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Vice President
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May 5, 1988

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U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

ATTN: Mr. Jose Calvo, Project Director
Project Directorate - IV
Division of Reactor Project - III,
IV, V and Special Projects

SUBJECT: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Request for Temporary Waiver of Compliance
Technical Specification 3/4.1.3.4 - CEA Drop Time

Dear Mr. Calvo:

Per our recent conversations, ANO-2 is faced with an immediate need for relief from Technical Specification (TS) 3/4.1.3.4, which specifies the maximum drop time for individual Control Element Assemblies (CEAs). A change in the measurement methodology has revealed that the indicated drop time for certain CEAs exceeds the 3.0 seconds specified by TS 3.1.3.4. The method used previously for measuring CEA drop time involved interrupting the power to Control Element Drive Mechanism (CEDM) from each individual CEDM breaker. The new test method implemented during the sixth refueling outage (2R6) involves interrupting the power to all the CEDMs simultaneously via the Reactor Trip Breakers (RTBs). CEAs and CEDMs are described in the ANO-2 SAR Section 4.2.3, and the reactor trip system is described in Section 7.2.1 and Figures 7.2-5 and 7.2-7A.

Testing utilizing the new test method (further described in Attachment 1) revealed an additional time delay factor due to circuit time constants associated with the electromagnetic decay of multiple CEDM coils vs. the decay time of an individual coil. Attachment 2 provides a detailed explanation of this circuit phenomenon.

It is important to note that the actual physical drop time of the CEAs has not increased, as shown by the test performed during 2R6 and the history of drop times included in Attachment 3.

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The accident analyses presented in Chapter 15 of the SAR are being individually reviewed and evaluated to determine the effects of the increased CEA drop times recorded during the recent surveillance testing for ANO-2. Although these evaluations have not been completed for all events, AP&L has addressed those events applicable to "low power" operations. These efforts are considered adequate to allow entry into Mode 1 operations to perform startup physics testing and low power (i.e., up to 30% power) operation. The favorable conclusions are supported by two separate considerations discussed below.

First, it is important to note that the safety analyses typically assume that all CEAs are inserted to 90% at the maximum technical specification limit (3.0 seconds). This assumption provides a straightforward method for verifying compliance with the technical specification and allows for relatively simple modeling of reactivity insertion in the safety analyses. However, this assumption is clearly conservative since the technical specification ensures that the limiting (i.e. slowest) CEA will reach the 90% limit within 3.0 seconds; consequently, most CEAs are inserted sooner. The recent testing, for example, in which (conservatively) 17 CEAs exceeded the 3.0 second assumption for 90% insertion, demonstrated that the majority of the CEAs (56) were inserted beyond 90% at 3.0 seconds and many were actually fully inserted. As a result, it is apparent that the total reactivity insertion remains greater than the safety analyses assumption since the "early" CEAs more than offset the CEAs which do not meet the technical specification criteria.

Notwithstanding the above considerations, specific evaluations of each affected safety analysis from the SAR Chapter 15 events are being undertaken. In order to support the initiation of startup physics testing and power operation up to 30%, each analysis pertinent to low power events has been addressed. For each affected event, it was assumed that all CEAs are inserted to 90% at the same time, but the time to 90% insertion was extended to represent the recent worst case CEA drop test results (3.18 seconds). In order to determine a more realistic impact of the change in the analysis assumption, the current 1D static reactivity insertion data was replaced by revised scram insertion data based on 1D space-time neutronics methods. An evaluation of the opposing effects demonstrates that the increased CEA drop times are more than offset by the more realistic scram insertion data. Consequently, the conclusions of the safety analyses in question remain valid. Additional explanation of the applied evaluation technique is provided in Attachment 4.

Greater than expected CEA drop time measurements were first observed on May 1 and were initially believed to be due to problems with the new testing software and/or methodology. Further troubleshooting and evaluations, however, led to the conclusion on May 3 that the current test results were valid at which time initial notifications were made to the NRR and Region IV staff. Due to the possible implications relative to previous testing and potential generic implications, a report was also made per 10CFR50.72. We have now completed our initial assessment of the acceptability of the increased measured CEA drop times and are now awaiting resolution of this issue to proceed with startup and initiation of Cycle 7 physics testing. Based on the attached justification, we request staff approval to proceed with zero power physics testing (moving to Mode 2), which will take about two days, and then to proceed into Mode 1 to the 30% power test plateau hold for three days. During this time period, AP&L will prepare a detailed justification for an emergency TS amendment request submittal for subsequent full power operation to be submitted to the NRC as soon as possible.

Very truly yours,

T. Gene Campbell

T. Gene Campbell

TGC:rt

Attachment

cc: Regional Administrator
Region IV
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ATTACHMENT 1

CEA DROP TIME TESTING AT ANO-2

The following is a summary of the two methods which have been used at ANO-2 to measure the drop times of the CEAs (see also Figure 1-1):

1) The first method is the "traditional" method used since the initial startup and through the Cycle 6 refueling outage. This method tests each CEA individually. A visicorder is connected to the subject CEA reed switch position transmitter (RSPT) to provide the position and to the upper gripper coil to show when current is interrupted to the CEA gripper. The CEA is then withdrawn from the core to its full out position; the visicorder is switched on to high speed; the CEA is dropped by opening its individual circuit breaker. Position of the CEA as a function of time is recorded on the visicorder chart in the form of the changing RSPT signal. From this chart the time from interruption of power to 90% CEA insertion can be determined.

2) The second method was used for the first time at ANO-2 during the pre-critical testing prior to Cycle 7 startup. This method uses special software loaded on one of the Control Element Assembly Calculators (CEACs) which turns the selected CEAC into a specialized high speed data acquisition system capable of the simultaneous monitoring of all 81 CEA positions every 50 milliseconds through their individual RSPTs. The data may then be transferred to a floppy disk for permanent storage or analysis. The special software (CEA Drop Time Test, or CDTT software) initiates the test by transmitting a large penalty factor to each of the Core Protection Calculator (CPC) channels, producing a reactor trip. It should be noted that the point at which power is interrupted to the CEA drive mechanism is the reactor trip breaker, not the individual breakers as in the "traditional" method.

   Because the CDTT software begins sampling data as soon as it issues the penalty factor, the recorded drop times must be corrected for the delay time which is associated with the CPC processing time and actuation of the trip logic and trip breakers. This delay is part of the CPC instrumentation response time and is therefore already accounted for. This delay time is determined by monitoring a target CEA during its drop using a visicorder which is connected to the CEA in the same way as done for the traditional method. The visicorder trace drop time and the CDTT computed drop time are then compared to determine the delay time in the CDTT output to be subtracted from each CEA drop time. (See Figure 1-2).

FIGURE 1-1 - CEA DROP TIME TEST ARRANGEMENT

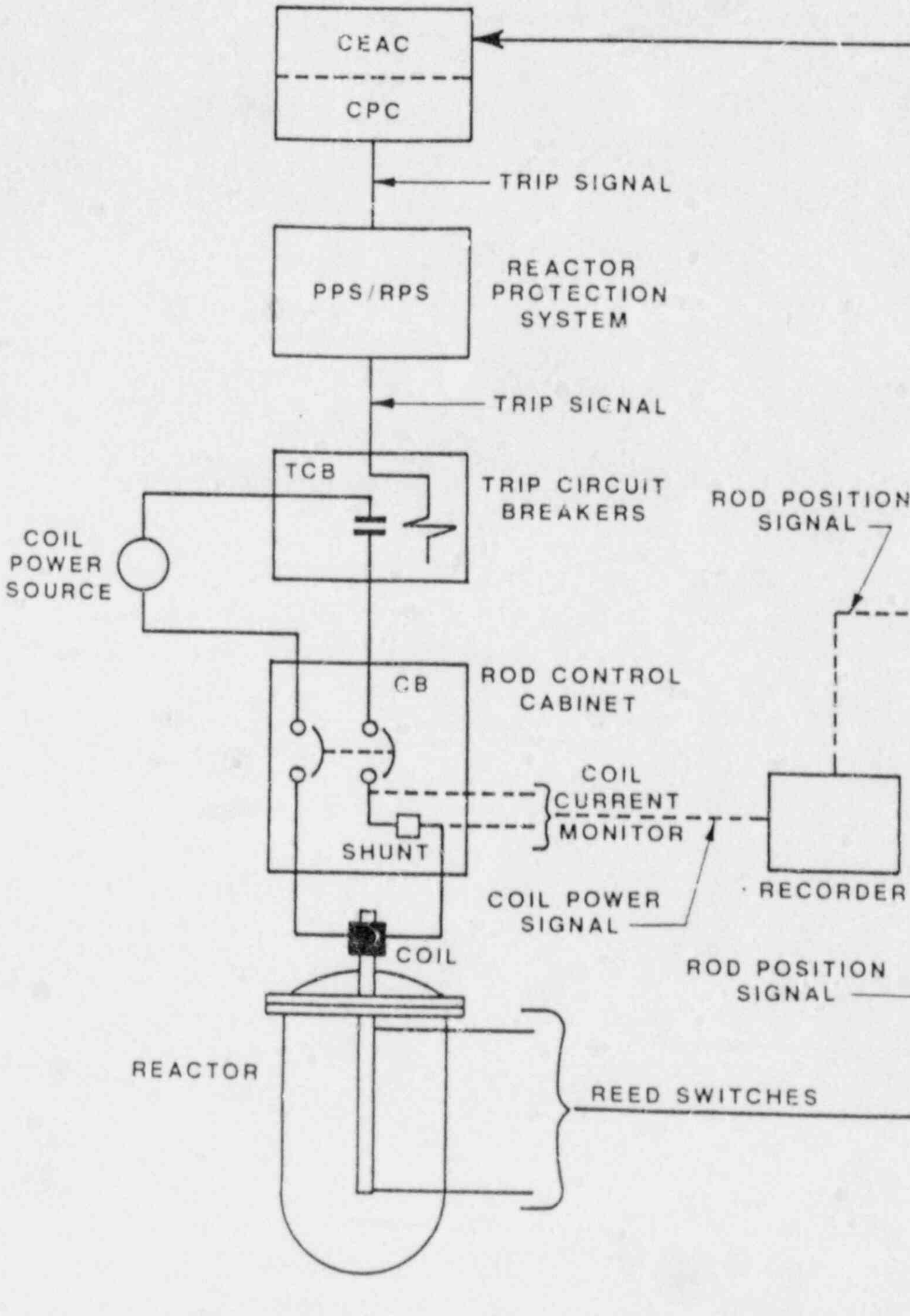
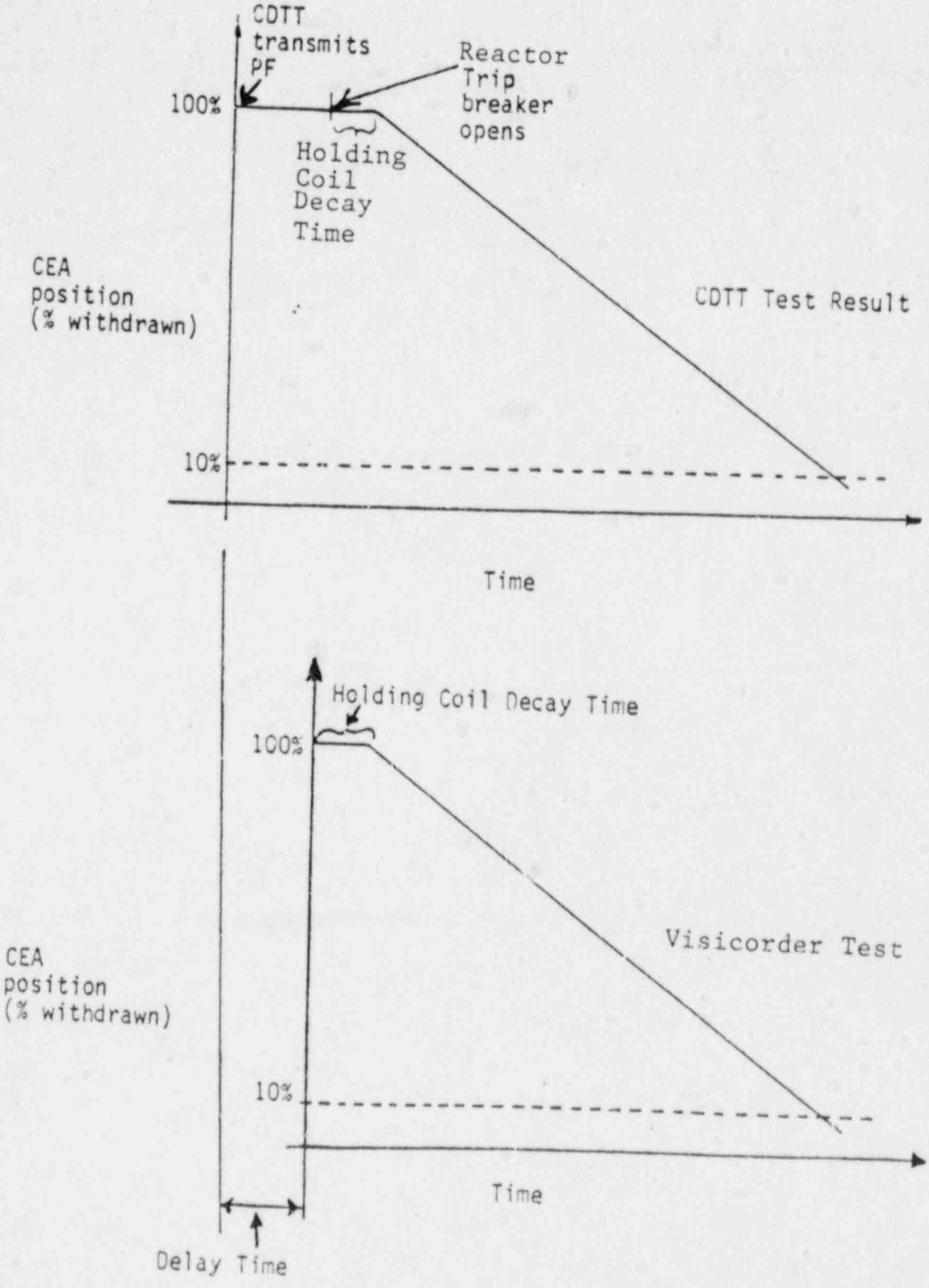


FIGURE 1-2
COMPARISON OF CEA DROP TIME RESULTS



ATTACHMENT 2

DESCRIPTION OF CEDM CIRCUIT TIME CONSTANT EFFECTS

Figures 2-1 and 2-2 are simplified drawings which illustrate the CEA trip circuit when tested by the "traditional" method (via the individual CEA breaker) vs. the revised testing method via the reactor trip breakers).

The "Traditional" method of response time testing provides coil discharge time of less than 0.3 seconds. Figure 2-1 represents the path for the energy stored in the holding coil which is dissipated through the resistor. The time for the energy to dissipate through the resistor established the response time.

The second method of response time testing (power removal by opening trip circuit breakers) provides discharge times of approximately 0.25 seconds longer than the "traditional" method. The discharge path is presented by Figure 2-2. Note in this figure the discharge path is mainly through the lower resistance across the two holding coils (Y1 & Y2). A longer time is required for the same amount of energy to dissipate through a lower resistance path, therefore, the response time measured in this method is longer than the traditional method.

FIGURE 2-1

"TRADITIONAL" METHOD AND HOLDING COIL CURRENT DISCHARGE PATH

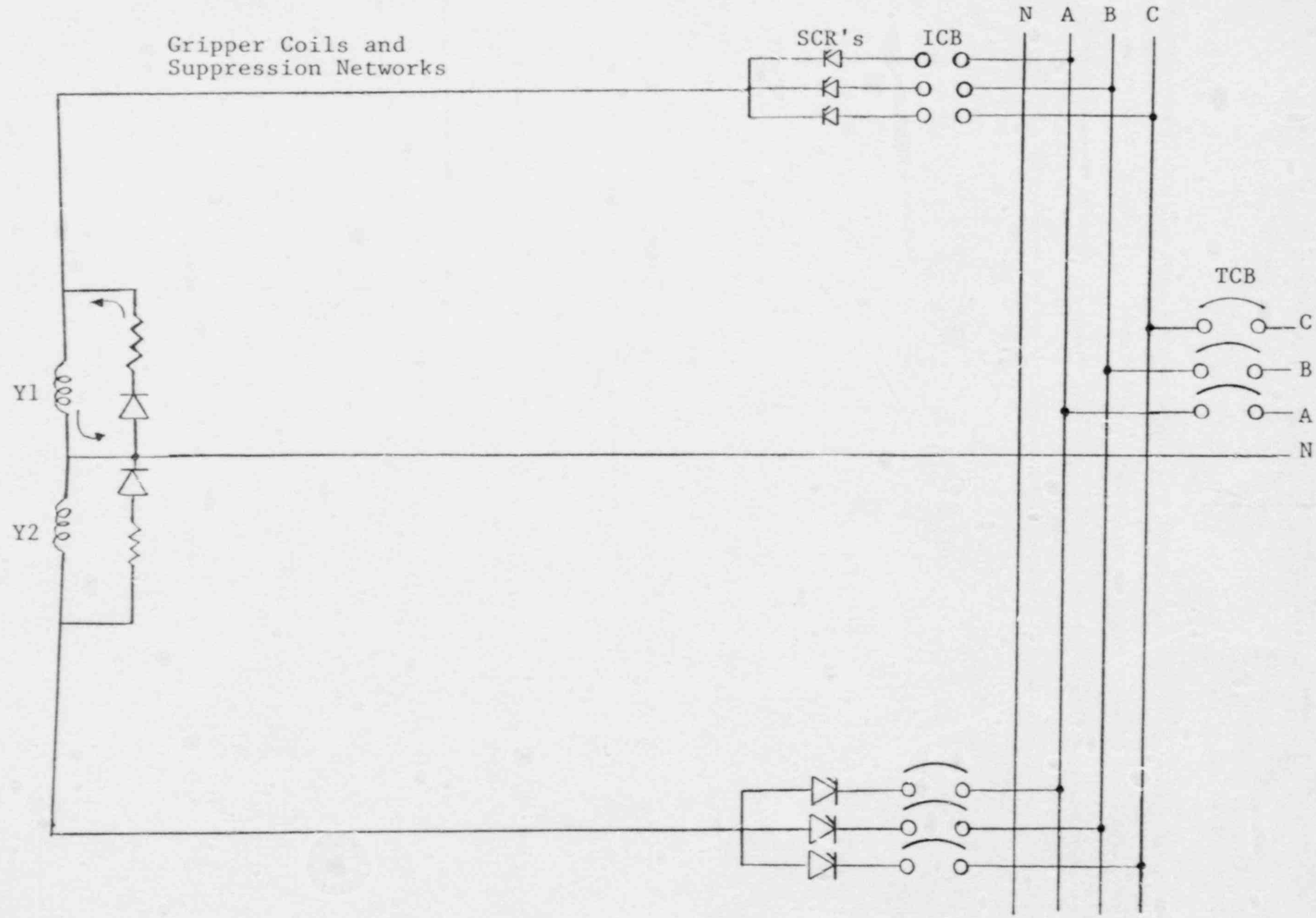
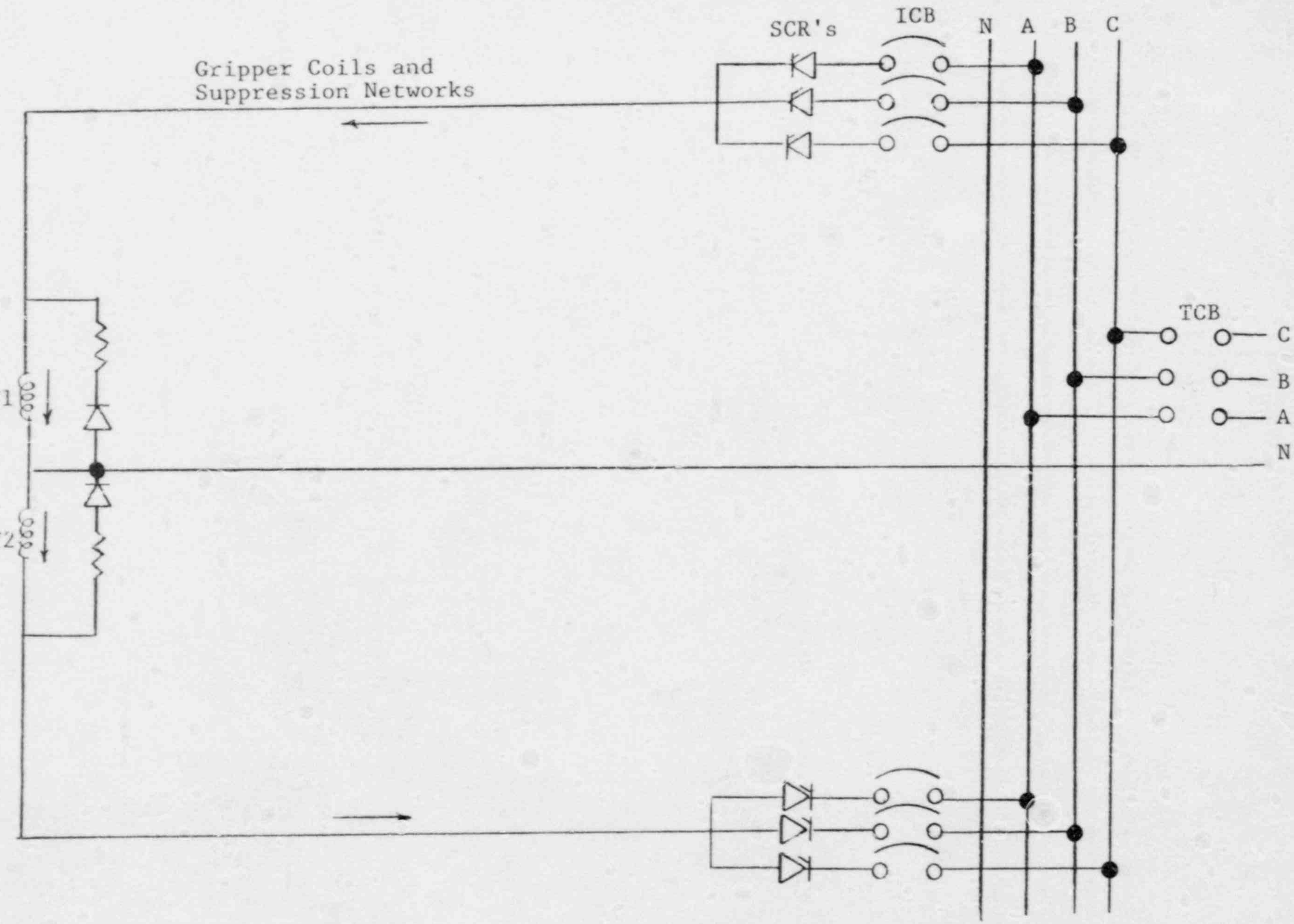


FIGURE 2-2

CDTT METHOD AND HOLDING COIL CURRENT DISCHARGE PATH



ATTACHMENT 3

ANO-2 CEA DROP TIME HISTORY

Table 3-1 provides CEA drop times for each CEA tested through the most recent Cycle 7 tests. During the 2R6 refueling outage two independent tests were performed utilizing the enhanced test method described in Attachment 1. Both test results are presented. Also provided are cycle average and maximum and minimum drop times. The spatial distribution of Cycle 7 test data is shown by Figure 3-1. A review of this data shows no trend or significant deviation in the physical drop times. Figure 3-1 indicates the slower dropping CEAs to be located around the core periphery. This is expected as these CEAs are lighter due to their shorter extension shafts (curvature of the reactor vessel head). A comparison of Cycle 7 CEA drop times, considering the additional delay of approximately 0.25 seconds associated with the electrical phenomenon described in Attachment 2, to those drop times associated with the previous six cycles' test results shows no significant change or trend in the physical drop times for the CEAs.

Table 3-2 summarizes the test results performed for select CEAs. Test results for all CEAs with drop times exceeding three seconds during Tests 1 or 2 are presented in this table. Values for CEA drops initiated from the individual breakers were recorded for seven CEAs. A comparison of these values to previous cycle data shows little difference. This results would be expected since this test method is identical to those performed for previous cycles. The RTB visicorder test results shown in Column 4 of the Table shows similar results to the drop times recorded during Test 1 and 2 These results are expected as all of the CEA coils are denergized simultaneously as was the case during Test 1 and 2, and therefore, the same electrical effect will be present. The result presented in Column 6 for CEAs 01 and 76 reflect drop times recorded for the CEA when the RTB is tripped and all other CEA individual breakers are open. As expected, these drop times are very similar to the drop times recorded when the individual breaker for these CEAs are utilized to trip the CEA.

The above demonstrates and verifies the electrical phenomenon described in Attachment 2. The phenomenon results in approximately 0.25 seconds delay in measured CEA drop time.

TABLE 3-1

ARKANSAS NUCLEAR ONE -- UNIT TWO
CEA DROP TIMES TO 90% INSERTION (SECONDS)

CEA #	CYCLE 1	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6	CYCLE 7 TEST 1	CYCLE 7 TEST 2
1	2.38	2.40	2.42	2.41	2.45	2.48	2.75	2.73
2	2.46	2.45	2.47	2.51	2.47	2.55	2.81	2.77
3	2.41	2.43	2.50	2.32	2.46	2.54	2.81	2.79
4	2.41	2.46	2.46	2.45	2.47	2.55	2.77	2.73
5	2.40	2.44	2.50	2.49	2.46	2.54	2.79	2.82
6	2.50	2.49	2.56	2.36	2.52	2.51	2.83	2.89
7	2.42	2.43	2.57	2.58	2.48	2.50	2.83	2.81
8	2.40	2.43	2.51	2.47	2.48	2.48	2.59	2.54
9	2.42	2.65	2.55	2.52	2.50	2.55	2.85	2.79
10	2.46	2.68	2.55	2.48	2.50	2.48	2.77	2.74
11	2.52	2.60	2.62	2.59	2.58	2.58	2.91	2.88
12	2.40	2.46	2.47	2.47	2.64	2.42	2.72	2.68
13	2.43	2.50	2.52	2.54	2.53	2.59	2.82	2.80
14	2.50	2.52	2.44	2.53	2.50	2.62	2.88	2.84
15	2.58	2.61	2.62	2.65	2.58	2.65	2.90	2.86
16	2.54	2.53	2.56	2.55	2.53	2.63	2.82	2.80
17	2.50	2.60	2.58	2.61	2.54	2.63	2.86	2.83
18	2.43	2.53	2.50	2.49	2.50	2.55	2.85	2.81
19	2.40	2.53	2.52	2.52	2.45	2.55	2.82	2.79
20	2.48	2.53	2.59	2.53	2.44	2.60	2.82	2.77
21	2.52	2.58	2.66	2.64	2.46	2.70	3.01	2.94
30*	2.64	2.63	2.65	2.70	2.70	2.68	2.95	2.94
31	2.46	2.48	2.50	2.52	2.50	2.67	2.83	2.81
32	2.48	2.52	2.55	2.54	2.56	2.53	2.84	2.81
33	2.65	2.67	2.68	2.74	2.70	2.70	2.97	2.95
34	2.52	2.65	2.59	2.64	2.60	2.56	2.86	2.84
35	2.50	2.53	2.56	2.62	2.58	2.52	2.77	2.78
36	2.65	2.65	2.65	2.65	2.65	2.63	2.93	2.90
37	2.51	2.54	2.55	2.59	2.53	2.47	2.87	2.84
38	2.57	2.55	2.71	2.69	2.67	2.67	2.98	2.95
39	2.50	2.54	2.57	2.53	2.51	2.57	2.83	2.85
40	2.59	2.63	2.67	2.46	2.62	2.64	2.92	2.91
41	2.55	2.60	2.64	2.64	2.58	2.64	2.92	2.92
42	2.55	2.59	2.61	2.61	2.55	2.59	2.93	2.90
43	2.27	2.48	2.52	2.52	2.54	2.58	2.84	2.81
44	2.58	2.62	2.58	2.60	2.59	2.65	2.93	2.90
45	2.55	2.57	2.60	2.51	2.59	2.61	3.02	2.97
46	2.70	2.72	2.75	2.53	2.73	2.83	3.03	3.00
47	2.65	2.69	2.76	2.70	2.71	2.78	3.03	3.02
48	2.60	2.63	2.67	2.66	2.58	2.65	2.99	2.93
49	2.62	2.61	2.68	2.68	2.65	2.70	3.05	2.98
50	2.60	2.56	2.63	2.64	2.64	2.62	2.89	2.88
51	2.59	2.57	2.57	2.46	2.60	2.54	2.93	2.88

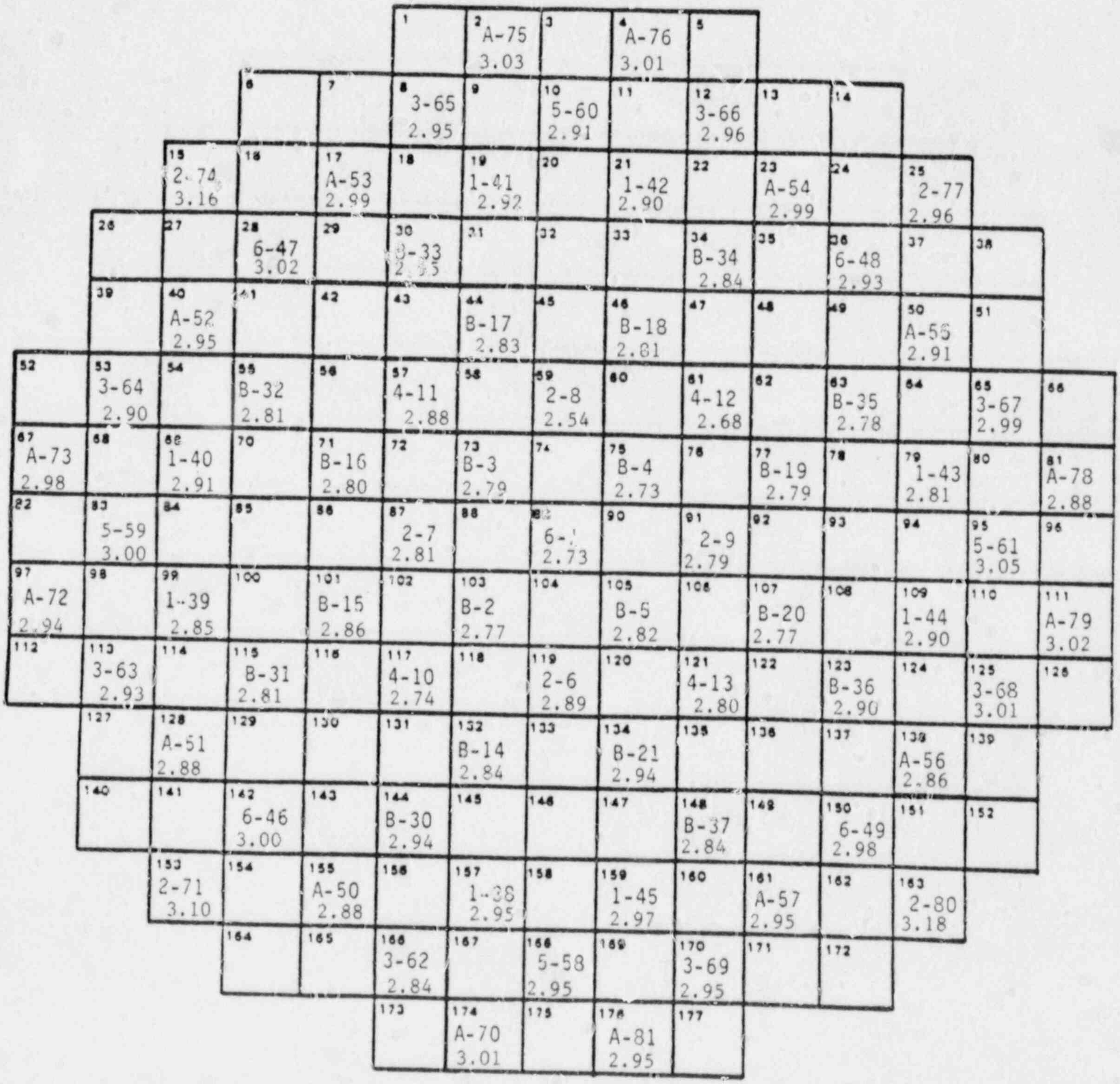
TABLE 3-1 (continued)

CEA DROP TIMES TO 90% INSERTION (SECONDS)

52	2.59	2.66	2.70	2.67	2.70	2.66	2.97	2.95
53	2.71	2.70	2.72	2.77	2.75	2.73	3.01	2.99
54	2.65	2.70	2.72	2.58	2.73	2.73	2.99	2.99
55	2.56	2.62	2.61	2.49	2.68	2.63	2.89	2.91
56	2.63	2.63	2.62	2.67	2.68	2.63	2.92	2.86
57	2.65	2.69	2.64	2.71	2.70	2.79	2.98	2.95
58	2.63	2.69	2.73	2.69	2.68	2.68	2.97	2.95
59	2.69	2.71	2.76	2.51	2.71	2.74	3.05	3.00
60	2.55	2.62	2.66	2.67	2.67	2.65	2.93	2.91
61	2.69	2.70	2.72	2.75	2.71	2.78	3.06	3.05
62	2.58	2.58	2.60	2.63	2.64	2.63	2.83	2.84
63	2.63	2.62	2.67	2.60	2.64	2.66	2.95	2.93
64	2.58	2.66	2.62	2.60	2.62	2.63	2.90	2.90
65	2.68	2.51	2.83	2.77	2.72	2.67	2.96	2.95
66	2.63	2.61	2.68	2.69	2.68	2.65	2.96	2.96
67	2.70	2.73	2.73	2.76	2.80	2.72	3.03	2.99
68	2.72	2.73	2.76	2.77	2.78	2.66	3.04	3.01
69	2.61	2.60	2.62	2.67	2.64	2.54	2.96	2.95
70	2.73	2.74	2.74	2.80	2.75	2.73	3.07	3.01
71	2.76	2.63	2.83	2.84	2.76	2.81	3.14	3.10
72	2.66	2.65	2.69	2.68	2.60	2.71	2.95	2.94
73	2.68	2.70	2.76	2.73	2.70	2.68	2.99	2.98
74	2.73	2.76	2.83	2.64	2.73	2.62	3.14	3.16
75	2.67	2.67	2.72	2.77	2.65	2.69	3.04	3.03
76	2.65	2.70	2.77	2.58	2.77	2.64	3.02	3.01
77	2.63	2.61	2.70	2.68	2.67	2.73	2.99	2.96
78	2.62	2.68	2.74	2.74	2.68	2.58	2.92	2.88
79	2.60	2.72	2.75	2.72	2.68	2.71	3.02	3.02
80	2.73	2.75	2.86	2.82	2.79	2.77	3.17	3.18
81	2.66	2.70	2.76	2.78	2.70	2.62	2.99	2.95
AVG.	2.57	2.60	2.64	2.61	2.62	2.63	2.92	2.90
MAX.	2.76	2.76	2.86	2.84	2.80	2.83	3.17	3.18
MIN.	2.27	2.40	2.42	2.32	2.44	2.42	2.59	2.54

*CEAs 22 through 29 are part length CEAs and are not subject to TS 3.1.3.4 limits.

FIGURE 3-1
ANO-2 CORE MAP SHOWING LOCATION OF TEST DATA



39	Assembly Location
6-1	CEA Group - CEDM Number
2.73	Cycle 7 CEA Drop Time

TABLE 3-2

ANO-2 CYCLE 7 STARTUP
DROP TIME SUMMARY FOR SELECTED CEAs

CEA's EXCEEDING 3 SECONDS

CEA #	COMPUTER DROP TIME TEST 1 (SEC)	COMPUTER DROP TIME TEST 2 (SEC)	VISICORDER DROP TIME RTB* (SEC)	VISICORDER DROP TIME IND.** (SEC)	VISICORDER DROP TIME OTHER*** (SEC)
21	3.01	2.94	--	--	--
45	3.02	2.97	--	--	--
46	3.03	3.00	--	--	--
47	3.03	3.02	2.94	2.72	--
49	3.05	2.98	--	--	--
53	3.01	2.99	--	--	--
59	3.05	3.00	--	--	--
61	3.06	3.05	--	--	--
67	3.03	2.99	--	--	--
68	3.04	3.01	--	--	--
70	3.07	3.01	3.01	2.76	--
71	3.14	3.10	3.07	2.81	--
74	3.14	3.16	3.11	2.89	--
75	3.04	3.03	--	--	--
76	3.02	3.01	2.96	2.72	2.72
79	3.02	3.02	--	--	--
80	3.17	3.18	3.16	2.81	--

ADDITIONAL CEA DATA

01	2.75	2.73	2.70	2.51	2.54

*NOTE: CEA Drop Initiated from Reactor Trip Breaker with all Individual CEA Breakers Closed.

**NOTE: CEA Drop Initiated from Individual CEA Breaker.

***NOTE: Single CEA Drop Initiated from RTB with Remaining Individual CEA Breakers Open.

ATTACHMENT 4

EFFECTS OF DELAYED CEA INSERTION ON SAR SAFETY ANALYSES

Scram insertion data is calculated from a "CEA position versus time" curve based on measured CEA drop time data and a "reactivity versus CEA position" curve based on neutronic calculations. Table 4-1 shows the scram insertion data used in the currently docketed ANO-2 low power safety analyses. The CEA position versus time data during the scram was based on design calcuations and verified during initial startup testing. This is shown as the "design" curve in Figure 4-1. The reactivity insertion data versus CEA position was calculated for the Cycle 2 analyses (the ANO-2 reference cycle) using static 1D neutronic methods.

Table 4-2 shows the revised scram insertion data which incorporates the effect of the increased CEA drop times and advanced 1D neutronic methods as discussed in CE Topical Reports "HERMITE Space Time Kinetics", CENPD-188-A, March 1976 and "FIESTA One Dimensional Two Group Space Time Kinetics Code for Calculating PWR Scram Reactivities", CEN-122, November 1979. The CEA position versus time data during the scram is determined from the slowest CEA measured during the current outage. This was CEA 80 which had a drop time of 3.18 seconds to 90% insertion. It should be noted that the average drop time for all CEA's is 2.92 seconds to 90% insertion and that 17 CEAs have drop times in excess of 3.00 seconds. The "revised" CEA position versus time data, based on the slowest CEA, is compared to the "design" data in Figure 4-1.

The revised CEA reactivity versus CEA position data is derived from 1D space-time neutronic results which have been utilized for other CE plants (Arizona-1, 2 & 3, SONGS-2/3, Waterford-3, BG&E-1 & 2, St. Lucie 1 & 2). Applicability of the data and methods is valid for ANO-2 based on parametric studies performed by Combustion Engineering.

Figure 4-2 compares the design curve of reactivity versus time (Table 4-1) to the revised curve (Table 4-2) which incorporates the increased CEA drop time and the space-time neutronics methods. As shown in Figure 4-2, the revised reactivity insertion curve is the same as the design curve up to approximately 2.0 seconds and is conservative relative to the design curve between approximately 2.0 and 2.8 seconds after the trip breakers open. Beyond this point, the design curve is more conservative than the revised curve.

The SAR Chapter 15 events were reviewed to determine which could be affected by a trip delay of approximately 0.25 seconds. Only three events result in rapid approach to the specified acceptable fuel design limits (SAFDL) and these are terminated by a reactor trip. For these events (listed in Table 4-3), the time to closest approach to a SAFDL is between 2.0 and 2.8 seconds. Figure 4-2 shows that the revised curve is conservative during this time. The remaining transients are either much slower to develop or approach a SAFDL after the scram (i.e, main steam line break) such that the delay of reactivity insertion does not significantly affect the conclusions.

TABLE 4-1

ANO-2 DESIGN SCRAM INSERTION
(USED FOR ORIGINAL ANALYSIS OF LOW POWER EVENTS)

Time sec	Position % Inserted	Reactivity Fraction	
0.00	0	0.0	
0.30	0	0.0	
0.66	5	0.0009	
0.84	10	0.0024	Position vs. time Based
1.00	15	0.0035	on Design calculation
1.16	20	0.0040	& start up Testing
1.31	25	0.0042	
1.46	30	0.0045	
1.60	35	0.0052	Reactivity vs. Position
1.72	40	0.0064	calculated using static
1.86	45	0.0086	Methods.
2.00	50	0.012	
2.11	55	0.018	
2.25	60	0.027	
2.38	65	0.040	
2.50	70	0.061	
2.63	75	0.096	
2.76	80	0.160	
2.88	85	0.28	
3.00	90	0.51	
3.24	100	1.0	

FIGURE 4-1 CEA POSITION VS. TIME

ANO UNIT 2 CYCLE 7 STARTUP

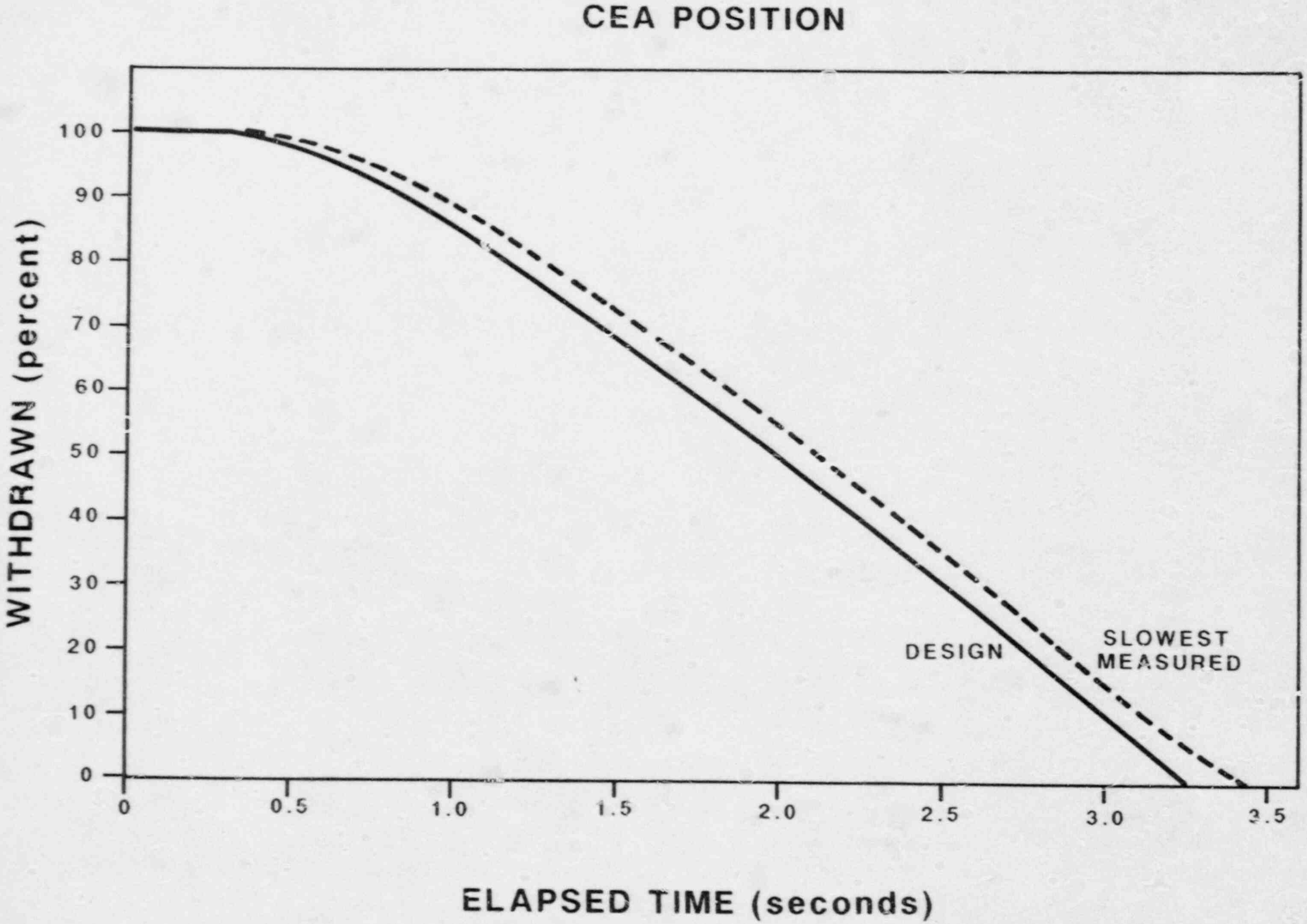


TABLE 4-2

REVISED ANO-2 SCRAM INSERTION
(USED FOR ANALYSIS OF LOW POWER EVENTS)

Time sec	Position % Inserted	Reactivity Fraction
0.00	0	0.0
0.57	0	0.0
0.85	5	0.0001
1.02	10	0.0004
1.18	15	0.0008
1.32	20	0.0014
1.48	25	0.0028
1.62	30	0.0043
1.77	35	0.0072
1.92	40	0.0117
2.05	45	0.0167
2.18	50	0.0250
2.31	55	0.040
2.46	60	0.0617
2.58	65	0.0950
2.70	70	0.1417
2.83	75	0.2083
2.95	80	0.3250
3.07	85	0.4917
3.18	90	0.7767
3.50	100	1.0

Position vs. time is for the slowest CEA measured 5/2/88.

Reactivity vs. Position Based on space-time calculations done for other plants.

FIGURE 4-2 CEA REACTIVITY VS. TIME

ANO UNIT 2 CYCLE 7 STARTUP

CEA REACTIVITY

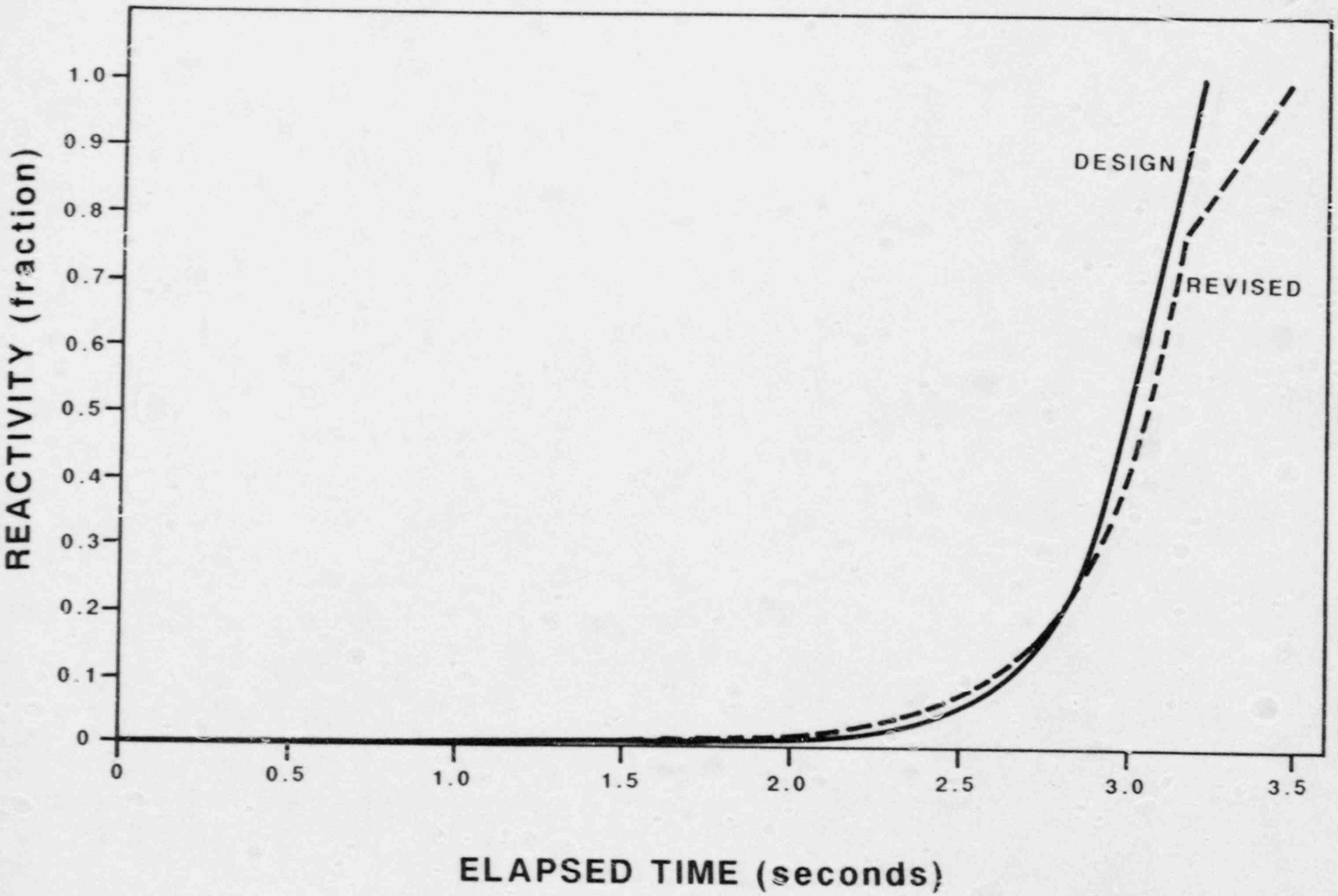


TABLE 4-3

EVENTS SENSITIVE TO DELAY IN SCRAM

EVENT	TIME TO CLOSEST APPROACH TO SAFDL
Uncontrolled CEA Withdrawal from a subcritical condition	~ 2.2 sec (Table 7.1.6-2*)
Uncontrolled CEA Withdrawal from a critical condition (1% power)	~ 2.2 sec (Table 7.1.6-4*)
CEA Ejection (0% power)	~ 2.5 sec (Figure 7.2.1-2*)

* D. Trimble (AP&L) to R. A. Clark (NRC), "Cycle 2 Reload Report", Part 1, February 20, 1981 and Part 2, March 5, 1981.