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Carolina Power & Light Co. Raleigh, N.C. 27602 J. A. Jones	7-31-74	8-2-74	X			

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J. F. O'Leary	1 signed			SENT AEC PDR X SENT LOCAL PDR X

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DESCRIPTION:	ENCLOSURES:
Ltr re their 4-26-74 submittal, trans the following: NOTE: Same dist as their 4-26-74 ltr PLANT NAME: H.B. Robinson Unit #2	Feasibility of Off-Stream Closed-Cycle Cooling Towers **ACKNOWLEDGED** **DO NOT REMOVE** (40 cys rec'd)

FOR ACTION/INFORMATION 8-2-74 GC

BUTLER (L) W/ CYS	SCHWENCER (L) W/ CYS	ZIEMANN (L) W/ CYS	REGAN (E) W/ CYS
CLARK (L) W/ CYS	STOLZ (L) W/ CYS	DICKER (E) W/ CYS	✓ LEAR W/ 9 CYS
~~PARR (L)~~ W/ CYS	~~VASSALLO (L)~~ W/ CYS	~~KNIGHTON (E)~~ W/ CYS	W/ CYS
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GIAMBUSSO	PAWLICKI	SPANGLER	LEE (L)	PLANS
BOYD	SHAO		MAIGRET (L)	MCDONALD
MOORE (L)(LWR-2)	STELLO	ENVIRO	REED (E)	CHAPMAN
DEYOUNG (L)(LWR-1)	HOUSTON	MULLER	SERVICE (L)	DUBE w/input
SKOVHOLT (L)	NOVAK	DICKER	SHEPPARD (L)	E. COUPE
✓ GOLLER (L)	ROSS	KNIGHTON	SLATER (E)	
P. COLLINS	IPPOLITO	YOUNGBLOOD	SMITH (L)	D. THOMPSON (2)
DENISE	TEDESCO	REGAN	✓ TEETS (L)	KLECKER
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Regulatory Docket File

CP&L

Carolina Power & Light Company

July 31, 1974

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U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

Mr. John F. O'Leary
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

RE: DOCKET NO. 50-261

Dear Mr. O'Leary:

On April 26, 1974, Carolina Power & Light Company transmitted to the AEC Staff a report titled, "Feasibility of Supplemental Cooling Towers," and indicated that an additional evaluation would be available by July 31. We are transmitting herewith for your review forty (40) copies of our report titled "Feasibility of Off-Stream Closed-Cycle Cooling Towers." This report evaluates the economic, operating, design, and environmental considerations of closed-cycle mechanical draft cooling towers for the H. B. Robinson Steam Electric Plant.

Yours very truly,

J. A. Jones
Executive Vice President

JAJ:md

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CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON STEAM ELECTRIC PLANT
UNITS 1 & 2

FEASIBILITY OF OFF-STREAM CLOSED-CYCLE COOLING TOWERS

JULY 1974

H. B. ROBINSON STEAM ELECTRIC PLANT
FEASIBILITY OF OFF-STREAM CLOSED-CYCLE COOLING TOWERS

INTRODUCTION

Discussed within this report is a study that has been made to determine the feasibility and cost of using off-stream closed-cycle cooling towers for the two existing units at the H. B. Robinson Steam Electric Plant. Since the existing Robinson cooling water pond has been classified as an impoundment, South Carolina Water Quality Standards apply only to the discharge from the impoundment into Black Creek, and not to the impoundment itself. Under certain conditions, however, discharges from the impoundment are subject to exceed both the 90°F maximum temperature and the 5°F limitation on temperature rise which apply to the stream below the dam. An earlier report, dated April 1974, discusses the feasibility and costs of supplemental cooling towers which could remove sufficient heat from the condenser cooling water, prior to its discharge into the lake, to comply with State Water Quality Standards in the stream below the dam. This report discusses the feasibility and costs of constructing an off-stream closed-cycle mechanical draft cooling tower system which could eliminate (except for cooling tower blowdown) the discharge of the plant circulating water system (CWS) into the existing Robinson impoundment. The amount of blowdown from the closed-cycle cooling towers would be such a small fraction of the CWS flow that the temperature of the impoundment, in effect, would be similar to any body of water used for storage of makeup. Use of closed-cycle cooling towers would be expected to increase the plant's consumptive water use and reduce the plant's maximum generating capability.

BACKGROUND

The Robinson plant is located along the shore of an impoundment on Black Creek approximately five miles northwest of Hartsville, South Carolina. The plant consists of an existing 700 MWe nuclear unit and a 185 MWe fossil unit. The units are located near the dam which impounds the the 2250-acre reservoir constructed by CP&L in the late 1950's.

Black Creek is an intrastate stream and tributary of the Pee Dee River. The Creek rises in the fall zone near Pageland, South Carolina, and flows through Chesterfield, Darlington, and Florence Counties to its confluence with the Pee Dee River east of Darlington, South Carolina. The drainage area of the Creek at the Robinson plant dam site is 173 square miles. Between October 1960 and September 1973, the flow in the Creek at the Hartsville USGS streamgage just downstream of the dam has averaged 241 cfs.

The Robinson plant impoundment and Unit 1 were constructed in the late 1950's in accordance with a water quality permit issued in May 1958 by the South Carolina Pollution Control Authority. The permit provided for expansion of the plant and for utilization of the impoundment for an ultimate capacity of 1000 MWe. Unit 1 began operation in 1960 and the 700 MWe nuclear Unit 2 began operation in 1971.

The two water-cooled units circulate a total of 1315 cfs, and reject a total of approximately 6.0×10^9 BTU/hour of excess heat at 100 percent load, causing a rise in temperature across the condensers of approximately

20.4°F. In the present system, the cooling water is withdrawn from the impoundment near the dam and is discharged through a 4 1/2 mile long canal toward the north end of the impoundment as shown on Figure 1.

Since the State permit covering construction and operation of the Robinson cooling water impoundment was issued, federal legislation has been enacted that has caused modifications in the State of South Carolina's water classification and standards system. The 1970 Federal Water Quality Improvement Act requires that the State Pollution Control Authority certify, in the case of federally licensed facilities, that a discharge to a state stream would not violate applicable water quality standards. In 1971, South Carolina adopted revised water quality standards which provide for a man-made pond that has been designed for waste water treatment to be classified as an impoundment. However, the discharge from an impoundment must comply with the standards of the receiving waters below the impoundment.

Waters within the water treatment impoundments themselves are not subject to the State of South Carolina water quality standards. Discharges from the Robinson plant impoundment are required to comply with State thermal standards for Black Creek, which limit stream temperatures after adequate mixing to a maximum of 90°F and/or a rise in temperatures no greater than 5°F above that of waters unaffected by a heated discharge. In November 1972, the South Carolina Pollution Control Authority acknowledged that the cooling system at the Robinson plant is an impoundment and issued at that time the required certification pursuant to the 1970 Federal Water Quality Improvement Act.

While the plant cooling system is effective over a wide range of conditions, thermal modeling has shown that the discharge from the Robinson plant impoundment cannot be expected to comply with the State's stream temperature standards in all operating and meteorological conditions. Since the impoundment is the source of all flow in Black Creek downstream of the dam, a mixing zone for the discharge is not available. Although temperatures of the water discharged from the impoundment have not exceeded 90°F, a combination of meteorological and plant load conditions can result in temperatures which infrequently exceed 90°F. During the winter and spring months, temperatures in the discharge from the impoundment usually exceed the ambient impoundment temperatures by more than 5°F. Surface temperatures at the dam, plant discharge temperatures, and natural impoundment equilibrium temperatures are shown in Table 1.

CLOSED-CYCLE OFF-STREAM COOLING TOWERS

If the entire excess heat load produced by the plant were to be removed from the impoundment, then any noncompliance with temperature standards (such as exceeding the 90°F maximum) would be the result of naturally occurring meteorological conditions. Removal of the entire heat load from the impoundment would require a closed-cycle off-stream cooling facility.

For closed-cycle cooling towers, the critical design conditions occur during the summer months; the summer design wet bulb would be approximately 79°F. Optimization studies of plant capacity and total costs indicate that the cooling tower approach to wet bulb should be 14°F. The existing condensers

have a differential temperature of approximately 20.4°F, which would dictate the cooling tower range. The studies indicate that passing the entire CWS flow of 1315 cfs through the cooling towers would result in the least additional annual costs. At design conditions, the cold water would be 93°F and the hot water would be approximately 113.4°F. Three conventional ten-cell mechanical draft towers would be required to meet the requirements of the optimization study. Table 2 provides a tabulation of the expected monthly cooling tower inlet and outlet water temperatures.

It is possible to construct natural draft towers that would have a 14°F approach to a design wet bulb of 79°F. While natural draft towers do not require fan motors, the initial costs would be greater than for mechanical draft towers, and the resulting annual costs would be greater. The availability of land that could accommodate mechanical draft towers, and the availability of fresh water from the existing impoundment that could be used for cooling tower makeup further support the use of mechanical draft towers instead of natural draft towers in this case. In addition, cooling tower drift at this site would not be expected to introduce a significant problem. Consequently, detailed engineering studies have been confined to the less expensive mechanical draft towers.

Various arrangements of closed-cycle cooling water return to the existing plant have been examined. Only two general concepts proved feasible; one arrangement (Case I) provides for creating a return bay along the west shore of the impoundment, as shown in Figure 2. An alternative arrangement (Case II) provides for returning cool water from the towers to the plant by means of a canal west of the existing coal storage area, as shown on Figure 3.

Case I would involve the use of the existing plant intake structure isolated from the impoundment by a north-south trending separating dike running parallel to the face of the structure. Case II involves a gravity-flow canal routed west of the coal yard to return water directly to the plant condensers. With Case II, the existing plant intake would not be used except for withdrawing service water.

COSTS OF CLOSED-CYCLE OFF-STREAM COOLING TOWERS

The cost associated with each of the two closed-cycle cooling tower arrangements are summarized in Tables 4 and 5. As shown in these tables, the least expensive construction costs would be those associated with involving the isolation of the existing intake structure from the impoundment and the construction of cooling towers over the newly created intake bay.

Case I would involve construction of three mechanical draft towers on a peninsula of land east of the existing discharge canal. A weir would be constructed across the discharge canal, and the entire CWS flow would be pumped to the towers. A 3000-foot long dike would be constructed along the west bank of the existing impoundment, as shown on Figure 2. The initial cost of this work would be about $26 million. The annual costs over those of the present system would be more than $5.6 million.

The only other feasible alternative for closed-cycle mechanical draft cooling towers would be a return canal located to the west of the coal storage area as shown on Figure 3. Three towers would be constructed on about 20 acres of

land to the west of the existing discharge canal. A weir would be constructed across the existing discharge canal and the cooling water would be pumped to the towers. An open canal could be routed west of the coal yard to the rail yard. The remaining distance to the condensers could be through a pipe. Elevations in this area would make it possible to return the water from the towers to the condensers by gravity flow, which would eliminate the need for an additional pumping station. However, the towers and canal would cost more than $29 million, or $3 million more than the first alternative. Annual costs for this plan would be more than $6.1 million greater than those associated with the present system.

The annual costs shown in Tables 6 and 7 are additional costs over those involved in operating the present cooling system. They include the costs for carrying the investment, for replacing the lost capacity, for providing energy to operate the towers and pumps, and for maintenance of the equipment.

BLOWDOWN

As a closed-cycle evaporative cooling system loses essentially pure water through the evaporative process, the solids naturally occurring in the cooling tower make-up water would tend to continue to increase in concentration unless there is a control of buildup by discharging a small amount of the cooling water. At the Robinson plant, this discharge to control water quality in the circulating water system would be less than 10 cfs (less than one percent of the CWS flow). The blowdown could be taken from the cooling tower cold water basin and discharged into the existing discharge canal downstream of the weir. The expected cooling tower cold water temperatures are shown in Table 2.

The only solids carried by the blowdown would be those naturally occurring in the make-up water, plus trace elements of corrosion products. Control of biological growth in the closed-cycle cooling system could be required periodically; however, blowdown could cease during these periods. A small amount of blowdown, not exceeding 10 cfs, could prevent the solids buildup from exceeding 10 concentrations. Dissolved solids in the Robinson impoundment have typically ranged between about 20 and 100 ppm.

ENVIRONMENTAL CONSIDERATIONS

Operation of closed-cycle off-stream cooling towers would not be expected to cause significant environmental impact at the Robinson plant. Environmental considerations include land use, water use, fog, icing, blowdown, drift, and noise.

Approximately 20 acres of land would be required for the towers; however, the land that could be used is presently within the boundaries of Company property at the plant and is presently dedicated to electric generation.

Consumptive water use would increase due to increased evaporative losses in the cooling towers of 7 to 10 cfs, which would decrease the average flow of the stream below the dam by approximately the same amount. During periods of low stream flow, 10 cfs would be a significant fraction (greater than 10%) of the total downstream flow.

There could be a small increase in the potential for fogging and icing in the vicinity of the towers, but the increased potential would be insignificant and confined to Company-owned property.

The small amount of blowdown (less than 10 cfs) would not cause adverse effects in the 2250-acre impoundment. More than 99 percent of the plant heat load would be removed from the impoundment by use of closed-cycle cooling towers. The dissolved solids that would be discharged in the blowdown would have been withdrawn from the impoundment, and because of the large dilution provided by the impoundment, the blowdown would not be expected to alter lake or downstream concentrations by meaningful amounts. During periods of biological growth control, the blowdown could be discontinued.

Makeup to the cooling towers would be fresh water. In addition, the number of concentrations of dissolved solids in the towers could be less than ten, and the drift rate would not be expected to exceed 0.01 percent. Therefore, there should be no adverse effects resulting from cooling tower drift.

The groundwater in the vicinity moves toward the impoundment. Any spillage or leakage around the towers would infiltrate and move to the discharge canal or to the impoundment. Deposition of dissolved solids carried from the tower in the form of drift would not be expected to cause significant effects on groundwater because of the low drift rates and low concentrations of solids in the circulating water. There would, therefore, be no adverse effects on groundwater uses.

The proposed location of the cooling towers is in a remote, unpopulated area, about 2500 feet from the plant. Noise from the fans and pumps would not be expected to create a problem.

There are presently underway modifications to the plant's radioactive waste treatment facilities which will reduce liquid discharges from the plant. If towers were installed, it would be expected that this discharge would be made into the existing discharge canal downstream of the required weir. A buildup of radionuclides in the cooling tower system would not be expected.

Installation of the cooling towers and the reduction of the impoundment temperatures would not be expected to significantly increase nor decrease recreational or environmental benefits.

SUMMARY

Installation of closed-cycle off-stream cooling towers at the Robinson plant could remove the plant heat load from the plant's cooling impoundment.

Any thermal discharges from the impoundment failing to comply with stream standards below the dam would result only from natural conditions and not from plant operation. The plant cooling could be performed by three ten-cell mechanical draft towers. The entire CWS flow could be passed through the towers and returned to the plant condensers through a canal. Other than a small amount of blowdown, there would be no heated discharge from the plant into the plant cooling impoundment. Drift could be reduced to a practical minimum and would not be expected to be a significant problem.

With the installation of closed-cycle towers, the discharges from the impoundment would be at essentially the same temperatures as those from any impounded body of water with no thermal loading. Use of closed-cycle cooling towers would reduce the downstream flow by an average of 7 to 10 cfs more than with the present system. This may not be significant on most streams with an average flow of 241 cfs; however, water use of Black Creek downstream of the plant during periods of low stream flow could be adversely effected by this reduction. Use of cooling towers would reduce overall plant efficiency, and would require a portion of the plant capacity and energy for operation of the fans and pumps. The least costly alternative would require an initial capital cost of more than $26 million, and would increase the annual operating costs over those of the present system by more than $5.6 million.

Figures and Tables

Table 1

H. B. ROBINSON STEAM ELECTRIC PLANT
SURFACE WATER TEMPERATURES OF THE EXISTING COOLING IMPOUNDMENT

	Plant Discharge Temperature °F	Temperature at Dam °F	Natural Water Equilibrium Temperature °F
January	81	61	46
February	83	63	50
March	89	69	59
April	95	75	68
May	104	84	78
June	110	90	84
July	111	91	86
August	111	91	86
September	106	86	79
October	94	74	62
November	88	68	55
December	81	61	46

Heat Load 6×10^9 BTU Per Hour
L.F. = 1.0

Table 2

H. B. Robinson Steam Electric Plant

Closed-Cycle Cooling Tower Temperatures

Month	Average Dry Bulb Temperature °F	Average Wet Bulb Temperature °F	Cooling Tower Hot Water °F	Cooling Tower Cold Water °F
January	47	42	96	76
February	48	43	97	77
March	54	48	98	78
April	64	55	101	81
May	72	63	105	85
June	80	70	108	88
July	82	73	110	90
August	81	72	109	89
September	75	68	107	87
October	65	58	103	83
November	54	48	98	78
December	46	41	95	75

Table 3

H. B. Robinson Steam Electric Plant

Blowdown Temperatures

Month	Natural Equilibrium Water Temperatures °F	Blowdown Temperatures °F	Maximum Heat Load of Blowdown Btu/hr (10^6)	Percent
January	46	76	67.4	1.1
February	50	77	60.7	1.0
March	59	78	42.7	0.7
April	68	81	29.2	0.5
May	78	85	15.7	0.3
June	84	88	9.0	0.1
July	86	90	9.0	0.1
August	86	89	6.7	0.1
September	79	87	18.0	0.3
October	62	83	47.2	0.8
November	55	78	51.7	0.9
December	46	75	65.1	1.1

*Percent of present heat load (L. F. = 1)

Table 4

H. B. Robinson Steam Electric Plant

Closed-Cycle Off-Stream Cooling Towers
Cost Evaluation for Mechanical Draft Towers

Case I

Item	Initial Cost
1. Site Preparation	$ 346,000
2. Excavation	1,478,000
3. Cooling Tower Basin	1,337,000
4. Cooling Towers	7,361,000
5. Cooling Tower Intake Pumping Station	2,933,000
6. Electrical Facilities	2,748,000
7. Weir	203,000
8. Riprap	97,000
9. Hydraulic Structures and Intake	2,424,000
	$18,927,000
Indirect Costs	2,311,000
Contingency	2,657,000
Interest During Construction	2,115,000
TOTAL	$26,010,000

Table 5

H. B. Robinson Steam Electric Plant

Closed-Cycle Off-Stream Cooling Towers
Cost Evaluation for Mechanical Draft Towers

Case II

	Item	Initial Cost
1.	Site Preparation	$ 746,000
2.	Excavation	4,553,000
3.	Cooling Tower Basin	1,337,000
4.	Cooling Towers	7,410,000
5.	Cooling Tower Intake Pumping Station	4,165,000
6.	Electrical Facilities	2,637,000
7.	Weir	203,000
		21,051,000
	Indirect Costs	2,588,000
	Contingency	2,975,000
	Interest During Construction	2,496,000
	TOTAL	$ 29,110,000

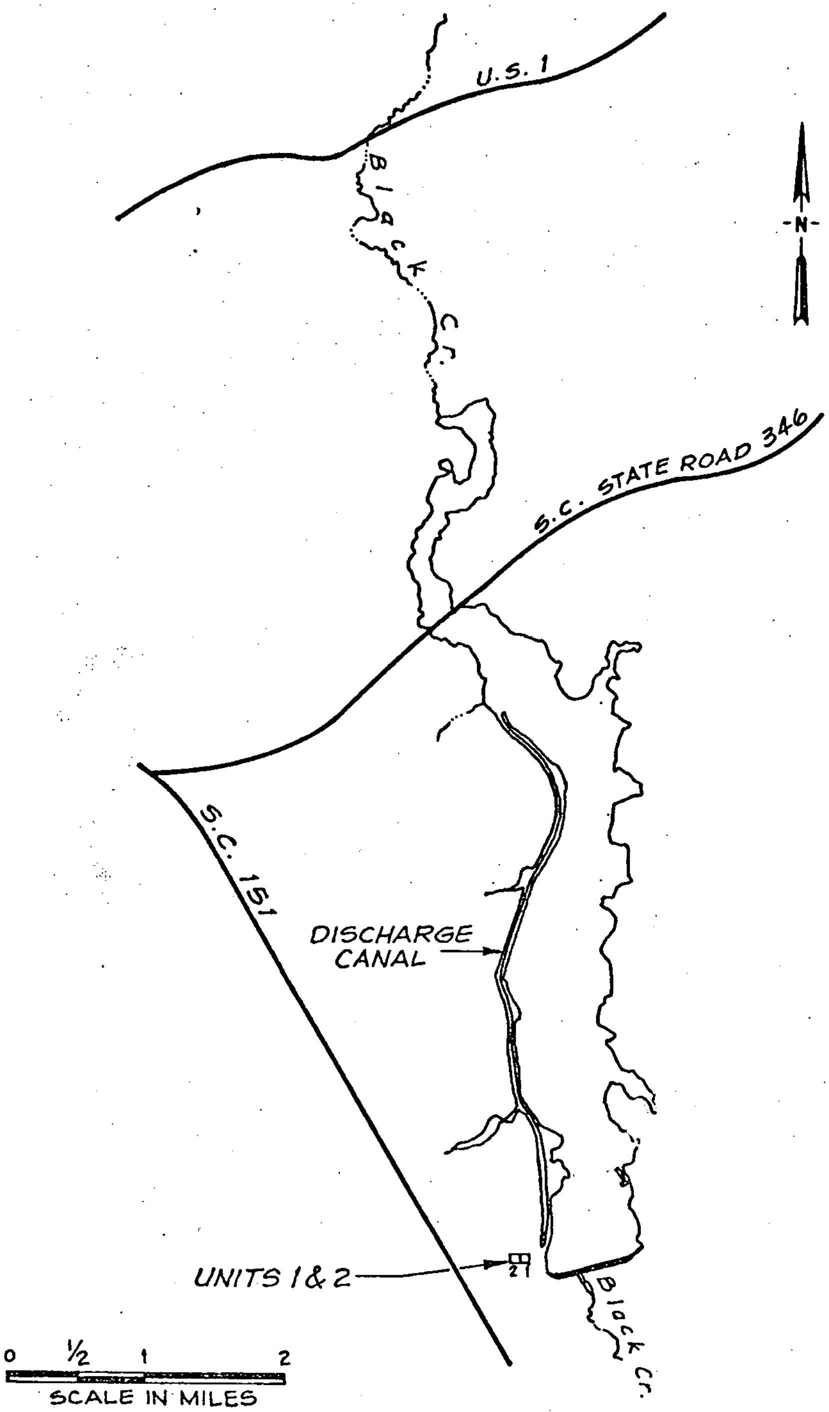
Table 6

H. B. Robinson Steam Electric Plant

Closed-Cycle Off-Stream Cooling Towers
Additional Annual Costs

Case I

	Item	Cost
1.	Carrying Charges on Investment	$ 4,058,000
2.	Capacity and Energy Costs	1,448,000
3.	Maintenance	140,000
	TOTAL	$ 5,646,000



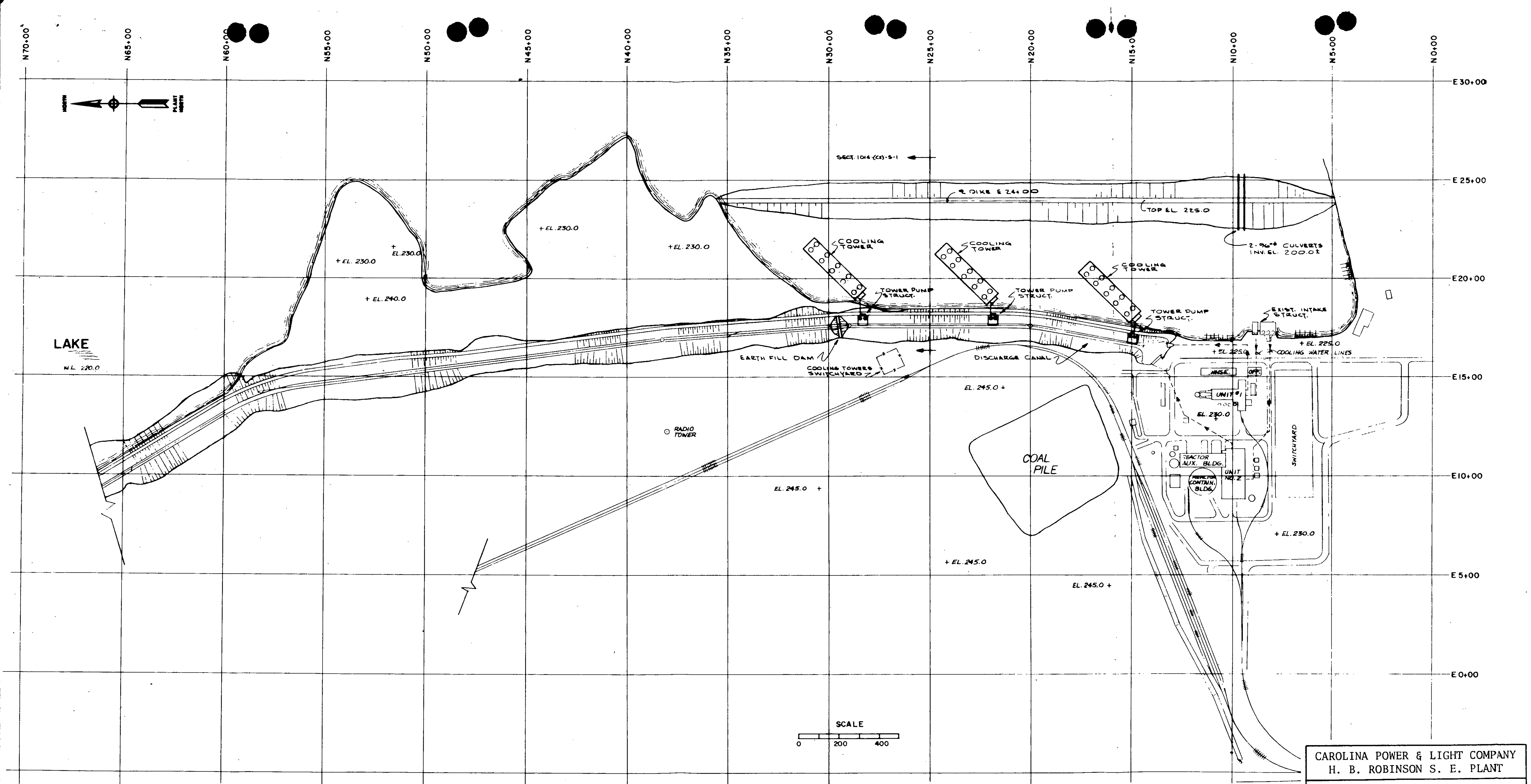
CAROLINA POWER & LIGHT COMPANY

H. B. ROBINSON S. E. PLANT

PLANT AND EXISTING CIRCULATING WATER SYSTEM

July, 1974

Figure 1

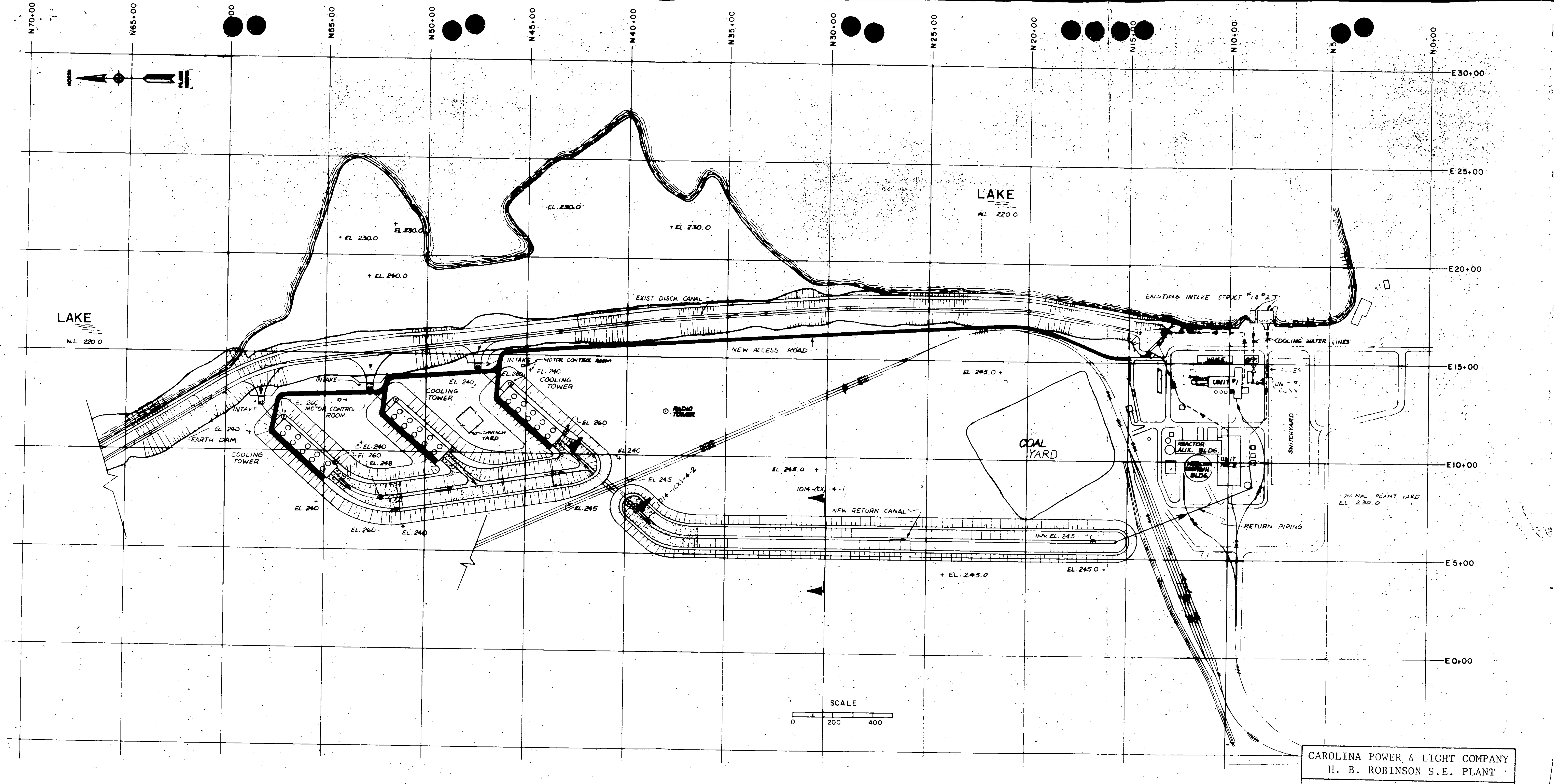


CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON S. E. PLANT

COOLING TOWER LAYOUT
CASE I

July, 1974

Figure 2



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON S.E. PLANT

COOLING TOWER LAYOUT
CASE II

July, 1974 Figure 3