 concerning "temperature effects on level measurement", an analysis was performed to determine these effects and consequences on the operation of the Ginna Nuclear Power Plant. A summary of the analysis and a description of corrective actions to be taken is attached.

Very truly yours,

L. D. White, Jr.

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xc: U.S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Division of Reactor Operations Inspection
Washington, D. C. 20555

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Temperature and Pressure Effects on Level Measurements

A review of the liquid level measurement systems has been undertaken at the Ginna Nuclear Power Plant. The systems investigated were those systems located inside containment designed to initiate safety actions. The systems subject to these qualifications are the steam generator and pressurizer level measurement systems.

A. System Description

1. Pressurizer Level Measurement System

The pressurizer level system consists of 3 duplicate measuring loops (hot channels) and a loop (cold channel) that shares the taps of one of the hot channels. The hot channels utilize Foxboro 613 HM-MOD dp transmitter with Barton Model 351 level system sealed reference legs.

The cold channel transmitter is a Foxboro model 613 HM with open reference leg. This channel does not perform a safety function but rather is used to monitor cold plant functions such as filling and venting the reactor coolant system. In the event of an accident, this channel could assist in post accident monitoring of the pressurizer level.

The hot channels are used to provide a reactor trip with a two out of three channel coincidence on pressurizer level at 92 percent. These channels would provide post accident monitoring for pressurizer level.

2. Steam Generator Level Measurement System

The steam generator level measurement system consists of 3 narrow range channels and a wide range channel per steam generator, all with independent taps and open reference legs. The transmitters are Foxboro model 613 HM dp transmitters.

The wide range steam generator level channel performs no safety function but is used for post accident monitoring.

The narrow range channels assist in post accident monitoring and initiate safety actions. A two out of three channel high-high steam generator level signal at 68% will isolate the main feedwater and feedwater bypass valves. A one out of two channel low-level at 30% coincident with a one out of two channel mismatch of

steam flow greater than feedwater flow by 0.8×10^6 lbs/hr will cause a reactor trip. A reactor trip is also initiated with two out of three channels at a low-low level at 15%. This signal will also start the auxiliary feedwater pumps. A low-low level in one steam generator will start both motor driven auxiliary feedwater pumps. A low-low level in both steam generators will start both motor driven auxiliary feedwater pumps and the turbine driven auxiliary feedwater pump.

B. Evaluation of Post Accident Conditions on Level Measurements

1. Pressurizer Level Measurement System

Table 3 illustrates the percent error introduced to the level measurement as a function of reference leg heat up caused by accident temperatures inside of containment. Figure 2 is a plot of this table. As the temperature of the reference leg increases, the density of the water column of the reference leg lessens causing an decrease in differential pressure across the transmitter which simulates a higher indicated level. This is a positive error and on rising actual level would activate high level set points sooner in time than normal. On falling level, low level set points would be actuated later in time than normal.

Figure 4 depicts the amount of error introduced to the level measurement for various primary system pressures that may be encountered. It should be noted that as the primary system pressure increases above the normal operating level the introduced error in level measurement becomes negative. A negative error simulates a lower level. Pressure increases then, cause the high level set points to act later than normal on rising level and low level set points earlier than normal on decreasing level.

To establish the worst case of error introduction affecting both high and low level set points, it was assumed that pressurizer pressure was 2600 psig. This pressure was conservative since the presurizer relief valves open at 2335 psig and the code safety valves at 2485 psig. This introduced an error of 6 percent of span in the positive direction at the zero level point which was added to the positive error introduced by heat up of the reference leg to establish column two of Table 4. Column 2 indicates the correction to the minimum allowed indicated level. Column three of Table 4 lists the error correction to the maximum allowed indicated level. For high level set point actuation the worst case was the 9% error induced by the maximum pressure considered 2600 psig. Figure 4 is a family of pressurizer pressure curves that the pressurizer could

be subjected to and the resulting error in level indication caused by a particular pressure.

2. Steam Generator Level Measurement System

Table 1 illustrates the percent error introduced to the steam generator level measurement as a function of reference leg heat up due to containment post accident conditions. Figure 1 is a curve derived from the table. In addition, steam generator pressure effects on level measurement was determined. The error in level measurement for a particular pressure can be determined from the curves of Figure 3. Again, to develop the worst case situation for steam generator level measurement, the positive error induced by reference leg heat up was added to the positive error generated by the worst case pressure considered (1200 psig) to develop column two of Table 2. Column two indicates the correction required to the minimum allowed indicated level.

The correction required to the high level set point is the most negative error developed by any pressure considered as indicated in Figure 3. This error does not consider the beneficial effect of positive error due to reference leg heat up on the high level set point. Column three of Table 2 indicates the calculated error.

C. Set Point Analysis

Table 5 lists all pressurizer and steam generator level set points. Of those listed in the table, only the latter three are assumed in the plant safety analysis; reactor trip and auxiliary feedwater initiation at a steam generator level of 5% and reactor trip at a pressurizer level of 92%. The first two, feedwater isolation at 68% steam generator level and reactor trip on 30% steam generator level with feed/steam mismatch, are not used in the plant safety analysis. Table 5 also lists the current set point requirements as listed in plant procedures. Table 5 then lists the required set points to ensure that safety actuations are accomplished as required by the plant safety analysis assuming all errors introduced by pressure and temperature effects.

1. Pressurizer Level Measurement System

Present operation of the Ginna Nuclear Plant does not require any pressurizer low level set points to initiate a safety action however, a high level set point of 92% is required for reactor trip. Error effects, as stated previously, are positive at the high set point level because of temperature effects on the reference leg and negative because of pressure effects.

The positive error effect was discounted because the error was in the safe direction (the set point would activate a safety function at a lower actual level). The negative error effect as listed in column three of Table 4 was determined to be -9 percent at 2600 psig. Since the high pressurizer pressure reactor trip set point is 2385 psig, it becomes inconsequential to consider a reactor trip for level affected by any pressure above this. The appropriate error then, would be the error induced by a pressure of 2385 psig. The maximum negative error calculation at this pressure is 3.9 percent. The pressurizer high level reactor trip set point will be corrected 4 percent ($\leq$ 88% of span).

2. Steam Generator Measurement System

The low-low steam generator level set point initiates reactor trip and auxiliary feedwater pump start. The Ginna Station Technical Specifications require this set point to be set at 5%. Positive error introduced because of reference leg heat up is determined to be 10.1 percent from Figure 1 based on a containment temperature of 280°F. The Ginna Plant reactor trip for high containment pressure is 6 psig which is equivalent to 230°F at saturation. Thus, it is not necessary to consider a temperature above 230°F. Calculations based on a temperature of 230°F demonstrates that the error incurred is 7.5 percent. In this case the error is not in the conservative direction. A positive error is also introduced by pressure effects based on a 1200 psig pressure, but it is less than 0.1 percent by calculation.

Although a total of 7.5 percent error has been introduced which would mean set point operation at 12.5 percent of span, the present setting of this set point is conservatively set at 15% and no change is intended.

The low level set point is used in conjunction with a steam flow-feedwater flow mismatch signal to provide a reactor trip. The low level is set at 30 percent but would be effective only at 22.5 percent because of the induced error. This is a tolerable setting since it is appreciably higher than the conservative low-low level reactor trip set point, also, to achieve this amount of error, would indicate a severe high energy line break in which case steam generator level would drop rapidly enough to activate both low level and low-low level set points simultaneously even if the low level set point were corrected to 30%.

The high-high steam generator level set point provides feedwater isolation at 68 percent level. The

negative induced error resulting from pressure effects is two percent, worst case, and when added to the positive induced error of 7.5 percent resulting from reference leg heat up yields a positive error of 5.5 percent which is in the conservative direction. The effective set point under these conditions is 62.5 percent which is acceptable.

D. As a result of this evaluation, several precautionary steps will be taken to advise operations personnel of potential problems that may evolve under accident conditions. Some of the more significant steps to be taken follow.

Proposed revisions to the plant emergency procedures.

1. Incorporate into the appropriate emergency procedures Tables 1 through 4 and Figures 1 through 4 of this report to aid the operator in interpreting post accident water level indication for the Steam Generators and the pressurizer.

2. Incorporate into the appropriate emergency procedures a caution statement to alert the operator to the fact that level indication may be erroneous and indicate to the operator the minimum and maximum indicated level that should be maintained for the pressurizer and steam generators under post accident conditions.

3. Incorporate into the appropriate emergency procedures a caution statement that will instruct the operators to not rely upon Steam Generator Water level indication in any depressurized steam generator following a high energy line rupture inside containment due to the possibility of reference leg boiling.

The revisions to the emergency procedure will be completed by 9/24/79 at which time a copy will be forwarded to the Shift Foremans office with instructions alerting the Shift Foreman of the changes made to the procedures and how to utilize the new information. The Operator training will be completed by 10/31/79.

In addition, the pressurizer high level trip set point will be adjusted as required by September 24, 1979.

Table 1

Correction to indicated Steam Generator Water level for Reference Leg Heatup effects due to post-accident containment temperature (before reactor trip)

Maximum Containment temperature reached before reactor trip, °F	Correction to S/G Level % of Span
90°	0%
150°	2%
200°	5%
250°	8%
300°	12%
350°	16%
400°	21%

Basis:

Level Calibration Pressure $\leq$ 1000 Psia
Reference Leg calibration temperature $\geq$ 90°F
Height of Reference Leg $\leq$ 1.1 x Level Span

Table 2

Corrections to allowable indicated Steam Generator water level for Reference Leg Heatup and Pressure changes following a high-energy line break, to assure that true level is between the level taps

Containment temperature °F	Correction to Minimum allowed Indicated Level % of Span	Correction to Maximum allowed Indicated Level % of Span
90°	+ 1	-4
150°	+ 3	-4
200°	+ 6	-4
250°	+ 9	-4
300°	+13	-4
350°	+17	-4
400°	+22	-4

Basis:

Level calibration Pressure $\leq$ 1000 Psia
Reference Leg Calibration Temperature $\geq$ 90°F
Height of Reference Leg $\leq$ 1.1 x Level Span
Pressure $\geq$ 50 Psia
Pressure $\leq$ 200 Psi + Calibration Pressure

Boiling in the Reference Leg is not assumed.

Table 3

Correction to indicated Pressurizer water level for Reference Leg Heatup effects due to post-accident containment temperature

Maximum Containment temperature reached °F	Correction to Pressurizer Level % of Span
90°	0%
150°	3%
200°	7%
250°	12%
300°	17%
350°	23%
400°	30%

Basis:

Level Calibration Pressure = 2250 Psia
Reference Leg Calibration Temperature $\geq$ 90°F
Height of Reference Leg $\leq$ 1.1 x Level Span

Table 4

Corrections to allowable indicated Pressurizer water level for Reference Leg Heatup and Pressure changes following a high-energy line break, to assure that true level is between the level taps

Containment temperature °F	Correction to Minimum allowed Indicated Level % of Span	Correction to Maximum allowed Indicated Level % of Span
90°	+ 6	-9
150°	+ 9	-9
200°	+13	-9
250°	+18	-9
300°	+23	-9
350°	+29	-9
400°	+36	-9

Basis:

Level Calibration Pressure = 2250 Psia
Reference Leg Calibration Temperature $\geq$ 90°F
Height of Reference Leg $\leq$ 1.1 x Level Span
Pressure $\geq$ 100 Psia
Pressure $\leq$ 350 Psi + Calibration Pressure

Boiling in reference Leg is not assumed.

TABLE 5

SAFETY AND CONTROL SETPOINTS

LOGIC	FUNCTION	REMARKS	TECH. SPEC SETPOINT	CURRENT SETPOINT	PROPOSED SETPOINT
2/3	FEEDWATER ISOLATION	FEEDWATER ISOLATION ON HIGH-HIGH STEAM GENERATOR LEVEL	NONE	68%	68%
1/2	REACTOR TRIP	REACTOR TRIP ON LOW STEAM GENERATOR LEVEL COINCIDENCE WITH 1/2 STEAM FLOW > FEEDWATER FLOW MISMATCH	NONE	30%	30%
2/3	REACTOR TRIP	REACTOR TRIP ON LOW-LOW STEAM GENERATOR LEVEL	$\geq$ 5%	15%	$\geq$ 13%
2/3	AUXILIARY FEEDWATER PUMP INITIATION	INITIATES AUTOMATIC START OF BOTH MOTOR DRIVEN AUX. F.W. PUMPS WITH LOW-LOW LEVEL IN ONE STEAM GENERATOR, AND BOTH MOTOR DRIVEN AUX. F.W. PUMPS & THE TURBINE DRIVEN AUX. F.W. PUMP WITH LOW-LOW LEVEL IN BOTH STEAM GENERATORS	NONE	15%	15%
2/3	REACTOR TRIP	REACTOR TRIP ON PRESSURIZER HIGH WATER LEVEL	$\leq$ 92%	91%	$\leq$ 88%

Figure 1

Bias Due to Steam Generator Reference Leg Heatup

Basis: Height of Reference Leg = 1.1 x Level Span
Calibration at 90°F, 1000 Psia

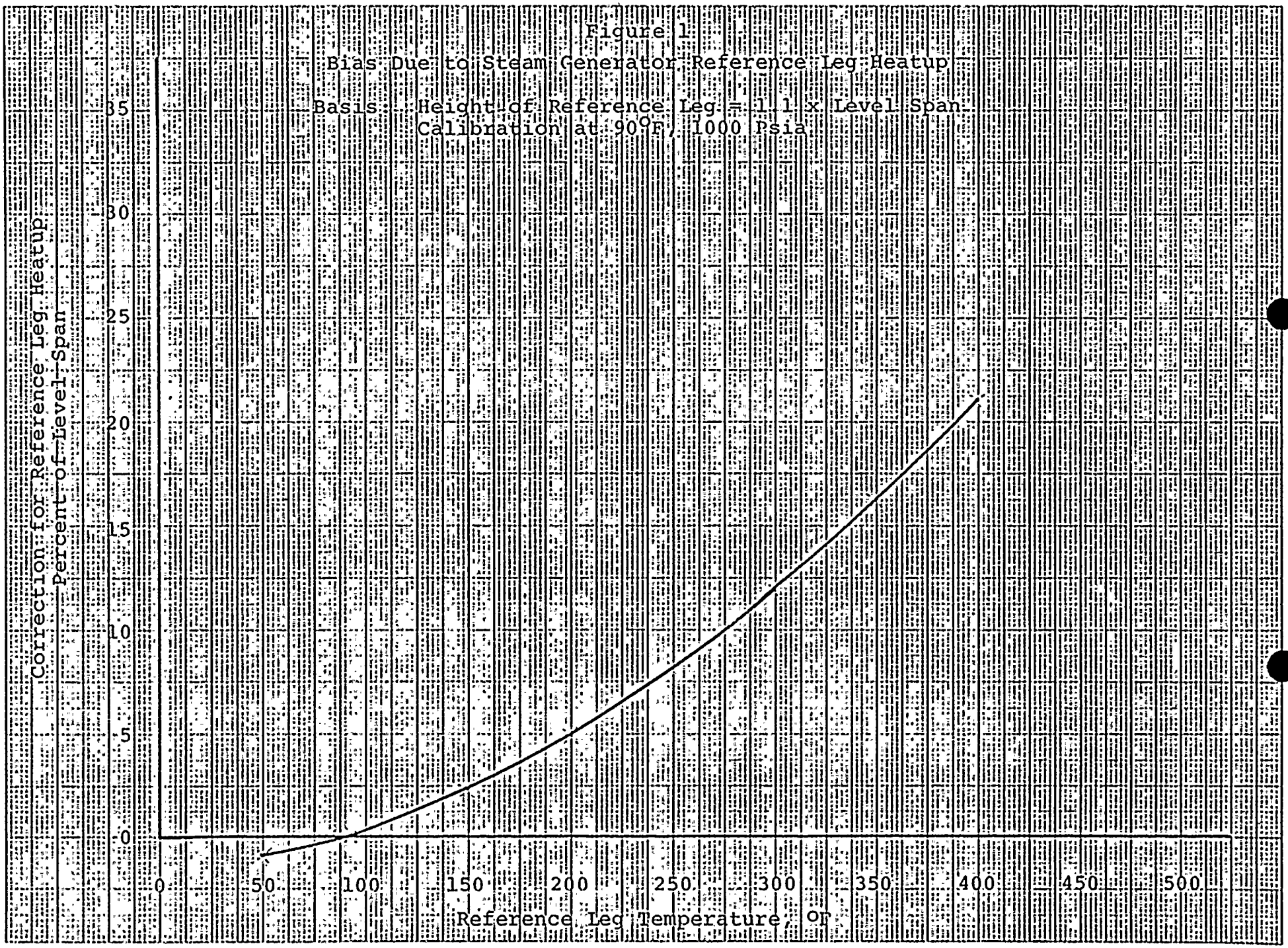

Figure 2

Bias Due to Pressurizer Reference Leg Heatup

Basis: Height of Reference Leg = 1.1 x Level Span
Calibration at 90°F, 2250 Psia

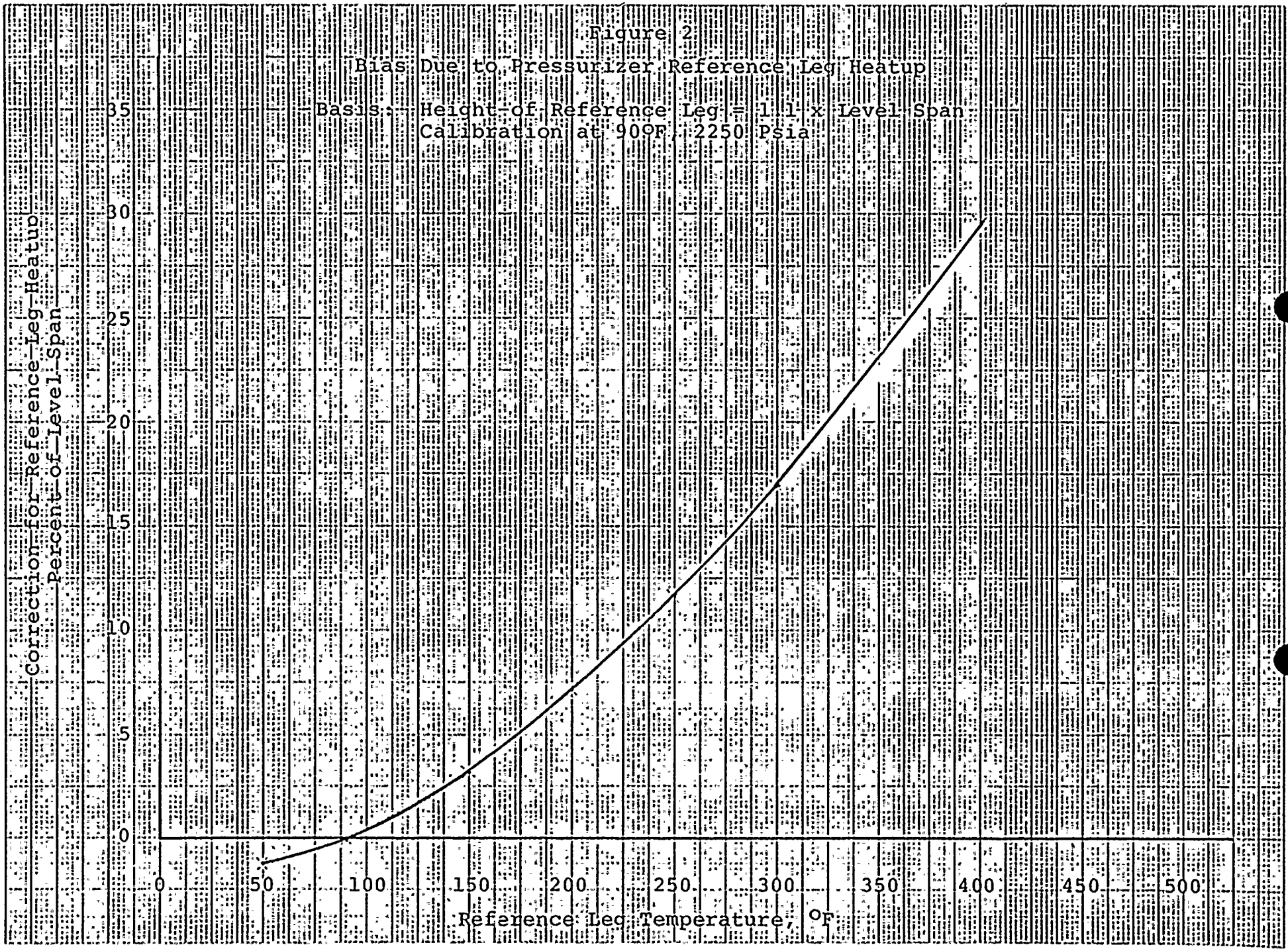

Figure 3

Bias Due to Steam Generator Pressure Change

Basis: Height of Reference Leg = 1.1 x Level Span
Calibration at 90°F, 1000 Psia

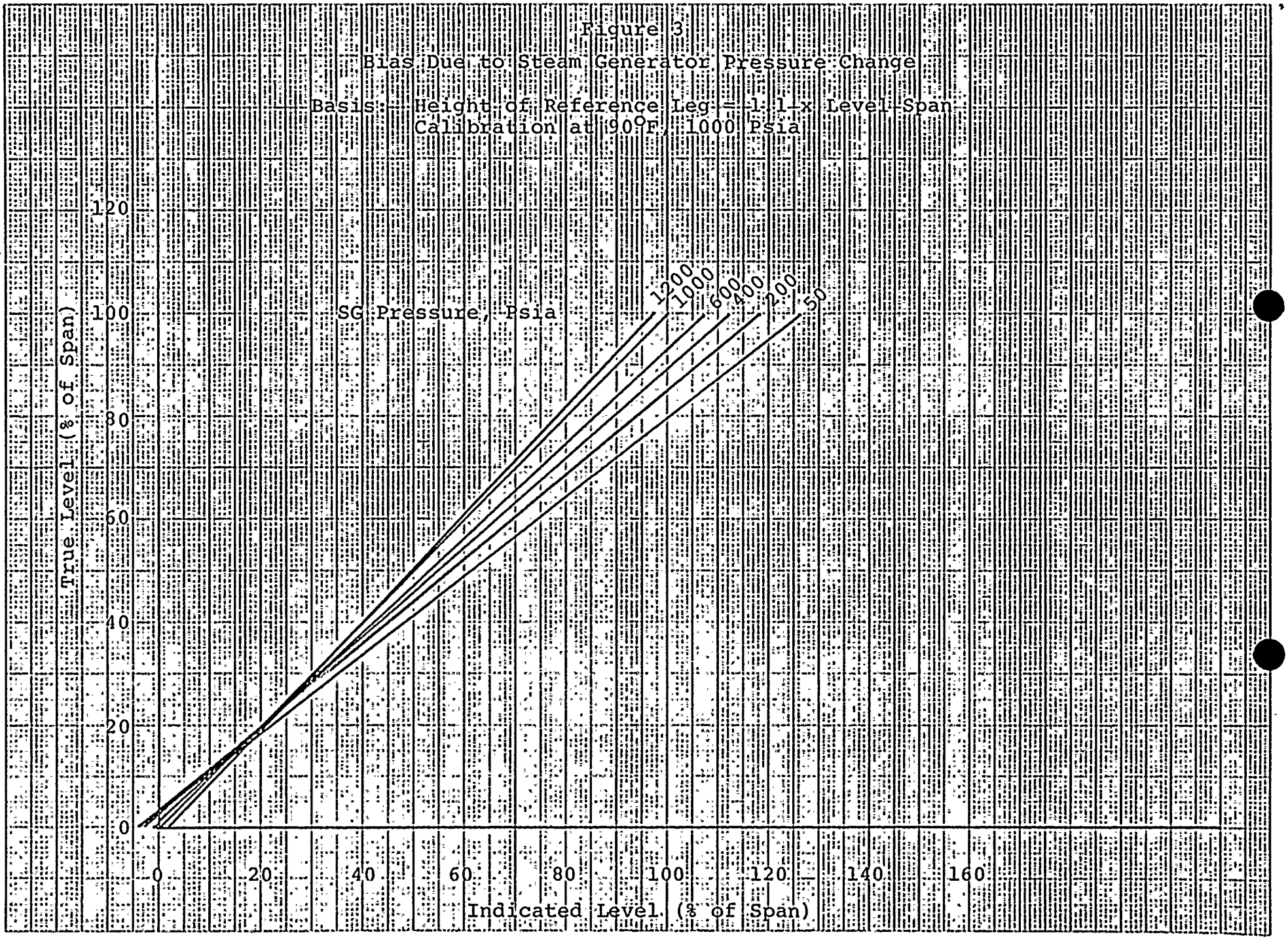

Figure 4

Bias Due to Pressurizer Pressure Change

Basis: Height of Reference Leg = 1.1 x Level Span
Calibration at 90°F, 2250 Psia