STARTUP TEST REPORT

VERMONT YANKEE CYCLE 16

Introduction

Vermont Yankee Cycle 16 initial startup commenced on 19 April 1992. The refueling and maintenance outage lasted 45.4 days. The core loading for Cycle 16 consists of:

40	DB324B	Reinserts loaded in Cycle 14
72	DB326B	Reinserts loaded in Cycle 14
60	BP8DWB311-10GZ	Reinserts loaded in Cycle 15
64	BP8DWB311-11GZ	Reinserts loaded in Cycle 15
4	ANFIX-3.04B-EGZ	Reinserted qualification assemblies loaded in Cycle 15
40	BP8DWB311-10GZ	Non-irradiated assemblies loaded in Cycle 16
88	BP8DWB311-.1GZ	Non-irradiated assemblies loaded in Cycle 16

An as-loaded Cycle 16 core map is included in Figure I. Details of the Cycle 16 core loading are contained in the Yankee Atomic Electric Company document YAEC-1844, "Vermont Yankee Cycle 16 Core Performance Analysis Report", January 1992.

The final as-loaded core loading was verified correct by Vermont Yankee personnel on 24 March 1992.

Control rod coupling verification was satisfactorily performed for all 89 control rods during control rod friction testing on 24, 25 and 26 March 1992. Control rod scram testing on all 89 rods was performed satisfactorily prior to reaching 30% core thermal power per the Technical Specifications. The testing was performed on 10 and 14 April 1992.

An in-sequence critical was performed satisfactorily on 19 April 1992. The cold shutdown margin was verified to be within the Technical Specifications based on data collected during the in-sequence critical.

Startup commenced on 19 April 1992 and full power steady state conditions were reached on 26 April 1992.

Core Verification

The final as-loaded core was verified correct on 24 March 1992. Three separate criteria were checked:

1. Proper fuel bundle seating was verified by traversing the core with the refueling grapple raised 1/2" to 3/4" above three randomly selected peripheral bundles.

2. Proper bundle orientation, channel fastener integrity and upper tie plate cleanliness were verified. One bundle was improperly oriented by 180 degrees. The bundle was reloaded in its proper orientation.

3. Proper core loading was verified by checking the serial number of each bundle through the use of an underwater video camera. The verification was recorded on tape and later independently reviewed and reverified to agree with the licensed core loading shown in Figure I.

Process Computer Data Checks

Process Computer data shuffling checks were completed on 17 April 1992. These checks included various manual and computer checks of the new data constants. A check for consistency of the data was also performed by Yankee Atomic Electric Co. (YAEC) and found to be satisfactory.

In-Sequence Critical

The in-sequence critical test was performed on 19 April 1992 as part of the reactor startup. Control rod sequence 16-A-2(1) was used to perform the in-sequence critical test. Criticality was achieved on the 6th rod in Group 7 (30-35) at notch position 12. The moderator temperature was 163° F.

The actual critical rod pattern and the YAEC prediction agreed within ±1% Δk/k. Figure II shows the actual, predicted and the ±1% Δk/k critical rod patterns.

Cold Shutdown Margin Testing

The cold shutdown margin calculation was performed using the data collected during the in-sequence critical and information provided in the YAEC "Core Management Report". The minimum cold shutdown margin required was 0.32% Δk/k. The actual was shown to be 1.675% Δk/k.

Control Rod Scram Testing

Single rod scram testing of all 89 control rods was performed successfully on 10 and 14 April 1992. All insertion times were within the limits defined in the Technical Specifications. Results are presented in Table I-A.

In accordance with Technical Specifications Section 4.3.C.2, scram time information for scrams occurring since the transmittal of the previous startup test report are also included. See Table I-B.

All scram time information was evaluated to insure proper drive performance is being maintained. No degradation of drive performance is noticeable.

Thermal Hydraulic Limits and Power Distribution

The core maximum fraction of critical power (CMFCP), the core maximum fraction of limiting power density (CMFLPD), the maximum average planar linear heat generation rate ratio to its limit (MAPRAT) and the ratio of CMFLPD to the fraction of rated power (FRP) were all checked daily during the startup using the process computer. All checks of core thermal limits were within the limits specified in the Technical Specifications.

The process computer power distribution was updated three times using the Traversing Incore Probe (TIP) system during the ascent to full power. The results of these updates and the rated power case are presented in Table II.

The Local Power Range Monitors (LPRMs) were calibrated once in conjunction with two TIP sets. The LPRM high and low trip alarm setpoints were verified correct prior to startup on 15 April 1992. The TIPs and LPRMs were both functionally tested and found to operate satisfactorily.

The process computer power distribution update performed on 28 April 1992 (TIP set 1444) was used as a basis for comparison with an off line calculation performed using the Yankee Atomic Electric Co. nodal computer code SIMULATE-3. For that power distribution the SIMULATE-3 core average axial power distribution was compared to that calculated by the plant process computer; comparisons are shown in Table III. A comparison was also performed between SIMULATE-3 and process computer peak radial power; comparisons are shown in Table IV.

TIP Reproducibility and TIP Symmetry

TIP system reproducibility was checked in conjunction with the power distribution update performed on 28 April 1992. All three TIP system traces were reproducible to within 1.6%.

The total TIP uncertainty was calculated using TIP set 1444. Since the control rod pattern was nearly symmetric, the actual plant TIP readings were used in the calculation. The resulting total TIP uncertainty for this case was 1.86%. The results of the TIP uncertainty test as shown in Figure III are well below the 8.7% acceptance criterion.

Table I-A
Control Rod Scram Testing Results
Vermont Yankee Beginning of Cycle 16

Single Rod Scrams - 10 and 14 April 1992

Maximum 92.01% insertion time (seconds) = 2.850
Maximum 87.84% insertion time (seconds) = 2.729
Tech. Spec. limit for slowest 90% insertion time (seconds) = 7.000

	4.51%	25.34%	46.18%	87.84%
Mean Time for % insertion				
Measured time (seconds)	0.344	0.854	1.373	2.476
Tech. Spec. limit (seconds)	0.358	0.912	1.468	2.686
Slowest 2x2 array for % insertion				
Measured time (seconds)	0.366	0.896	1.427	2.549
Tech. Spec. limit (seconds)	0.379	0.967	1.556	2.848

Table I-B
Control Rod Scram Testing Results
Vermont Yankee Cycle 15

Full Scram - 4 November 1990

Maximum 87.84% insertion time (seconds) = 2.923
Tech. Spec. limit for slowest 90% insertion time (seconds) = 7.000

	4.51%	25.34%	46.18%	87.84%
Mean Time for % insertion				
Measured time (seconds)	0.320	0.839	1.372	2.506
Tech. Spec. limit (seconds)	0.358	0.912	1.468	2.686
Slowest 2x2 array for % insertion				
Measured time (seconds)	0.363	0.890	1.438	2.641
Tech. Spec. limit (seconds)	0.379	0.967	1.556	2.848

Full Scram - 13 March 1991

Maximum 87.84% insertion time (seconds) = 2.923
Tech. Spec. limit for slowest 90% insertion time (seconds) = 7.000

	4.51%	25.34%	46.18%	87.84%
Mean Time for % insertion				
Measured time (seconds)	0.311	0.819	1.341	2.447
Tech. Spec. limit (seconds)	0.358	0.912	1.468	2.686
Slowest 2x2 array for % insertion				
Measured time (seconds)	0.352	0.871	1.383	2.508
Tech. Spec. limit (seconds)	0.379	0.967	1.556	2.848

Table I-[illegible] (cont'd)
Control Rod Scram Testing Results
Vermont Yankee Cycle 15

Full Scram - 23 April 1991

Maximum 87.84% insertion time (seconds) = 2.874
Tech. Spec. limit for slowest 90% insertion time (seconds) = 7.000

	4.51%	25.34%	46.18%	87.84%
Mean Time for % insertion				
Measured time (seconds)	0.302	0.802	1.317	2.412
Tech. Spec. limit (seconds)	0.358	0.912	1.468	2.686
Slowest 2x2 array for % insertion				
Measured time (seconds)	0.352	0.838	1.382	2.524
Tech. Spec. limit (seconds)	0.379	0.967	1.556	2.848

Full Scram - 15 June 1991

Maximum 87.84% insertion time (seconds) = 2.633
Tech. Spec. limit for slowest 90% insertion time (seconds) = 7.000

	4.51%	25.34%	46.18%	87.84%
Mean Time for % insertion				
Measured time (seconds)	0.291	0.790	1.310	2.435
Tech. Spec. limit (seconds)	0.358	0.912	1.468	2.686
Slowest 2x2 array for % insertion				
Measured time (seconds)	0.318	0.817	1.352	2.509
Tech. Spec. limit (seconds)	0.379	0.967	1.556	2.848

Table I-B (cont'd)
Control Rod Scram Testing Results
Vermont Yankee Cycle 15

Single Rod Scrams - 23 November 1991

Maximum 87.84% insertion time (seconds) = 2.696
Tech. Spec. limit for slowest 90% insertion time (seconds) = 7.000

	4.51%	25.34%	46.18%	87.84%
Mean Time for % insertion				
Measured time (seconds)	0.324	0.826	1.347	2.459
Tech. Spec. limit (seconds)	0.358	0.912	1.468	2.686
Slowest 2x2 array for % insertion				
Measured time (seconds)	0.376	0.879	1.399	2.509
Tech. Spec. limit (seconds)	0.379	0.967	1.556	2.848

Full Scram - 6 March 1992

Maximum 87.84% insertion time (seconds) = 2.761
Tech. Spec. limit for slowest 90% insertion time (seconds) = 7.000

	4.51%	25.34%	46.18%	87.84%
Mean Time for % insertion				
Measured time (seconds)	0.328	0.851	1.389	2.510
Tech. Spec. limit (seconds)	0.358	0.912	1.468	2.686
Slowest 2x2 array for % insertion				
Measured time (seconds)	0.353	0.896	1.466	2.609
Tech. Spec. limit (seconds)	0.379	0.967	1.556	2.848

Table II
Power Distribution Measurements
Vermont Yankee Beginning of Cycle 16

Date	Time	% CTP	% Flow	CMFLPD	CMFCP	MAPRAT
23 Apr. 92	07[illegible]5	59.6	50.3	0.566	0.719	0.554
23 Apr. 92	1223	58.1	50.2	0.555	0.705	0.542
24 Apr. 92	1829	80.5	64.0	0.790	0.798	0.760
28 Apr. 92	0931	99.8	97.8	0.937	0.810	0.913

The Tech. Spec. limit for the three the[illegible] limits above is less than or equal to 1.0.

Table III
Comparison of Process Computer and SIMULATE-3
Core Average Axial Power Distributions
Vermont Yankee Beginning of Cycle 16

Node	SIMULATE-3	Process Computer
25	0.128	0.146
24	0.267	0.284
23	0.541	0.579
22	0.676	0.714
21	0.761	0.792
20	0.855	0.882
19	0.924	0.945
18	0.969	0.984
17	1.027	1.048
16	1.093	1.113
15	1.135	1.146
14	1.159	1.153
13	1.222	1.222
12	1.254	1.246
11	1.260	1.223
10	1.243	1.225
9	1.264	1.259
8	1.290	1.278
7	1.326	1.293
6	1.373	1.372
5	1.403	1.401
4	1.376	1.324
3	1.244	1.195
2	0.949	0.825
1	0.262	0.352

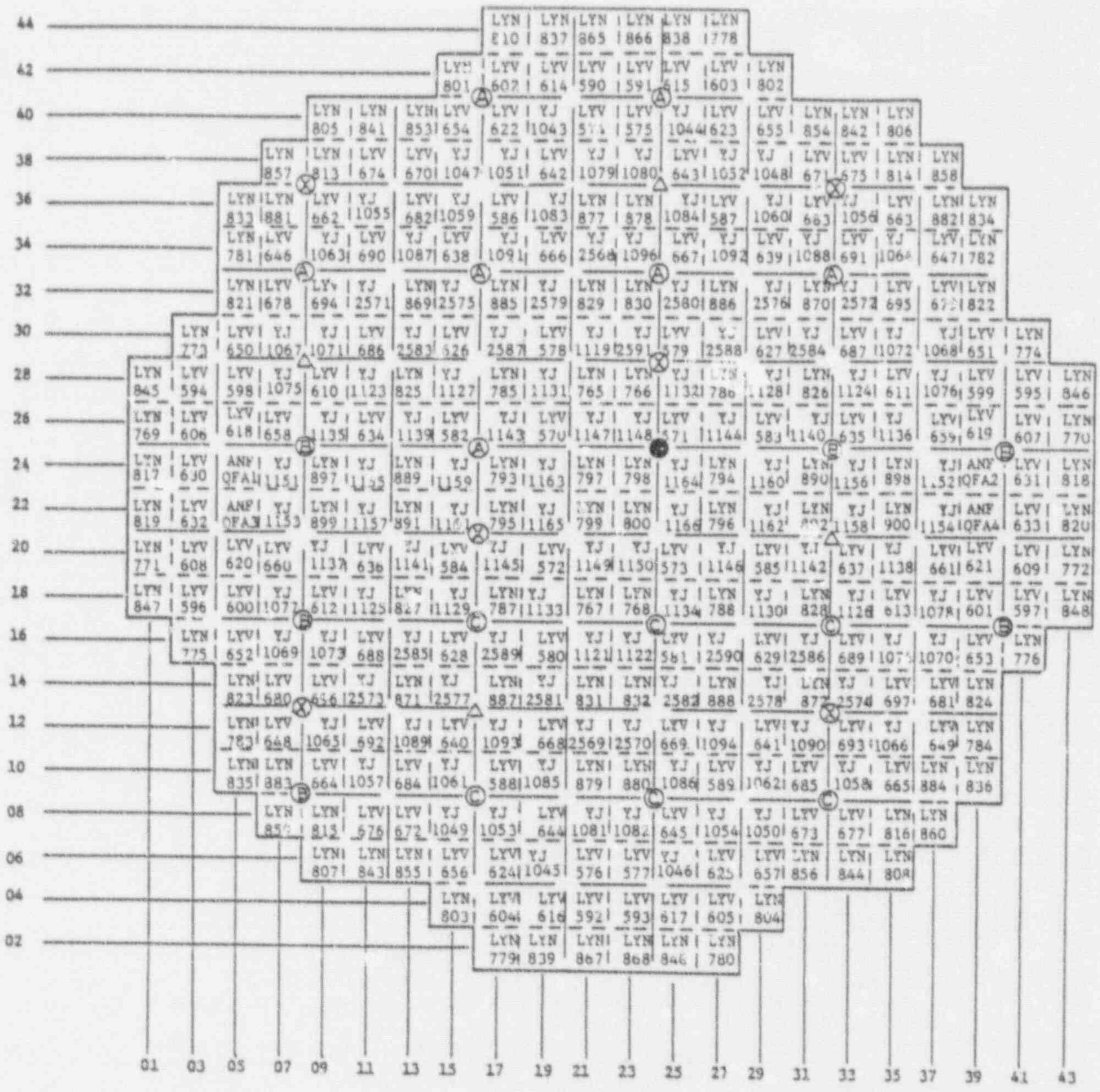
Table IV
Comparison of Ten Highest Relative Radial Powers
Vermont Yankee Beginning of Cycle 16

Location	Process Computer	SIMULATE
29-16	1.285	1.306
29-12	1.283	1.281
33-16	1.256	1.278
31-12	1.248	1.221
31-10	1.247	1.212
27-10	1.240	1.240
29-10	1.239	1.206
29-14	1.238	1.243
27-12	1.236	1.228
33-12	1.235	1.223

Figure I

Cycle 16 Core Map

VERMONT YANKEE



● LPRM LOCATION (COMMON LOCATION FOR ALL TIP MACHINES)

○ LPRM LOCATION (LETTER INDICATES TIP MACHINE)

⊗ IRM LOCATION

△ SRM LOCATION

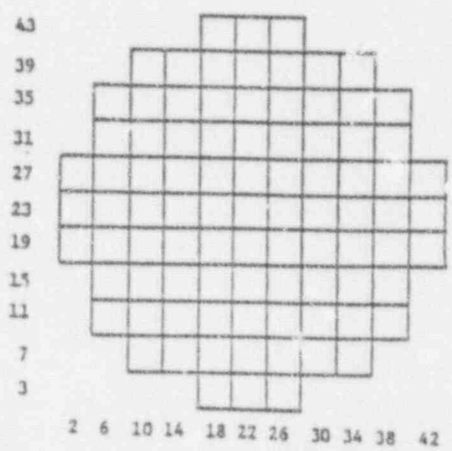
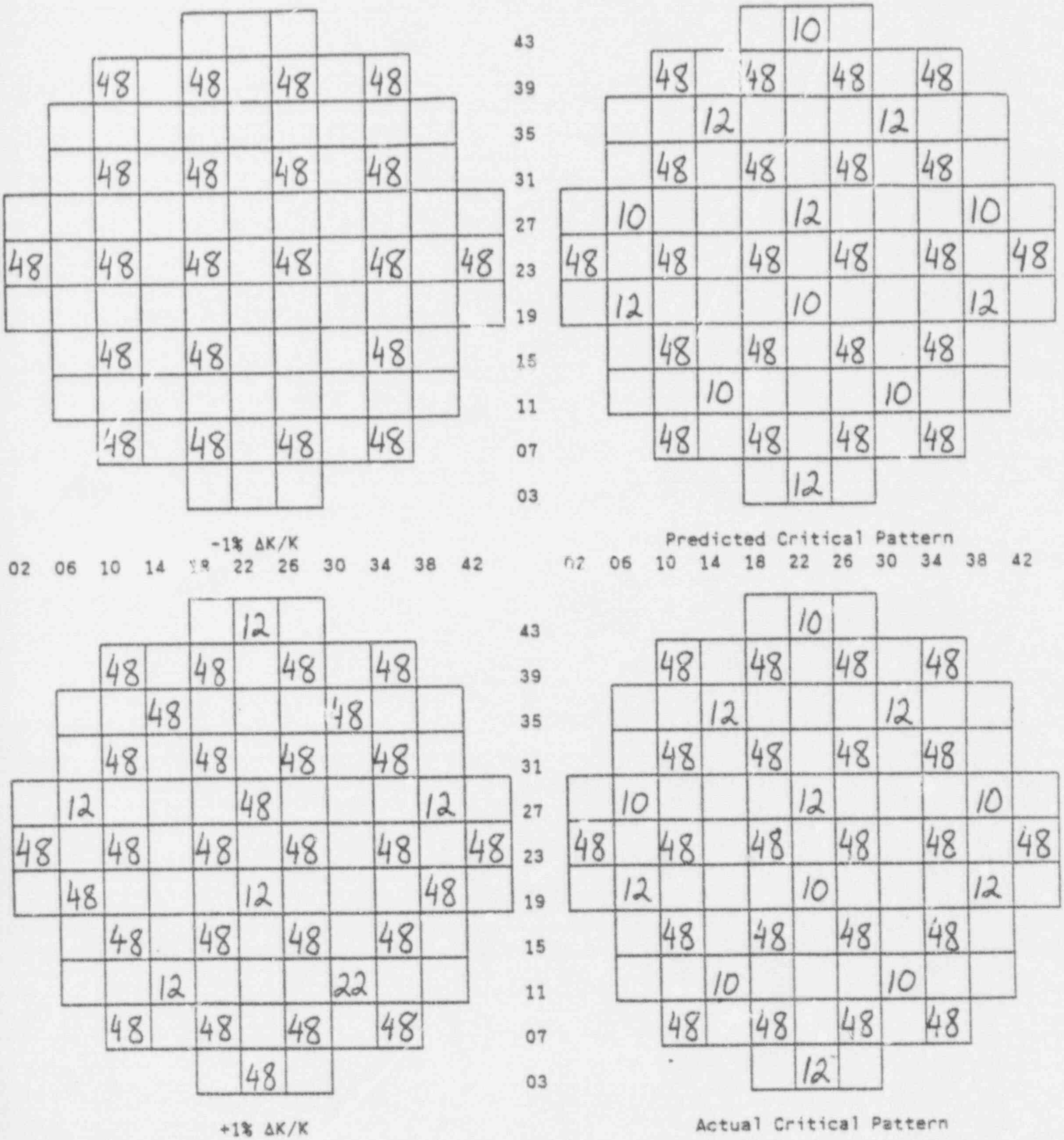
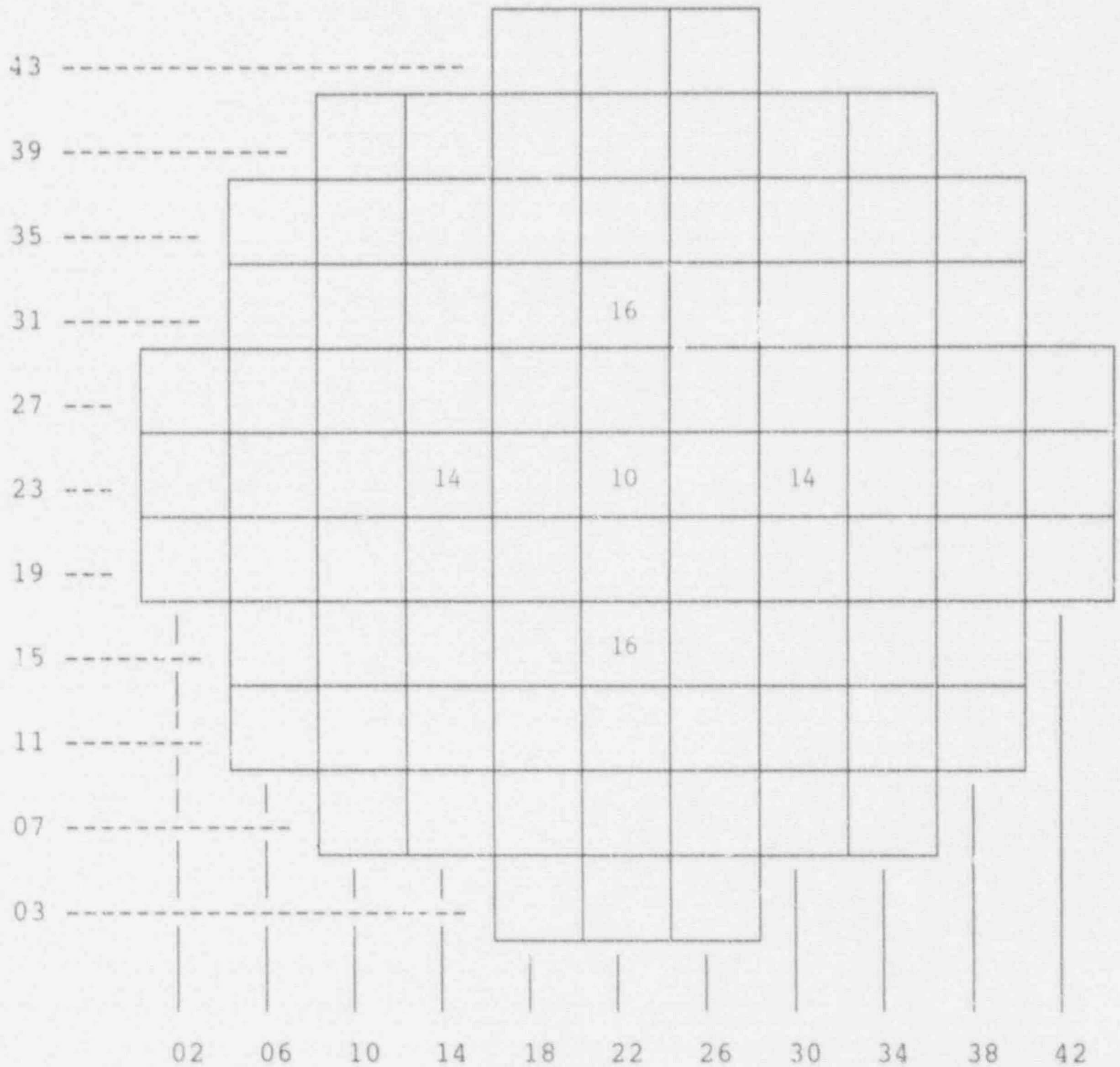


Figure II
Vermont Yankee
Beginning of Cycle 16
Critical Rod Configuration Comparison



Note: A blank box denotes rod position 00.

Figure III
Vermont ankee
Total TIP Uncertainty



TIP: 1444

Date: 28 April, 1992

CTP: 99.8%

Core Flow: 97.8%

Uncertainty: 1.86%