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YANKEE NUCLEAR POWER STATION

OPERATION REPORT NO. 45

For the month of

SEPTEMBER 1964

Submitted by

YANKEE ATOMIC ELECTRIC COMPANY
Boston Massachusetts

October 22, 1964

This report covers the operation of the Yankee Atomic Electric Company plant at Rowe, Massachusetts for the month of September, 1964.

At the beginning of the reporting period the plant was in the cold borated condition as Core IV startup testing was in progress. Following completion of cold testing the main coolant system was brought to normal operating temperature and pressure.

On September 2, difficulties were encountered with the drive mechanism on Control Rod No. 10 as it appeared to hang-up at the 81 inch position while the other rods in the group were being driven to 71 5/8 inches. Group B was withdrawn to an odometer of 75 6/8 inches and Rod 10 went to 87 inches on the indicating candlesticks. Group B was then inserted to 68 5/8. However, as experienced previously, Rod 10 would not insert and remained at the 87 inch position. The lift coils on all rods in the group except No. 10 were disconnected and the pull down coil energized. Rod 10 then moved satisfactorily from an indicated 87 inches to 72 inches. With the other rods still out of service, Rod 10 was withdrawn to 87 inches and then inserted to 6 3/8 inches according to the odometer; however, the 87 inch indicator light remained on. Group B was then dropped by opening the stationary gripper switch, the odometer was reset and the other seven rods returned to service. Since the rod scrammed on signal it was theorized that the difficulties were in the drive mechanism and no positive interference existed.

Also on September 2, pressurizer safety valve leakage was discovered, thus necessitating a plant cooldown. The cooldown was of two days duration and main coolant heatup did not begin until 2200 hours on September 4. Hot physics testing commenced as the primary plant was brought to operating temperature and pressure.

On September 5, during main coolant boron dilution, Rod 10 was again seen to be out of position with other rods in the group. With the Group B odometer reading 49 1/8 inches, the Rod 10 indicating light measured 63 inches. Group B was then scrammed and all rods dropped to the full in position. Group B was withdrawn to a critical position without interference and dilution was restarted. Since all scram times on the rod were normal and the rod can be driven in with the pull down coil energized, it is felt that there is no reason not to operate Rod 10 in its normal program. There has been no further indication of a problem with this rod drive since September 5.

Initial generation from Core IV commenced at 1929 hours on September 6. The plant load was raised to 137 MWe and remained essentially constant at that point until September 9, when the plant was taken off the line for a turbine overspeed trip test. Plant conditions following the test were normal and approximately two hours were required for rephasing whereupon plant electrical output was raised to 150 MWe.

The plant load remained constant until 0907 hours on September 11, when a plant scram occurred. The scram occurred as maintenance was being performed on the pressurizer level narrow range recorder. The scram was traced to a spurious low main coolant pressure signal originating in the recorder amplifier which had just been interchanged. The new amplifier was later found to be shorted out thus causing the spurious scram signal. Realizing that the scram had been caused by a false low main coolant pressure signal, the reactor was brought critical and the plant phased back on the line at 1120 hours.

At 2058 hours on the same day the plant was again scrammed and the reactor scram sequence panel indicated that the dropped rod circuit had initiated the scram. All rods were, therefore, exercised with no abnormalities noted. Attention was, therefore, turned to the nuclear instrumentation with investigation showing the high voltage supply to channel 7 was low enough to activate the dropped rod circuit.

Condenser tube cleaning prolonged the outage as the plant was rephased to the line at 1143 hours on September 12, and plant load was raised to 70 MWe. On September 14, it was raised to 174 MWe.

For the balance of the reporting period plant electrical output varied between 174 and 178 MWe. At no time was the plant able to reach fully rated conditions of 185 MWe due to high circulating water inlet temperatures combined with a relatively low condenser cleanliness factor.

Plant Shutdowns

Shutdown No.	72-4-1	9- 9-64	A 2.4 hour scheduled shutdown for a turbine overspeed trip test.
Shutdown No.	73-4-2	9-11-64	A 2.2 hour shutdown resulting from a spurious reactor scram.
Shutdown No.	74-4-3	9-11-64	A 14.75 hour shutdown resulting from a spurious reactor scram.
Scram No.	45-4-1	9-11-64	An automatic reactor scram from a power level of 485 MW_t resulting from a spurious signal in the pressurizer level narrow range recorder.
Scram No.	46-4-2	9-11-64	An automatic reactor scram from a power level of 485 MW_t resulting from a failure of the high voltage power supply to Channel 7.

Plant Maintenance

Following is a summary of major activities carried out by the plant maintenance staff during September.

1. A new seal was installed in the evaporator recirculating pump.

2. The purification system filter was exchanged for the spent fuel pit filter unit.

3. The main condenser was cleaned.

4. The seal water tank in the PAB was shielded, and the blowdown monitor tanks were cleaned.

5. Steam traps in various areas were cleaned and repaired.

6. The spare control air compressor valves were reconditioned.

7. A new valve and seat was installed in No. 1 charging pump.

8. The radioactive waste incinerator overload heater was rebuilt.

9. One spent ion exchanger was emptied by pumping of the resin.

Chemistry

Operation with boron continued throughout the month with periodic dilutions made as required to follow burnup.

Following the plant cooldown on September 2, the main coolant was sampled for evidence of arsenic-76 and antimony-122. Spectographic results were negative and it has, therefore, been concluded that all four sources now in service are intact and structurally sound.

Following plant heatup the main coolant dissolved oxygen was scavenged when a hydrogen overpressure was established in the low pressure surge tank and no hydrogen injection was required. For the balance of the reporting period the main coolant oxygen concentration was below the point of detection.

Throughout the month the average main coolant specific activity ranged between 8.5 and 9.0 x 10^{-2} μc/ml.

Following stabilization of plant operations the main coolant crud concentration varied between 0.26 and 0.42 ppm. Following the control rod drop tests the crud concentration increased to approximately 1.0 ppm.

Radiochemical analysis of the crud indicates that Indium-116m ($t^{\frac{1}{2}}$ = 54 min) dominates the short lived spectra; the concentration of In-116m at sample time is 4.0 x 10^{8} dpm/mg crud. The long lived spectra appears to contain substantial hafnium. A new multi-channel analyzer has been added to the chemistry section equipment which performs radiochemical analysis electrically and, therefore, time delay caused by the need of chemical separation is eliminated. It is, therefore, possible that the new equipment results in detection of more complete spectrums that could not be detected by the previous equipment.

A typical main coolant crud analysis made during the period indicated:

Cr - 51	2.0 x 10^{6} dpm/mg
Mn - 54	8.6 x 10^{5} dpm/mg
Fe - 59	1.4 x 10^{6} dpm/mg
Co - 58	3.0 x 10^{6} dpm/mg
Co - 60	1.1 x 10^{6} dpm/mg
Hf - 181	3.9 x 10^{6} dpm/mg
In - 116m	4.0 x 10^{8} dpm/mg

The main coolant I-131 concentration was measured at 3.6×10^{-5} μc/ml and the I-131/I-133 atomic ratio is 1.3. This data indicates that essentially no fuel defects exist in Core IV at this time.

Reactor Plant Performance

Summarizing the physics test program, from 450 to 530°F T average $\Delta \rho / \Delta T$ temperature coefficient data and banked control rod worth data was obtained. At 520°F an all rods out boron measurement was obtained. During boron dilution of the mian coolant all rods out boron concentration groups A and B control rod worth data was obtained. Additional testing was performed to obtain the worth of selected stuck control rods.

Physics test data was taken as the turbine generator was phased on the line and core reactivity was followed in detail during power operation. Power, temperature and boron coefficients were measured at power as well as control rod and xenon poison worth.

A complete report of Core IV parameters as measured during the Core IV start-up test program is being prepared and will be issued in a subsequent Operations Report.

Analysis of the Core IV hot control rod drops both with and without main coolant pumps indicate that the square guide tubes do not affect Group D control rod drop times. Measured drop times with all four pumps running were in excellent agreement with those measured on Core III.

The following were determined by means of in-core instrumentation measurements at a power level of 480 MW_t, C_B = 980 ppm, control group at 54 6/8 inches.

F_Q	-	3.0
$F_{\Delta H}$	-	2.3
QDNBR	-	4.2
Hot Channel Outlet	-	598°F

Turbine Plant Performance

Following plant start-up higher than normal condenser backpressure was experienced resulting in a 6-8 MWe loss in capability. Condenser performance testing was initiated with the results indicating a high terminal difference across the condenser with a very low cleanliness factor. The poor performance was attributed to fouling or blanketing of condenser tubes and tube cleaning was, therefore, initiated during the plant shutdown on September 11. Subsequent calorimetric data upon start-up showed the heat transfer coefficient to be still lower than that measured during Core III operation.

High circulating water inlet temperature was partially responsible for the high backpressure condition as subsequent data after tube cleaning indicated that 70% of the increase in backpressure is due to higher circulating water temperatures and 30% due to tube fouling.

For the balance of the month routine secondary plant calorimetric data were taken and analyzed. A 10 MW_t shift from the Core III curves was found from the data. The shift has been attributed to the fact that the low pressure turbine spindle was shifted .100 inches during the refueling operations.

At the end of the reporting period the condenser cleanliness factor was measured at 65% and feedwater terminal difference at 177 MWe, 3.2" Hg backpressure were:

No. 1 = 10.7
No. 2 = 13.5
No. 3 = 11.7

Instrumentation and Control

A summation of recent instrumentation changes made during the past refueling is presented below:

Feedwater Control - Radiation Monitoring Loss of Power Failsafe Alarm

The 120v AC power which feeds the feedwater control rack and the radiation monitoring panel is now monitored with a failsafe relay.

Turbine Trip Sequence Panel

Sequencing of originating scram signals has been expanded to include:

1. Left hand moisture separator trip switch.
2. Right hand moisture separator trip switch.
3. Turbine trip pushbutton.
4. Scram auxiliary relay.
5. Turbine stop valve trip solenoid.

Moisture Separator Switches

The switches on each of the moisture separator high level trip Magnetrols have been changed from a single standard mercury switch used for turbine trip to a double, vibration-resisting switch with one switch used for turbine trip and the other switch used to initiate the trip sequence. The vibration-resisting feature should aid in minimizing false switch operations.

Low Steam Generator Level Trip

A pressure switch has been added on the input to each narrow range steam generator level recorder. Each switch will close when the level drops to -12 inches, and if all four levels drop to this set point, the four closed switch contacts in series will initiate a turbine trip. Reactor scram will follow if the generator load is above the 15 MWe permissive switch set point.

Tool Boom Telescope Alarm

An alarm has been added on the No. 1 manipulator crane tool motion signal which will provide an audible signal when the tool bottoms and telescopes into its boom.

Vapor Container Pressure System Modifications

Several changes have been made on the instrumentation which is used to determine VC leakage to improve the quality of data used in leakage calculations.

1. The range has been changed on the VC temperature indicator in order to provide more accurate temperature indication and its selector switch was improved to provide more consistent readings.

2. The north and south hemisphere temperature detector and the relative humidity detector have been relocated and are now in the path of air circulation at the suction of ventilation fans. This change was made to make the detectors more responsive to changes in conditions.

3. The VC pressure manometer was relocated to eliminate a possible water leg in the piping of the former arrangement.

Health and Safety

During the month of September, 135 drums of radiactive wastes containing a total activity of 1208 mc were prepared. One hundred nineteen drums containing a total activity of 993 mc were shipped from the site during the same period.

Liquid wastes containing a total activity of 0.07 mc were discharged during September. Gaseous wastes containing a total activity of $\sim$ 32 mc due primarily to radiochemistry sampling were discharged during the same period.

On September 3, after filling and pressurizing the shutdown cooling pump gland seal water tank in preparation for starting the shutdown cooling system, a main coolant spill was experienced. The spill path was through leaking shutdown cooling pump seals to the seal water supply line and then to the seal water tank. Once the tank was filled the liquid flowed out the vent connection into the common relief valve discharge line into the PAB upper and lower levels and out onto the Primary Auxiliary Building roof. An estimated maximum of 35 gallons of water containing a total activity of 270 μc were spilled. A sample drawn from the seal tank drain indicated a gross activity of 2×10^{-3} μc/ml. A puddle on the PAB roof indicated a gross activity of 1×10^{-3} μc/ml. A sample of the storm drain indicated a gross activity of 1×10^{-6} μc/ml, the predominant isotopes being Co-58, Co-60 and Mn-54. Future recurrences of this incident will be eliminated by installing check valves in the line between the seal water tank and the pumps.

Leakage from the ion exchange pit during the month of August, 1964 amounted to 117,849 gallons of water containing a total activity of 0.76 mc. Leakage during September was 114,048 gallons containing a total activity of 1.69 mc. In preparation for pit dewatering a radiation survey of all nineteen

capsules in the pit was made during September. Maximum radiation levels at 3" are broken down as follows; the maximum level of each capsule does not encompass the entire range but falls within it.

Eight capsules	3.5 - 14 R/hr
Eight capsules	20 - 80 R/hr
Three capsules	150 - 300 R/hr

One spent ion exchange capsule was removed from the pit for resin removal and reclamation of the capsule. Maximum contact radiation level of the capsule, out of water and before resin removal, was 2 R/hr. Radiochemical analysis showed the resin to contain an estimated total activity of 215 mc. Isotopes present were identified as Co-60 and Mn-54.

Personnel exposure for Yankee plant personnel as measured by film badge for the month of September, 1964 were:

Average for all station personnel	= 130 mr
Maximum individual exposure	= 350 mr

Design Changes

To provide backup to the normal plant protection system during accidents involving the total loss of AC power to the station, a steam driven boiler feed pump has been added to the secondary plant makeup system to the steam generators. The pump is a horizontal triplex positive displacement pump directly connected to a single stage steam turbine. Driving steam is obtained from the 24 inch main steam line while discharge is to atmosphere. Feedwater suction is the secondary side demineralized water storage tank with discharge located in the four steam generator feed lines upstream of the motor operated isolation valves.

Plant Operations

Attached is a summary of plant operation statistics for the month of September, 1964 and a plot of daily average plant load for the same period.

YANKEE ATOMIC ELECTRIC COMPANY -- OPERATING SUMMARY

ELECTRICAL		MONTH	YEAR	TO DATE
Gross Generation	KWH	91,209,300	866,539,800	3,572,099,700
Sta. Service (While Gen. Incl. Losses)	KWH	5,900,503	58,124,044	255,896,079
Net Generation	KWH	85,308,797	808,415,756	3,316,203,621
Station Service	%	6.45	6.71	7.16
Sta. Service (While Not Gen. Incl. Losses)	KWH	743,900	1,554,100	20,409,551
Ave. Gen. For Month (720 HRS)	KW	126,679	--	--
Ave. Gen. Running (561.13 HRS)	KW	162,546	--	--

PLANT PERFORMANCE				
Net Plant Efficiency	%	27.74	27.76	--
Net Plant Heat Rate	Btu/KWH	12,302	12,293	--
Lbs. Steam/Net KWH		14.37	14.48	--
Circulating Water Inlet Temp.				
Maximum	°F	65	--	--
Minimum	°F	48	--	--
Plant Operating Factor	%	71.19	73.82	66.99

NUCLEAR		MONTH	CORE IV	TO DATE
Times Critical		16	17	342
Hours Critical	HRS	647.56	647.56	28,448.05
Times Scrammed		3	3	47
Equivalent Reactor Hours @ 600 MWt	HRS	512.60	512.60	18,670.13
Average Burnup of Core	MWD/mtU	*	*	--

Control Rod Position at Month End

Equilibrium at 595 MW_t 527°F Tavg

Group A Rods out-inches	67
Group B	90
Group C	90
Group D	90

REGION	MONTH	CORE IV
INNER	633.7	9397.1
MIDDLE	789.7	5668.9
OUTER	443.6	443.6
E-6	534.7	22,802.9

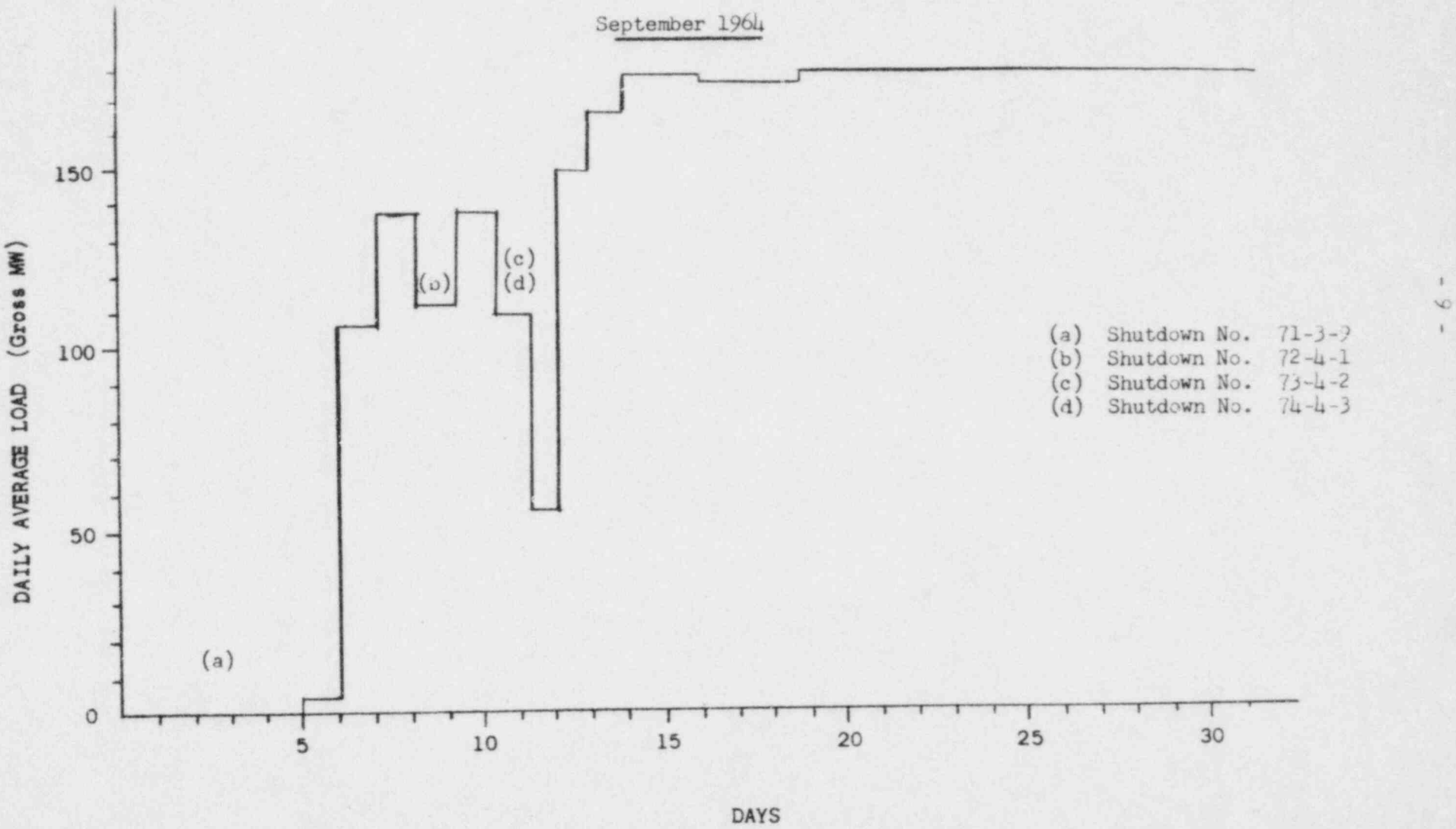
Boron 740 ppm

YANKEE ATOMIC ELECTRIC COMPANY

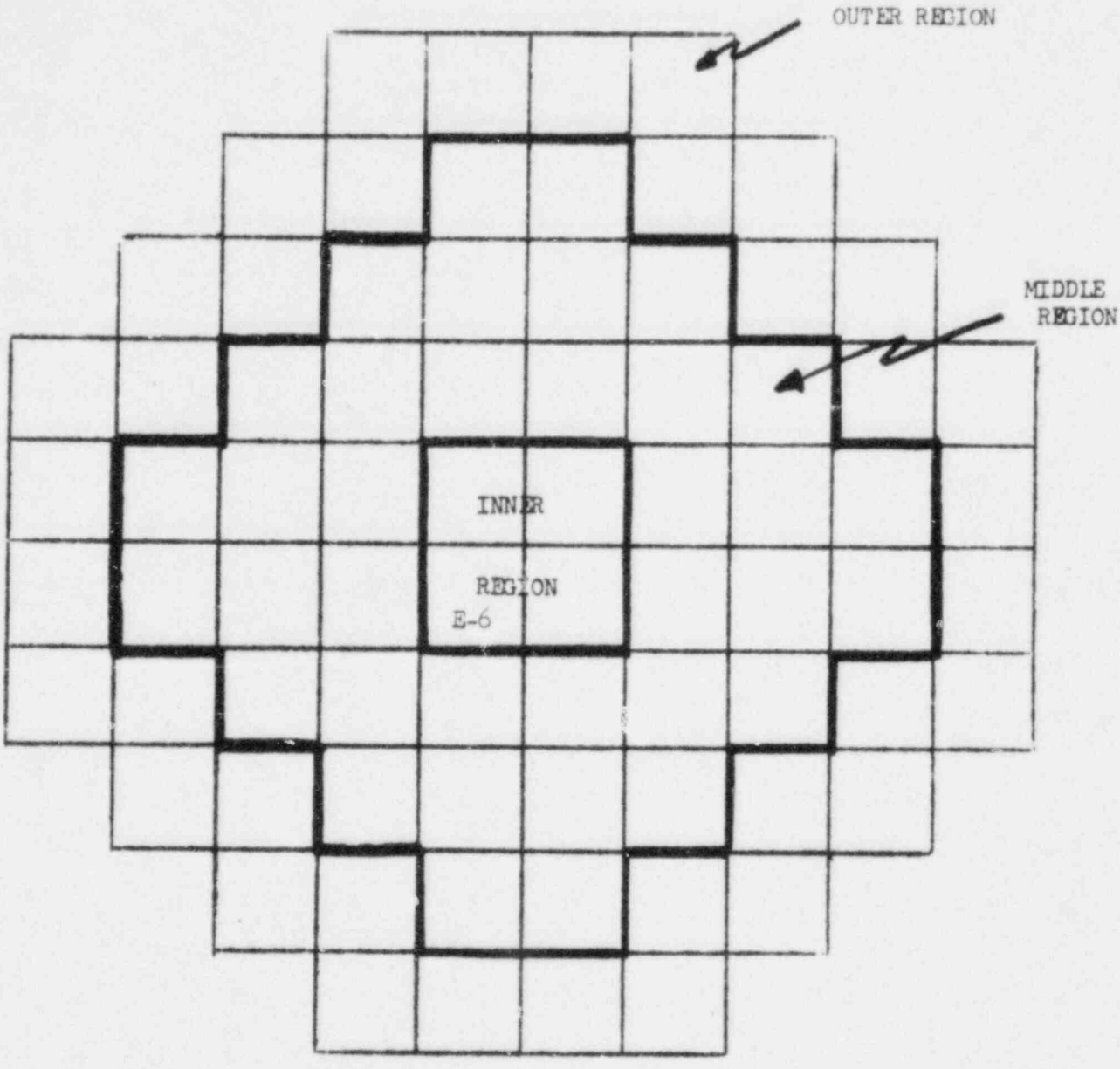
DAILY AVERAGE LOAD

for

September 1964



CORE III REGION LOCATIONS



E-6 Assembly No. A-8