Proposed Change No. 125
Supplement No. 7
Addendum No. 1

Telephone 617 366-9011
TWX
710-390-0739

WYR 76-31

YANKEE ATOMIC ELECTRIC COMPANY

20 Turnpike Road Westborough, Massachusetts 01581

Regulatory File Cy.

March 3, 1976

United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Office of Nuclear Reactor Regulation

Subject: Core XII Technical Specification D.2.c.

Reference: (1) License No. DPR-3 (Docket No. 50-29)
(2) Proposed Change No. 125, Supplement 7, dated February 19, 1976.

Dear Sir:

With reference to a conversation on February 26, 1976 between your Mr. Burger and our Mr. Cacciapouti, enclosed is additional information in support of Reference (2).

We trust that this information is satisfactory; however, should you desire additional information feel free to contact us.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

W. P. Johnson
Vice President

COMMONWEALTH OF MASSACHUSETTS)
)ss.
COUNTY OF WORCESTER)

Then personally appeared before me, W. P. Johnson, who being duly sworn, did state that he is a Vice President of Yankee Atomic Electric Company, that he is duly authorized to execute and file the foregoing request in the name and on the behalf of Yankee Atomic Electric Company, and that the statements therein are true to the best of his knowledge and belief.

Armand R. Soucy Notary Public
My Commission Expires September 9, 1977

8011140571

2194

1.0 INTRODUCTION

The xenon multiplier was chosen to conservatively account for the maximum transient xenon peaking expected due to control rod motion at full power.

In the development of this multiplier, only control rod motion above 75" was considered, since rod insertion curve limits the control rods to this band during operation at the maximum allowable power level.

Control rod insertion below 75 inches requires a concomitant reduction in power level below the maximum allowable value. The reduced load multiplier was therefore chosen to offset the increase in peaking which could be induced by an increase in power level combined with control rod withdrawal from below 75 inches to above 75 inches. The 24 hour hold at the reduced power specified by this multiplier allows sufficient time for the initial xenon maldistribution to accommodate itself to the new power distribution.

The following approach was used in evaluating limits for this Technical Specification:

A. Results for the Technical Specification were evaluated in terms of the ratio:

$$\frac{F_z \text{ (equilibrium xenon)}}{\max F_z \text{ (transient conditions)}}$$

B. The F_z's used were those for the assemblies containing the hottest GULF fuel rod (assembly location C-4) and the hottest EXXON fuel rod (assembly location F-2).

C. The maximum allowable core power level was assumed to be 600 MWt, even though the application of item C of the Technical Specification may limit core power to lower values.

2.0 XENON TEST AND COMPARISON WITH CALCULATIONS

On December 30 and 31, 1975 a xenon transient test was performed at Yankee Rowe to verify the adequacy of the three-dimensional nodal code SIMULATE to follow xenon transients.

The test was performed as follows:

A. The plant was at equilibrium conditions at 125 MWe, 250 MWD/MTU, 1684 ppm boron and the Group A control rods at 83 inches. Power was then reduced to 33 MWe by inserting control rod Group A to 45 inches. This maneuver took 1.5 hours.

B. The load was held at 33 MWe for 5 hours.

C. After 5 hours, load was increased to 115 MWe by withdrawing rods. This maneuver took 1 hour to complete.

D. Full core traces were taken at the equilibrium condition, at reduced load and every six hours after return to power. In addition, individual traces in the assemblies in locations F-2 and C-4 were taken every hour for 30 hours after return to power.

The SIMULATE mockup of the test was as follows:

A. Core XII was depleted to 250 MWD/MTU, Equilibrium Xe was built in at 125 MWe (407 MWt), with Group A at 83 inches and 1680 ppm boron.

B. Load was reduced in three steps; 363 MWt for 1/2 hour with rods at 76 inches, 249 MWt for 1/2 hour with rods at 62 inches and 131 MWt for 1/2 hour with rods at 49 inches.

C. For the next 5 hours, load was kept at 105 MWt (33 MWe) and the rods were kept at 45 inches.

D. Load was increased in two steps; 190 MWt for 1/2 hour with rods at 56 inches and 336 MWt for 1/2 hour with rods at 72 inches.

E. For the next 30 hours, load was held at 374 MWt (115 MWe) and control rod Group A was held constant at 86.5 inches.

The comparison between calculation and measurement of the relative axial power distribution at equilibrium conditions before the test for the assemblies in locations F-2 and C-4 is given in Figures 1 and 2. These assembly locations contain the hottest fuel rods in the Exxon and Gulf fuel assemblies, respectively. The comparison of the relative axial power distribution at reduced load with control rod Group A at 45 inches is given in Figures 3 and 4 for the assemblies in locations F-2 and C-4. A comparison two hours after return to power in the same assembly locations is given in Figures 5 and 6. From these six figures, it can be seen that SIMULATE gave excellent agreement with the test results.

For 30 hours after return to 374 MWt, incore traces were taken in assembly locations F-2 and C-4. Comparison of the calculated and measured values of F_z are presented in Figures 7 and 8 for these assemblies. Again, this data showed excellent agreement between the SIMULATE calculation and the measured data.

Based on the data taken and the comparisons made, it was concluded that SIMULATE could be used to adequately predict xenon transients.

3.0 DETERMINATION OF XENON REDISTRIBUTION MULTIPLIER

To determine the xenon redistribution multiplier in Figure 8-4 of the Technical Specification, a number of rod motion studies were made between the rod insertion limits of 75 and 90 inches. The studies were made using the SIMULATE model of Core XII at BOL (0 MWD/MTU), MOL (6000 MWD/MTU) and EOL (13000 MWD/MTU).

Using the critical boron at each time in life the following transient was calculated:

A. Rods at 83", equilibrium xenon, 600 MWT.

B. Instantaneously insert rods to 75 inches with power remaining constant.

C. Hold at 75 inches for 8 hours. From sensitivity studies with SIMULATE, it was determined that a hold between 6 and 8 hours would give maximum axial peaking.

D. Instantaneously withdraw rods to 90 inches with core power remaining constant and follow transient for 15 hours in one hour steps.

For EOL, the ratios of the maximum F_z to the equilibrium values are given in Table I for the assemblies in locations F-2 and C-4. With similar data at BOL and MOL, the maximum ratios as a function of lifetime were plotted. For added conservatism, a straight line was drawn above the data to be used for the xenon redistribution multiplier in the Technical Specification. Figure 9 shows the calculated data and the xenon redistribution multiplier presented in Figure 8-4 of the Technical Specification.

4.0 DETERMINATION OF REDUCED LOAD MULTIPLIER

The reduced load multiplier, Figure 8-5, was determined by typical transients using the SIMULATE model of Core XII at BOL (0 MWD/MTU), MOL (6000 MWD/MTU) and EOL (13000 MWD/MTU). All transients used the critical boron at that time in life. SIMULATE calculations were run as follows:

A. The initial power was 600 MWT with equilibrium xenon and control rod Group A at 83 inches.

B. Power was instantaneously reduced to 450 MWt and control rod Group A instantaneously inserted to 45 inches. These conditions were held for 8 hours.

C. After 8 hours, rods were instantaneously withdrawn to 83 inches and power was instantaneously increased to 600 MWt. The xenon transient was followed for up to 100 hours in one hour steps.

To show the effect of this maneuver, the relative power at three axial positions in the core is plotted in Figure 10, node 3 which is 1/4 of the way up the core, node 6 which is half way up and node 9 which is 3/4 of the way up. Figure 10 presents the ratio of the average axial power in the node to the equilibrium value of power in the node, showing how rapidly the oscillation is damped.

For assembly locations F-2 and C-4, the ratio of the maximum F_z over the 100 hours to the equilibrium values at EOL is given in Figures 11 and 12 as a function of time. As can be seen, the ratio starts at a high value and decreases rapidly with time. The inverses of the maximum ratios at BOL, MOL and EOL were plotted as [illegible] in Figure 13. For added conservatism, a straight line drawn below this data is given as the reduced load multiplier in Figure 8-5 in the Technical Specification. Application of this restriction insures that the maximum linear heat rate during the xenon transient does not exceed the value in Figure 8-1 of the Technical Specifications.

The requirement in the Technical Specification for a 24 hour hold came after a series of calculations to determine the optimum time at the reduced load. The 24 hour hold allows sufficient time for the initial xenon maldistribution to accommodate itself to the new power distribution. The restriction in control rod location during these 24 hours assures that the return to the allowable fraction of full power will not cause additional redistribution due to rod motion in excess of that given in Figure 8-4.

Table I
EOL
Ratio of F_z as a Function of Group A
Position and Time in Assemblies F-2 and C-4

For 8 Hours During Rod Insertion

Group A Position (inches withdrawn)	Time (Hrs)	Ratio of F_z to Eq Value of F_z	
		F-2	C-4
75	0	1.017	1.018
75	1	1.020	1.021
75	2	1.027	1.027
75	3	1.032	1.033
75	4	1.034	1.035
75	5	1.037	1.038
75	6	1.038	1.039
75	7	1.040	1.041
75	8	1.042	1.042

For 15 Hours After Rod Withdrawal

Group A Position (inches withdrawn)	Time (Hrs)	Ratio of F_z to Eq Value of F_z	
		F-2	C-4
90	0	1.019	1.024
90	1	1.006	1.009
90	2	0.991	0.997
90	3	1.004	1.010
90	4	1.017	1.024
90	5	1.024	1.032
90	6	1.032	1.041
90	7	1.034	1.044
90	8	1.036	1.047
90	9	1.038	1.049
90	10	1.039	1.049
90	11	1.040	1.049
90	12	1.040	1.049
90	13	1.039	1.048
90	14	1.037	1.045
90	15	1.032	1.038

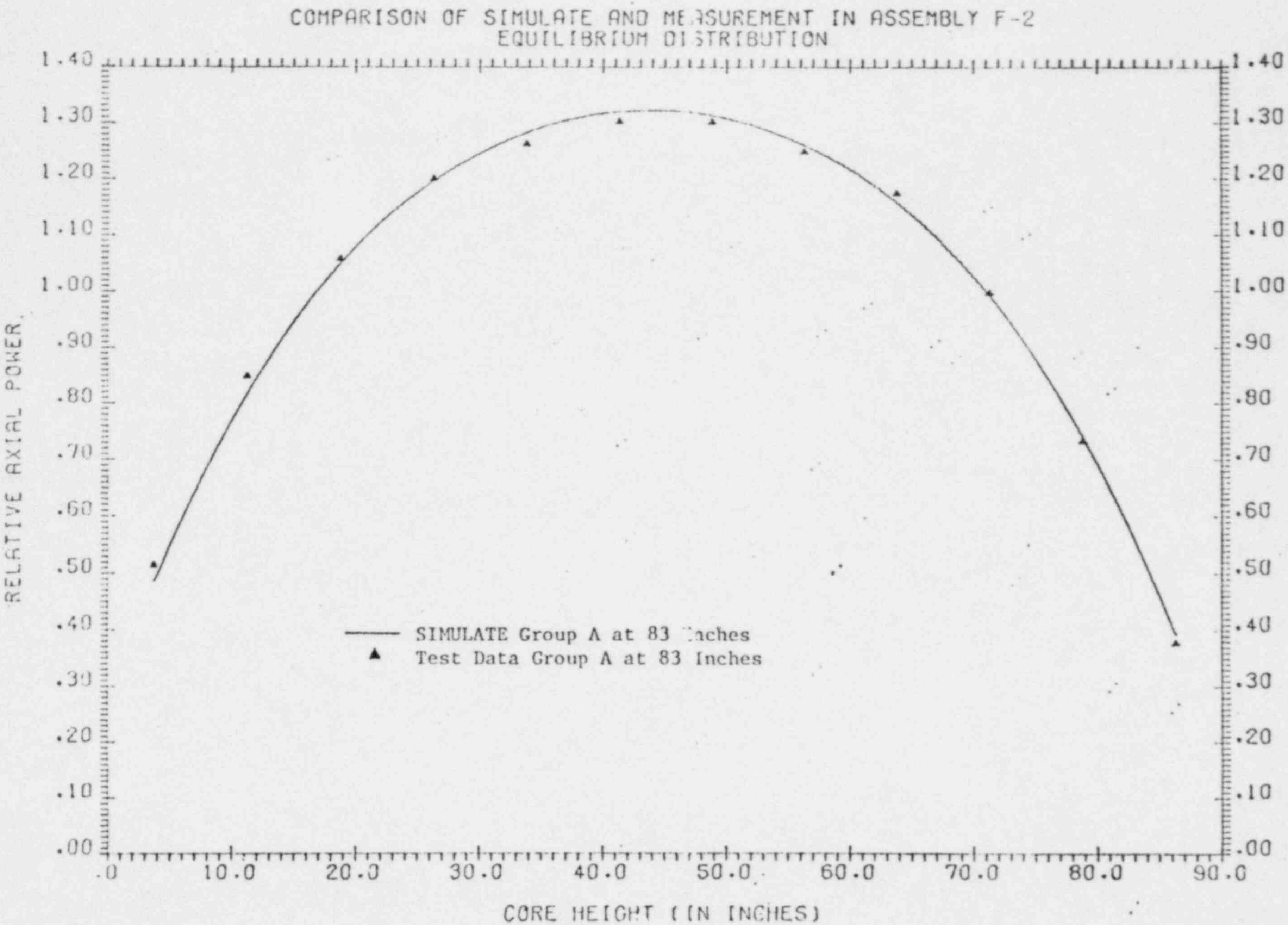


Figure 1

3/3/76

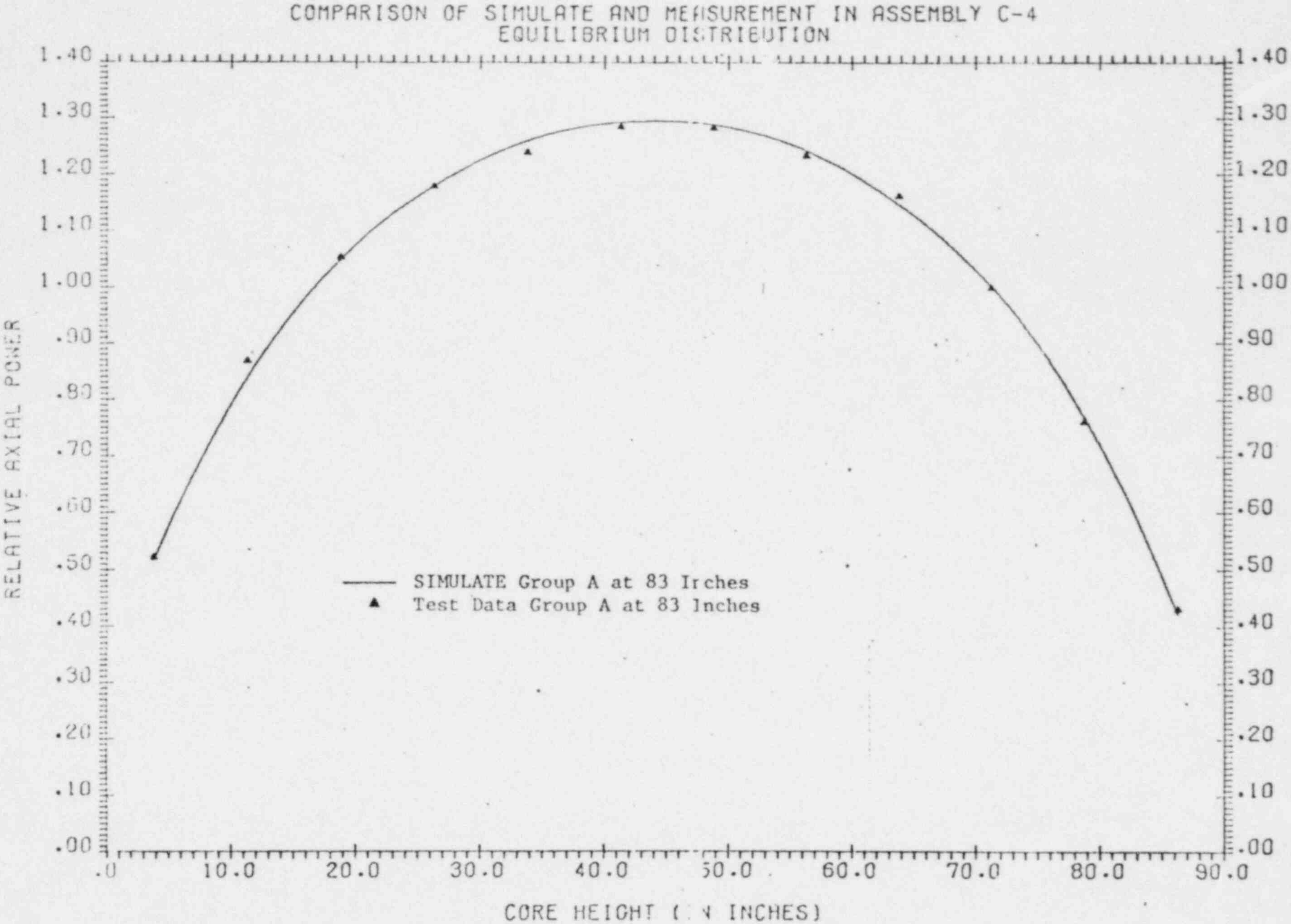


Figure 2

3/3/76

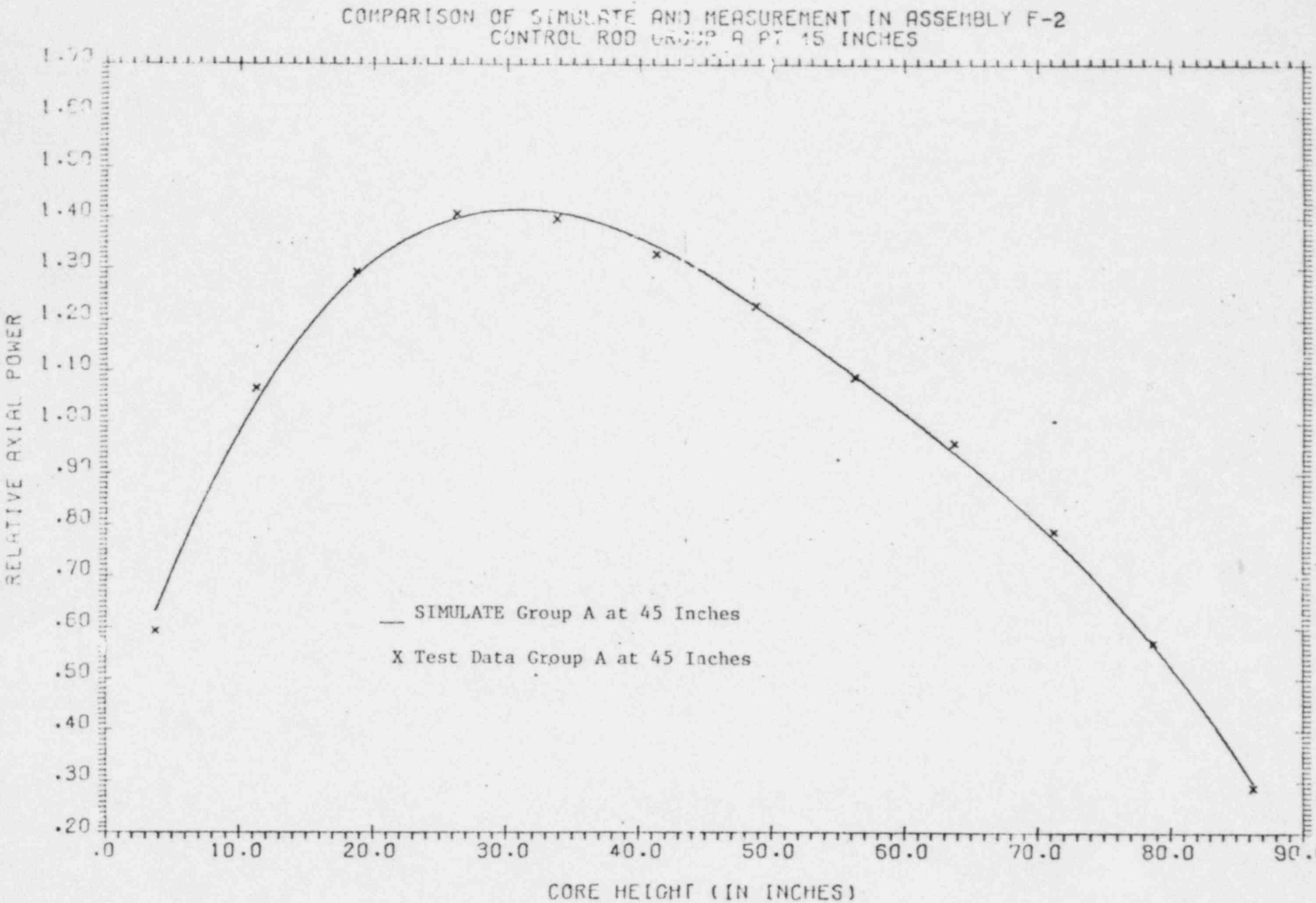

COMPARISON OF SIMULATE AND MEASUREMENT IN ASSEMBLY F-2
CONTROL ROD GROUP A AT 45 INCHES
RELATIVE AXIAL POWER
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
.90
.80
.70
.60
.50
.40
.30
.20
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
CORE HEIGHT (IN INCHES)
— SIMULATE Group A at 45 Inches
X Test Data Group A at 45 Inches

Figure 3

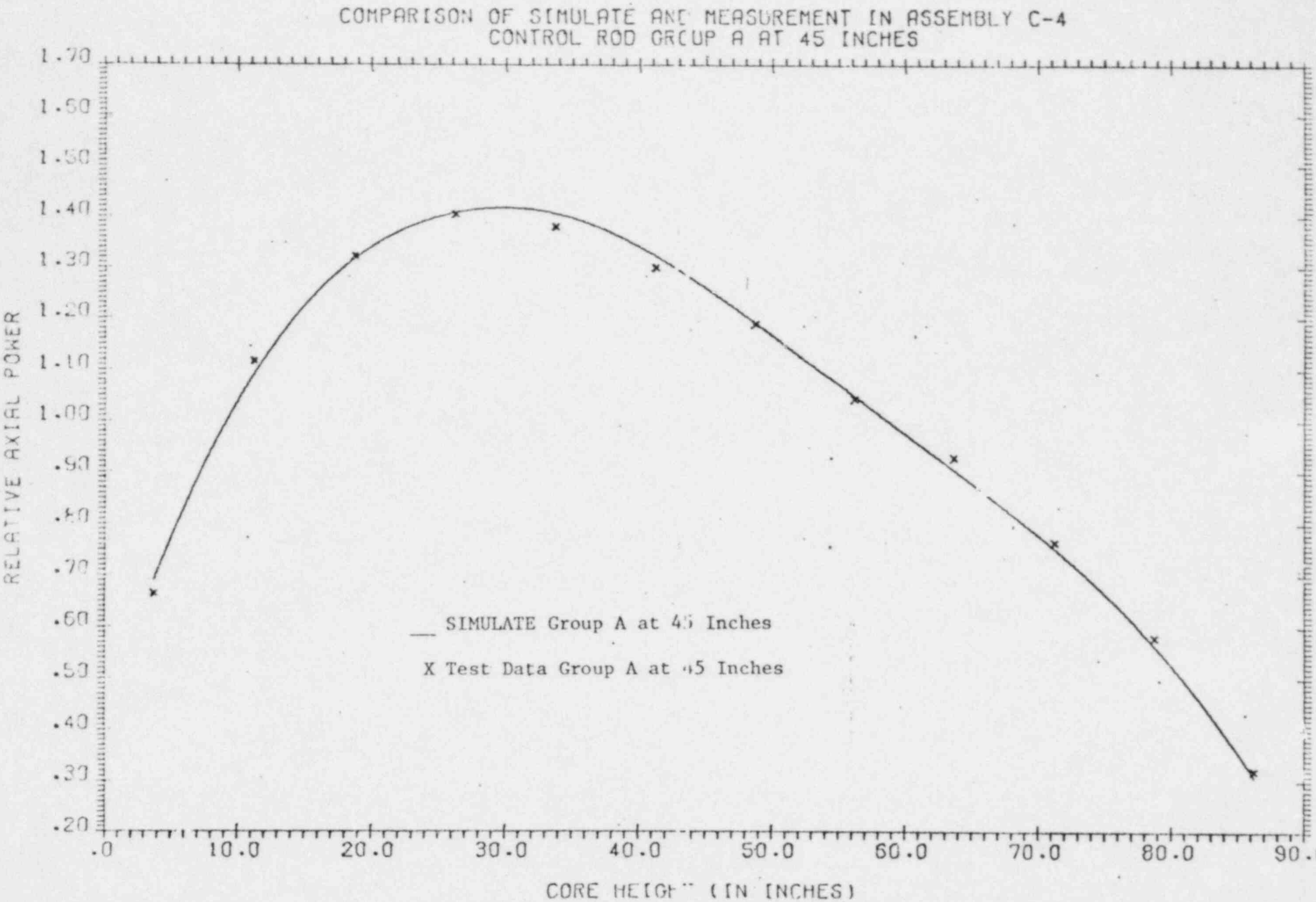

COMPARISON OF SIMULATE AND MEASUREMENT IN ASSEMBLY C-4
CONTROL ROD GROUP A AT 45 INCHES
RELATIVE AXIAL POWER
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
.90
.80
.70
.60
.50
.40
.30
.20
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
SIMULATE Group A at 45 Inches
X Test Data Group A at 45 Inches
CORE HEIGHT (IN INCHES)

Figure 4

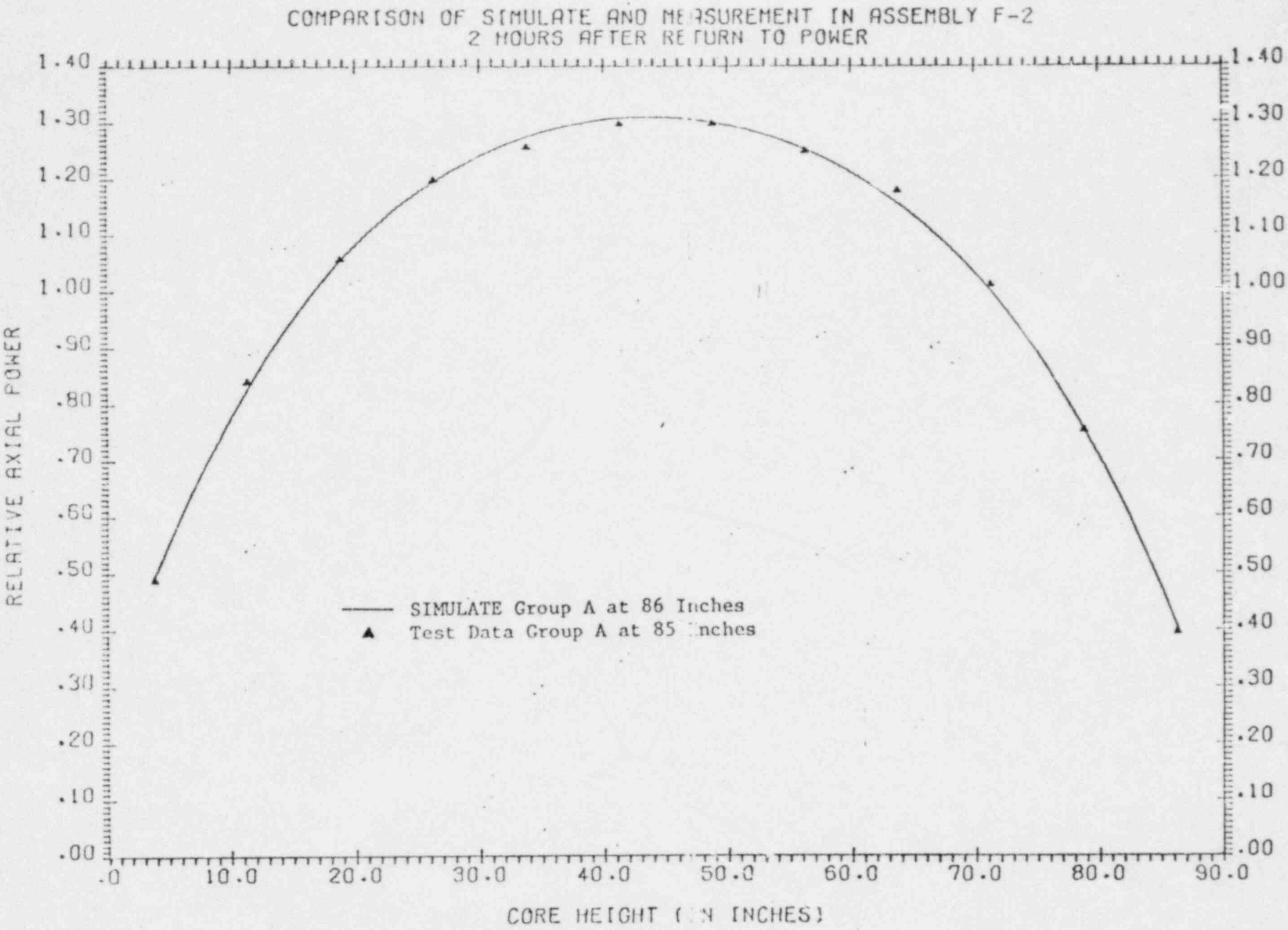


Figure 5

3/3/76

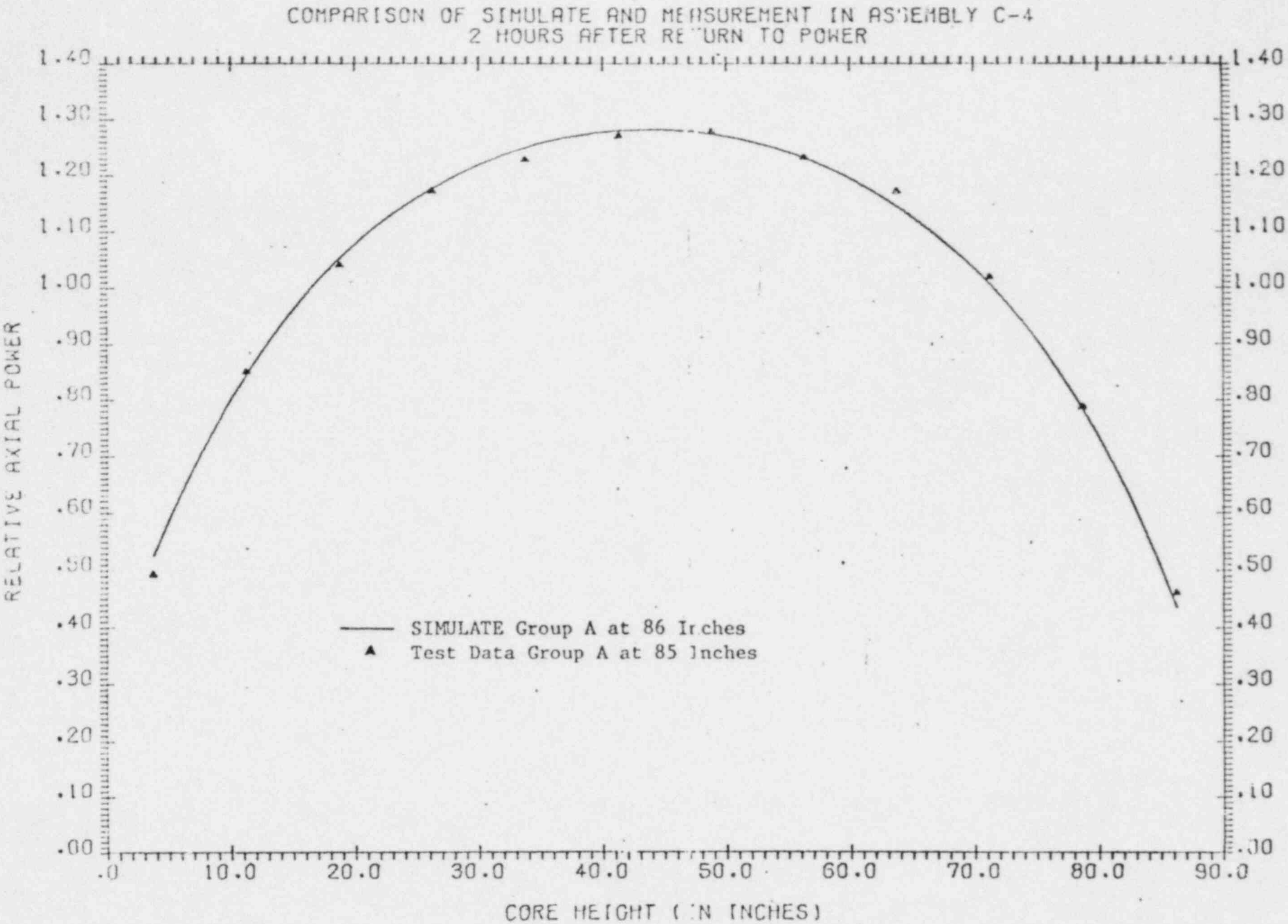


Figure 6

3/3/76

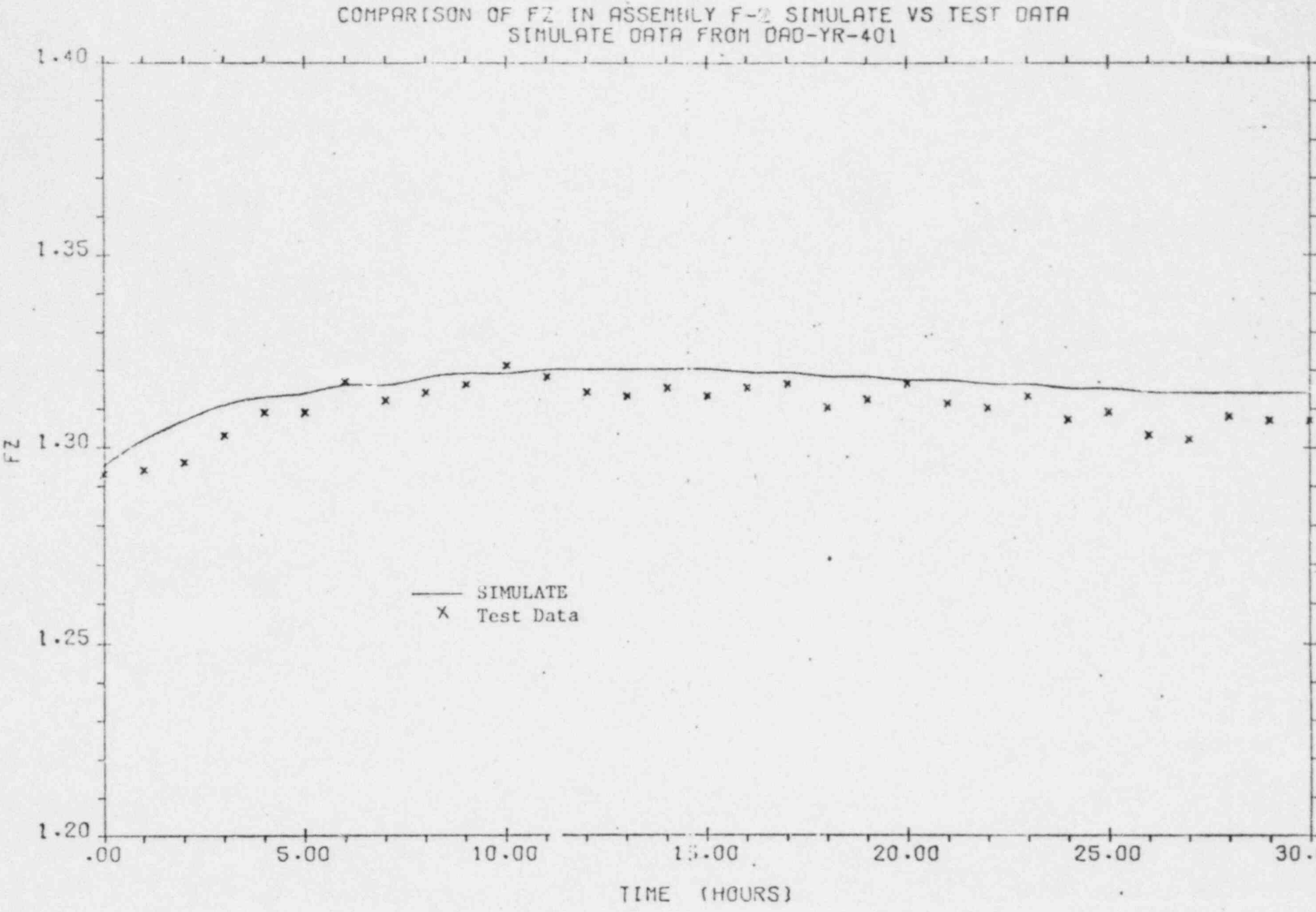

COMPARISON OF FZ IN ASSEMBLY F-2 SIMULATE VS TEST DATA
SIMULATE DATA FROM DAO-YR-401
1.40
1.35
1.30
1.25
1.20
FZ
.00
5.00
10.00
15.00
20.00
25.00
30.00
TIME (HOURS)
SIMULATE
Test Data

Figure 7

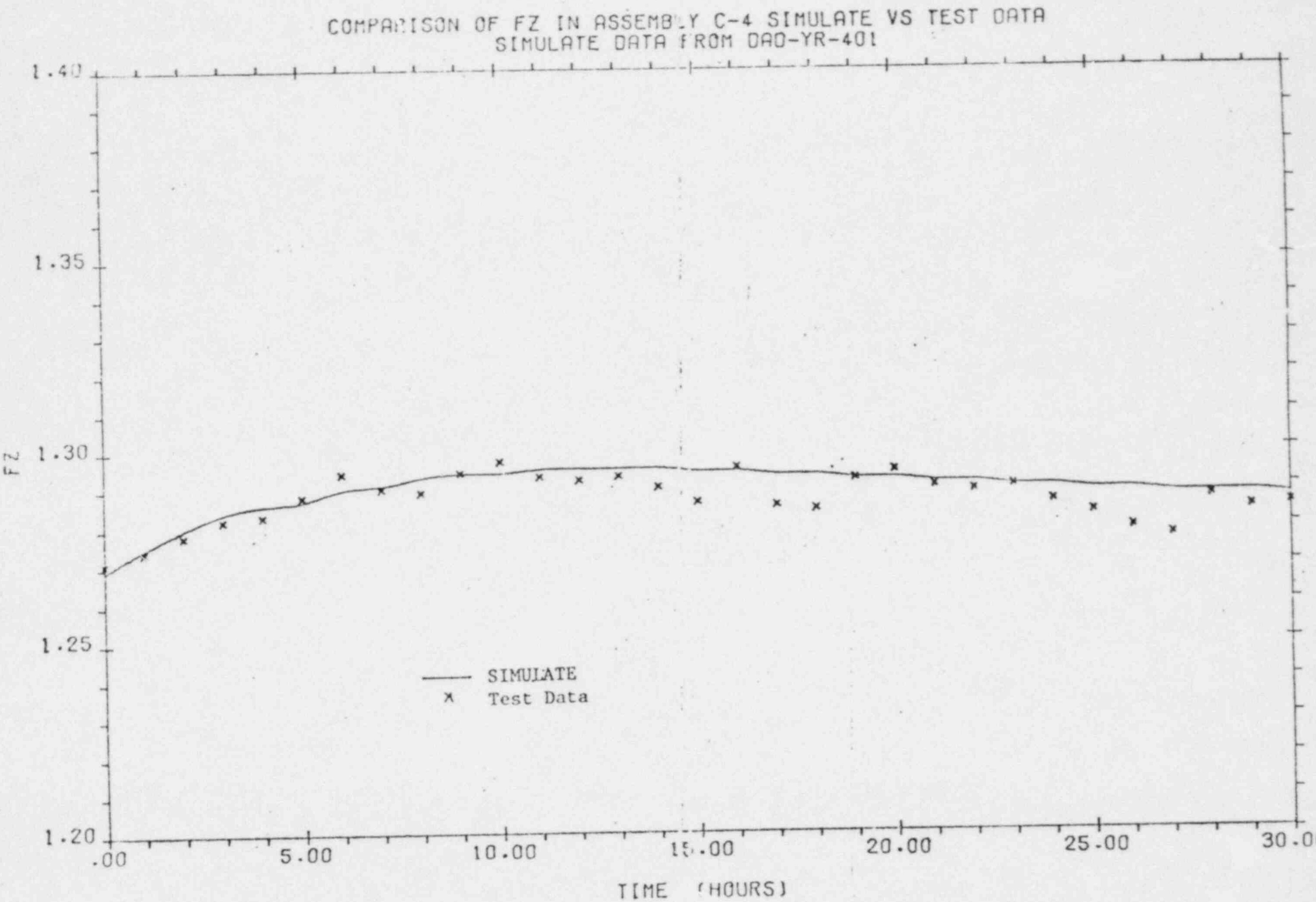
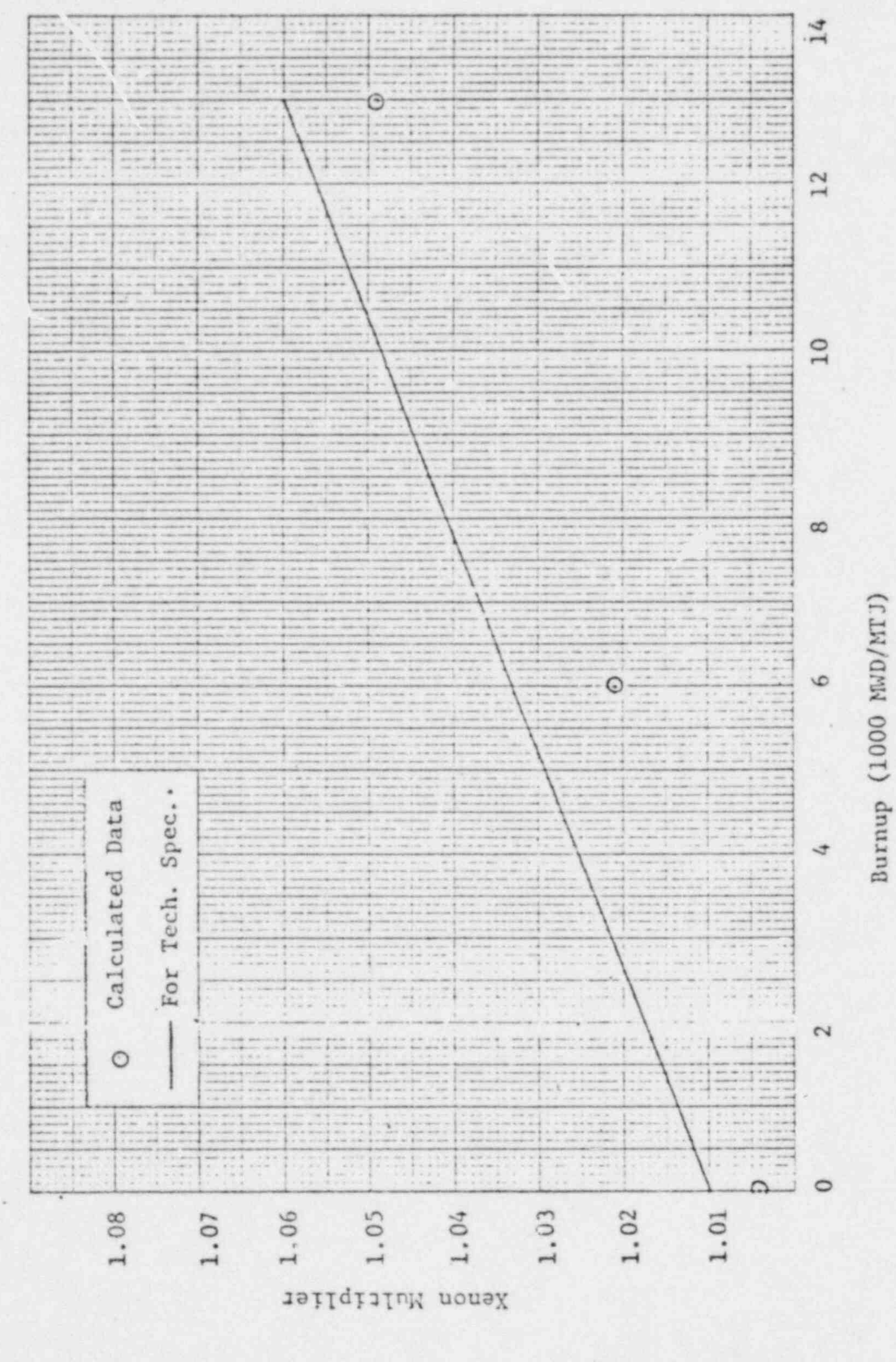

COMPARISON OF FZ IN ASSEMBLY C-4 SIMULATE VS TEST DATA
SIMULATE DATA FROM DAO-YR-401
1.40
1.35
1.30
1.25
1.20
FZ
SIMULATE
Test Data
.00
5.00
10.00
15.00
20.00
25.00
30.00
TIME (HOURS)

Figure 8

Figure 9

Xenon Redistribution Mul:iplier



3/3/76

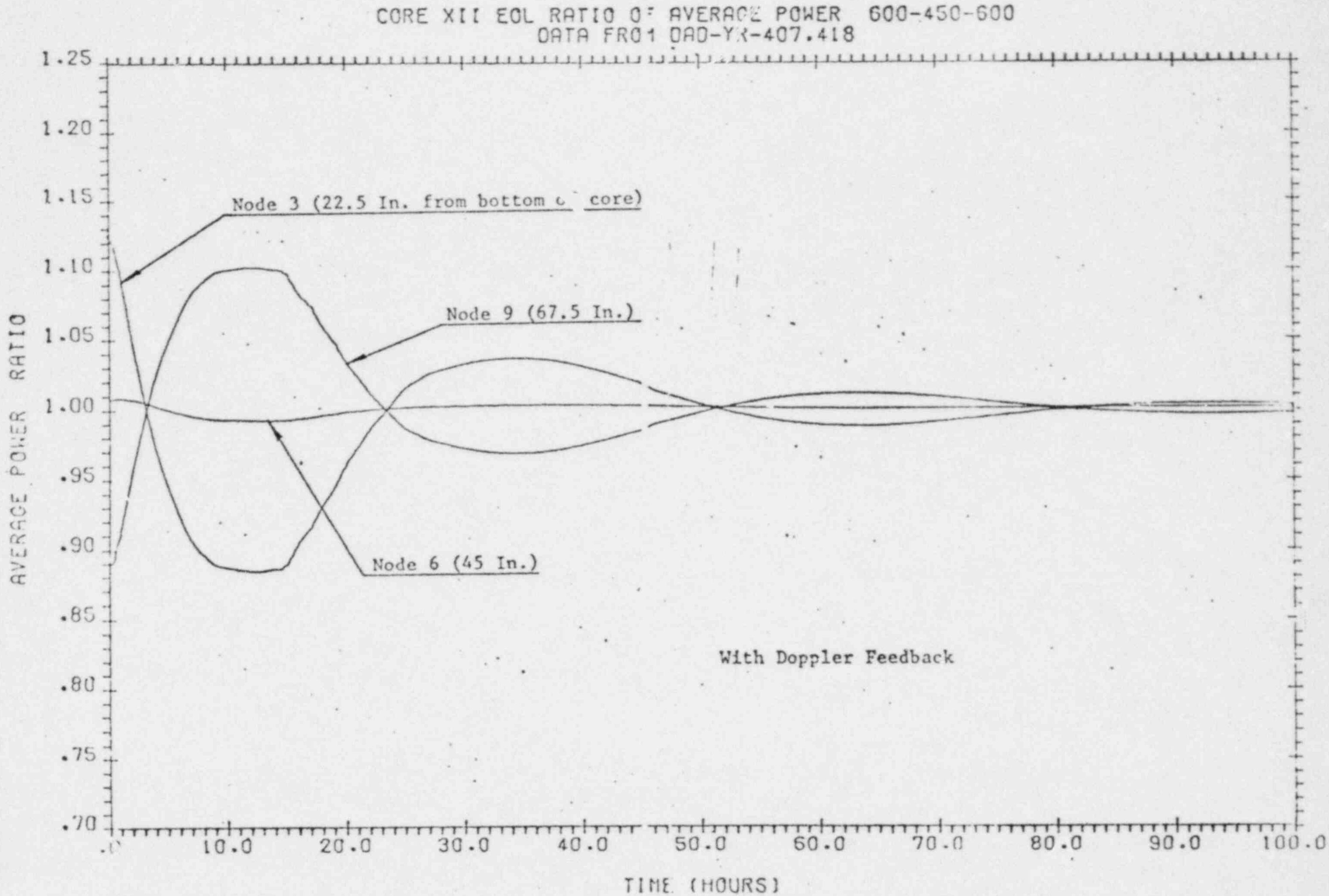
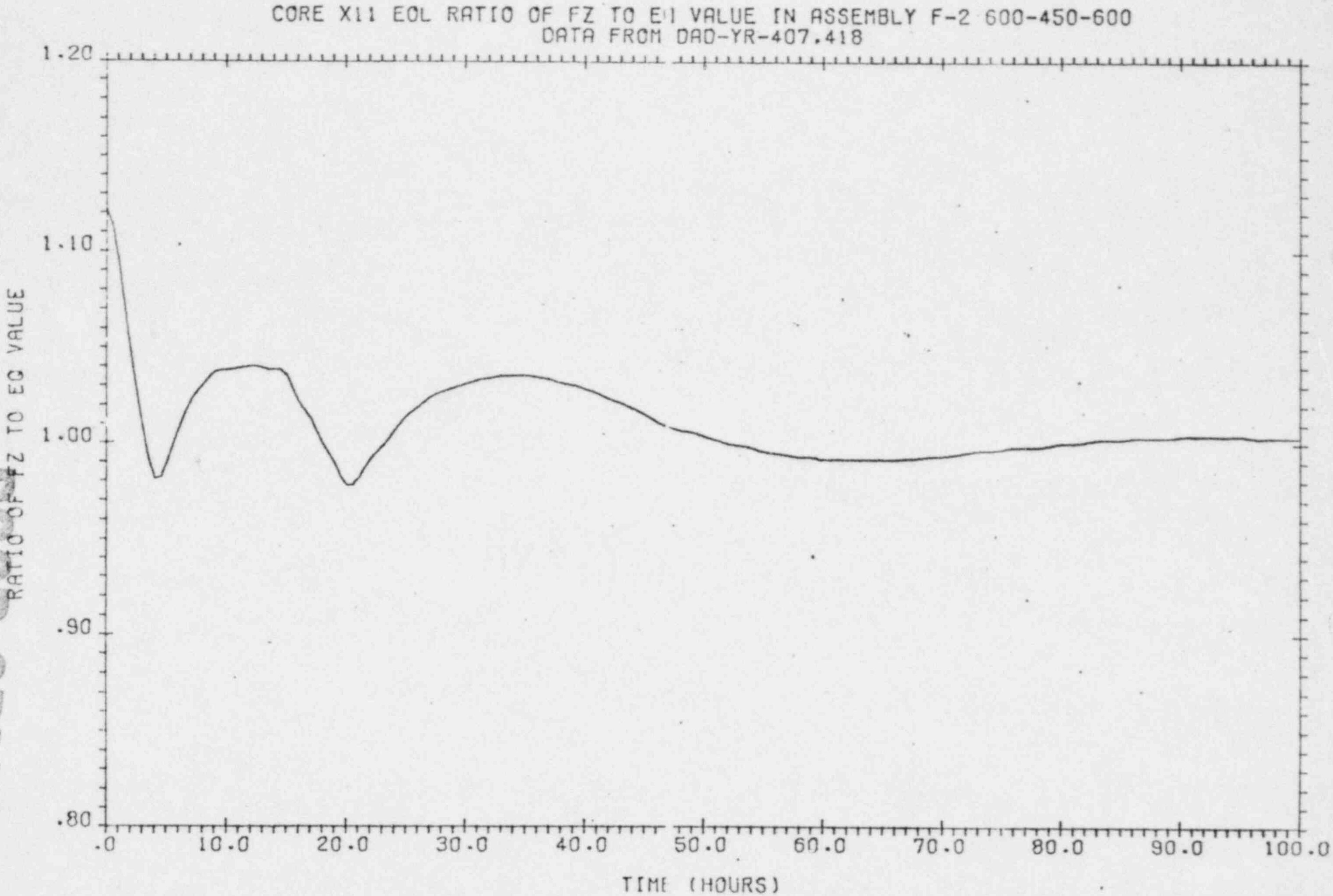


Figure 10

POOR ORIGINAL

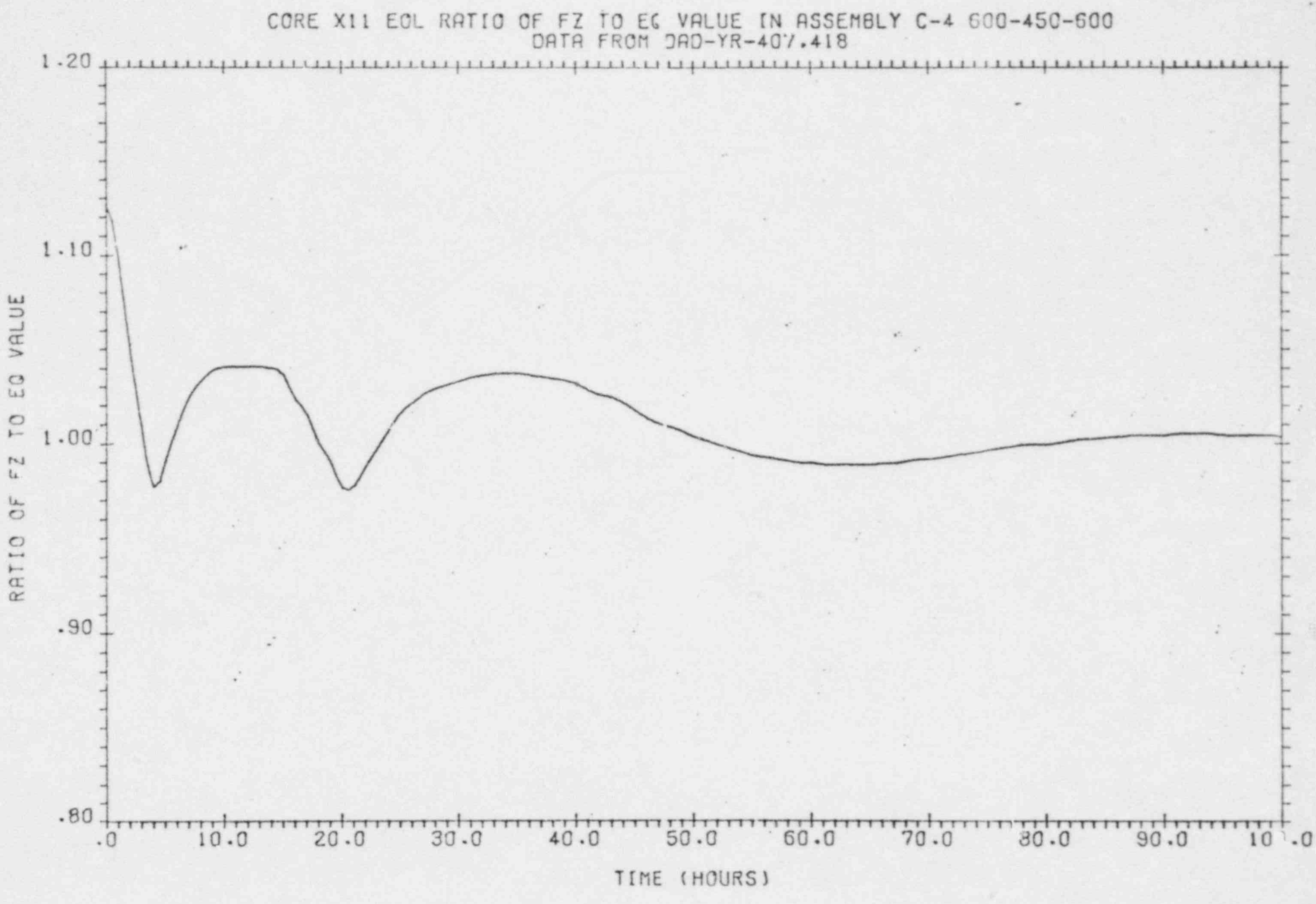
3/3/76



CORE XII EOL RATIO OF FZ TO EQ VALUE IN ASSEMBLY F-2 600-450-600
DATA FROM DAD-YR-407.418
RATIO OF FZ TO EQ VALUE
1.20
1.10
1.00
.90
.80
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
TIME (HOURS)

Figure 11

Figure 1?


CORE XII EOL RATIO OF FZ TO EG VALUE IN ASSEMBLY C-4 600-450-600
DATA FROM DAD-YR-407.418
RATIO OF FZ TO EQ VALUE
1.20
1.10
1.00
.90
.80
.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0
TIME (HOURS)

Multiplier for Reduced Power as a Function of Exposure

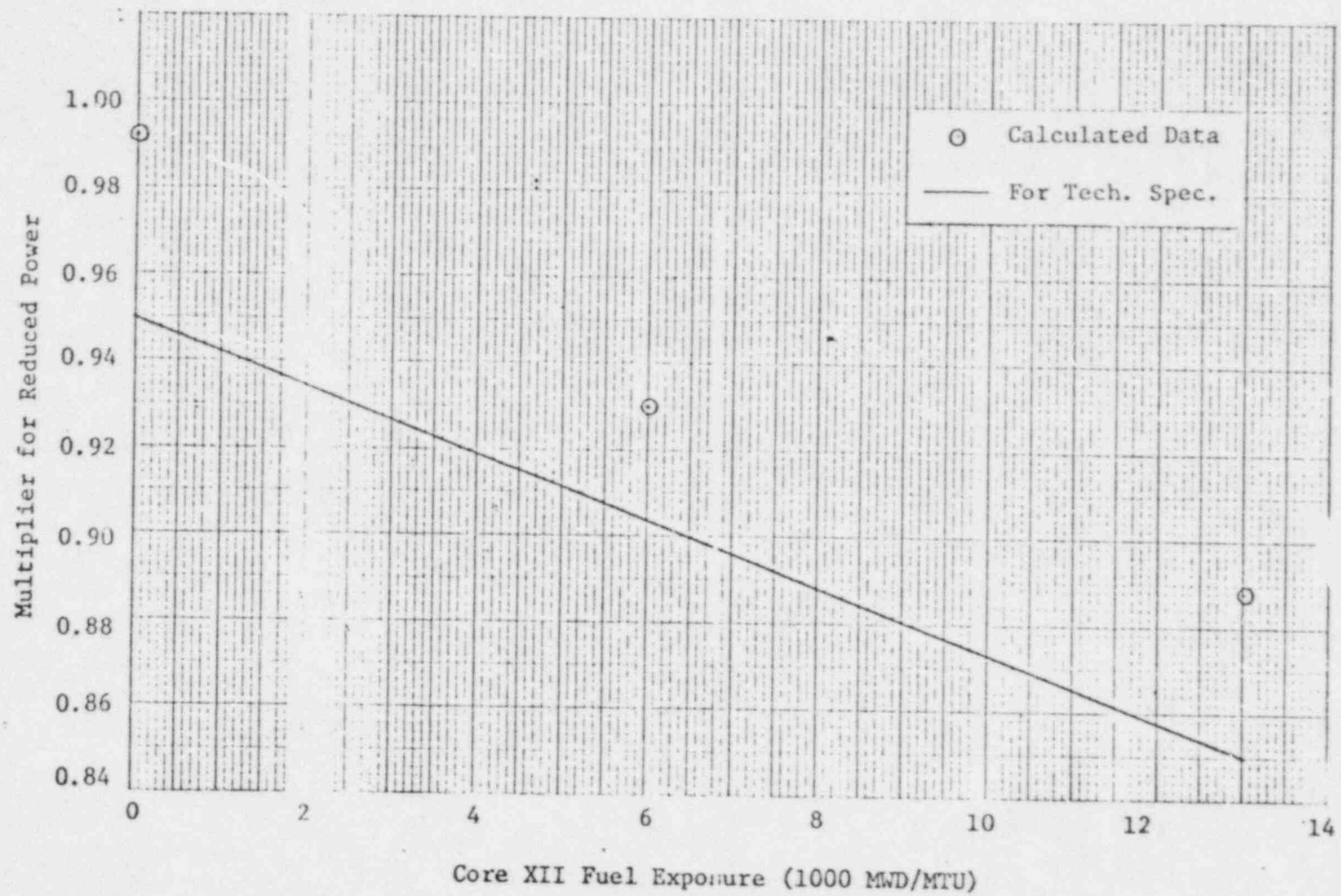


Figure 13

3/3/76

NRC FORM 195 (2-76) U.S. NUCLEAR REGULATORY COMMISSION

DOCKET NUMBER 50-29

FILE NUMBER

NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL

TO: U.S.N.R.C.

FROM: Yankee Atomic Elec. Co.
Westboro, Mass.
W.P. Johnson

DATE OF DOCUMENT 3-3-76

DATE RECEIVED 3-5-76

☐ LETTER ☒ ORIGINAL ☐ COPY ☐ NOTORIZED ☒ UNCLASSIFIED

PROP

INPUT FORM

NUMBER OF COPIES RECEIVED 40

DESCRIPTION Ltr. re. conversation of 2-26-76
Ltr. notarized 3-3-76...trans the following..

ENCLOSURE
Additional information in gegard to Proposed Change # 125, Supplement 7 dated 2-19-76...

(40 Cys. Received)

ACKNOWLEDGED

DO NOT REMOVE

PLANT NAME: Yankee Rowe

SAFETY — FOR ACTION/INFORMATION — ENVIRO SAB 3-8-76

SAFETY		ENVIRO	
ASSIGNED AD :		ASSIGNED AD :	
✓ BRANCH CHIEF :	Purple W/6	BRANCH CHIEF :	
PROJECT MANAGER:		PROJECT MANAGER :	
✓ LIC. ASST. :	Sheppard	LIC. ASST. :	

INTERNAL DISTRIBUTION

✓ REG FILE	SYSTEMS SAFETY	PLANT SYSTEMS	ENVIRO TECH
✓ NRC PDR	HEINEMAN	TEDESCO	ERNST
✓ I & E (2)	SCHROEDER	BENAROYA	BALLARD
✓ OELD		LAINAS	SPANGLER
✓ GOSSICK & STAFF	ENGINEERING	IPPOLITO	
MIPC	MACCARY		SITE TECH
CASE	KNIGHT	OPERATING REACTORS	GAMMILL
HANAUER	SIHWEIL	STELLO	STEPP
HARLESS	PAWLICKI		HULMAN
		OPERATING TECH	
PROJECT MANAGEMENT	REACTOR SAFETY	✓ EISENHUT	SITE ANALYSIS
BOYD	ROSS	✓ SHAO	VOLLMER
P. COLLINS	NOVAK	✓ BAER	BUNCH
HOUSTON	ROSZTOCZY	✓ SCHWENCER	✓ J. COLLINS
PETERSON	CHECK	✓ GRIMES	KREGER
MELTZ			
HELTEMES	AT & I	SITE SAFETY & ENVIRO	
SKOVHOLT	SALTZMAN	ANALYSIS	
	RUTBERG	DENTON & MULLER	

EXTERNAL DISTRIBUTION

✓ LPDR: Greenfield, Mass.	NATL LAB	BROOKHAVEN NATL LAB	CONTROL NUMBER
✓ TIC	REG. V-IE	ULRIKSON(ORNL)	
✓ NSIC	LA PDR		
ASLB	CONSULTANTS		2194
ACRS 16 HOLDING/SENT			