AEOD TECHNICAL REVIEW REPORT*

UNITS: Multiple C-E Units

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SUBJECT: PRESSURIZER LEVEL INSTRUMENTATION OF COMBUSTION - ENGINEERING REACTOR UNITS

REFERENCE: Memorandum for Karl V. Seyfrit from E. V. Imbro dated October 16, 1984 "Potential Inability to Detect an Empty Pressurizer Using Existing Level Instrumentation"

SUMMARY

During a review of an overcooling transient at Calvert Cliffs 2, the reviewer identified that the lower level taps of the unit's pressurizer level instrumentation lines were located 14 inches below the surge line inlet (see referenced memorandum). It was postulated that this configuration could lead to the level instrumentation indicating some level when the pressurizer is empty.

A brief review of typical pressurizer level instrumentation of other vendor's PWRs (Westinghouse and B&W) showed that this configuration applied to Combustion Engineering units only.

On C-E units, pressurizer level instrumentation does not perform any safety function. It does provide certain control, alarm and indication functions. A review of the instrumentation and these functions showed that the configuraton of the lower tap does not affect the performance of these functions. The reactor vessel level instrumentation required by TMI Action Plans when installed, will monitor levels below the range of existing instrumentation.

*This document supports ongoing AEOD and NRC activities and does not represent the position or requirements of the responsible NRC program office.

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DISCUSSION

The referenced memorandum showed that on the Calvert Cliffs pressurizer, the pressurizer lower level tap is located 14" below the surge line thermal sleeve outlet (see Figure 1). This configuration could imply that with the pressurizer empty, the level indication would show approximately 14". A review of FSAR drawings of some Westinghouse and B&W plants showed that this configuraton did not apply to the level instrumentation on the pressurizer for these venders. A review of the FSAR drawings of all C-E units showed that their pressurizer was the same as the pressurizer of the Calvert Cliffs units. Hence, it was assumed that the configuration of the level instrumentation was also the same.

On C-E units, the pressurizer level instrumentation is not used for any safety function. It is, however, used for the following control, alarm and indication fuctions:

1) Maintaining pressurizer level at the programmed set point during normal steady state operation.

2) Reducing letdown flow and starting backup charging pumps during a decreasing pressurizer level transient.

3) Decreasing letdown flow during an increasing level transient.

4) Providing alarms to warn of channel failure or malfunction of the instrumentation system.

5) Energizing all pressurizer heaters on a high level deviation.

6) Providing low level heater protection.

7) Providing input to the control room indicators and recorders.

The pressurizer level set point is a function of T average and is typically programmed to increase from 120 inches at 538 F to 200 inches at 568 F (see Figure 2). The programmed level set point will control charging and letdown flow to keep the pressurizer level at the set point level.

Two separate level channels are provided for control of pressurizer level. Each channel has four bistables and a level indicator controller (LIC). A channel selector switch determines which channel bistable and controller outputs are used for the various functions. Level indication for each channel is provided on the LIC and level from the selected channel is recorded on a level recorder (LR) - See Figure 3.

CALVERT CLIFFS PRESSURIZER

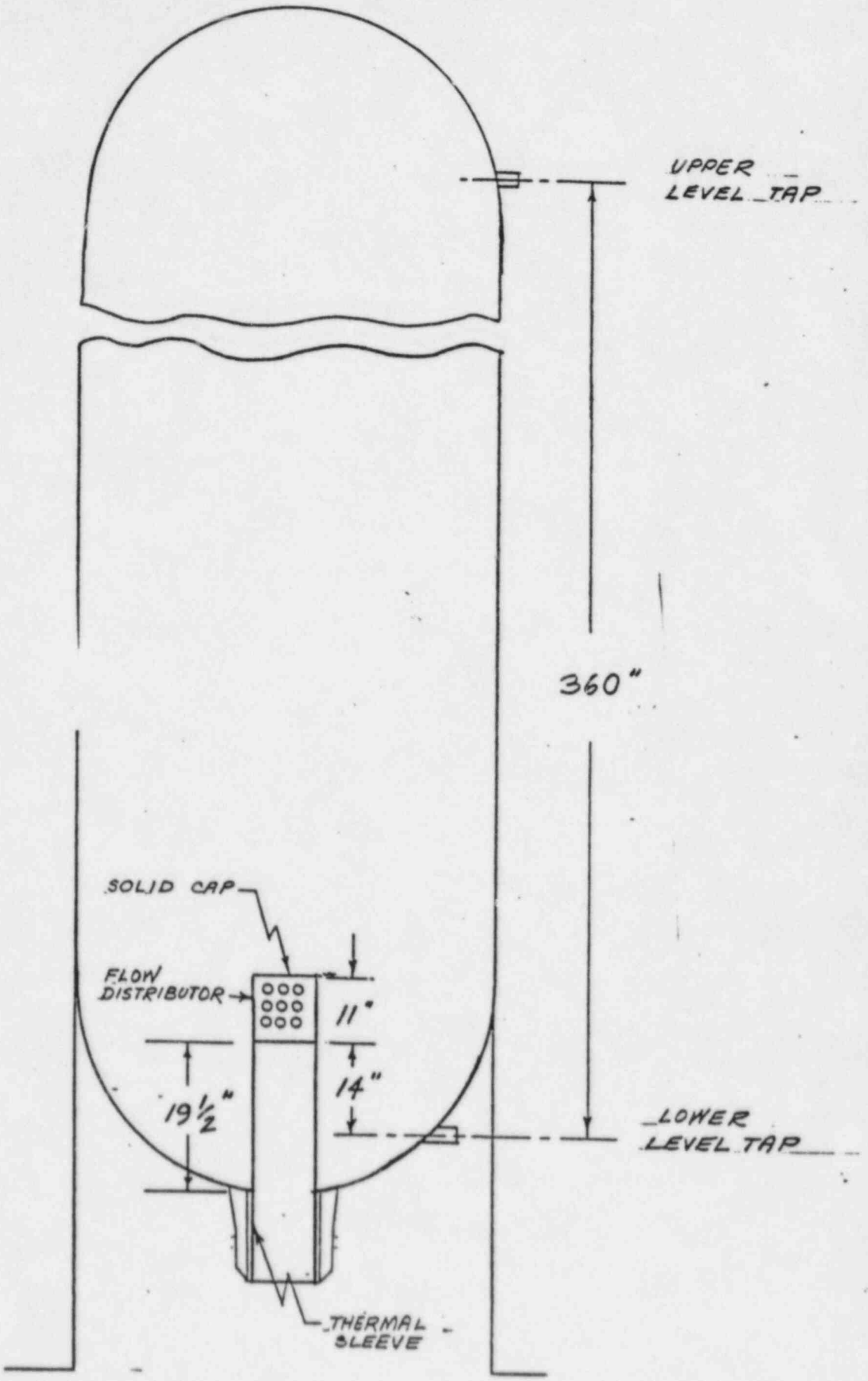

FIGURE - 1

PRESSURIZER LEVEL PROGRAM

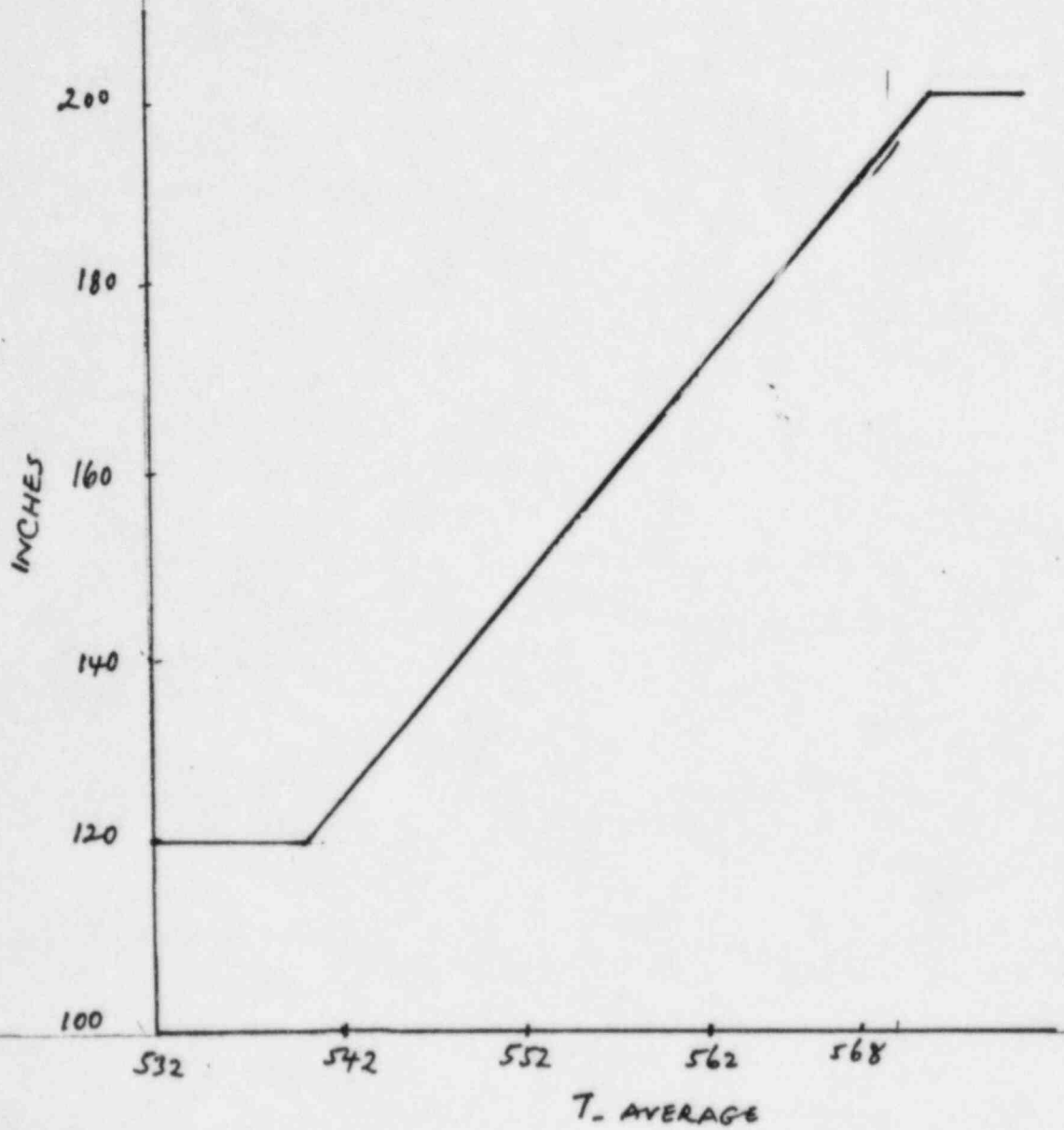

FIGURE . 2

PRESSURIZER LEVEL CONTROL BLOCK DIAGRAM

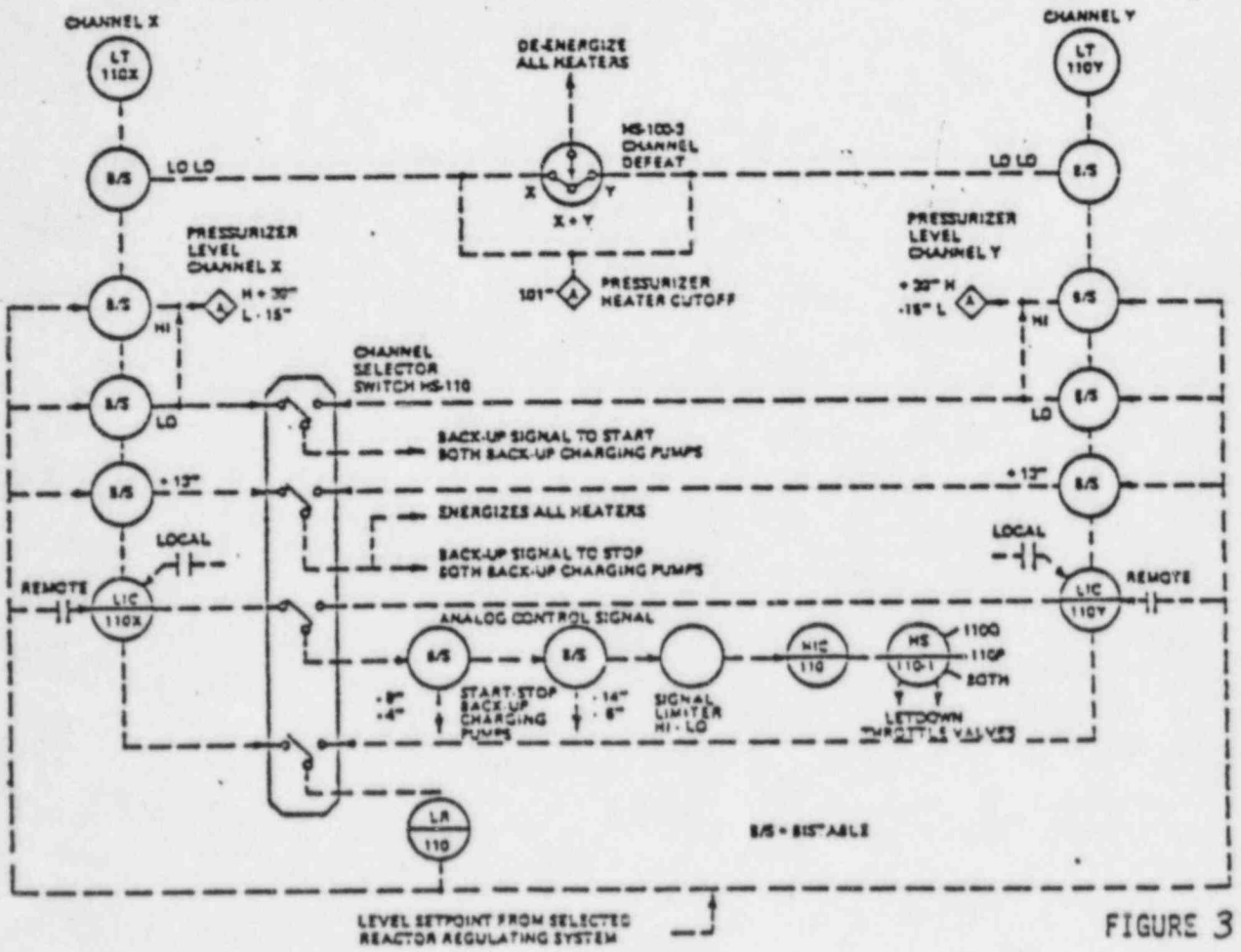

FIGURE 3

Each channel has bistables which compare the actual level with the level set point and will alarm on high level deviation (39 inches) and low level deviation (-15 inches). An output from the low level deviation alarm bistable is also sent, through the channel selector switch, as a backup signal to start the charging pumps. If pressurizer level increases to 13 inches above setpoint, a bistable in each channel will supply a signal to the selector switch and the selected signal will provide a backup signal to stop both backup charging pumps and turn all pressurizer heaters on.

A level indicator controller is provided in each channel. The analog level control signal from the selected level controller is used to start and stop the backup charging pumps and control the position of the letdown throttle valves. Two bistables give the normal start and stop signals for the backup charging pumps. One bistable set at nine inches below the setpoint will start the first pump and will stop the pump when the level increases to four inches below the setpoint. The second bistable similarly controls the second backup charging pump at 14 inches and six inches below the setpoint. The selected controller output is also sent through a signal limiter to the letdown throttle valve controller. The signal limiter will limit letdown flow to a minimum of 29 gpm at four inches below the setpoint and a maximum of 123 gpm at 33 inches above the setpont.

If the pressurizer level decreases to 101 inches (low-low level) on either channel a signal will be generated to de-energize all pressurizer heaters.

Thus, with all the setpoints of the level instrumentation established well above instrument zero (the minimum being 110 inches), the location of the lower tap has no effect on the functions performed.

Another item that could be considered is the calibration of the level transmitters. The pressurizer level signal is generated by a differential pressure transmitter that measures the differential pressure between a reference leg (high pressure side of the dp cell) and a variable leg (low pressure side). The dp instrument is usually calibrated for full power conditions (2250 psia). For pressures other than normal full power pressure in the pressurizer, the actual level and indicated level will differ as shown in Figure 4. This figure shows that for pressure lower than normal operating pressure at the lower end of the level scale the indicated level will read lower than the actual level. Since the pressurizer heaters are cut-off at 110 inches level, the pressurizer pressure will be lower than normal full power pressure for levels below this point. This is the reason why C-E plant operators have been cautioned about the level indication at the lower range.

PRESSURIZER LEVEL ERROR

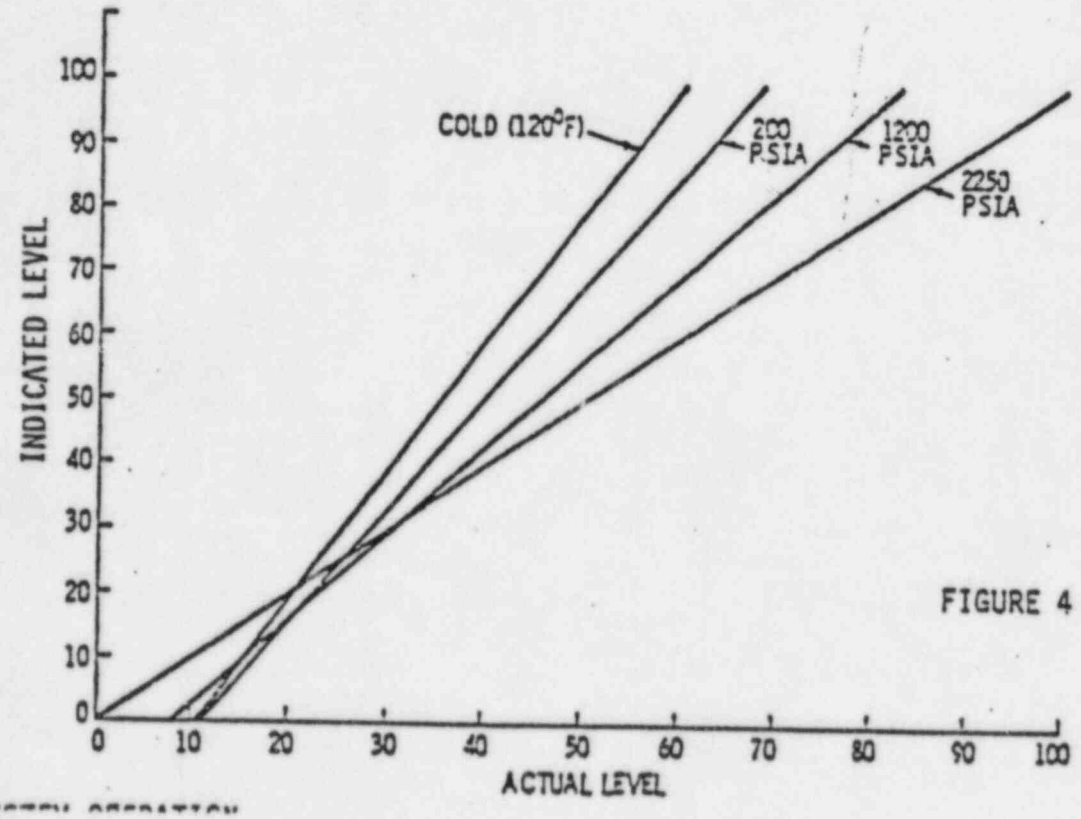

FIGURE 4

The referenced memorandum has stated that reactor vessel level instrumentation as required by TMI Action Plan will be installed on all C-E units. These instruments will be utilized by plant operators to monitor reactor coolant level beyond the normal range of the pressurizer level instrumentation.

FINDINGS AND CONCLUSION

Based on the review of the level instrumentation of a typical Combustion - Engineering reactor's pressurizer, the following findings and conclusions were reached:

1) The arrangement of the instrument taps for the level instrument appear to be the same for all C-E plants.

2) The level instrumentation does not provide any safety function.

3) All control, protection and alarm functions performed by the pressurizer level instrumentation system are unaffected by the location of the lower level tap - i.e., the set points required for the various functions are set well above the instruments' lower range.

4) In general the plant operators are aware of the inaccuracies associated with the level indication in the lower range (i.e., there is an error in the pressurizer level for conditions other than normal full power condition).

5) The installed pressurizer level instrumentation adequately performs all the functions required of it.

6) For levels beyond the range of the pressurizer level instrumentation, the TMI Action Plan required reactor vessel level instrumentation will be used.

On C-E Units, pressurizer level instrumentation does not perform any safety function. It does provide certain control, alarm and indication functions. This review has shown that the configuration of the lower tap does not affect the performance of these functions. The reactor vessel level instrumentation required by TMI Action Plans when installed, will monitor levels below the range of the existing instrumentation.