SALEM NUCLEAR GENERATING STATION
UNIT NO. 2
SIGNIFICANT DEFICIENCY EVALUATION REPORT 79-06

## Potential Deficiency

Westinghouse has notified PSE&G and its other utility customers that a potential safety problem exists with the heatup of the steam generator level measurement reference legs during accident conditions. Pipe breaks inside the containment resulting in elevated containment ambient temperatures could cause heatup of the steam generator level reference legs. This would result in a decrease in water column density and an increase in the indicated steam generator water level. The actual water level will be lower than the level indicated by the instruments. The erroneous indication of level could result in delayed protection system actuation (reactor trip and auxiliary feedwater initiation) and could affect operator response for post-accident recovery.

## Analysis/Safety Implications

Level measurement of the steam generators at Salem employ an open column reference leg. Only steam generator narrow range level is utilized in a protective function. Three separate instruments and reference leg measurement systems are provided for each steam generator. The instrument lines are not insulated, and therefore, are subject to potential heatup and subsequent indication errors due to increased containment ambient temperatures. Large steam generator pressure changes caused by high energy line pipe ruptures could also cause indication errors.

The steam generator narrow range level instruments provide information for the following protective functions:

1. Initiation of turbine trip, feedwater isolation, and feedwater pump trip on high-high steam generator water level.

2. Initiation of reactor trip on low steam generator water level in coincidence with steam flow-feedwater flow mismatch.

3. Initiation of reactor trip on low-low steam generator water level.

4. Initiation of auxiliary feedwater system on low-low steam generator water level.

5. Post-accident monitoring for operator action.

The potential error bias in instrument indication due to reference leg heatup is on the high side. The first two protective functions of high-high level trip and low level trip are not required for plant protection during postulated high energy line breaks. These items are primarily for feedwater control system malfunctions. The potential error bias for the remaining three items could result in a less conservative analysis of high energy line break events.

A review of the safety analyses for accident conditions indicates that the only high energy line rupture within the containment, for which the steam generator water level provides the primary trip function, is a feedwater line rupture. For such a case, the low-low water level trip must be actuated at a setpoint level which is above the steam generator tubes. Thus, the trip setpoints must be at or above the value that would be indicated by the instruments when the actual level is just above the steam generator tubes. Because large steam generator pressure changes are not expected before the trip, only the reference leg heatup effects need be considered, and not the effects of system pressure changes. Correction factors are required for the level setpoints to compensate for the reference leg heatup effects.

The backup trip function for the feedwater line rupture is provided by the high containment pressure signal. In addition, this signal will initiate operation of the motor driven auxiliary feedwater pumps. Therefore, revisions to the level setpoints are only required to compensate for reference leg heatup up to the temperature at which the containment high pressure signal is received. A conservative upper bound for reference leg temperature would be at the peak containment temperature reached following a feedwater line break before the containment high pressure bi-stables are tripped. Steam line break results provide an upper bound for a feedwater line break due to the design characteristics of the system at Salem. Based on the results of the steam line break analysis for Salem presented in the response to FSAR question 5.82, the containment high pressure setpoint would be reached prior to a containment temperature of 240°F.

An analysis has been performed of potential indication errors assuming different reference leg ambient temperatures compared with the entire reference leg calibration data. The results of the analysis are presented in Table 1. Assuming that the reference leg is at an ambient temperature of 240°F (a conservative assumption), the indication error bias is 5.7% of span. The indication error bias is constant over the entire span for a particular reference leg temperature.

The existing steam generator low-low level setpoint is 5%, and will require a revision to assure that the protection system actuation is initiated in a time frame consistent with the safety analysis. A setpoint change to 11% will maintain existing safety margins. No other setpoint changes are required for the steam generator levels.

With regards to post-accident monitoring, the existing operating procedures require the use of steam generator level indication in accident recovery as an aid in controlling auxiliary feedwater flow to the unaffected steam generators for primary to secondary heat transfer. The indication errors associated with reference leg heatup should not have an adverse effect on operator actions. Existing procedures at Salem direct the operator to maintain steam generator level at 33%. The maximum containment design temperature for Salem is 350°F, which occurs for a very short period of time (one minute with only an additional two minutes above 300°F). The probable maximum heatup of the reference legs will be to some temperature less than 300°F, which would result in indication errors of less than 10% of span. Even assuming this error and the errors in indication from the expected pressure fluctuations in the unaffected steam generators, the steam generators would be maintained at an actual level sufficient to maintain the unit in a safe condition. The indication bias will decrease as the containment ambient and reference leg temperatures decrease during the course of the postulated accident.

Corrective Action

The low-low steam generator water level setpoints will be changed to 11% to account for indication bias due to reference leg heatup. A change of 6% is based on the preceding analysis of containment temperature, steam generator level, and the containment high pressure signal. ECN 35397 has been initiated to accomplish this change. Setpoints will be revised prior to start up of Salem Unit 2.

The Salem operating procedures and training program for post-accident recovery will be revised to address the concerns discussed herein. Cautionary statements will be added to the procedures alerting the operators of the potential errors in steam generator level indications. Correction curves similar to the attached figures will be provided for the operator's use in determining actual level for reference

leg heatup and fluctuating steam pressure. In addition, the operator will be directed to examine auxiliary feedwater flows, steam line pressures, and reactor coolant system temperatures to assist in verification of primary to secondary heat transfer. This will also be accomplished prior to start up of Salem Unit 2.

JPG:jb

Attachments

HL2 1/4

SALEM NUCLEAR GENERATING STATION
UNIT NO. 2
SIGNIFICANT DEFICIENCY EVALUATION
REPORT 79-06

TABLE 1

STEAM GENERATOR LEVEL INSTRUMENTATION
REFERENCE LEG HEATUP COMPENSATION

| Reference Leg Ambient Temperature | Correction to Steam Generator Level % of Span |
|---|---|
| 120°F | 0% |
| 200°F | 3.5% |
| 240°F | 5.7% |
| 300°F | 9.6% |
| 350°F | 13.4% |

Basis: Reference Leg Calibration

Temperature 120°F

Pressure 805 psia

Calculations assumed constant steam pressure with varying reference leg temperature.

Example: Containment ambient temperature is 240°F.
Instrument indicates a level of 33%.
Assuming reference leg has reached containment ambient temperature, the actual level in the steam generator is lower at 27.3%. Steam pressure is assumed to remain approximately the same (no large changes).

SALEM NUCLEAR GENERATING STATION
UNIT NO. 2
SIGNIFICANT DEFICIENCY EVALUATION
REPORT 79-06

TABLE 2

STEAM GENERATOR LEVEL INSTRUMENTATION
REFERENCE LEG COMPENSATION DUE TO STEAM PRESSURE

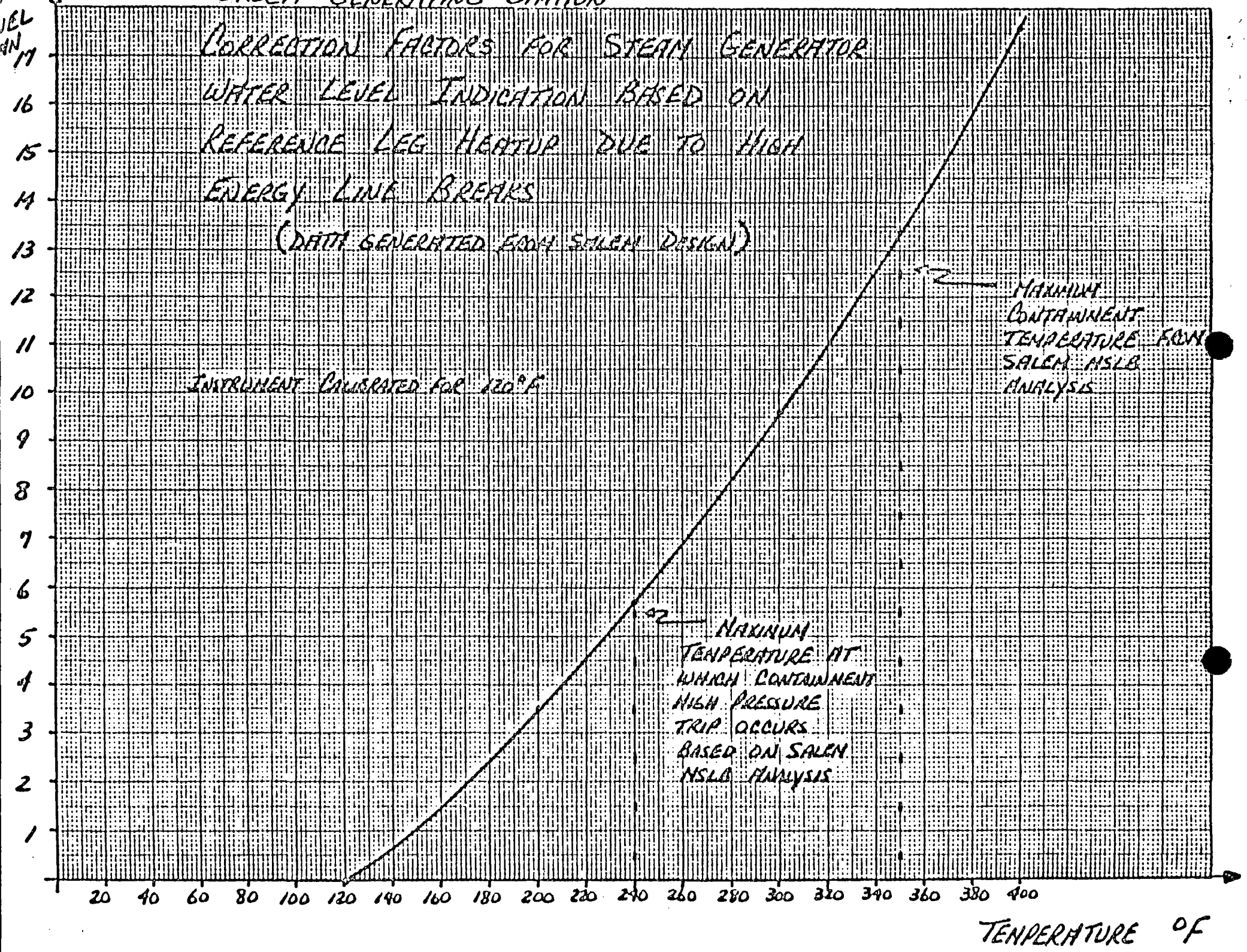
| Steam Generator Pressure | Instrument Indicated Level | Actual Level |
|---|---|---|
| 1000 psia | 5.7% | 5% |
| | 32.5% | 33% |
| | 48.7% | 50% |
| 805 psia | 5% | 5% |
| | 33% | 33% |
| | 50% | 50% |
| 600 psia | 4.3% | 5% |
| | 33.7% | 33% |
| | 51.5% | 50% |
| 400 psia | 3.7% | 5% |
| | 34.6% | 33% |
| | 53.3% | 50% |
| 200 psia | 3.2% | 5% |
| | 36.0% | 33% |
| | 55.9% | 50% |

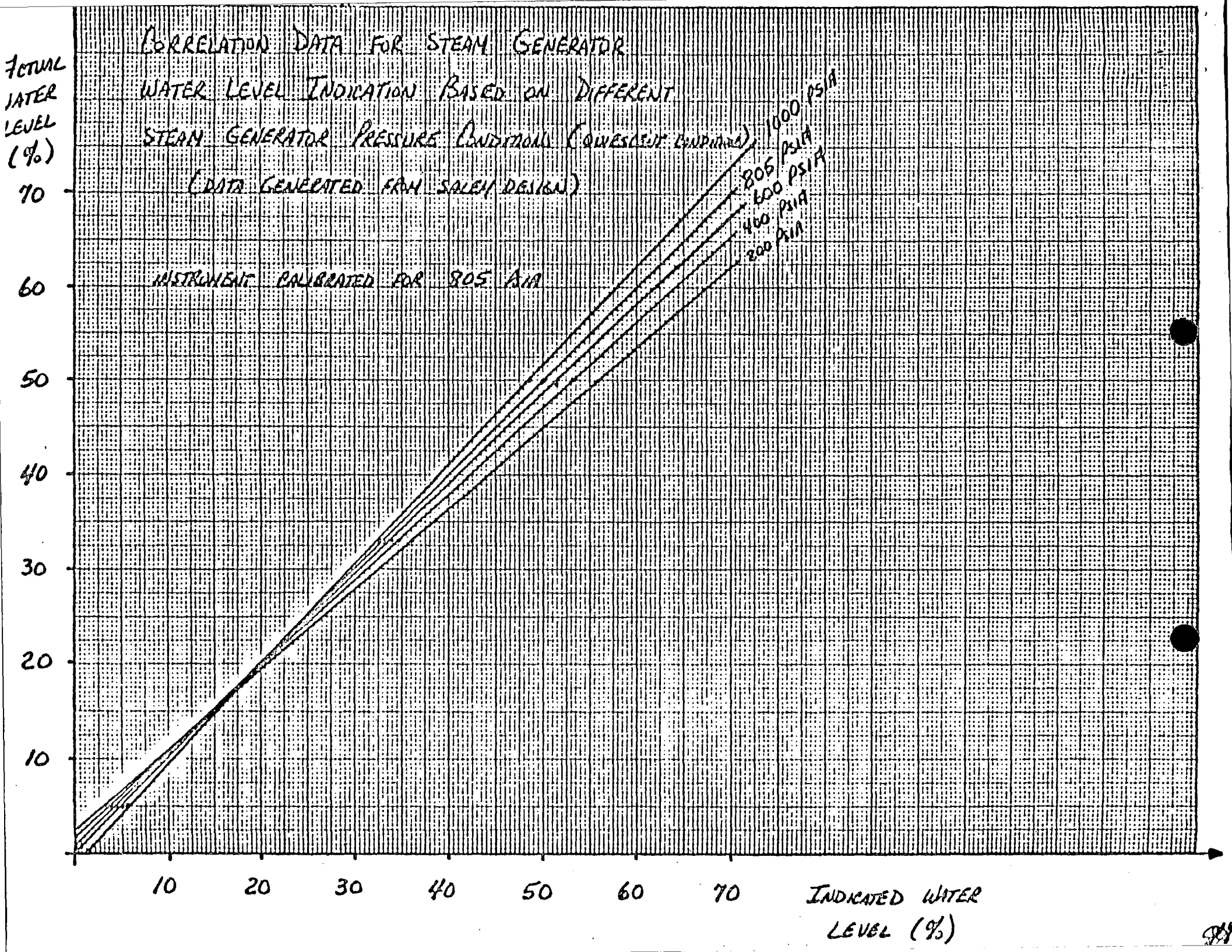
Basis: Reference Leg Calibration

Temperature 120°F

Pressure 805 psia

Calculations assumed constant reference leg temperature with varying steam pressure.


CORRECTION FACTORS FOR STEAM GENERATOR WATER LEVEL INDICATION BASED ON REFERENCE LEG HEATUP DUE TO HIGH ENERGY LINE BREAKS
(DATA GENERATED FROM SALEM DESIGN)
INSTRUMENT CALIBRATED FOR 120°F
MAXIMUM CONTAINMENT TEMPERATURE FROM SALEM MSLB ANALYSIS
MAXIMUM TEMPERATURE AT WHICH CONTAINMENT HIGH PRESSURE TRIP OCCURS BASED ON SALEM MSLB ANALYSIS
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
TEMPERATURE °F


CORRELATION DATA FOR STEAM GENERATOR
WATER LEVEL INDICATION BASED ON DIFFERENT
STEAM GENERATOR PRESSURE CONDITIONS (LOWEST CONDITION)
(DATA GENERATED FROM SALEM DESIGN)
INSTRUMENT CALIBRATED FOR 805 PSIA
1000 PSIA
805 PSIA
600 PSIA
400 PSIA
200 PSIA
ACTUAL WATER LEVEL (%)
70
60
50
40
30
20
10
10
20
30
40
50
60
70
INDICATED WATER LEVEL (%)