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Hugh L. Thompson, Director
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: System 80™ Safety Valves - Increased Blowdown

References: (1) NRC Letter, G. W. Knighton to E. E. Van Brunt, Jr. (Arizona Public Service), dated March 12, 1985

(2) Arizona Public Service Letter ANPP-32381, E. E. Van Brunt, Jr., to G. W. Knighton, dated April 12, 1985

(3) Arizona Public Service Letter ANPP-32401, E. E. Van Brunt, Jr., to G. W. Knighton, dated April 15, 1985

Dear Mr. Thompson:

The NRC Staff recently requested additional information from Arizona Public Service [Reference (1)] on the effect of increased blowdown settings for pressurizer safety valves (PSVs) which resulted from the EPRI safety valve test program in 1981. The Staff's primary concern was that increased blowdown (delayed closure) could result in high pressurizer water levels during transients and two-phase discharge through the PSVs. Responses to NRC questions [Reference (2)] showed that the pressurizer water level would not increase to the elevation of the PSV nozzles.

In subsequent conversations with the Reactor Systems Branch reviewer, C-E was asked to address the issue of increased PSV blowdown the on CESSAR docket. In addition, C-E was requested to provide information on the effect of increased blowdown for the secondary-side main steam safety valves (MSSVs).

The attachment to this letter provides results of the CESSAR analysis of increased PSV blowdown. This analysis is consistent with the analysis submitted by Arizona Public Service for the Palo Verde Nuclear Generating Station (PVNGS). The CESSAR analysis demonstrated that the maximum water level for the most limiting transient is well below the elevation of the PSV nozzles. There is no concern, therefore, regarding two-phase discharge through the PSVs.

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C-E has also reviewed the issue of increased blowdown for the CESSAR MSSVs. Due to the fact that increasing MSSV blowdown changes neither the valve's capacity nor opening setpoint, the maximum secondary pressure of any CESSAR event will remain unchanged. Increasing the MSSV blowdown can, however, affect secondary steam releases and the resulting radiological doses. For the safety analyses in CESSAR, the effect of increased MSSV blowdown on radiological doses was evaluated and it was found that only the steam generator tube rupture (SGTR) events would have measurable changes in the consequences. For the SGTR with loss of power and with a stuck open atmospheric dump valve, the increased MSSV blowdown setting (18.5%) was used for the analysis already in CESSAR and, therefore, the doses remain unchanged. The safety analysis conclusions in CESSAR, therefore, remain valid.

If you have any questions or comments concerning the above information, please contact me or Mr. S. E. Ritterbusch of my staff at (203) 285-5206.

Very truly yours,

COMBUSTION ENGINEERING, INC.

A. E. Scherer
Director
Nuclear Licensing

AES:las
Attachment

ANALYSIS OF INCREASED BLOWDOWN FOR PRESSURIZER SAFETY VALVES

Full scale, full pressure prototypical testing of pressurizer safety valves was performed by EPRI in 1981 (C-E Owner's Group Report CEN-227, December 1982). Results showed that the blowdown settings required to insure stable valve operation during blowdown from the set pressure were above the 5% setting specified in the ASME Code. In order to insure that the extended blowdown would not adversely affect plant performance, analyses were performed to evaluate the NSSS responses. The analyses demonstrated that a blowdown setting of 18.5% is acceptable. These analyses included a review of overpressure protection (reported in CESSAR-F appendix 5A) and a review of the safety analysis in Chapter 15 of CESSAR-F.

CESSAR Section 15.2 provides results for those events that fall in the Decreased Heat Removal category and result in the greatest increase in pressurizer pressure, pressurizer water level, and RCS temperature. Of these transients, the Feedwater Line Break (FWLB) event with the loss of offsite power is the most adverse when maximizing pressurizer level. This fact is confirmed by close examination of the pressurizer water volume response of the Chapter 15 transients and by reviewing the response to the NRC's request for additional information on the increased blowdown for the Palo Verde pressurizer safety valves (PSVs).

To determine the maximum pressurizer water level of the CESSAR FWLB, the initial conditions of the event were adjusted in the following manner:

(a) The initial pressurizer pressure was raised from 2250 psia to the maximum Technical Specification pressurizer pressure of 2370 psia. Although this change causes an earlier reactor trip on high pressurizer pressure, and therefore, less pressurizer insurge, the maximum pressurizer level is potentially greater due to the larger volume of flashed steam as pressurizer pressure decreases during tne extended blowdown.

(b) The initial assumed pressurizer water volume is increased from 900 ft^3 to 998 ft^3, which is the maximum CESSAR Technical Specification value. This assures that the maximum level of the transient is conservatively predicted.

(c) The blowdown setting of the PSVs is increased from the nominal value of 13.5% (closure at pressures below 2160 psia) to 18.5% (closure at pressures below 2040 psia). The maximum pressurizer level of the transient is increased primarily due to the fact that a larger volume of flashed steam will be generated during the increased blowdown.

(d) The initial RCS cold leg temperature is increased from 565°F to 570°F, which is the maximum Technical Specification value. While this change does not significantly increase the pressurizer water volume, it does reduce the RCS subcooling margin, which is of interest when concerned with RCS voiding.

The other significant initial conditions for the CESSAR FWLB case to maximizethe pressurizer water volume are summarized in Table 1.

The limiting FWLB case was simulated with the CESEC III code and the results are discussed below. Figure 1 provides the pressurizer water volume for the transient. The solid line indicates the CESEC-predicted pressurizer level response and shows a maximum value of 1213 ft^3. Figure 2 provides the RCS pressure response as a function of time for this transient. Figure 3 provides the RCS subcooled margin and Figure 4 provides the minimum DNBR for the transient. As demonstrated by these figures, there is adequate subcooled margin available to prevent RCS voiding and the minimum DNBR for the transient remains well above 1.19.

The CESEC code assumes that the subcooled insurge is mixed homogeneously with the water volume in the pressurizer. The pressurizer water volume is assumed to be saturated liquid at the initiation of the event. This mixing potentially underpredicts the volume of water that will flash due to the additional depressurization caused by the increased PSV blowdown. Secondly, the code assumes instantaneous phase separation of any voids formed during the depressurization and consequently may underpredict the pressurizer level response.

To conservatively account for these two phenomena, the CESEC pressurizer level results presented in Figure 1 were adjusted. The maximum adjusted value is also shown in Figure 1. Although some mixing will occur, the adjustment

assumed that none of the subcooled insurge entering the pressurizer during the transient mixed with the 998 ft^3 of saturated liquid (at 2370 psia) in the pressurizer at the initiation of the event. This maximized the potential for this initial volume to flash during the depressurization caused by the increased blowdown, maximizing the pressurizer level response.

The additional volume added to the CESEC predicted response to account for phase separation is calculated in the following manner:

> As the pressurizer pressure drops below its initial value of 2370 psia, the volume initially in the pressurizer is assumed to begin to flash. Thereafter, in discrete time intervals during the depressurization to 2040 psia (18.5% blowdown), an average void fraction is calculated. Once this average void fraction is calculated, a linear bubble gradient is assumed over the volume initially present in the pressurizer. This is reasonable since the static pressure will be highest near the bottom and the bubbles tend to coalesce as they rise through the mixture. (This method is analogous to what the RELAP and RETRAN simulation codes utilize.)
>
> Coupled with this assumed void distribution, a conservatively low bubble rise velocity of 0.5 ft/sec is assumed. This velocity is based on the Wilson bubble velocity model (Wilson, et al., Velocity of Rising Steam in a Bubbling Two-Phase Mixture, ANS Transactions, 5, 151, 1962) using an average void fraction which is small compared to the void fraction expected in the pressurizer. A more realistic value of the bubble rise velocity is approximately 2.0 ft/sec.

This conservative adjustment to the limiting FWLB increases the CESEC predicted maximum level response by 306 ft^3 (from 1213 ft^3 to 1519 ft^3). Even so, the pressurizer level is 12% below the elevation of the bottom of the PSV nozzle for the limiting CESSAR case. (This corresponds to a distance greater than 4 ft. below the nozzle.) Because of this large margin to the PSV nozzle, water carryover will not occur for this or any other event and, therefore, no concern exists regarding two-phase safety valve discharge.

TABLE 1
INITIAL CONDITIONS FOR THE
LIMITING FWLB WITH RESPECT
TO MAXIMIZING PRESSURIZER WATER LEVEL

	Nominal Plant Operating Conditions	Analysis Value
Power, MWT	3817	3893
Cold Leg Temperature, °F	565	570
Pressurizer Pressure, psia	2250	2370
PSV Opening Setpoint, psia	2500	2525
High PZR Pressure Trip Setpoint, psia	2400	2475
PSV Closing Setpoint, psia	2160	2040
Pressurizer Level, $Ft.^3$	900	998
PZR Pressure Control System	Automatic	Manual
PZR Level Control System	Automatic	Manual
Steam Generator Inventory, lbm	173000	107500
Feedwater Pipe Break Area, $Ft.^2$	----	0.2
Moderator Temperature Coefficient	----	Most Positive Technical Specification Value
Steam Bypass Control System	Automatic	Manual
Offsite Elect. Power After Turbine Trip	Available	Unavailable

FIGURE 1
PRESSURIZER LEVEL RESPONSE FOR THE LIMITING FWLB
TRANSIENT WITH LOP

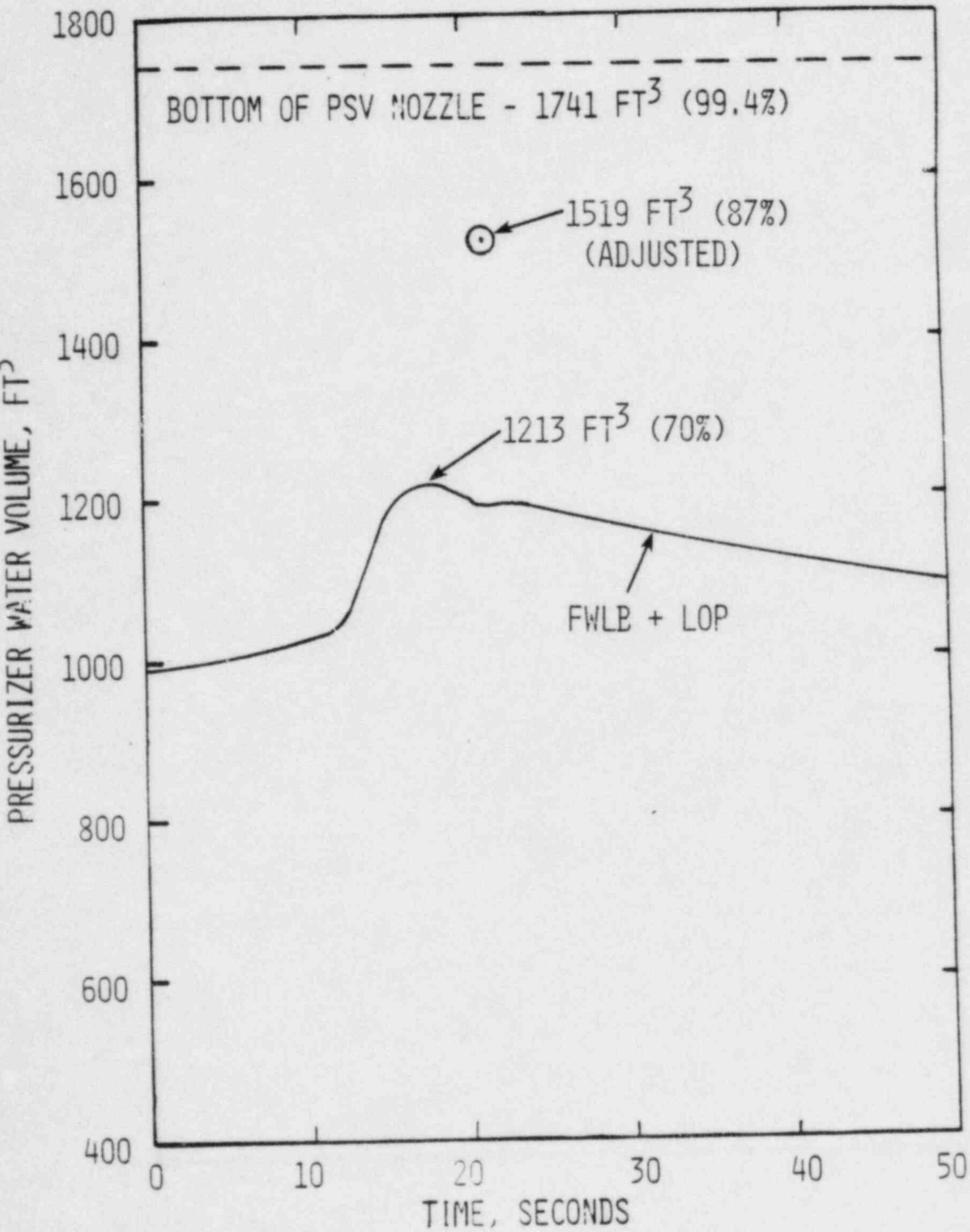

FIGURE 2
RCS PRESSURE RESPONSE
FOR THE LIMITING FWLB TRANSIENT WITH LOP

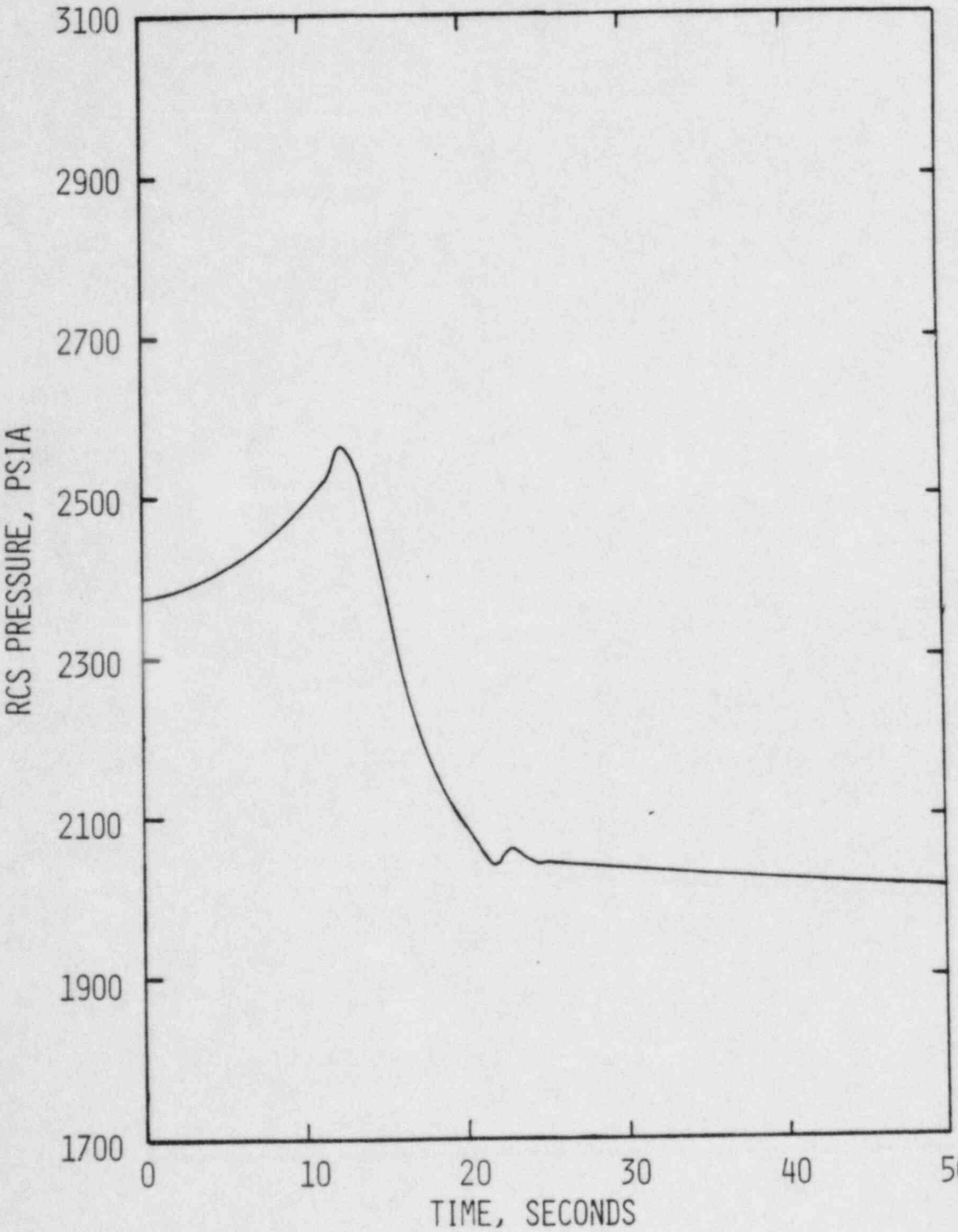

FIGURE 3
RCS SUBCOOLING MARGIN
FOR THE LIMITING FWLB TRANSIENT WITH LOP

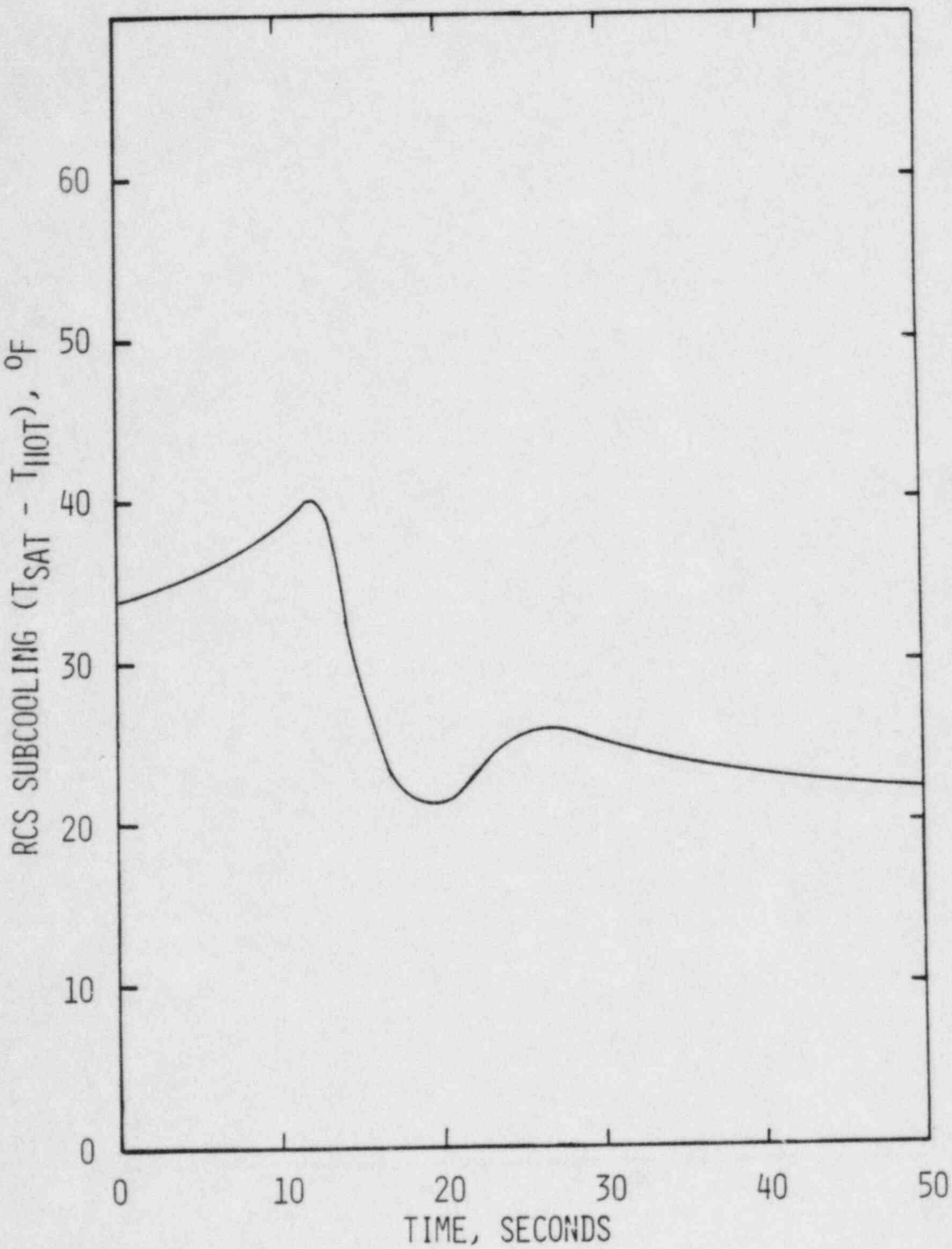

FIGURE 4

MINIMUM DNBR RESPONSE

FOR THE LIMITING FWLB + LOP TRANSIENT