YANKEE NUCLEAR POWER STATION

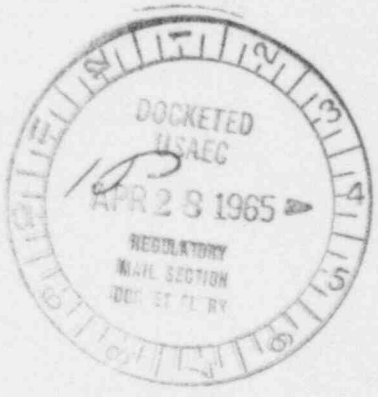
50-29

OPERATION REPORT NO. 51

File Copy (formal)

For the month of

MARCH 1965



Submitted by

YANKEE ATOMIC ELECTRIC COMPANY
Boston Massachusetts

April 27, 1965

This report covers the operation of the Yankee Atomic Electric Company plant at Rowe, Massachusetts for the month of March, 1965.

At the beginning of the reporting period the plant was operating at full rated power of 185 MWe. Plant output remained constant at that level until March 5 when the plant was shutdown for electrical repairs to a 115 KV connector in the outdoor switchyard. A failed strand in the B phase conductor on the structure side of 126-6 disconnect was repaired and all bolted connections in the yard were checked.

Necessary repairs were completed in approximately seven hours following which the plant was returned to the line reaching an output of 185 MWe at 1800 hours on March 6.

Plant load remained at 185 MWe until March 16. On that date, an abnormal increase in main coolant crud level was experienced and shortly thereafter plant load started to drop, reaching a low of 174 MWe on March 17. A more detailed description of this occurrence can be found in the Chemistry section of this report. As the system crud concentration returned to normal levels plant load was regained reaching 185 MWe on March 19.

For the balance of the reporting period plant output varied between 183 and 185 MWe. At the end of the month, all control rods were withdrawn and the main coolant boron concentration was reduced to essentially zero. The effective end of core full power life was recorded as being 0400 hours on March 31.

During the March 5 shutdown a Vapor Container inspection was made and no unusual conditions noted.

On March 24, 13,500 scf of makeup air was charged to the Vapor Container. The overall leakage rate for the 60 day period since the last charge was .0176 %/day. The leakage rate data taken early in the period was somewhat in error because of trouble with the Vapor Container temperature instrumentation coupled with a leak of short duration that was later secured. The leakage rate for the last 48 days of the period was .0084 %/day or 2.31 scf/hr. The leakage rate when extrapolated to 15 psig internal pressure would be 8.30 scf/hr. or .0137 %/day.

Plant Shutdowns

Shutdown No. 78-4-7	3-5-65	A 7.95 hour shutdown for switchyard electrical repairs.

Plant Maintenance

The following is a summary of major activities carried out by the plant maintenance staff during March:

1. The 100 ton turbine hall crane was lubricated and inspected.

2. Repaired an oil leak on No. 1 boiler feed pump.

3. During the plant outage, the short piece of conductor from the structure side of B phase 126-6 disconnect switch to the structure bus was replaced. As corrosion was noted under the clamps, all bolted connections on both sides of 126-5, 126-6, 177-5 and 177-6 disconnect switches were dismantled, inspected and coated with oxide inhibiting grease. Dice metering to measure the contact resistance of all bolted connections in the structure indicated a higher than normal resistance between the pad of the switch and tongue of the connector on B and C phases of the T-1 air break switch. As the connections were taken apart, pitting was noted making surface cleaning necessary.

4. Installed a new diaphram in the distillate line valve in the water treatment room.

5. Due to the raising of the elevation of Sherman Dam, minor rennovations to the screenhouse were required to permit it to remain watertight in the unlikely event that the maximum flood stage in the cooling pond is experienced. This work, accomplished during the month, included minor changes in screen wash piping, the addition of stop log channels on doors, and inspection and sealing of all foundation penetrations.

6. Installed a new valve on No. 1 steam generator sample line, replacing the existing valve which had a leaking bonnet and an eroded seat.

7. The hydrazine pump in the water treatment room was repacked.

8. Installed new inlet and outlet valves on No. 2 control air compressor.

9. Loaded and shipped off site for disposal, a spent filter capsule.

Chemistry

Following the plant shutdown on March 5, the main coolant crud level increased to 2.0 ppm. Also noted was an increase in the Co-58/Co-60 ratio, a similar effect having been noted during previous ammonia runs with Core III and IV and the data now indicates that the phenomena is a combined result of ammonia and control rod movement.

On March 16, No. 3 anion exchanger and No. 4 filter were valved into service in series for boron removal. As boron removal progressed, control rods were inserted as required for reactivity control. However, approximately mid-way through the rod insertion, the radiation monitoring system alarm on the main coolant bleed line annuciated, indicating a high bleed line radiation level. Feed and bleed was secured and the radiation level at the bleed line was measured at 600 mr/hr. A main coolant crud sample was measured at 44.5 ppm and it appears the sample was representative of main coolant actual crud concentration, although the sample was not taken under ideal conditions.

Because of the abnormally high crud level, purification with No. 2 cation exchanger and No. 4 filter was initiated resulting in a decrease in crud level over the succeeding 48 hours to 2.1 ppm. As system purification progressed, samples from the outlet of the cation exchanger and filter combination indicated partial boron removal. Investigation of the valving to the anion exchanger showed that there was no split flow problem. The possibility of anion resin in the filters was speculated on.

On March 22, the No. 3 anion exchanger and the No. 4 filter were again placed in service for boron removal. Shortly thereafter the flow rate through the exchanger and filter decreased to zero. The No. 4 filter was found to be completely plugged.

Reconstruction of the events of the preceding days coupled with the plugging of No. 4 filter indicated a failure on No. 3 anion exchange resin retaining screen on March 16, thus allowing anion resin to flow into No. 4 filter. Use of this filter, now partially plugged with anion resin, and No. 2 cation bed explains the previously unexplained simultaneous removal of boron and crud from the purification stream on March 16 and 17.

Resin fines and resin fragments were observed in crud samples from the low pressure surge tank on March 20 and from the main coolant on March 22. These and other samples indicated that no detrimental quantity of resin was present in the primary water. It was possible for resin to enter the coolant during the use of No. 3 anion exchanger on March 16 and 22, due to operational valving required in establishing the pressure drop measurement across the filter after placing it in service. Periodically the pressure drop across the filter is checked by temporarily bypassing the filter and noting the reduction in the pressure drop across the whole system. Upon verification that the pressure drop is not excessive, and thus assuring only reasonable fouling of the filter, the bypass is closed and flow then proceeds through the filter in a normal manner.

An internal inspection of No. 3 anion exchanger on March 24 confirmed earlier suspicions as the resin retaining screen was found to have pulled away from its support ring.

Summarizing the theories concerning the crud burst of March 16, it is believed that this highly radioactive burst could have been caused by one or more of the following:

1. Previous operation with ammonia in the main coolant, even though at lower power levels and in the complete absence of boron, has shown an increased main coolant equilibrium crud level. The present ammonia operation at maximum power levels and in the presence of low boron shows again higher equilibrium crud levels which can mean either higher release rates or higher corrosion rates. It is perhaps possible that the higher crud levels contributed to crud retention in the core and then a release of crud in the form of a burst.

2. The March 16 crud burst could have been initiated by the small amount of resin (calculated to be between .005 and .234 cu. ft.) getting into the main coolant system, although no pH changes were measured and perhaps only rubbing action can be assumed.

3. The March 16 crud burst could have been triggered by the control rod action required to compensate for reactivity as boron was being removed.

Following the March 16 crud burst the frequency of crud sampling was increased and a program was initiated to study the relationship of high crud readings to control rod motion. In this program three other unusually high crud readings were measured from what was at first felt to be representative samples. These three crud readings were logged at 20.4 ppm, 48 ppm and 6.0 ppm. Further study cast considerable suspicion on the representativeness of the three samples and on the mode and accuracy of crud sample taking. These studies are continuing and are focusing on the temperature transients realized in the bleed line (which provides part of the flow path to the crud sample point) by other plant operations and periodic tests such as rod exercise and throttle valve exercise.

Throughout the reporting period the main coolant oxygen levels were below the point of detection. High pH operation, ammonia controlled, continued throughout the month with the ammonia concentration varying between 6.1 and 12.5 ppm.

With no anion purification, the main coolant I-131 and I-131/I-133 atomic ratio experienced normal increase to 7.1×10^{-5} μc/ml and 1.5 respectively.

Boron concentration in the main coolant decreased from 120 ppm at the beginning of the reporting period to essentially zero at month's end.

During the month, on-site laboratory testing of purposely defected Boral specimens produced a thus far unexplained blistering of the clad on two specimens. These two specimens along with other control specimens were sent off site for more detailed analyses, the results of which are not yet available. However, with the finding of the clad blisters, an underwater inspection of the storage rack was carried out. Visual inspection with binoculars was followed by borescope investigation of questionable areas. There were no blisters observed such as might have been expected from the laboratory tests. Several fuel elements were partially withdrawn from the storage rack and no evidence of mechanical binding was found.

A typical main coolant crud analysis performed on March 26, 1965, indicated:

Cr-51	1.4×10^7 dpm/mg
Mn-54	6.2×10^6 dpm/mg
Fe-59	5.1×10^6 dpm/mg
Co-58	3.3×10^7 dpm/mg
Co-60	3.8×10^6 dpm/mg
Hf-181	2.4×10^6 dpm/mg
In-116m	6.1×10^7 dpm/mg

A typical main coolant gas analysis performed on March 17, 1965 indicated:

Xe - 133	1.3×10^{-2} µc/cc gas
Xe - 135	1.2×10^{-2} µc/cc gas
A - 41	7.2×10^{-2} µc/cc gas

Reactor Plant Performance

Performance data on No. 1 component cooling heat exchanger before and after chemical cleaning indicated that some performance improvement was achieved as the terminal temperature difference was reduced by a factor of two. Although the performance did improve it was concluded that the exchanger is still not completely clean nor is it operating at maximum efficiency.

Following the abnormal crud increase on March 16, a loss in core reactivity and power output were experienced. The loss occurred at a maximum rate of 0.038% $\triangle$ K/hr. to a minimum power of 560 MWt at 0800 hours on March 17. The total reactivity loss recorded was approximately 0.5% $\triangle$ K. As crud levels stabilized early in the day on March 17, the reactivity loss also stabilized and shortly thereafter a reactivity gain commenced. The gain, occurring at a maximum rate of 0.015 % $\triangle$ K/hr. continued until the entire 0.5% $\triangle$ K previously lost had been recovered.

The normal 0.98% $\triangle$ K/1000 MWtD/MTU depletion rate was established by March 20. On March 22, with purification secured, a reactivity "flat-spot" was experienced and continued through March 26, although purification was resumed on March 25.

The results of a five wire flux wire irradiation were:

597 MWt 526°F Tavg. 5303 MWtD/MTU
Grp. A @ 84 1/8" Grps. B, C and D @ 88 7/8"

F_Q	= 2.5
$F^{\triangle H}$	= 2.2
"q" DNBR	= 2.7
Maximum Outlet Temperature	= 595°F

A similar wire irradiation performed during the crud transient on March 16 produced no measureable differences in recorded data.

The end of Core IV full power life was effectively established at 0400 hours on March 31. A summation of plant statistics at that time indicated:

Total MWe Gross	-	871,628.4
Total MWt Hours	-	2,854,812.0
MWtD/MTU	-	5,726.4
Group A @	-	90 0/8"
Groups B, C & D @	-	89 2/8"

Main coolant pH adjusted high with NH_3

Turbine Plant Performance

Early in the reporting period, secondary plant performance, as measured by the MWt/MWe ratio, measured constant at a loss of 8 MWt from Core IV startup. Late in the month a further shift in the curves was noted. The study to determine possible causes for the change in performance is continuing, although, as work progresses, and additional data gathered, it appears the turbine feedwater heater cycle is the area responsible for the change in plant performance.

Instrumentation and Control

Principal maintenance items performed by the plant Instrumentation and Control group during March were:

1. Installed a test gauge on the Vapor Container pressure detection system.

2. Replaced the microswitch in the service air compressor low oil pressure switch.

3. Installed a temperature thermocouple and indicator on the waste disposal plant incinerator.

4. Installed a test circuit on the BK1 greenlight for use during control rod drop testing.

5. Checked the output of the No. 1 feedwater heater thermocouple against standard calibration tables. Between 200°F and 360°F the thermocouple output was within 1°F of the standard yellow-black thermometer.

6. Installed a new spent fuel pit water temperature indicator.

7. Recalibrated TR600, the condensate and feedwater temperature recorder.

8. Completed assembly of a voltage detector test set for use with the visicorder on control rod drive tests.

Health and Safety

During the month of March, 1965, the following radioactive wastes were prepared and shipped off site for disposal:

1. Forty-six drums of routine waste containing a total activity of 799.9 mc.

2. Four "stove pipe" drums of special waste (resins) containing a total activity of 377 mc.

3. Two casks containing a total of 76 cubic feet of resins with a total activity of 46.2 curies.

4. Two casks, each containing a spent ion exchange filter capsule. The total activity contained in the capsules was 46.2 curies.

Liquid wastes containing a total activity of 25 mc of gamma emitting isotopes and 389.53 curies of tritium were discharged during March. Gaseous wastes containing a total activity of 66.6 mc were discharged during the same period. Leakage from the ion exchange pit accounted for an additional 7.76 mc of gamma emitters and 12.7 curies of tritium during the month.

A radiation survey in No. 4 loop, approximately four hours after shutdown on March 5, 1965, indicated the following levels, all levels contact maximum except for the general area reading:

Base of Steam Generator	450 mr/hr
Bypass Valve	750 mr/hr
Bypass Pipe	625 mr/hr
Main Coolant Pipe Th	800 mr/hr
Main Coolant Pipe Tc	400 mr/hr
Main Coolant Stop Valve Th	600 mr/hr
Main Coolant Stop Valve Tc	500 mr/hr
Chemical Injection Valve	350 mr/hr
Cubicle - General Area	15-60 mr/hr

Health Physics coverage was provided for borescope inspection of No. 20 drive shaft pressure housing. Radiation levels at one inch were 20-150 mr/hr from the top of the housing down to the top of the internal assembly section of the housing; 800 mr/hr mid-way down the internal assembly section; and 100 mr/hr at the lower end. Contamination outside the housing was 10^3 - 10^5 dpm/ft^2, and inside the internal assembly in the latch finger area, 10^6 dpm/ft^2.

Continued investigation and analyses of tritium contamination at the Yankee plant was in progress throughout the month. Liquid samples were sent off site to two private laboratories for tritium analysis. The spread of the reports of both organizations and those of the State Department of Public Health was as follows:

Sample	Tritium Concentration uc/ml
Main Coolant	2.22
Vapor Container Atmospheric Condensate	$5.9 - 8.0 \times 10^{-1}$
Plant Drinking Water	4.6×10^{-6}
Safety Injection Tank	$6.3 - 7.5 \times 10^{-2}$
Spent Fuel Pit	$5.7 - 6.5 \times 10^{-3}$
Ion Exchange Pit	$3.5 - 3.7 \times 10^{-2}$; 2.2×10^{-3}
Condenser Discharge	$3.6 - <7 \times 10^{-6}$
Deerfield River	2.4×10^{-5}, $< 5 \times 10^{-6}$
Waste Gas Storage System	1×10^{-2} µc/cc

Also investigated was the Spent Fuel Pit airborne activity. Tritium in the form of water vapor in the air of the Spent Fuel Pit area was calculated to be 1.1×10^{-7} µc/cc based on a relative humidity of 75%, temperature 55.5°F, barometric pressure 29.0" Hg., and 6.1×10^{-3} µc/ml of Spent Fuel Pit water. To establish a basis of calculations it was assumed that the water vapor in the air was the same activity as that in the pit.

Similar analysis of the Vapor Container airborne activity showed that the concentration of tritium in the form of water vapor in the Vapor Container was 9.2×10^{-6} µc/cc.

Personnel exposures for Yankee plant personnel as measured by film badge for the month of March, 1965 were:

Average for all station personnel	= 84 mr.
Maximum individual exposure	= 440 mr.

Plant Operations

Attached is a summary of plant operation statistics for the month of March, 1965 and a plot of daily average plant load for the same period.

YANKEE ATOMIC ELECTRIC COMPANY -- OPERATING SUMMARY

MARCH 1965

ELECTRICAL		MONTH	YEAR	TO DATE
Gross Generation	KWH	134,488,200	393,068,800	4,356,185,000
Sta. Service (While Gen. Incl. Losses)	KWH	7,991,226	23,368,970	303,031,081
Net Generation	KWH	126,496,974	369,699,830	4,053,153,919
Station Service	%	5.94	5.94	6.95
Sta. Service (While Not Gen. Incl. Losses)	KWH	49,034	155,936	19,954,387
Ave. Gen. For Month (744 HRS)	KW	180,764	--	--
Ave. Gen. Running (736.05 HRS)	KW	182,716	--	--

PLANT PERFORMANCE				
Net Plant Efficiency	%	28.99	29.10	--
Net Plant Heat Rate	Btu/KWH	11,772	11,728	--
Lbs. Steam/Net KWH		13.84	13.80	--
Circulating Water Inlet Temp.				
Maximum	°F	42	--	--
Minimum	°F	35	--	--
Plant Operating Factor	%	97.75	98.02	71.00
Reactor Plant Availability	%	100.00	99.38	82.67

NUCLEAR		MONTH	CORE IV	TO DATE
Times Critical		0	20	345
Hours Critical	HRS	744	4975.62	32,776.31
Times Scrammed		0	5	49
Equivalent Reactor Hours @ 600 MWt	HRS	727.27	4,777.56	23,666.26
Average Burnup of Core	MWD/mtU	*	*	*

Control Rod Position at Month End
Equilibrium at 590 MWt, 525°F T avg.

		REGION*	MONTH	TOTAL BURNUP
Group A Rods out-inches	90 0/8			
Group B	89 2/8	INNER	953.04	14,911.21
Group C	89 2/8	MIDDLE	1,066.03	11,991.34
Group D	89 2/8	OUTER	680.04	4,379.91
		E-6	808.32	27,387.87

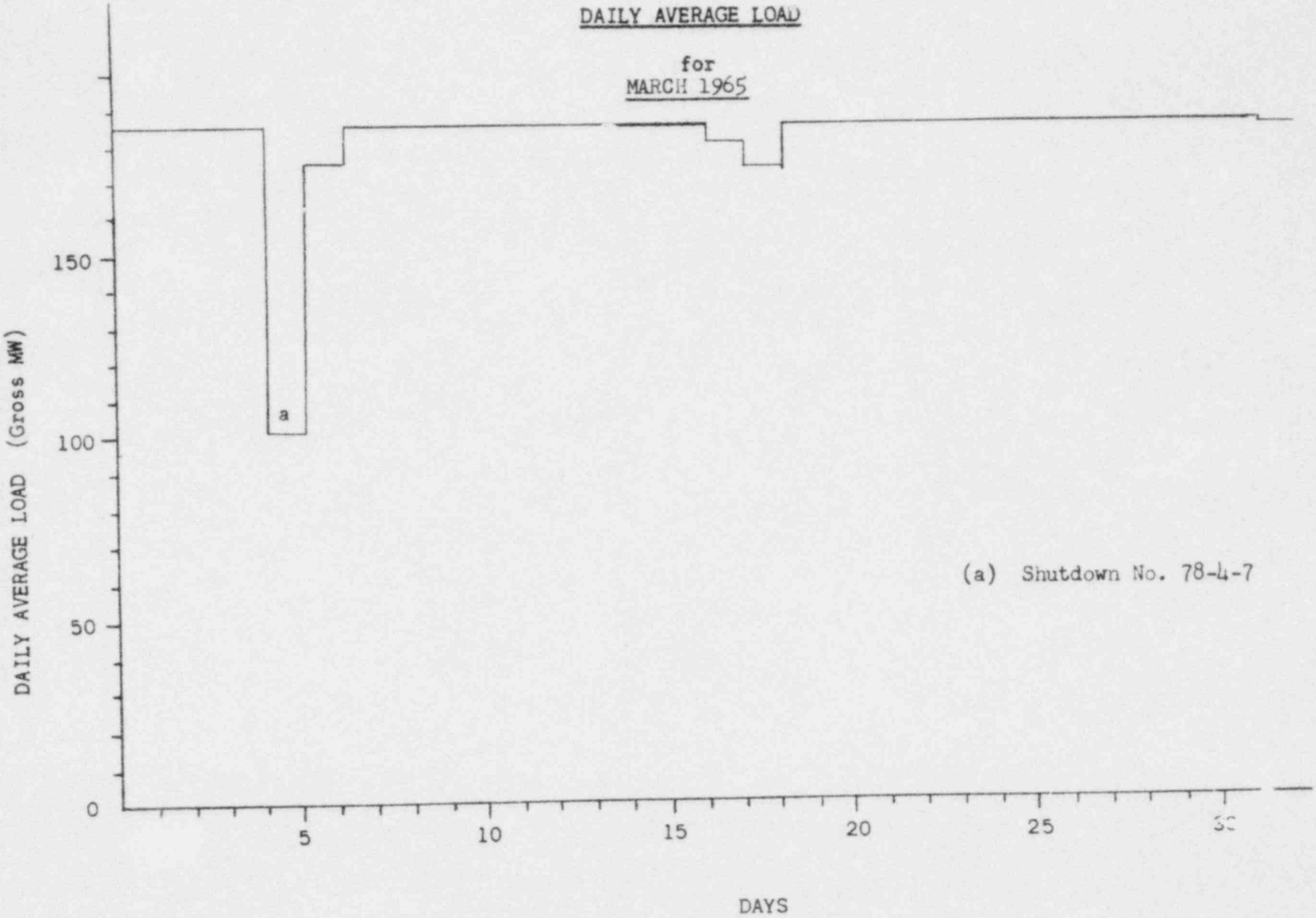
Boron < 1

YANKEE ATOMIC ELECTRIC COMPANY

DAILY AVERAGE LOAD

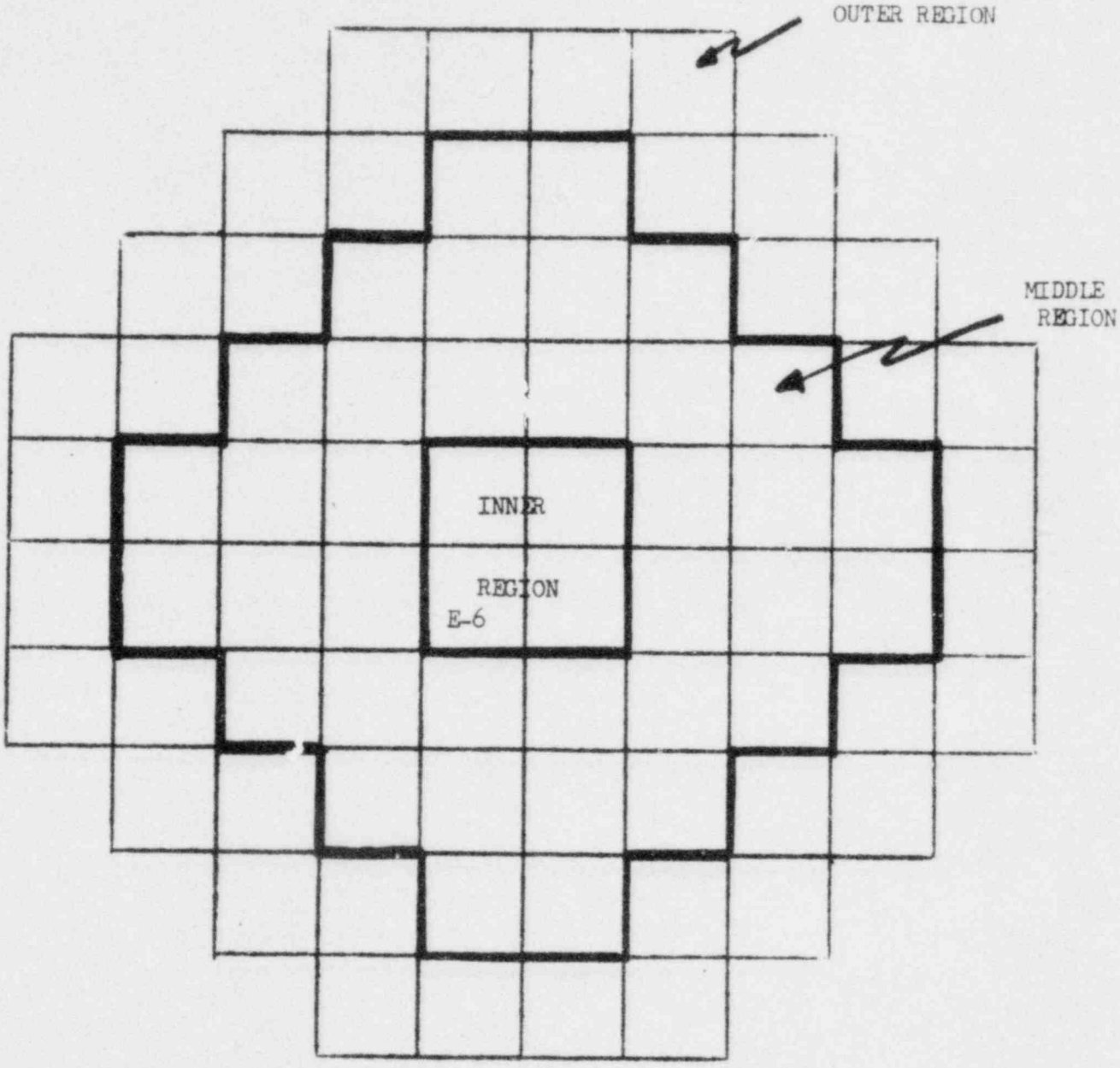
for

MARCH 1965



(a) Shutdown No. 78-4-7

CORE IV REGION LOCATIONS



E-6 Assembly No. A-8