SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29202

E. H. CREWS, JR.
VICE-PRESIDENT
CONSTRUCTION
PRODUCTION ENGINEERING

May 16, 1972

Mr. R. C. DeYoung
Assistant Director for Pressurized Water Reactors
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

RE: Virgil C. Summer Nuclear Station
Docket No. 50-395

Dear Mr. DeYoung:

In response to your letter of May 2, 1972, we are submitting the attached answers to your questions. As you requested, forty-five (45) copies of the answers are submitted.

If you have any further questions, please do not hesitate to call us.

Very truly yours,

/s/ E. H. Crews, Jr.

E. H. Crews, Jr.

JWH:EHC:md

Attachments

230

PRESSURIZED WATER REACTORS

Basic Data for Source Term Calculation

Question No. 1: Operating power (MWt) at which impact is to be analyzed.

Answer: 2904 MWth

Question No. 2: Weight of U loaded (first loading and equilibrium cycle).

Answer: First Loading - 156,000 lbs. of Uranium
Equilibrium Cycle - 52,000 lbs. of Uranium, Average

Question No. 3: Isotopic ratio in fresh fuel (first loading and equilibrium cycle).

Answer: Isotopic Ratio of U^{235} to U^{238}

Region	Enrichment
1	2.0
2	2.7
3	3.35
Equilibrium Cycle	3.35

Question No. 4: Expected percentage of leaking fuel.

Answer: 0.2%

Question No. 5: Escape rate coefficients used (or reference).

Answer:

Isotope	Escape Rate Coefficient (sec^{-1})
Noble gases	6.5×10^{-8}
Br, I and Cs	1.3×10^{-8}
Te	1.0×10^{-9}
Mo	2.0×10^{-9}
Sr and Ba	1.0×10^{-11}
Y, La, Ce and Pr	1.6×10^{-12}

Question No. 6: Plant factor.

Answer: 80%

Question No. 7: Number of steam generators.

Answer: Three (3) per unit

Question No. 8: Type of steam generators (recirculating, straight through).

Answer: Vertical Shell, U tube, recirculation type steam generators

Question No. 9: Mass of primary coolant in system total (lb) and mass of primary coolant in reactor (lb).

Answer: Total mass of primary coolant = 382,500 lbs.
Mass of coolant in reactor vessel = 162,600 lbs.

Question No. 10: Primary coolant flow rate (lb/hr).

Answer: 1.082×10^{8} lb/hr

Question No. 11: Mass of steam and mass of liquid in each generator (lb).

Answer: Mass of steam in each steam generator = 8,100 lbs.
Mass of liquid in each steam generator = 97,800 lbs.

Question No. 12: Total mass of secondary coolant (lb).

Answer: Total (with Condensate Storage) - 5.59×10^{6} lb.

Total (without Condensate Storage) - 2.26×10^{6} lb.

Question No. 13: Turbine operating conditions (temperature °F, pressure psi, flow rate, lb/hr).

Answer: Inlet steam temperature - 535°F

Inlet steam pressure - 928 psia

Maximum calculated flow - 12.6×10^{6} lb/hr

Question No. 14: Total flow rate in the condensate demineralizer (lb/hr).

Answer: There are no condensate demineralizers in this system.

Question No. 15: What is the containment volume (ft^3)?

Answer: Total free volume in the reactor building is 1.9×10^{6} ft^3.

Question No. 16: What is the expected leak rate of primary coolant to the containment (lb/hr)?

Answer: 1.67 lb/hr

Question No. 17: How often is the containment purged? Is it filtered prior to release? Are iodine absorbers provided? What decontamination factor is expected?

Answer:
a. The reactor building is expected to be purged once per year, prior to refueling.
b. The reactor building purge exhaust is filtered through roughing, HEPA, and charcoal filters prior to release.
c. Iodines will be removed by the charcoal filters.
d. The charcoal filter efficiency for removal of iodines is expected to be 99%. (DF = 100).

Question No. 18: Is there a continuous air cleanup for iodine in the containment? If so, what volume per unit time is circulated through it? What decontamination factor is expected? At what concentration will purging be initiated?

Answer:
a. Yes, operated only prior to entry into reactor building.
b. There w . be two 12,000 cfm units.
c. Charcoa. filter efficiency for iodines is expected to be 99% (DF = 100).
d. Purging will begin at a maximum of 7 x MPC for I-131 for the design basis reactor coolant leakage (40 lb/day with 1% failed fuel).

Question No. 19: Give the total expected continuous let down rate (lb/hr).
a. What fraction is returned through the demineralizer to the primary system? What is the expected demineralizer efficiency for removal of principal isotopes?
b. What fraction of this goes to boron control system? How is this treated, demineralization, evaporation, filtration?
c. Is there a separate cation demineralizer to control Li and Cs?

Answer: The normal letdown flow rate is 60 gpm. (maximum is 120 gpm)
a. Essentially, all of the letdown is demineralized and returned to the primary system. Following are the mixed bed demineralizer decontamination factors:

Noble gases, Cs 134, 136, 137, Y 90, 91 and Mo 99	1.0
All other isotopes including corrosion products	10.0

b. The letdown goes through a mixed bed demineralizer, then through the Boron Thermal Regeneration System (on load follow, approximately 10%), then through the Boron Recycle System on demand (approximately 2.4% of total letdown). The mixed bed demineralizer is common to the letdown streams; the Boron Thermal Regeneration System has thermal regeneration demineralizers for removal and resubmittal of boron (no credit for fission product removal is taken). The Boron Recycle System is described in answer to question 21.

c. There is a separate cation bed demineralizer intended to control the lithium and cesium concentration of the Reactor Coolant.

Question No. 20: What fraction of the noble gases and iodines are stripped from that portion of the let down stream which is demineralized to the primary return system? How are these gases collected? What decay do they receive prior to release?

Answer: The DF for iodine in the mixed bed demineralizer is that at least 10 as previously shown in the answer to 19a. However, the let-down must pass through the volume control tank where noble gases are stripped from the liquid and remain in the tank's gaseous environment. Stripping fractions for the noble gases are as follows:

Isotope	Stripping Fraction
Kr 85	2.3×10^{-5}
Kr 85m	2.7×10^{-1}
Kr 87	6.0×10^{-1}
Kr 88	4.3×10^{-1}
Xe 133	1.6×10^{-2}
Xe 133m	3.7×10^{-2}
Xe 135	1.8×10^{-1}
Xe 135m	8.0×10^{-1}
Xe 138	1.0

Removal of the gaseous fission products from the volume control tank is accomplished through a remotely operated vent valve which discharges to the gaseous waste processing system. Decay time for stripped gases is a minimum of 90 days.

Question No. 21: What fraction of the noble gases and iodines are stripped from that portion of the letdown stream which is sent to boron control system? How are these gases collected? What decay do they receive prior to release?

Answer: There are two Boron control systems, the Boron Recycle System and the Boron Thermal Regeneration System. In either system the DF for iodine in the mixed bed demineralizer is at least 10 as previously shown in the answer to 19a. Depending on the particular system chosen, noble gases and additional iodines may be stripped in the volume control tank (as discussed in the answer to question 20), the recycle evaporator, and the recycle evaporator condensate demineralizer. All stripped gases are processed by the gaseous waste processing system where they receive a minimum 90 day holdup.

Question No. 22: Are releases from the decay tanks passed through a charcoal absorber? What decontamination factor is expected?

Answer: a. All gases released from the waste gas decay tanks will be made through charcoal and HEPA filters in the Auxiliary Building Ventilation Exhaust system.

b. Expected DF of the charcoal filter for iodines is 100.

Question No. 23: How frequently is the system shut down and degassed? How many volumes of the primary coolant system are degassed in this way each year? What fraction of the gases present are removed? What fraction of other principal nuclides are removed, and by what means? What decay time is provided?

Answer: The system can be degassed at periods of cold shutdown and during reactor refueling. At each of these shutdowns, one reactor coolant volume is degassed. During degassing essentially 100% of the gases that have collected in equipment are removed to the gaseous waste processing system. The gases are collected and stored in waste gas decay tanks for a minimum of ninety (90) days. No credit is taken for the removal of other nuclides.

Question No. 24: Are there any other methods of degassing (i.e., through pressurizer, etc.)? If so describe.

Answer: There are no other methods of degassing.

Question No. 25: If gas is removed through the pressurizer or by other means, how is it treated?

Answer: Does not apply.

Question No. 26: What is the expected leak rate of primary coolant to the secondary system (lb/hr)?

Answer: The expected primary to secondary leak rate is 20 gpd, 52.3 lb/hr.

Question No. 27: What is the normal rate of steam generator blowdown? Where are the gases from the blowdown vent discharged? Are there charcoal absorbers on the blowdown tank vent? If so, what decontamination factor is expected?

Answer: a. Blowdown will be intermittent. An average value based on continuous blowdown is 0.5 gpm.

b. The blowdown flash tank is vented to the main condensers. The exhaust of the condenser vacuum pumps is vented through the auxiliary building ventilation system.

c. The auxiliary building ventilation system has roughing, HEPA and charcoal filters.

d. Expected DF of the charcoal filter for iodines is 100.

Question No. 28: What is the expected leak rate of steam to the turbine building? What is the ventilation air flow through the turbine building (CFM)? Where is it discharged? Is the air filtered or treated before discharge? If so, provide expected performance.

Answer: a. During normal operation, it is expected that there will be about 1 gpm (equivalent) steam leakage. About 0.1 gpm of this will be inside the turbine building.

b. Maximum turbine building ventilation rate is 1.4×10^6 cfm. Expected average operating rate is 1.0×10^6 cfm.

c. Discharge is through ventilators on the roof of the turbine building.

d. This air is not filtered or treated prior to release.

Question No. 29: What is the flow rate of gaseous effluent from the main condenser ejector? What treatment is provided? Where is it released?

Answer: a. The gaseous effluent from the main condenser is evacuated by vacuum pumps rather than steam ejectors. The expected discharge rate is 40 scfm.

b. These gases are routed through roughing, HEPA and charcoal filters prior to release.

c. Release is through the auxiliary building ventilation system and filters and discharge from the plant vent.

Question No. 30: What is the origin of the steam used in the gland seals (i.e., is it primary steam, condensate, or demineralized water from a separate source, etc)? How is the effluent steam from the gland seals treated and disposed of?

Answer: a. Gland seal steam is main steam during normal operation. During cold start-up, gland steam is furnished from an auxiliary boiler.

b. Steam coming from the gland seals is condensed in the steam packing exhauster and is drained to the condenser hotwell. Off-gas from the gland steam condenser is vented to the atmosphere.

Question No. 31: What is the expected leak rate of primary coolant to the auxiliary building? What is the ventilation air flow through the auxiliary building (CFM)? Where is it discharged? Is the air filtered or otherwise treated before discharged? If so provide expected performance.

Answer: a. The expected leak rate of primary coolant to the auxiliary building is approximately 20 gallons per day.

b. Auxiliary building ventilation rate from areas of possible leakage is 32,000 cfm. The rate from areas not expected to have leaks is 112,000 cfm. Fuel handling building ventilation rate is 32,000 cfm.

c. Auxiliary building ventilation system is vented from the plant vent.

d. That portion of the auxiliary building ventilation from possible areas of leaks and from the fuel handling building is sent through roughing, HEPA, and charcoal filters. The 112,000 cfm is sent through roughing and HEPA filters before discharge.

e. Charcoal filter efficiency for iodine removal is expected to be 99% (DF = 100).

Question No. 32: Provide average gallons/day and uCi/cc for following categories of liquid effluents. Use currently observed data in the industry where different from the SAR or Environmental Report (indicate which is used).

a. High-level wastes (for example, primary coolant let down, "clean" or low conductivity waste, equipment drains and deaerated wastes);
b. "Dirty" wastes (for example, floor drain wastes, high-conductivity wastes, aerated wastes, and laboratory wastes);
c. Laundry, decontamination, and wash-down wastes;
d. Steam generator blowdown - give average flow rate and maximum short-term flows and their duration:
e. Drains from turbine building.

For these wastes (a-e) provide:

1. Number of capacity of collector tanks.
2. Fraction of water to be recycled or factors controlling decision.
3. Treatment steps - include number, capacity, and process DF for each principal nuclide for each step. If step is optional, state factors controlling decision.
4. Cooling time from primary loop to discharge.
5. How is waste concentrate (filter cake, demineralizer resin, evaporator bottoms) handled? Give total volume or weight and curies per day or year.

Answer: The data presented below are based on the processing system given in Section 11 of the Preliminary Safety Analysis Report and are based on operation with defects in fuel producing 0.2% of the core power as presented in Section S5 of the Environmental Report. Considering both normal processing and holdup times for decay the total annual liquid discharge for these assumptions would be less than 0.4 curies excluding tritium and 481 curies tritium.

a. High Level Wastes

Source of Liquid Wastes	Release Rate Average (gal/day)	Concentration Before Processing (uCi/cc)
Reactor Coolant*	112	2.5×10^1
Non-Recycleable Reactor Coolant	19	2.5×10^1

1. The number and capacity of all collector tanks for all wastes is presented in Table 11.1-1 of the PSAR. They are:

Liquid Waste Collection Tanks	Quantity	Volume (gal)
Reactor Coolant Drain	1	350
Laundry and Hot Shower	1	10,000
Chemical Drain	1	600
Floor Drain	1	10,000
Waste Holdup	1	10,000

2. It is planned to recycle as much of this waste as is practical, with the exception that some discharge of primary coolant may be necessary for the control of tritium concentrations in the plant (to 1.5 uc/cc in the primary coolant system or 1.0 uc/cc at refueling).

3. These liquids pass through either the Waste Processing System or the Boron Recycle System before being released. These systems provide an evaporator-demineralizer combination processing for a process DF of 7200.

4. The average decay time for liquids removed from the primary coolant system prior to discharge is estimated to be 15 days.

5. Resins will be stored and shipped off-site in approved containers or shielded truck mounted cask. Evaporator bottoms or concentrated boric acid will be reused when possible or solidified and drummed for off-site shipment when not. An estimate of the volumes and curies generated per day is not available.

b. "Dirty" Wastes

Source of Liquid Wastes	Release Rate Average (gal/day)	Concentration Before Processing (uCi/cc)
Lab Equipment Rinses	44	10^{-1}
Non-Reactor Grade Leaks	36	10^{-3}

* May be processed through Boron Recycle System or Waste Processing System.

1. See answer to a.1.

2. It is planned to recycle as much of this waste as is practical. Factors controlling this are tritium build-up, pH, chloride and fluoride content.

3. These liquids are processed in the liquid Waste Processing System before being released. They pass through the waste evaporater and a demineralizer. A process DF of 7200 may be taken over both pieces of equipment.

4. Average decay time prior to discharge is estimated to be 15 days.

5. See answer to a.5.

c. Laundry, Decontamination and Wash-Down Wastes

Source of Liquid Wastes	Release Rate Average (gal/day)	Concentration Before Processing (uCi/cc)
Decontamination Water	41	10^{-4}
Laundry and Hot Shower	329	10^{-4}

1. See answer to a.1.

2. None of this water is recycled.

3. Normally these wastes are filtered and checked for activity levels before being released.
Normally the activity of the floor drain tank contents will be well below permissible levels and following analysis to confirm the acceptable low level, the tank contents are discharged without further treatment. Provision is made to process these liquids in a demineralizer, or the waste evaporator and demineralizer should this become necessary because of an unexpected high level of activity. This treatment could provide a process DF of up to 7200.
Laundry and hot shower drains normally need no treatment for removal of radioactivity.

4. Average decay time prior to discharge is estimated to be 15 days.

5. See answer to a.5.

d. Steam Generator Blowdown

Steam generator blowdown average flow rate is expected to be 0.5 gpm with a maximum expected short term "average" rate of 6 gpm for thirty days (based on steam generator solids control with a steam generator leak). As discussed in Section 11.1.5 of the PSAR, steam generator tube leakage in conjunction with fuel clad defects is considered a fault of moderate frequency.

1. In addition to a flash tank, there will be one 10,000 gallon holdup tank ahead of a processing system and two 7200 gallon monitor tanks following the processing system.

2. It is planned to recycle treated blowdown as much as practical when it meets quality standards for condensate make-up. Blowdown not requiring treatment will be discharged.

3. Treatment consists of holdup, filtration, and two stage demineralization (mixed bed). Demineralizer DF is expected to be 100 for all nuclides except Mo-99 and Y-99 (DF=10) and tritium (DF=1). Blowdown will be treated only when there is primary to secondary leakage carrying detectable quantities of radionuclides.

4. Cooling time is determined by the required blowdown rate for solids control, tank capacities (listed) and the suitability of the processed blowdown for recycle.

5. Resins from the demineralizers will be stored and shipped off-site in approved containers or shielded truck mounted cask. No estimate of quanitites is now available.

e. Turbine Building Drains

Turbine building drains are estimated to be 1500 gallons per day (from miscellaneous condensate leaks). These wastes are normally non-radioactive. In the event of a primary to secondary leakage, most leaked radionuclides except tritium, iodines and noble gases will remain in the steam generators and will be carried in the blowdown. Those which are carried over with the steam and leaked will normally be discharged without treatment.

Question No. 33: Dilution flow rate for liquid effluents, normal gpm and total gallons per year.

Answer: Liquid radioactive releases to the environment are piped to the penstock of the Fairfield Dam where they are diluted by thorough mixing with the water released through the dam during the generating portion of the pumped hydro cycle. Planned releases will only be made during the generating portion of the cycle. The average annual flow out the penstock of the Fairfield Dam, with half the generation capacity in operation, is 3,380 cfs (21,900 cfs for eight hours per day, 169 days per year). Thus, normal dilution flow is 9.83×10^6 gpm and the total dilution flow per year is 7.97×10^{11} gallons. The Preliminary Safety Analysis Report is being revised to note this form of discharge.

During the pumping portion of the cycle, some of the fission and corrosion products released to the Parr Reservoir will be pumped up to the Monticello Reservoir. Continued operation of the cycle will cause concentrations in both reservoirs to increase over plant life. The theoretical maximum concentration is the same as that concentration that would be obtained if liquid releases were diluted by a flow equivalent to the average flow of the Broad River. There is a 95% probability that the monthly average flow in the Broad River will exceed 910 cfs.

APPENDIX C

STATUS OF PERMITS REQUIRED FROM FEDERAL, STATE AND LOCAL AGENCIES

PERMITS AND CERTIFICATIONS

The following is a list of most of the local, state, and federal agencies from which South Carolina Electric & Gas Company intends to obtain permits and certifications. Each agency is followed by a listing of the permits which will be applied for from that agency.

Local

1. Fairfield County Auditor's Office:
   (a) Building permit for const:uction of major structures.

State

1. South Carolina Pollution Control Authority - Water Section:
   (a) Letter of Water Quality Certification.
   (b) Effluent Discharge Permit.
   (c) Sewage Disposal System Permit.
   (d) Industrial Waste Permit.
2. South Carolina Pollution Control Authority - Air Section:
   (a) Permit for heating boiler and diesel-generator emissions.
3. State Board of Health - Radiological Health Department:
   (a) Permit for radioactive sources used during construction.
4. Public Service Commission:
   (a) Certificate of Public Convenience and Necessity for the Summer Nuclear Station and associated transmission lines.
5. South Carolina Highway Department:
   (a) Permits for oversize, overweight, and overlength loads.
   (b) Permit for any entrance roads to state highway system.

Federal

1. Federal Aviation Agency:

    (a) Permit for any structures over 200 ft. tall.

2. Atomic Energy Commission:

    (a) Nuclear Station Construction Permit.

    (b) Nuclear Station Operating License.

    (c) Nuclear Station Operating Personnel Licenses.

3. Corps of Engineers:

    (a) Refuse Discharge Permit.

    (b) Intake and Discharge Structure Permit.

    (c) Dredging of river.

None of the permits and certifications listed above have been applied for because the information required by the issuing agency is not yet available. South Carolina Electric & Gas Company plans to file applications as soon as possible following the development of the required information.

CONTENTS

LIST OF PLATES

LIST OF TABLES

SUPPLEMENT TO THE ENVIRONMENTAL REPORT

VIRGIL C. SUMMER NUCLEAR STATION

S1.0 INTRODUCTION

This supplement to the Virgil C. Summer Nuclear Station Unit No. 1 Environmental Report, which was filed with the Atomic Energy Commission on June 30, 1971, presents additional information in compliance with the revisions to Appendix D of 10 CFR 50 of September 9, 1971, with regard to implementation of the National Environmental Policy Act of 1969, and in accordance with the Atomic Energy Commission document "Scope of Applicants' Environmental Reports with respect to Transportation, Transmission Lines, and Accidents", issued on September 1, 1971. Specifically, this supplement provides information concerning the following:

1. Benefits and Costs of the Virgil C. Summer Nuclear Station Unit No. 1 (Summer Station) and Alternatives.
2. Environmental Effects of the Transportation of Fuel Elements and of Packaged Radioactive Material.
3. Environmental Effects of Transmission Lines.
4. Environmental Effects of Accidents.

As discussed in the Environmental Report, South Carolina Electric & Gas Company (SCE&G) has been conducting quarterly biological sampling to establish baseline information in the proposed project area. The results of the March 1971 and June 1971 sampling are also included in this supplement, and are presented in Appendices A1 and B1. South Carolina Electric & Gas Company will continue to conduct biological samplings through the preoperational and part of the operational phases.

This supplement also amends the heat rejection information, based on the latest engineering data, as contained in Sections 2.1.3.2 and 2.3.3 of the Environmental

Report as follows:

a. Cooling water for the main and feedwater pump condensers, nuclear equipment cooling, and other miscellaneous station cooling will be provided by the circulating water and service water systems at a rate of approximately 530,000 gpm.

b. The temperature rise across the condensers during normal full power operation will be approximately 25° F. A total of approximately 6.6×10^9 BTU/Hr. of waste heat will be removed by Unit No. 1 cooling water systems.

c. The hydraulic model studies of Monticello Reservoir are based on heat rejection of two units with a total cooling water flow of approximately 1,060,000 gpm.

d. Cooling water intake velocities for the nuclear station are expected to be on the order of one (1) fps.

Additional information on details of the site, station design and safety evaluation are contained in the Preliminary Safety Analysis Report for the Virgil C. Summer Nuclear Station (AEC Docket No. 50-395).

S2.0 BENEFIT-COST ANALYSES

S2.1 GENERAL

The benefit-cost analyses require an approach outlined by the National Environmental Policy Act, the Federal Court of Appeals Calvert Cliffs Decision, and by the AEC Revised Appendix D to 10 CFR 50. In general, "the particular economic and technical benefits of planned action must be assessed and then weighed against the environmental costs; alternatives must be considered which would affect the balance of values". The decisions made by S. C. Electric & Gas Company to supply the area's growing power needs through the proposed project have been evaluated on the basis of economic, social, and environmental factors in the context of the above general guideline. The benefit-cost analyses presented in the following sections review this decision-making process and illustrate the balancing of alternatives which were considered at each decision point to optimize the social, economic, and environmental costs and benefits.

Although the benefit-cost approach to decision-making has been utilized for many years, especially by some government agencies, the application of this tool to the power industry has only recently been suggested. The benefit-cost technique was developed by economists to evaluate alternative projects in the water resources field and in recent attempts to solve urban, health, military, and educational problems. Under such diverse applications, it is understandable that no uniform approach has emerged. Rather, a diversity of techniques has been employed to fit specific decision-making problems. In view of this lack of consensus, the following comments are presented as a guide to the philosophy of the benefit-cost analyses used in this supplemental report.

A basic part of most benefit-cost analyses is to evaluate "benefits" and "costs" in quantitative monetary terms wherever possible so that a ratio of dollar benefit to dollar cost can be compared. Alternatives are then rated and selected on the basis of the maximum benefit to cost ratio. While this approach affords a firm, objective basis for decision-making in some fields, it is lacking in social and environmental concerns particularly because some of the most important and relevant factors are the least amenable to quantification in monetary terms.

The approach used in this supplemental report is to quantify costs and benefits wherever possible using a multidimensional format. If "dollars" represents a good measure of a given cost or benefit, as in the case of capital and operating costs for an alternative, then these costs are given dollar dimensions. In other cases where input data is more subjective, as in the case of some environmental effects, the emphasis is placed on developing ranges of values for the parameters in the dimension that best describe the particular effect. Thus, "pounds of fish" damaged, "acres of land" removed from a terrestrial ecosystem, and "rems per year" dose rate are typical quantifications of environmental costs. There is no attempt to aggregate all of these costs and benefits in common dimensions. Rather, the costs and benefits are left in the most applicable dimension so that a rational decision can be made without assigning subjective, and often misleading, monetary values to the effects.

S2.2 NEED FOR POWER

S2.2.1 Introduction

South Carolina Electric and Gas Company has been an important participant in the social and economic development of the area it serves for many years by supplying a large portion of the energy needs of its industrial, commercial, and residential customers. It has contributed to the general elevation of the standard of living in the South Carolina area by providing the energy for the production of goods and services and for the general enhancement of society through improved health, safety, and comfort. South Carolina Electric & Gas Company recognizes its obligation to not only supply the power needs of its customers, but also to participate responsibly in the stewardship of South Carolina's environmental resources.

The load demand on the SCE&G system is such that the company must supply both base load generation and peak load generation. South Carolina Electric & Gas Company is predominantly a summer peaking system, with a summer peak that normally exceeds the winter peak by approximately 20 percent. There are no indications that this pattern will change in the foreseeable future, and the annual system load factor is expected to remain at approximately 57 to 60 percent.

S2.2.2 Peaking Power

The annual total load duration curve projection for 1980 (Figure S2-1) indicates that the SCE&G peak loads will occur for a relatively small number of hours during the year, but that this peak load demand will be large at certain times during the year. The installation of two 30 MW Internal Combustion (IC) Turbines at Williams Station in 1972 will increase the system IC Turbine capacity to 287 MW. This, combined with existing hydro capacity of 243 MW, will supply a total of 530 MW

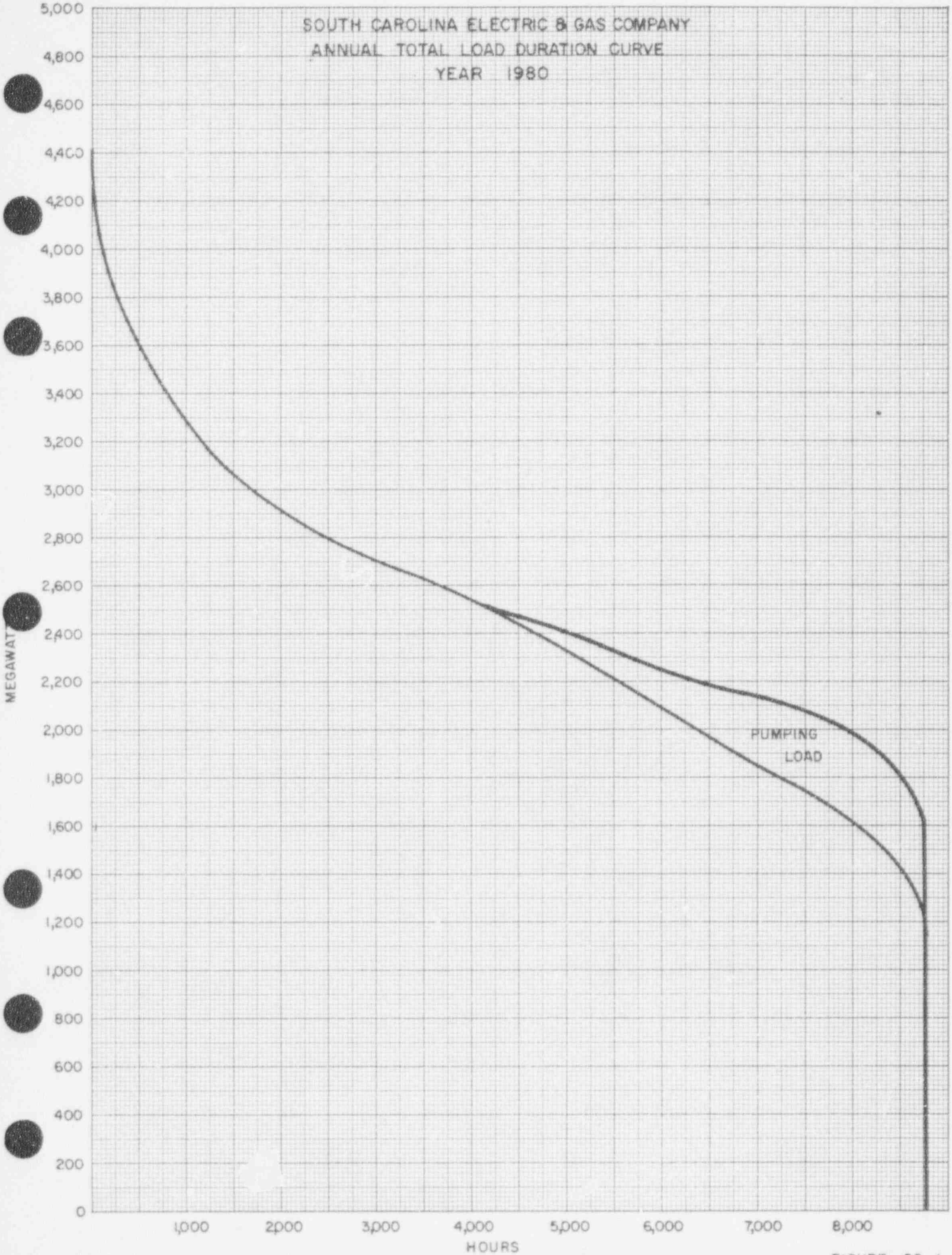

SOUTH CAROLINA ELECTRIC & GAS COMPANY
ANNUAL TOTAL LOAD DURATION CURVE
YEAR 1980
PUMPING
LOAD
MEGAWATTS
HOURS
5,000
4,800
4,600
4,400
4,200
4,000
3,800
3,600
3,400
3,200
3,000
2,800
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1,000
2000
3,000
4,000
5,000
6,000
7,000
8,000

FIGURE S2-1

of peaking capacity, which is only 12 percent of the 1980 forecasted peak load of 4410 MW. A planned addition of 480 MW in two increments of 240 MW each will increase the peaking capacity to 22 percent in 1980.

S2.2.3 Base Load Power

There is a definite need for peaking power; however, as load demand increases, a large portion of the increase must be met with additional base load plants. Thermal power plants provide the best method of supplying base load in the SCE&G service area.

Load growth information for the Virginia-Carolinas Group of the Southeastern Electric Reliability Council filed September 1, 1970, with the Federal Power Commission shows an annual electrical load growth for the area of 9.8 percent. The projected growth rate for the South Carolina Electric & Gas Company electric system area for the period through 1977 is 11.3 percent. This growth reflects both an increasing number of customers and an increasing per capita consumption of electricity. If electrical load growth does in fact continue at or near the projected rate, one can readily see the need for additional large electric generating facilities.

The South Carolina Electric & Gas Company presently has a fossil generating unit under construction (A. M. Williams Station) near Charleston, South Carolina, scheduled to go into operation in May, 1973, and will purchase 140 MW from the CP&L Company's Sutton No. 3 Unit until May 1, 1977.

The above capacity additions will increase the South Carolina Electric & Gas Company's available capacity to 3196 MW in 1975. Peak system load in 1975 is forecasted to be 2711 MW, resulting in system reserve of 485 MW, or 17.9 percent of the system peak. Without additional capacity in 1976, the system reserve that year is projected to decrease to about 6.4 percent. Thus, the addition of capacity in 1976 is necessary in order to increase the system reserve. The additional planned peaking capacity of about 240 MW, will bring the system capacity to 3436 MW. In 1977 the projected peak load is 3335 MW. Without a large capacity addition, the system reserve would then be only about 3 percent. Based on the above projected demands and capacities, it will be necessary to place a large base load plant in service in 1977.

S2.2.4 Summary

South Carolina Electric & Gas Company has legal, economic, and moral responsibilities to furnish electricity for homes, commercial businesses, industries, hospitals, transportation, and for the public health and safety on the same demand basis as in the past. Although the desirability of limiting power usage is being suggested today, until and if such a decision is made a national policy, South Carolina Electric & Gas Company must continue to meet the electric power needs of its customers.

S2.3 BENEFITS OF ELECTRICAL POWER

The development and provision of electrical power has been a significant factor in the economic and social growth of the United States. The use of this important form of energy has contributed to a standard of living for the United States which is unparalleled in the world. Indeed, the standard of living can be related to the per capita consumption of power; e.g., underdeveloped countries have a lower per capita consumptive use than highly-developed countries.

South Carolina Electric & Gas Company recognizes its important role in the social and economic development of the area which it serves. By the provision of low cost electrical energy to its residential, commercial, and industrial customers, South Carolina Electric & Gas Company has contributed to the standard of living of the citizens of South Carolina and helped to develop a healthy, viable economy.

The average rates for South Carolina Electric & Gas Company's customers during the twelve month period ending November 30, 1971, are shown on Tables S2-1, along with a breakdown of sales by customer groups. South Carolina Electric & Gas Company residential customers ranked among the highest in the nation in the use of electricity in 1970; however, they paid for this electricity at a rate 9.1% below the national average. Large commerical and industrial customers also enjoy rates which are as low as or lower than the national average.

The benefits of dependable, low cost power should not be underestimated. It is a factor in attracting new industries and keeping existing industries. New industries spawn new jobs and create opportunities to fill the employment and social needs of an increasing population. Additional monies are pumped into the state economy through an expanded tax base. Provision of low cost electrical power thus contributes significantly to the maintenance of a healthy, prosperous and viable economy.

TABLE S2-1

POWER SALE AND AVERAGE RATE DATA

12 Month Period Ending November 30, 1971*

	Average Rate ¢/KWH	% of KWH Sales	Millions KWH Sales
Residential	2.01	35.0	2356
Commerical	1.78	23.7	1594
Industrial	.91	38.7	2609
Other - Street Lighting Other Public Authority	1.57	2.6	174
Total Ultimate Consumers	1.52	100.0	6733

* This data does not reflect the effect of the rate increase effective December 1, 1971.

While the afore-mentioned benefits of low cost electrical power are related to the economy of an area, there are many other benefits which are not so easily identifiable in economic terms. Economic growth is associated with many other changes in a society. Life styles usually change with economic opportunities. Educational opportunities increase. Services are better. Health care improves. Certain work formerly accomplished by man power is accomplished by machines at greater efficiency. Leisure time increases; cultural and recreational horizons broaden. All these changes, resulting in a higher standard of living for society, occur because power is available to support the process.

The availability of low cost power also provides advantages in terms of environmental benefits. The waste-product recycling industry, which removes discarded aluminum cans, junk autos, throw-away bottles, paper, etc., from our environment, has a significant electric power requirement. Since this is a competitive industry, its health depends in part on dependable low cost power; high cost power may inhibit this industry's growth. Modern sewage treatment plants, so vital in improving the water quality of our environment, require large amounts of energy. Air pollution control systems, such as electrostatic precipitators, also require substantial amounts of power for operation.

The provision of low cost electrical power to meet the increasing demands of society, however, is not without its environmental costs. As with other types of industrial facilities, the construction and operation of a power plant causes certain effects on the environment. Concern for environmental protection has grown in the past few years, and the continuing responsibility of power companies to protect the environment has been emphasized. However, the responsibility on the part of power companies to produce power has not been reduced. The demand for power continues to increase at a high rate.

To accommodate conflicting priorities, decision-making in the production of power must seek a balance among the competing criteria. The impact of power generating facilities is being greatly reduced through the continuing programs of environmental awareness and the incorporation of technological developments. South Carolina Electric & Gas Company is committed to the implementation of new technology and the expenditure of funds for land management programs in its efforts to reduce environmental impact and provide environmental enhancement; but environmental costs will never be completely eliminated. On balance, however, it appears that the benefits of low cost power to meet the ever-increasing demands of South Carolina Electric & Gas Company's service area outweighs the environmental costs associated with the production of this power.

S2.4 EVALUATION OF ALTERNATIVE GENERATION

S2.4.1 General

There are essentially two types of load demand: "base", where continued operation at maximum generator capacity is used to meet the minimum load demand, and "peaking", where operation is limited to a few hours to satisfy maximum load demand. Several types of generating facilities are available to meet either base or peaking load demands, but no one type is totally suitable for both base and peaking power generation.

South Carolina Electric & Gas Company is predominantly a summer peaking system, with a summer peak that normally exceeds the winter peak by approximately 20 percent. There are no indications that this pattern will change in the foreseeable future, and the annual system load factor is expected to remain at approximately 57 percent to 60 percent.

Base load power is normally furnished by thermal generating plants, such as nuclear or fossil fuel facilities. Section 2.5.3 of the Environmental Report includes a discussion of alternatives of base load facilities.

Other alternatives, such as not providing the power and purchasing power, are discussed in Section 2.5 of the Environmental Report.

The amount of reserve capacity that should be provided in a system depends upon the total system capacity, the size and condition of the individual units, and the sharing and transfer arrangements with other utilities. The South Carolina Electric & Gas Company was part of the CARVA pool, which also included the Virginia Electric and Power Company, the Carolina Power and Light Company, and the Duke Power Company. With the addition of three new members, the Southeastern Power Administration, the South Carolina Public Service Authority and Yadkin, Inc., the expanded group is now called the Virginia-Carolinas Reliability Group, a member of the newly organized Virginia-Carolinas Reliability Council. In response to the FPC Order 383-2, load growth information for the Virginia-Carolinas Reliability Group filed September 1, 1970, with the Federal Power Commission shows an average annual load growth for the area of 9.8%.

The growth rate of South Carolina Electric & Gas Company is greater than the average annual growth rate of the Virginia-Carolinas Reliability Group, indicating a need for increased power generation by SCE&G rather than reliance on the Group to provide for the company's requirements. Therefore, the purchasing of electric power cannot be considered as a real alternative.

S2.4.2 Base Load and Peaking Power

Thermal base load facilities, either fossil fuel or nuclear, have many similar features. Both produce large amounts of low cost power to give reliable capacity to the system and both require large amounts of cooling water. Forms of cooling presently used are once-through cooling from natural or man-made water bodies and cooling towers.

The South Carolina Electric & Gas Company's system peaking power demand usually occurs during the summer and is of long duration due to the air conditioning load. A peaking power facility should have the capability of fast, reliable starts and reliable operation, and require low maintenance. The three forms of peaking power in most common usage by the utility industry are IC turbines, regular hydro, and pumped hydro.

In SCE&G's opinion the combination of thermal plants for the base load and pumped storage hydro for peaking power built as a single complex results in maximum utilization of water resources. Also economically, the two form an attractive combination since the water resource is used both for power production and cooling. The combination is particularly attractive with nuclear thermal generation where power generation costs are low and capital costs are high, thus requiring a high utilization of the plant. Based on SCE&G's experience with conventional hydro, pumped storage hydro is expected to be the most reliable peaking power or emergency power source available to a utility today.

Figures S2-2 and S2-3 present a projected load duration curve for a peak day and a projected peak week total load curve respectively for 1978. These figures show the advantages of pumped hydro to maintain maximum utilization of base load thermal plants. This utilization of stored power from modern base load plants decreases the use of thermally inefficient IC turbines or older thermal plants for peaking.

The load curves shown in Figures S2-2 and S2-3 show examples of the usage of base load with peaking power.

By providing pumped storage hydro for peaking power, the thermal generation can be as shown by the flattened line. Using this combination, the thermal generation can support the base load, while the pumped hydro can support the peaking demands as they fluctuate up and down. Since the base thermal generation provides the most economical generation at a high load factor and the pumped storage has high reliability for peaking duties, the efficiency of the combination is increased. From the figures, the use of off-peak thermal power for pumped storage can be seen. The usage of base load power during off-peak hours to store water for pumped hydro also shows the compatibility of base load with pumped storage hydro as peaking power.

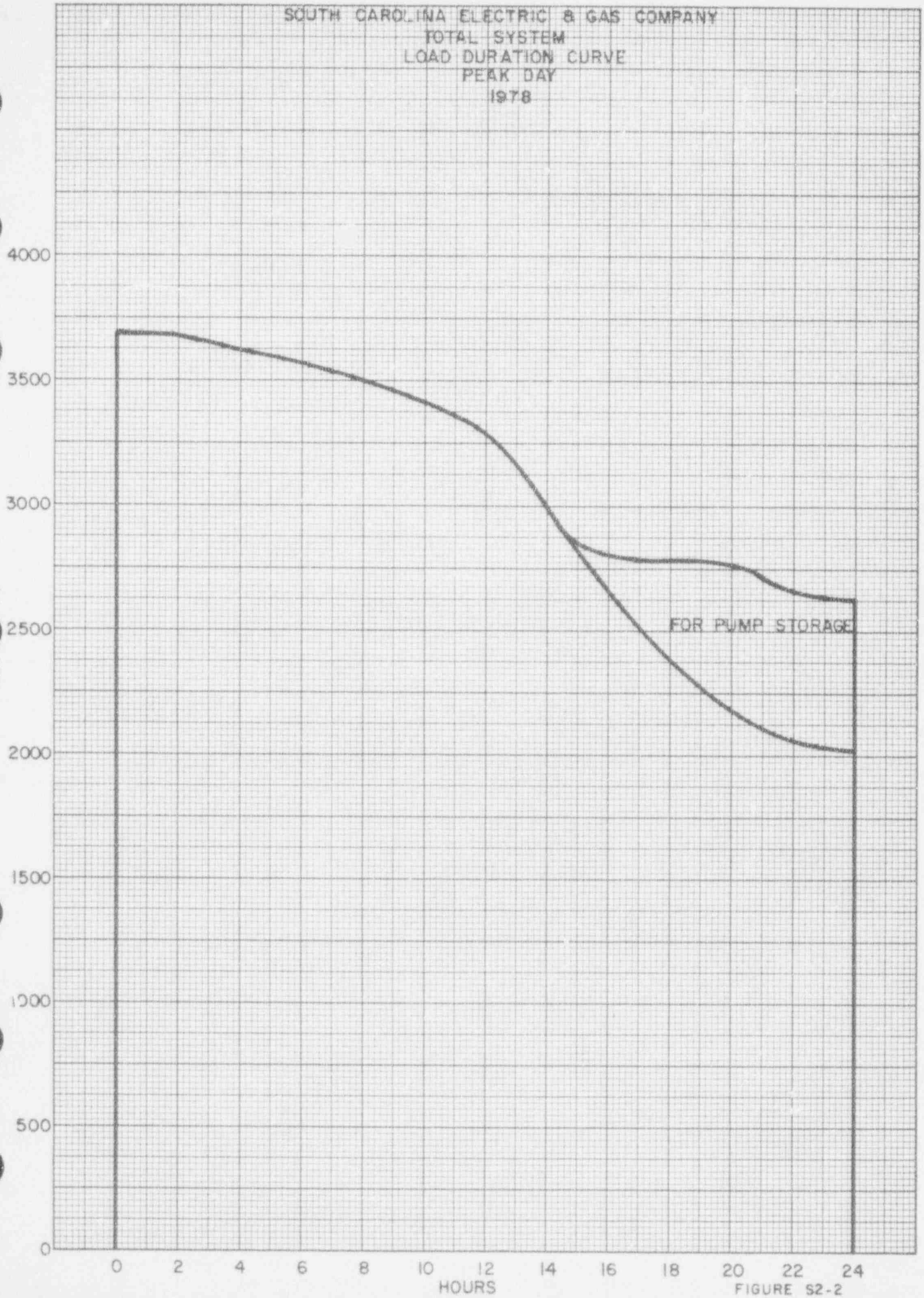

SOUTH CAROLINA ELECTRIC & GAS COMPANY
TOTAL SYSTEM
LOAD DURATION CURVE
PEAK DAY
1978
FOR PUMP STORAGE
MEGAWATTS
0
500
1000
1500
2000
2500
3000
3500
4000
0 2 4 6 8 10 12 14 16 18 20 22 24
HOURS

FIGURE S2-2

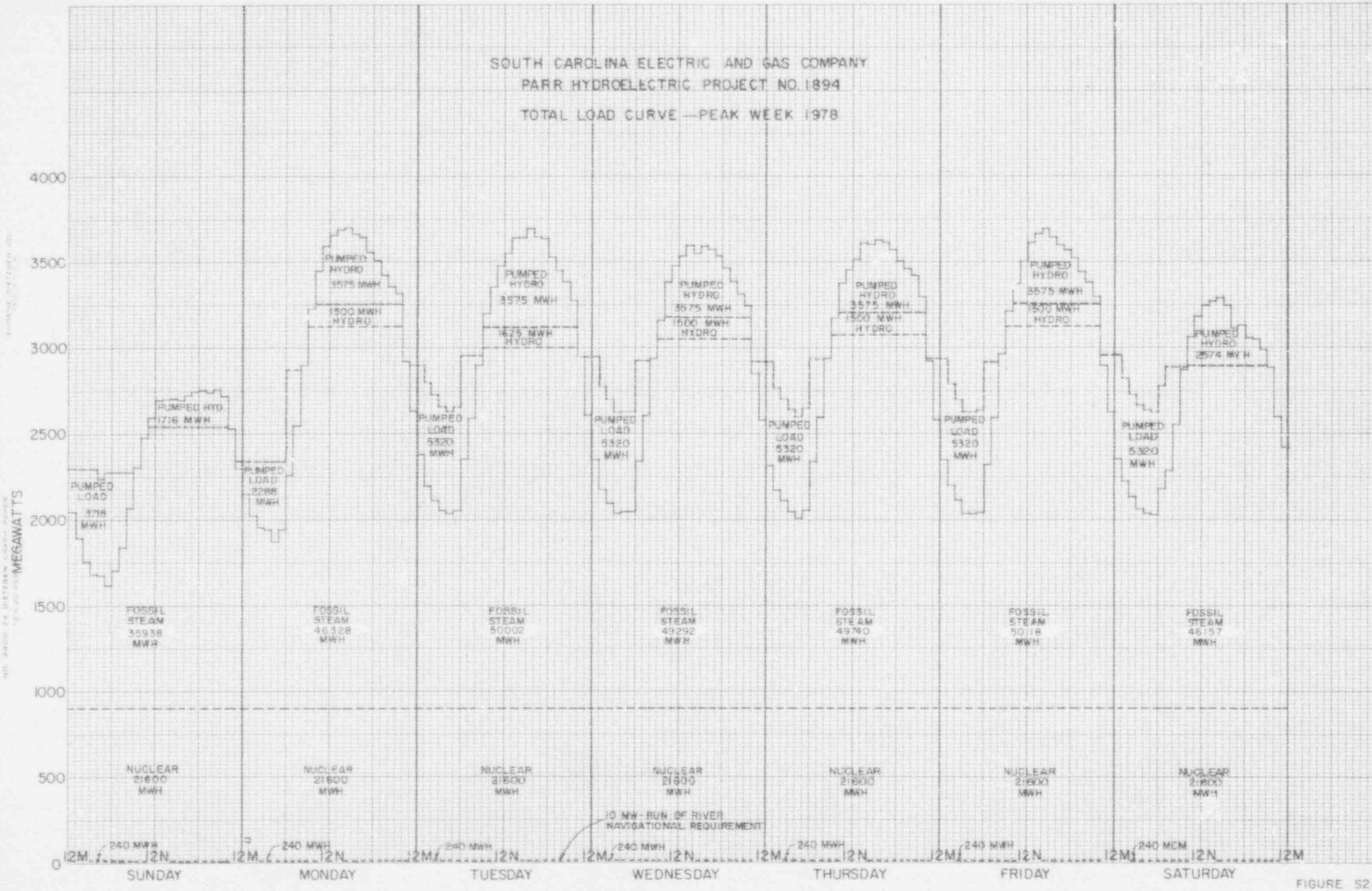

SOUTH CAROLINA ELECTRIC AND GAS COMPANY
PARR HYDROELECTRIC PROJECT NO. 1894
TOTAL LOAD CURVE—PEAK WEEK 1978
MEGAWATTS
4000
3500
3000
2500
2000
1500
1000
500
0
PUMPED LOAD 3718 MWH
PUMPED HYD 1716 MWH
FOSSIL STEAM 35938 MWH
NUCLEAR 21600 MWH
PUMPED LOAD 2288 MWH
PUMPED HYDRO 3575 MWH
1500 MWH HYDRO
FOSSIL STEAM 46328 MWH
PUMPED LOAD 5320 MWH
PUMPED HYDRO 3575 MWH
1625 MWH HYDRO
FOSSIL STEAM 50002 MWH
PUMPED HYDRO 3575 MWH
1500 MWH HYDRO
FOSSIL STEAM 49292 MWH
PUMPED HYDRO 3575 MWH
1500 MWH HYDRO
FOSSIL STEAM 49740 MWH
PUMPED HYDRO 3575 MWH
1500 MWH HYDRO
FOSSIL STEAM 50118 MWH
PUMPED HYDRO 2574 MWH
PUMPED LOAD 5320 MWH
FOSSIL STEAM 46157 MWH
10 MW - RUN OF RIVER NAVIGATIONAL REQUIREMENT
240 MWH
12M
12N
SUNDAY
MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY

FIGURE S2-3

S2.4.3 Alternate Peaking Capacity and Cooling Facilities

The proposed Fairfield project will be used as an example of the combination of pumped storage hydro with cooling reservoir in making comparisons of alternative peaking capacity facilities. Alternatives to this are IC Turbines for peaking and natural draft cooling towers for heat dissipation of the thermal plant and a coal fired plant for peaking with cooling towers. A cost comparison of these three can be seen in Table S2-2. The net benefit of selecting Fairfield pumped storage hydro and cooling reservoir instead of the alternative coal fired plant for peaking with cooling towers is $25,000,000. The net benefit of selecting the Fairfield project instead of IC Turbines and cooling towers is $633,000. Both of these are the capitalized values of the pumped storage and cooling reservoir as measured by the excess annual cost of the alternative generation.

As can be seen in Table S2-2, the total saving per year, including capacity costs, to be realized if pumped storage hydro is installed in lieu of fossil steam equals $4,276,000. On this basis, the fossil steam plant appears economically unattractive.

Gas turbine units can use natural gas or kerosene and have low initial cost. However, fuel costs and maintenance costs are high if the units are operated for long periods of time. Other problems arise with the use of IC Turbines; extensive maintenance is required, and they do not compare with pumped storage hydro in reliability. During emergencies, pumped storage hydro units can be started and brought on line in less than 10 minutes. An IC Turbine may be brought on in 15 minutes, but operating experience emphasizes the fact that on numerous occasions IC Turbines develop malfunctions in starting that require the service of a mechanic. This may consume one hour or more. IC Turbines require a large storage of fuel, the cost of which has not been included. This cost would include the installation of a suitable oil tank at each location (SCE&G will have turbines located at 8 locations

TABLE S2-2

ALTERNATE PEAKING CAPACITY AND COOLING FACILITIES

	Fairfield Pumped Storage + Cooling Reservoir	Fossil Steam Peaking + Cooling Towers	Alternate IC Turbines + Cooling Towers
Plant size, MWe	480	611	480
Cooling capacity, MWe (Nuclear)	1800	1800	1800
Estimated investment cost $/KW	208	180	115
Fixed charge rate	15.1%	17.078%	17.078%
Energy costs, Mills/KWH	5.20 (1)	6.00 (2)	15.0 IC Turbine (3) 6.0 System Peaking
Annual generation, Million KWH	650	650	240 IC Turbine (3) 410 System Peaking
INVESTMENT COSTS (480 MWe Capacity)			
Estimated investment, peaking capacity	$99,821,000	$86,400,000	$55,200,000
Cooling capacity @ $10 / KW	0	18,000,000	18,000,000
Total Estimated Investment Costs	$99,821,000	$104,400,000	$73,200,000
ANNUAL COSTS (480 MWe Capacity)			
Fixed capital charges	$15,073,000	$17,829,000	$12,501,000
Energy costs			
Pumped Storage	$ 3,380,000	0	0
IC Turbine	0	0	$ 3,600,000
Other Peaking	0	$ 3,900,000	$ 2,460,000
Additional O & M Fossil Steam	0	$ 1,000,000	0
Total Annual Costs	$18,453,000	$22,729,000	$18,561,000
Excess Annual Costs of Alternatives	-	$ 4,276,000	$ 108,000
Capitalized Value of Summer-Fairfield Pumped Storage and Cooling Reservoir as Measured by Excess Annual Cost of Alternatives	-	$25,000,000	$ 633,000

TABLE S2-2

NOTES

1. Energy costs to supply pumping load

   Input energy - 60% @ $0.002 / KWH

   40% @ $0.005 / KWH

   Operating and Maintenance @ $0.0004 / KWH

   Note: It requires 975 million KWH of input power to the pump hydro to generate 650 million KWH peaking power.

2. New fossil steam energy costs based on coal @ $.608/MBTU, No. 6 oil @ $0.55/MBTU, average heat rate 9,500 BTU/KWH, and operating and maintenance @ $.0006/KWH.

3. IC Turbine energy based on oil @ $0.80 / MBTU and includes operating and maintenance expenses. System peaking based on peaking with older system units and includes operating and maintenance.

in early 1972).

The consumption of large amounts of fuel for IC Turbines has previously been mentioned; however, consideration must be given to the fact that the world's fuel resources are becoming limited. One of the most optimistic estimates of the amount of oil that will ultimately be produced reflects the peak to occur about the year 2000, resulting in a decreased production from then until near zero production in the year 2100 (Ref. 1). Estimates have been made of the ultimate crude-oil production, including oil from offshore areas, which consist of oil already produced, proved and probable reserves, and future discoveries. These estimates of the ultimate world production of oil range from 1350 billion barrels to 2100 billion barrels. Of this higher amount, the U. S. could produce about 9.5 percent, while the Middle East, China, and U.S.S.R. could produce about 52.3 percent (Ref. 1).

U. S. production and usage will have to be implemented by the production of oil from other areas, such as the Middle East. With political situations in these areas, the possibility of obtaining oil could seriously be impaired. The shortage of oil supplies in the U. S. could strongly be influenced more by these political situations than by lack of world production.

The criticality of limited natural resources is not entirely clear at this time; however, in the span of several decades these limits will become more evident. The incorporation of pumped storage hydro into the system, although not immediately noticeable, will add to the conservation of these limited natural resources.

S2.4.4 Summary

Based on the consideration discussed previously, South Carolina Electric & Gas concludes that the combination project of thermal base load and pumped storage hydro generation can best fulfill the company's additional base and peak load generating requirements when brought on line during the period 1976 - 1978.

S2.5 ALTERNATE SITES

S2.5.1 Introduction

Section 2.5.4 of the Environmental Report described a 1967 system study of three alternate sites near load centers for construction of base-load generating facilities. Both nuclear and fossil-fuel plants were considered. To provide for rapid expansion of system capacity to meet customer demands, it was decided to install fossil-fuel plants at two of the sites; Bushy Park, near Charleston, and Wateree Station, about 25 miles south of Columbia. The third site evaluated was at Parr, about 26 miles northwest of Columbia.

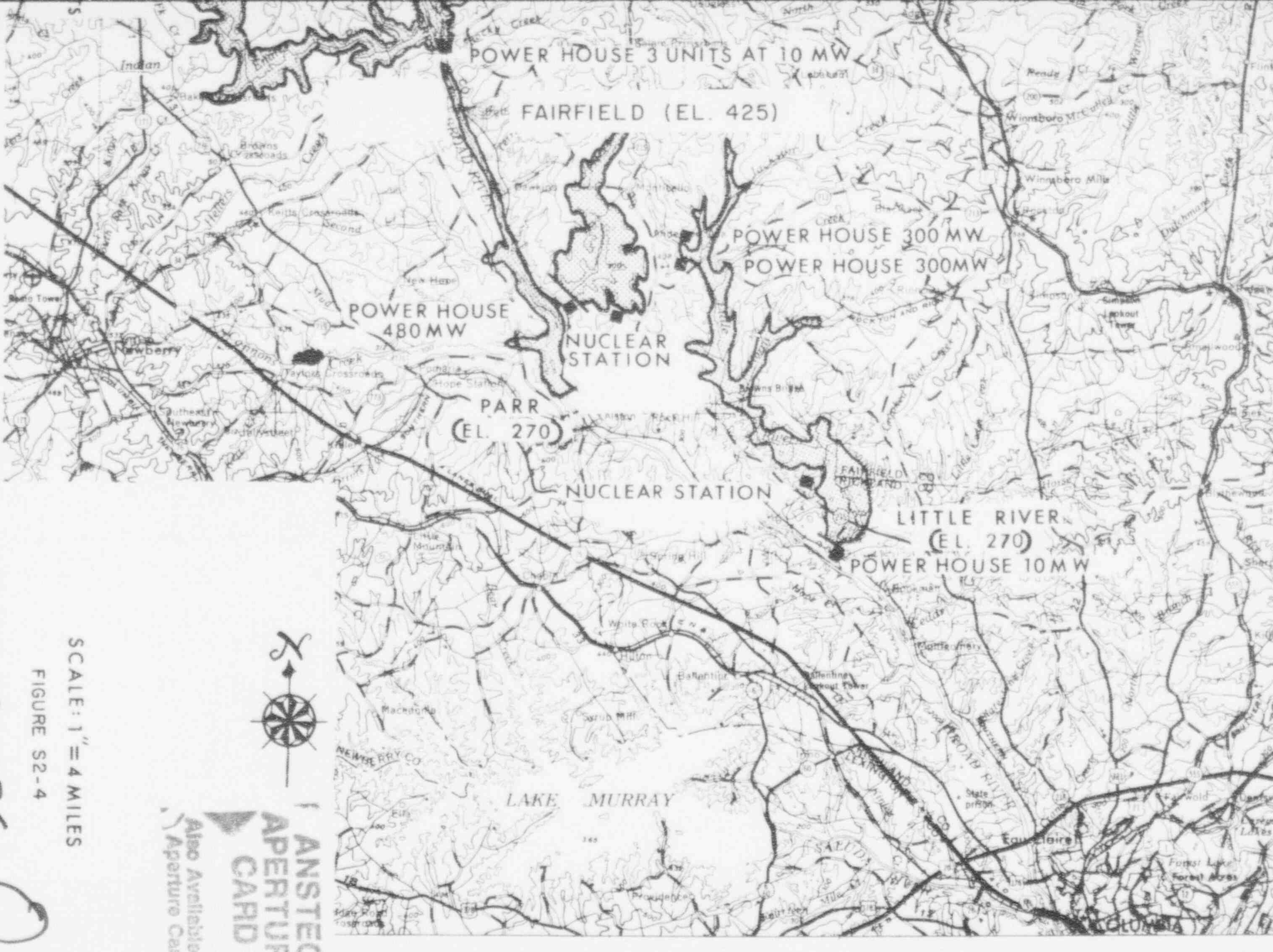
Subsequent studies determined the need for both peaking and base load capacity to meet increasing customer demands. Section S2.4 described the alternates evaluated to provide the types of generating capacities required. As discussed, studies indicated that an integrated pumped storage - thermal base load power complex would provide a reliable, economical source of generating needs. This scheme also offered the advantage of maximum utilization of water resources for power generation and cooling requirements. Consequently, SCE&G evaluated alternate combination pumped storage hydro - thermal base load sites with a view to maximizing generating benefits and minimizing environmental costs.

Partly because of the requirement for topographical relief, site selection studies centered in the hilly region north of the Columbia load center. Three alternative sites designated as Fairfield, Blair and Little River - Frees Creek were considered; the site locations are shown on Figure S2-4. As illustrated, all three sites are located on the Broad River and/or its tributaries.

S2.5.2 Economic Analysis

An economic analysis of the alternative sites in terms of peaking power and cooling

LOCATION OF PROJEC



SCALE: 1" = 4 MILES

FIGURE S2-4

9406090236-01

capacity for base-load thermal generation was performed, and is presented on Table S2-3. As indicated, the Little River - Frees Creek site was the most attractive from an economic standpoint.

S2.5.3 Siting and Environmental Factors

The general siting factors and environmental costs considered by South Carolina Electric & Gas Company that are associated with the alternate sites are listed on Tables S2-4 and S2-5.

All of the alternate sites required the construction of dams to supply the needed water for both cooling and generation. The general meteorological conditions at each site were considered to be similar because of the relative locations and similar topography. Also, the alternate sites were judged equal concerning geology, their distance to the load centers and transmission proximity. Accessibility to transportation facilities and considerations of fuel transportation problems were also nearly equal.

The impact on air quality due to discharge of chemical and/or radioactive effluents would depend on the type of base-load plant selected (nuclear or fossil-fueled). Radioactive discharges by a nuclear plant are practically negligible, while chemical discharges by a fossil-fueled plant would be slight to moderate. In any case, the standards of the Federal and State regulations would be met. All sites were judged to have adequate meteorological conditions for satisfactory diffusion.

The disturbance of the natural setting of the environment by all three sites would create an aesthetic impact. In addition the level of the natural background sounds would be raised, although only slightly. From the standpoint of aesthetical impact, the Blair project would cause the most imposing change upon the existing

TABLE S2-3

ECONOMIC EVALUATION OF ALTERNATE SITES

	Fairfield Pumped Storage & Cooling Reservoir		Blair Alternate Pumped Storage & Cooling Reservoir		Little River Frees Creek Alt. Pumped Storage & Cooling Reservoir	
Peaking Plant Size, MWe	480		550 (1)		610 (2)	
Cooling Capacity, MWe	1800		2520		3600	
Fixed Charge Rate	15.1%		15.1%		15.1%	
Energy Costs, Mills/KWH	5.20 (3)		5.20 (3)		5.20 (3)	
Annual Generation, Million KWH	650		650		650	
INVESTMENT COSTS						
Estimated Investment, Peaking Capacity	$99,821,000		$151,310,000		$139,932,000	
Cooling Capacity @ $10 / KW	0		(7,200,000)	(4)	(18,000,000)	(4)
Total Estimated Investment Costs	$99,921,000		$144,110,000		$121,932,000	
ANNUAL COSTS (Based on 480 MWe Capacity)						
Fixed Capital Charges	$15,073,000		$ 21,761,000		$ 14,488,000	
Energy Costs Pumped Storage	3,338,000		3,338,000		3,338,000	
Total Annual Costs	$18,411,000		$ 25,099,000		$ 17,826,000	
Excess Annual Costs of Alternatives	-		$ 6,688,000		$ (585,000)	
Capitalized Value of Summer-Fairfield Pumped Storage and Cooling Reservoir as Measured by Annual Cost of Alternatives	-		$ 44,291,000		$ (3,874,000)	

TABLE S2-3

NOTES

1. 520 MWe pumped storage plus 30 MWe run of river hydro
2. 600 MWe pumped storage plus 10 MWe run of river hydro
3. Energy costs to supply pumping load

   Input energy - 60% @ $0.002 / KWH

   40% @ $0.005 / KWH

   Operating and Maintenance @ $0.0004 / KWH

   Note: It requires 975 million KWH of input power to the pump hydro to generate 650 million KWH peaking power.
4. Credit given for additional cooling capacity of reservoir relative to Summer-Fairfield Project.

TABLE S2-4

GENERAL SITING FACTORS OF ALTERNATE SITES

BASED ON COMBINED PEAKING LOAD (PUMPED STORAGE) FACILITY & BASE LOAD (THERMAL) PLANT

Siting Factor	Factor Description	Fairfield Site	Blair Site	Little River-Frees Creek Site
Meteorology	Estimated suitability	Adequate	Adequate	Adequate
Topography	Surface relief	Rolling Hills	Rolling Hills & Bottom Land	Rolling Hills
Geology	Rock type; probable earthquake intensity; significant faulting	Metamorphic with granitic intrusions; V11 MM; None	Metamorphic with granitic intrusions; V11 MM; None	Metamorphic with granitic intrusions; V11 MM; None
Reservoir Development	Upper (Acres)	New 6800 Acre (400,000 Acre Ft.)	New 3300 Acre (33,000 Acre Ft.)	Same as Fairfield
	Lower (Acres)	Increase existing 1850 Acre Reservoir by 2550 Acres (Increase 29,000 Acre Ft.)	New 21 [illegible]30 Acre (500,[illegible] Acre Ft.)	New 6000 Acre (173,000 Acre Ft.)
	Penstocks	8 - 800 Ft. Surface Penstocks	1 - 8500 Ft. Tunnel to 8 Penstocks	2 - 8000 Ft. Tunnel to 10 Penstocks
Dam Development	Lower Reservoir	Raise existing Broad River concrete dam 9 Ft.	2500 Ft. Long - 70 Ft. High Concrete Dam across Broad River	3000 Ft. Long - 85 Ft. High Earth Dam across Little River (Tributary of Broad River)

TABLE S2-4 (Continued)

Siting Factor	Factor Description	Fairfield Site	Blair Site	Little River-Frees Creek Site
Dam Development	Upper Reservoir (Earth Dams)	1 - 180 Ft. High 5000 Ft. Long Main Dam; 3 Saddle Dams	Main Dam with 3 Saddle Dams	Same as Fairfield
Load Center	Distance to Transmission System	Same	Same	Same
Transportation	Rail	Approx. 2 miles West	Approx. 6 miles North	Approx. 2 miles West
	Highway	Near State Rd. 215 and I-26	Near State Rd. 45 and I-26	Near State Rd. 215 and I-26
	Air	Approx. 26 miles S. E. to Columbia Airport	Approx. 32 miles S. E. to Columbia Airport	Approx. 18 miles S. E. to Columbia Airport
Relative Economic Development	Relative Construction Costs	Moderate	High	Moderate

TABLE S2-5

GENERAL ENVIRONMENTAL FACTORS OF ALTERNATE SITES

BASED ON COMBINED PEAKING LOAD (PUMPED STORAGE) FACILITY & BASE LOAD (THERMAL) PLANT

Environmental Factor	Description of Effect	Fairfield Site	Blair Site	Little River-Frees Creek Site
Air Quality	Discharge of Chemical and/or Radioactive Effluents	Moderate to Negligible	Moderate to Negligible	Moderate to Negligible
Wildlife	Natural Habitat	Loss of about 9400 Acres of Habitat	Loss of about 24,500 Acres of Habitat	Loss of about 13,000 Acres of Habitat
Relocation of Man-Made Facilities	Additional Environmental Disruption	6 1/2 miles R. R.; 4 Bridges; 10 miles Transmission Lines; 2 1/2 miles Route 99	14 miles R. R.; 7 Bridges and 1 major Bridge across Broad River	4 miles Route 215; 1400 feet Route 213; 3 Bridges 2 1/2 miles Rt. 99
Water Quality	Temperature Increase to Natural Water Body (Broad River)	Slight	Moderate	Moderate
Aquatic Biota	Change and Disruption of Natural Conditions	Flood 8 miles Broad River; 4 miles Frees Creek	Flood 12 miles Enoree River; 8 miles Tyger River; 12 miles Sandy River; 20 miles Broad River	Flood 18 miles Little River; 4 miles Frees Creek
Human Population	Relocation	Approx. 4-8 Residences	Approx. 75-100 Residences	Approx. 100-125 Residences

TABLE S2-5 (Continued)

Environmental Factor	Description of Effect	Fairfield Site	Blair Site	Little River-Frees Creek Site
Human Population	Aesthetics	Disturbs natural setting	Disturbs natural setting	Disturbs natural setting
	Noise	Increases existing natural level	Increases existing natural level	Increases existing natural level
Land Use	Recreation	Negligible Loss	Loss of existing limited facilities	Negligible Loss
	Agriculture	Loss of about 700 Acres - Poor Land	Loss of about 1400-1500 Acres	Loss of about 1000-1100 Acres
	Forest	Loss of about 8700 Acres	Loss of about 23,000 Acres, including portions of Sumter National Forest	Loss of about 12,000 Acres
	Historical & Cultural	Relocation of 5 small cemeteries	Relocation of 1 - 2 small cemeteries	Relocation of 3-4 small cemeteries

natural setting with the Little River-Frees Creek site next in severity.

The general disturbance to existing manmade facilities represents an environmental cost. As listed in Table S2-5 all sites require the relocation of several transportation facilities.

Construction at the Fairfield site would cause relocation of approximately four to eight residential dwellings and five small cemeteries, remove the agricultural use of about 700 acres of land rated as poor in production and pre-empt approximately 8700 acres of predominantly pine and mixed hardwood trees. Reservoir development would consist of increasing the size of the existing Parr Reservoir by about 2550 acres to 4400 acres by raising the existing Parr Dam across the Broad River, and impounding a new upper reservoir by damming Frees Creek, which has a very small flow.

Parr Reservoir is part of a presently licensed project (FPC Project No. 1894). It has been utilized for hydroelectric generation since 1914, and as a source of cooling water for Parr Steam Plant since 1925.

Construction at the Blair site would cause removal of nearly 23,000 acres of forest lands supporting both pines and deciduous trees and approximately 1500 acres of fair to poor agricultural land. The Blair project would require the impounding of large portions of the Broad River, Tyger, Enoree and Little Sandy Rivers due to damming of the Broad River for the lower reservoir. The bottom lands inundated by the upper reaches of the impoundment have a more valuable wildlife habitat than is contained in the other two sites evaluated. Relocation of an estimated 75 to 100 residences and 1 to 2 small cemeteries would be required.

The Little River-Frees Creek Project would preempt the use of nearly 12,000 acres of pine and hardwood lands. The agricultural production of 1,000 to 1,100 acres of land would be lost. The human population would be affected by the relocation of about 100 to 125 residences, and three to four small cemeteries.

Based on present knowledge the inundation of bottom lands at the Blair site would represent the greatest loss to wildlife. Populations of deer and wild turkey are well established in the bottomlands of the Enoree, Tyger, and Sandy Rivers since a restocking program was begun in the 1950's. Based on conversations with the South Carolina Wildlife Resources Department, hunting days for these areas are estimated to be in the thousands. In addition, a great loss of habitat acreage for other wildlife of the area would occur. The Blair site would flood 11,000 acres more than the Little River site and 15,000 more acres than the Fairfield site.

The Little River and Fairfield sites are estimated to have similar populations of animals, based on conversations with the South Carolina Wildlife Resources Department. Accordingly, there would be less impact at the Fairfield site because about 4000 less acres will be flooded.

The species of fish present in the Enoree, Tyger, and Sandy Rivers, major tributaries of the Broad River, are expected to be similar to that of the Broad River. The major sport fish sought is expected to be catfish and centrarchids. Flooding is known to alter the physical, and as a result, the biological characteristics of a river. On this basis, the least desirable site from the standpoint of impact to aquatic biota would be Blair, which would flood 52 miles of river in 4 streams. The Little River site would flood 22 miles on 2 streams and the Fairfield site would flood 12 miles in 2 streams. Both the Fairfield and Little River sites would flood Frees Creek and the choice would remain between 8 miles of the Broad River or 18 miles of the Little River. Little is known of the fish fauna present in Little River; however, based on SCE&G studies to date, fish production in the Broad River is relatively poor. On the basis of miles of river flooded the Fairfield site would have a lesser impact on aquatic biota than the Little River-Frees Creek site.

S2.5.4 Summary and Conclusions

Based on economic comparisons, the Little River-Frees Creek alternative was the most favorable for development of a pumped storage (peaking) - thermal generating (base-load) power complex. From an environmental standpoint, development of the Fairfield alternate appeared to cause less disruption of the natural conditions and have a lesser impact on population, land use and terrestrial and aquatic biota.

Development of the Blair site would require a new dam across the Broad River, causing flooding of about 24,500 acres, including portions of Sumter National Forest and excellent bottomland wildlife habitat. The resulting impoundments in the Broad River, Enoree River, Tyger River and Sandy Rivers would change the physical and biological characteristics of these reaches of the rivers with accompanying stress to existing aquatic biota. Up to 100 residential dwellings would have to be relocated. Development of the Little River-Frees Creek alternate would require dams across Little River and Frees Creek, flooding an estimated 13,000 acres of predominantly forested land. Over 100 residences would have to be relocated. For the Fairfield alternate, increasing the size of the existing Parr Reservoir, and the impoundment of Frees Creek (common to the Fairfield and Little River-Frees Creek alternate) would cause a total loss of about 9400 acres of predominantly forested land. Only four to eight residences, however, would require relocation.

Balancing the environmental and economic factors of alternate sites studied, SCE&G determined that the development of the Fairfield site represented the best utilization of resources to supply future power needs.

S2.6 BENEFIT-COST ANALYSIS OF SUMMER STATION AND ALTERNATIVES AT FAIRFIELD SITE

S2.6.1 Introduction

On the basis of site evaluation studies described in Section S2.5, the Fairfield site was selected for development of a pumped storage-thermal electric generating power complex to provide projected peaking and base-load needs. This section describes the beneftis of providing power and environmental costs associated with power production at the Fairfield site, considering the proposed Virgil C. Summer Nuclear Station and alternatives to provide the thermal base-load capacity integral to the power complex.

The experience and judgment of South Carolina Electric and Gas and its consultant, Dames and Moore, is utilized in the evaluation and quantification of these benefits and costs. Information from referenced reports, the Baseline Biotic Surveys noted as appendices A1 and B1, and conversations with various South Carolina state agencies has been used in the preparation of this analysis.

The only viable alternative to the proposed nuclear station for providing base-load power is a fossil-fueled plant. Thus, nuclear and fossil-fueled generation have been evaluated and compared in terms of economic considerations and environmental costs. Because the proposed power generating complex provides an off-stream cooling reservoir as a basic feature, consideration of alternate cooling schemes is discussed in section S2.4. Furthermore, the radioactive waste processing system proposed for the Summer Nuclear Station incorporates the Westinghouse Environmental Assurance System (EAS), and is considered to satisfy the criteria of "as low as practicable". It is proposed that quantities of radioactive material in the station liquid and gaseous effluents will be limited to levels that are within the numerical guides for design objectives and limiting conditions of operation set forth in the AEC's proposed Appendix I to 10 CFR 50 dated June 9, 1971.

S2.6.2 Economic Analysis

An important factor in the economic comparison of nuclear and fossil-fueled generating units is the cost and availability of fuels. Of equal importance is the reliability of fuel supply. Fossil-fuels usually considered for generating plants include natural gas, oil, and coal. Natural gas, while environmentally superior to oil and coal, is in short supply and would not be available in the necessary quantities regardless of its price. Unless adequate quantities of low-sulfur oil are available, sulfur removal equipment would be required for an oil fueled station.

Oil, although presently available, would have to be obtained from distant sources. Presently the Middle East is one of the areas in which the U. S. hopes to obtain oil; however, with the political situation of this area, this source is questionable as a long term supply. Thus, with the distance and problems involved in obtaining oil, the total cost of this fuel may in the long term be substantially more than for coal.

The oil industry has expressed concern in developing sufficient petroleum reserves to meet future demands. This, coupled with the increasing reliance on international oil with its attendant problems, increases the risk of obtaining a reliable, long term supply of this fuel. Thus, for this study the fossil fuel that is considered a feasible alternative to nuclear fuel is coal.

Coal is the only major fossil fuel which will not reach its peak production within the next few decades. The most recent compilation of the present information on the world's initial coal resources was made by the USGS. Taking their estimate of an initial supply of 6.9 trillion tons and assuming that the present production rate of about 2.7 billion tons per year does not double more than three times, one can expect that the peak in the rate of production will be reached sometime between 2100 and 2150. Disregarding the long time required to produce the first 10 percent and the last 10 percent, the length of time required to produce the middle 80 percent will be roughly the 300-year period from 2000-2300 (Ref. 1).

It is estimated that the U. S. contains about 17 percent of the world's coal resources as determined by mapping and exploration, and about 20 percent of the world's estimated total resources. The Bureau of Mines has recently disclosed the fact that beneath thirteen states west of the Mississippi River, there lies 77 percent of the country's total economically strippable coal reserves, with Wyoming and Montana containing the major portion of the Western reserve of low-sulfur coal (Ref. 2).

Although the Eastern and Midwestern fields supply 94 percent of the 600 million ton-a-year coal production today, they contain only 17 percent of the remaining reserve of strippable low-sulfur reserve. Due to the future shift of coal production to the Western states, South Carolina Electric & Gas Company will face even greater problems with the cost of transportation of these fuels into its service area (Ref 2).

Even with the increased coal production for the next century, coal will not be able to economically supply all the demand for the energy needs. As oil and natural gas supplies diminish, coal will be called on to replace these items in certain areas. This will allow even less use of coal for energy production.

Exact quantities on the world's resources of nuclear fuels are not presently available; however, a review of fuel literature points out the fact that a shortage of the uranium oxide ore could also exist in the next several decades.

With present nuclear plants, only a small fraction of the potential energy of the uranium is used. With the development of the breeder reactor, the nuclear fuel supply would be assured. Without the breeder, nuclear fuel would be depleted.

The economics of the present day nuclear versus coal costs favors the nuclear fuel. Comparative fuel costs of today show uranium in present day non-breeder reactors is already cheaper than fossil fuel (Ref. 3). Table S2-6 shows a cost comparison between generation by nuclear fuel and by coal at the proposed site. The nuclear and fossil fuel costs have been escalated to the 1977 operation date. Coal prices are based on South Carolina Electric and Gas projection.

Considering both investment and operating costs, Table S2-6 shows that a coal-fired station would cost $56,647,000 more than a nuclear station on a capitalized basis.

The prediction of the escalation of fossil fuel prices are based on numerous factors. Two of the general factors are the transportation cost due to the distance of the deposit sites from commerical demand centers and the diminishing supply of low sulfur content fuels.

Nuclear plants can be built far from the source of the raw fuel without incurring costs equivalent to the cost of transporting enormous quantities of fossil fuels, because nuclear fuels are extremely compact and have long life. Large nuclear power plants are expected to produce electricity more cheaply than fossil-fueled

TABLE S2-6

ECONOMIC ANALYSIS OF NUCLEAR VS FOSSIL FUEL GENERATION

Base Load Plants	Nuclear	Fossil
Plant Costs, $/KW	252.77	180.00
Annual Fixed Charge Rate, %	17	17
Heat Rate, BTU/KWH	10,300	8,800
Average Load Factor, %	80	80
Fuel Costs ¢/MBTU	18.4	60.8
Annual Costs / KW		
Generation Fixed Charges	$ 43.17	$ 30.60
Insurance (Liability) (1)	.40	-
Fuel	13.30	37.44
Operating & Maintenance	1.87	1.40
	$ 58.74	$ 69.44
Annual saving with nuclear/KW	$ 10.70	-
Capitalized value of savings	$56,647,000	-

(1) Insurance on buildings and associated equipment included in generation fixed charges.

plants, even in or adjacent to areas where fossil fuels are naturally abundant in some cases.

It is estimated that the proposed Summer Station will utilize approximately 300 tons of natural uranium per year whereas the alternative equivalent capacity coal-fired plant would require about 5,900,000 tons of coal per year. Transportation of uranium fuel to the site after initial fuel loading would require about 6 truck shipments per year, while transportation of coal to the site would require an average of about 1.6 trains per day, every day of the year. This assumes that each train has 100 coal cars with each car containing 100 tons of coal. This coal would require storage and transfer facilities which would occupy a large area on the site. An even larger area would be required for an ash pond which would be used for ash disposal. An estimated 400 acres would probably be required for these facilities based on existing requirements at coal fired plants now in operation on our system.

Because of the large amounts of coal which must be shipped each day, there would be greater risks associated with fuel reliability. For example, labor strikes in the coal mining and railroad industries, which are not uncommon, would cause stoppage in fuel supplies resulting in reduced power generation and possible customer hardship.

S2.6.3 Environmental Costs

S2.6.3.1 Introduction

Section 2.3 of the Environmental Report described the environmental impact due to construction and operation of the proposed Virgil C. Summer Nuclear Station at the proposed site. The environmental factors considered and environmental costs evaluated, for the Summer Station and the alternative fossil-fueled plant, are presented on Table S2-7. The estimated environmental costs have been quantified where possible; otherwise, qualitative assessments have been made.

The information presented on Table S2-7 is discussed further in the following sections.

S2.6.3.2 Effluent Discharge into Parr Reservoir

No significant effects on fish or organisms of the food chain can be expected in the Broad River and Parr Reservoir as the result of thermal, chemical or radioactive discharges into the Broad River.

Throughout the year the monthly average temperature rise of the Broad River of the Frees Creek confluent will not exceed 3° F. as a result of discharging water from the Monticello impoundment, based on thermal discharge from a two-unit nuclear operation. The pH of effluents will be neutralized before release into coolant water, a mechanical condenser cleaning system will eliminate the need for algacides and other potential chemical toxicants will be handled such that state and federal water quality standards are met at the point of discharge.

TABLE S2-7

ENVIRONMENTAL COSTS OF ALTERNATE GENERATION AT PROPOSED SITE

Primary Impact	Population or Resource Affected	Description of Effect	Nuclear Fueled	Fossil Fueled
1. Heat Discharge into Parr Reservoir at Frees Creek Confluent	1.1 Primary Producers & Consumers	Change in Species Diversity or Abundance	Slight Monthly Average Discharge not more than 3° F. above unaffected water	Slight Monthly Average Discharge not more than 3° F. above unaffected water
	1.2 Fish	Interference with Migration or Spawning or Direct Death	No Thermal Barrier No Migratory Fish	No Thermal Barrier No Migratory Fish
2. Cooling Capacity of Water (Broad River)	2.1 Thermal Capacity	Capacity Loss (Downstream)	None Lost	None Lost
3. Heat Discharge to Cooling Lake (Monticello Reservoir)	3.1 Primary Producers[(1)] & Consumers	Change in Abundance	Decreases Maximum 120,000 lbs/day	Decreases Maximum 80,000 lbs/day
	3.2 Fish [(1)]	Reduced Production	Slight	Slight
4. Mechanical, Thermal Chemical Effects of Entrainment on Populations of Parr Reservoir	4.1 Primary Producers[(1)] & Consumers	Loss	Max. 35,000 lbs/day	Max. 29,000 lbs/day
	4.2 Fish [(1)]	Loss	Undefined	Undefined
5. Effect on Biota due to Parr Reservoir Fluctuations	5.1 Aquatic Biota	Loss of Fish	$210,000/year	$210,000/year

(1) Refers to organisms coming from Parr Reservoir compared to organisms being returned to Parr Reservoir.

TABLE S2-7 (Continued)

Primary Impact		Population or Resource Affected	Description of Effect	Nuclear Fueled	Fossil Fueled
6. Synergistic Effects of Chemical and Thermal Additions & Water Level Fluctuation in Parr Reservoir	6.1	Primary Producers & Consumers	Change in Production or Survival	Negligible	Negligible
	6.2	Fish	Change in Production or Survival	Negligible	Negligible
7. Water Quality	7.1	Physical	Increase in suspended Solid Content	Negligible	Negligible
8. Chemical Discharge to Water Bodies	8.1	People	Recreation Use	Applicable State Standards will be met	Applicable State Standards will be met
				No Change in Broad River Use	No Change in Broad River Use
	8.2	Water Quality - Chemical	Downstream Water Quality	Applicable State Standards will be met	Applicable State Standards will be met
9. Consumption of Water	9.1	People	Diminish Domestic Water Supply	None	None
				Low Flow Maintained Downstream in Broad River	Low Flow Maintained Downstream in Broad River
	9.2	Property	Degradation & Loss to Agriculture	No Significant Agricultural Users-Low Flow Maintained in Broad River	No Significant Agricultural Users - Low Flow Maintained in Broad River

TABLE S2-7 (Continued)

Primary Impact	Population or Resource Affected	Description of Effect	Nuclear Fueled	Fossil Fueled
10. Chemical Discharge to Ambient Air	10.1 Air Quality Chemical	Pollution of Local Ambient Air	None	Slight to Moderate would meet State Air Quality Standards
	10.2 Air Quality Odor	Odor in Gaseous Discharge or from Effects on Water	Negligible	Slight
11. Chemical Contamination of Ground Water (Excluding Salt)	11.1 People	Domestic Supply	Negligible	Negligible
	11.2 Plants	Trees, Deep Rooted Vegetation	Negligible	Negligible
12. Radionuclides Discharged to Water Body	12.1 People - External	Increase Over Natural Background	Less than 0.0001 rem/yr. (indiv.)	None
			Less than 1 man-rem/yr. (Population)	None
	12.2 People - Ingestion	Increase Over Natural Background	0.00012 rem/yr. (individuals)	None
			Less than 1 man-rem/yr. (Population)	None
	12.3 Primary Consumers	Increase Over Natural Background with Initiation of Concentration in Food Chain	Higher than Humans but so low as to be negligible with regard to damage	None

TABLE S2-7 (Continued)

Primary Impact	Population or Resource Affected	Description of Effect	Nuclear Fueled	Fossil Fueled
	12.4 Fish	Increase Over Natural Background	Higher than Humans but so low as to be negligible with regard to damage	None
13. Radionuclides Discharged to Ambient Air	13.1 People - External	Increase Over Natural Background	0.0017 rem/year	Negligible
	13.2 People - Ingestion	Increase Over Natural Background	Less than 0.0C01 rem/year (indiv.)	None
			Less than 1 man-rem/yr. (Population)	
	13.3 Plants & Animals	Increase Over Natural Background	Less than 0.001 rem/yr.	None
14. Radionuclides Contamination of Ground Water	14.1 People	Increase Over Natural Background	Less than 0.0001 rem/yr. (indiv.)	None
			Less than 1 man-rem/yr. (Population)	None
	14.2 Plants & Animals	Increase Over Natural Background	Less than 0.0001 rem/yr.	None
15. Fogging & Icing	15.1 People	Safety Hazards	Nearest Major Roadway One Mile, No Hazard	Nearest Major Roadway, One Mile, No Hazard
	15.2 Plants	Damage to Trees & Crops	No Effect	No Effect

TABLE S2-7 (Continued)

Primary Impact	Population or Resource Affected	Description of Effect	Nuclear Fueled	Fossil Fueled
16. Raising/Lowering Ground Water Levels	16.1 People	Decrease Domestic Supply from Wells	No Adverse Effect, Water Table Elevation may be increased	No Adverse Effect, Water Table Elevation may be increased
	16.2 Plants	Trees or Other Deep Rooted Vegetation	No Effect	No Effect
17. Land Use	17.1 Agricultural	Removal from Production	700 Acres or less than 1% of total County Farm Land $35,000/yr. Production	700 Acres or less than 1% of total County Farm Land $35,000/yr. Production
	17.2 Forestry	Removal from Production	8700 Acres or about 3% of total County Forest $78,000/yr. Production	8700 Acres or about 3% of total County Forest $78,000/yr. Production
	17.3 Plants and Animals	Loss of Habitat	Loss of about 9400 Acres of Pine and Hardwood Forest	Loss about 9400 Acres of Pine and Hardwood Forest
	17.4 Recreational	Disturbance to Parks, Lakes, Historic Sites	None Present	None Present
	17.5 Fishing	Loss of Fishing Potential due to Parr Reservoir Fluctuations	$18,000/yr.	$18,000/yr.
	17.6 Industrial	Unavailable to Development	No Effect	No Effect

TABLE S2-7 (Continued)

Primary impact	Population or Resource Affected	Description of Effect	Nuclear Fueled	Fossil Fueled
18. Ambient Noise	18.1 People	Unusually Loud	Negligible	Slight to Moderate
19. Aesthetics	19.1 People	In Terms of Sight, Sound, Odor	Disturbs Natural Setting	Disturbs Natural Setting
20. Impediments to Navigation	20.1 Waterway	Navigability	Broad River has no commercial navigation	Broad River has no commercial navigation
21. Degradation of Flood Control & Erosion	21.1 People & Property	Risk to Health and Safety	Has no implications for Flood Control	Has no implications for Flood Control

Radioactive emissions will meet the criterion of "as low as practicable", and the proposed Appendix I to 10 CFR 50. The predicted rem doses will be very low and in the opinion of SCE&G are not expected to have a damaging effect on aquatic organisms.

S2.6.3.3 Organisms from Parr Reservoir Entering Monticello Reservoir

Some deleterious effects on the primary producers and consumers and on fish life can be expected on those that are pumped from Parr Reservoir into Monticello Reservoir. Approximately 29,000 acre feet of Parr Reservoir waters along with plankton and an unknown proportion of fish will enter Monticello Reservoir daily. This is approximately 7% of the volume of Monticello Reservoir. These organisms may enter the plant cooling system or be affected by the thermal plume in Monticello Reservoir.

If there is no dilution of the water (pumped from Parr Reservoir) and associated organisms with those of Monticello Reservoir, then 2,350 acre feet of about 8% of the Parr Reservoir organisms will go through the Virgil C. Summer Nuclear Station condensers daily. A conservative estimate (over estimating the biological damage) is that there will be a 50% dilution of incoming waters with those of Monticello Reservoir and that 50%[1] of all of these organisms will

[1] It is unlikely that all, or even a major portion, will be killed at the predicted ΔT. Studies on periphyton at the Point Beach nuclear site (Ref. 4) did not show any demonstrable effect on algal growth in the vicinity of the thermal plume (a summer temperature rise of 20° F. is normal for this plant). A measure of effect on Parr Reservoir will be made during the operational phase of the biological sampling program from an empirical comparison of the abundance and species of plankters that are removed from Parr Reservoir with those returned to the system from Monticello Reservoir.

perish. On this basis about 2% of the total daily incoming organisms will perish. If the remaining organisms mix with populations developing in Monticello Reservoir to at least the extent of 50% before being returned to Parr Reservoir, the net loss to Parr Reservoir from organisms passing through the condenser system will be about 1%. This corresponds to about 35,000 pounds of plankton/day lost, as a conservative measure, based on the maximum abundance of plankton sampled in Parr Reservoir in June, 1971, (Appendix B1).[2] For a fossil fueled plant, the loss would be about 29,000 pounds of plankton/day, because of reduced thermal discharge to Monticello Reservoir.

Of those primary producer and consumer populations pumped up from Parr Reservoir that do not go through the condenser system, but are exposed to waters warmed by thermal discharge, an effect on population diversity and abundance may occur. Temperature profile maps from the results of model studies conducted by Alden Laboratories (Ref. 5) indicate that approximately 2/3 of the reservoir surface and depths of 15 feet or more below the surface do not experience more than 6° F. rise during the warmest summer conditions, based on a two-unit nuclear station. If we consider that the incoming water and organisms mix with 1/4 the volume of Monticello Reservoir and these in turn are distributed about the reservoir to a depth of 15 feet, the percent of organisms pumped from Parr Reservoir and exposed to the warmed plume would be approximately 7%. It is likely organisms will be distributed to a depth of greater than 15 feet, which will reduce

[2] Calculated on the basis of 4500 plankton/liter and weight of plankton at 10^{-5} grams each.

this figure further. This thermally affected group will be further diluted (by at least 50%) with populations within Monticello Reservoir before being returned to Parr Reservoir, so approximately 3.5% or about 120,000 lbs/day of the original amount will be affected. A portion of the mixture of Monticello and Parr Reservoir populations will return to Parr Reservoir. Fewer organisms would be affected by fossil fueled plant operations.

At present, there is little basis for estimating the numbers of fish that would be carried up to Monticello Reservoir and thus, the number that would be influenced by thermal effects in the reservoir. Some of the fish population developing in the reservoir would be expected to be pumped down to Parr Reservoir and thus balance any loss due to the facility operation. For this reason fish losses to Parr Reservoir through the intermediary of Monticello Reservoir are considered slight.

S2.6.3.4 Effect of Water Level Fluctuations in Parr Reservoir

The effect on aquatic biota as a result of daily water fluctuations on Parr Reservoir will probably be the most severe of all factors considered. The water fluctuations will cause periodic draining of the shallow area and reduction of the spawning area. These fluctuations are not the result of the nuclear station operations, but are due to the pumped storage operations, which are independent of the nuclear operations. These effects are discussed herein in the spirit of providing complete information regarding the impact of total project operations. A conservative approach has been taken, and the resulting environmental costs have been included in this analysis.

The present size of Parr Reservoir is estimated at 1,850 surface acres. It will be enlarged by an additional 2,550 surface acres when Parr Dam is raised approximately 9 feet.

There is as yet insufficient information for accurate assessment of population and standing crop sizes; however, Parr Reservoir does not appear to be a very productive body of water based on biological surveys performed and conversations with local fisheries biologist and fishermen. Because of high turbidity of the reservoir, the euphotic zone is severly reduced. Benthic organisms are not abundant. A productivity of fish on the order of 75 pounds per acre per year is considered conservatively high. These fish have been valued at an average of $1.50 per pound taking into account information on fish values established by the Southern Division of the American Fisheries Society (Ref. 6). On this basis, present annual value of fish in Parr Reservoir is estimated at about $210,000.

Observations made during quarterly biological surveys revealed a paucity of fishermen. No more than 10 fisherman were seen in any one day. This may be due partly to poor access to the reservoir shore and partly to relatively poor fishing. If an average of 10 people per day fish the reservoir, the total annual fisherman days equal approximately 3,650. Bureau of Sport Fisheries and Wildlife estimates each fisherman day is worth $4.98 (Ref. 7). Total annual value for sport fishing, then, is about $18,000. There is little other recreational use of the reservoir because of its shallowness and high turbidity, muddy bottom with stumps and dead trees in most parts of the reservoir, and poor access facilities.

If the total recreation and fishery is considered lost from Parr Reservoir as a result of water level fluctuations and their effects on aesthetics and biological productivity, the estimated annual monetary loss would be about $230,000. A realistic estimate, while still conservative, is a loss of 50% to 75% of the value.

The only additional environmental costs of nuclear operation would be possible synergistic effects of heat, chemical, and radioactive effluents added to the biological stress of water level fluctuations. These costs would be in addition to potential losses of biota due to thermal plume and entrainment effects. It is not believed that these synergistic effects will be significant for either a nuclear or fossil-fuel plant. Under the assumption that the production of young fish in Parr Reservoir is severly curtailed by exposing potential spawning areas, there may be some net benefit to Parr Reservoir from young fish produced in Monticello Reservoir moving down to Parr Reservoir.

The estimating procedures used for calculating losses of aquatic organisms conservatively overestimate the potential loss to the Parr Reservoir system. Partly this is to allow for effects which are imperfectly known and partly to estimate a maximum effect. A significant change in the biological community of Parr Reservoir in terms of aquatic resources potentially available to people would probably not occur from thermal discharges due to the mitigating effects of Monticello Reservoir. The greatest impact would be from the loss of shallow bottom area and spawning grounds due to water level fluctuations as a result of the pumped storage operations.

S2.6.3.5 Effect of Water Level Fluctuations in Monticello Reservoir

Daily water level fluctuations in Monticello Reservoir will be approximately 4½ feet. This will have a deleterious effect on the production of shallow water benthic organisms and on fish that may spawn in this area. The fluctuation, however, is not so great as to eliminate all spawning and a reduction in the production of young may actually be beneficial in allowing fewer fish to grow to larger size.

S2.6.3.6 Chemical Effluents and Water Quality

The systems for handling chemical discharges are in the early design stages and precise information on the design characteristics, types and quantities of materials to be handled, levels of treatment they will receive, and the methods to be used for their release is in the process of being developed. For other pressurized water reactors, sulfuric acid and caustic soda solutions are used in the water treatment plant for regeneration of ion exchange resins and various cleaning compounds are used throughout the plant. Chromates and borates are used at other locations in the plant. The Summer Nuclear Station will include provisions for neutralizing, pH and chemical testing of the chemical discharges. Chemical water handling systems will be provided to assure that discharges meet South Carolina Pollution Control Authority standards. A sewage treatment plant will be installed to process all domestic wastes from the Station. The treatment plant will be designed in accordance with applicable state and local regulations.

The South Carolina Pollution Control Authority adopted the "Water Classification - Standards System" for the state of South Carolina on September 8, 1971. Consistant with these standards, waters whose existing quality is better than the established standard will not be lowered in quality unless and until it has been affirmatively demonstrated to the South Carolina Pollution Control Authority that such change is justifiable as a result of necessary economic or social development and will not interfere with or become injurious to any assigned uses made to such waters. Any project or development which could constitute a new source of pollution or an increased source of pollution to high quality waters will be required by the South Carolina Pollution Control Authority as part of the project design to provide the highest and best degree of waste treatment practical under existing technology.

South Carolina Electric & Gas Company will meet the water quality standards adopted by the South Carolina Pollution Control Authority for the established classes for fresh waters:

(I) Class A waters are those suitable for use as swimming waters. Suitable also for other uses requiring waters of lesser quality.

QUALITY STANDARDS FOR CLASS A WATERS

Items	Specifications
1. Fecal coliform.	Not to exceed a geometric mean of 200/100 ml nor shall more than 10% of the total samples during any 30 day period exceed 400/100 ml.

Items	Specifications
2. Phenolic compounds.	Not gı-ater than 1 microgram per liter, unless caused by natural conditions
3. pH.	Range between 6.0 and 8.0, except that swamp waters may range from pH 5.0 to pH 8.0.
4. Dissolved Oxygen.	Not less than 5 mg/l, except that swamp waters may have an average of 4 mg/l.

(II) Class B waters are those suitable for domestic supply after complete treatment in accordance with requirements of the South Carolina State Board of Health. Suitable also for propagation of fish, industrial and agricultural uses and other uses requiring water of lesser quality.

QUALITY STANDARDS FOR CLASS B WATERS

Items	Specifications
1. Fecal coliform.	Not to exceed a log mean of 1000/100 ml based on five consecutive samples during any 30 day period; not to exceed 2000/100 ml in more than 20% of the samples examined during such period (not applicable during or following periods of rainfall).
2. pH.	Range between 6.0 and 8.5, excep. that swamp waters may range from pH 5.0 to pH 8.5.

Items	Specifications
3. Dissolved Oxygen.	Daily average not less than 5 mg/l with a low of 4 mg/l, except that swamp waters may have an average of 4 mg/l.
4. Phenolic compounds.	Not greater than 1 microgram per liter unless caused by natural conditions.

S2.6.3.7 Consumption of Water

No diminishment of the domestic water supply of downstream users along the Broad River will occur. The impounded waters of the Parr Reservoir will be regulated in order to meet the low flow volumes of the Broad River.

The water returned to the Broad River will not be degraded in quality due to the pumped storage operations and cooling uses; therefore, neither agricultural nor domestic water users will be affected. There are no large irrigational users downstream of the site.

S2.6.3.8 Chemicals Discharged to Ambient Air

There will be essentially no chemical discharges to the ambient air as a result of Summer Nuclear Station operations; however, chemical discharges would occur due to the alternative fossil fueled plant operations.

When fossil fuels are burned, combustible elements of the fuel are converted to gaseous products and the non-combustible elements to ash. Typically, more than 95% of these gaseous combustion products (Oxygen, nitrogen, water vapor, and carbon dioxide) are not presently known to be harmful and are therefore, not significant in terms of air pollution.

The noxious gases (oxides of sulfur, the oxides of nitrogen, and hydrocarbons)may be harmful to humans, plants, animals, and certain inert materials.

The sulfur oxide emissions for a hypothetical 1.6% sulfur coal will be about 70 pounds of SO_2 per ton of coal burned, or about 125 tons of sulfur oxide per day for a 900 megawatt plant. Sulfur oxide removal equipment is assumed to be available to remove about 60% of the SO_2 from the effluent, leaving 50 tons per day emission. The ground concentrations of SO_2 can be further reduced by careful plant sitings and selection of stack height, effluent temperatures and exit velocities. For a ground level release and no removal, the annual average concentration at the site boundary (worst sector) would be 1.6 ppm, for a conservative effective stack height of 500 feet, and under atmospheric neutral conditions the concentration would be reduced to .007 ppm (20 micrograms/cubic meter).

Nitrogen oxides are produced at the rate of about 20 pounds of NO_x per ton of coal. For a 900 megawatt plant, the NO_x daily effluent output into the atmosphere is about 70 tons per day. For no removal and a ground level release, assuming oxides of nitrogen such as NO_2, this output will yield an annual average concentration at the site boundary (worst sector) of 1.2 ppm. Under atmospheric neutral conditions, a 500 foot effective stack height would reduce this value to .005 ppm (15 micrograms/cubic meter).

In an atmosphere containing unsaturated hydrocarbons (which come from combustion of and evaporation of gasoline, kerosene and oils) the nitrogen oxides would react with the unsaturated hydrocarbons producing some odorous and visibility-restricting smogs.

Visible particulate emissions can be greatly reduced from stacks of coal fired units with modern electrostatic precipitators. Ninety-nine and five-tenths (99.5) percent removal is possible.

Proposed air quality standards for the State of South Carolina are indicated on Table S2-8. It is anticipated that these standards would be met if a fossil-fueled plant were constructed.

S2.6.3.9 Consideration of Radiological Impacts

The Westinghouse EAS waste processing system, described in Section 2.3.7 of the Environmental Report features hold-up of gaseous wastes except for containment purges and minor leaks and planned releases under controled conditions. Furthermore, it features liquid waste processing by filtration, evaporation, and ion exchange. Release estimates are within the numerical guides for design objectives set forth in the proposed Appendix I to 10 CFR 50 and are believed to be as low as practicable. Dose calculations made for this system are described in Section 2.3.7.

S2.6.3.10 Fogging and Icing

The increase in the frequency of fog, both advection and steam type fog, as a result of Monticello Reservoir were analyzed (Appendix B of Environmental Report). The frequency increase due to advection

TABLE S2-8

PROPOSED AMBIENT AIR QUALITY STANDARDS

STATE OF SOUTH CAROLINA

POLLUTANT	MEASURING INTERVAL	MICROGRAM/M^3 * **
Sulfur Dioxide	1 hour	790
	24 hours	260
	annual	45
Suspended Particulates	24 hours	250
	annual G. M. ***	70
Carbon Monoxide	1 hour	25×10^3
	8 hours	10×10^3
Photochemical Oxidant	1 hour	100
Non-methane hydrocarbons	3 hours	130
Gaseous Fluorides (as HF)	30 days	ugm/cm^2/mo. 0.3
Oxides of Nitrogen	annual	100

* Arithmetic Average except in case of suspended particulates.
** At 25° C and 760 mm Hg.
*** Geometric Mean.

type fog is an estimated 3.6% during the colder months with no estimated change in the summer months. Increases of up to 16% were estimated for the less significant, steam type fog. The effects of this increased frequency of fog would be generally limited to an area over Monticello Reservoir with only a few feet of inland penetration. This fog would not create a risk or safety hazard to vehicles on the nearest major roadway nearly one mile to the east of the site. No additional icing is expected due to operation of the Summer Station or fossil-fueled alternate.

S2.6.3.11 Raising or Lowering of the Ground Water Level

The impoundment of Monticello Reservoir will affect the existing water table by raising the present depth to ground water over the site. There should be no decrease in the domestic water supply from wells near the site as a result of the proposed construction. Rather, because of the expected higher water table, well yields may increase. The water yield from local wells is presently low, averaging around five (5) gallons per minute. This is due to the low permeability of the water bearing rock and the relative impervious surface soils. The only municipal use of well fields is at Jenkinsville, three miles southeast of the site. The increased demand for water uses of this town is expected to be low because of the forecasted negligible growth. Therefore, the construction and the operation of the project facilities will not affect the local ground water supplies.

S2.6.3.12 Land Use

To develop the proposed project, land will be taken out of production which will represent an environmental cost. The total land area which will be acquired or controlled by South Carolina Electric & Gas Company for purposes of both the Summer Station and pumped storage facility amounts to about 11,000 acres. The largest land requirements are about 6800 acres to be occupied by Monticello Reservoir and about 2550 acres which will be inundated by raising the level of Parr Reservoir. The remaining area will consist of land to be occupied by buildings, access roads, land reserved for recreational use and other project elements.

Land values in the area vary depending on the type of land and the existing timber stands on the lands. Timber stands will also vary in value depending on the species of timber and how recent the last timber cut was made. Value of pine stands in the area may vary from $100 to $250 per acre. Hardwood stands may vary from $100 to $200 per acre. It becomes hard to generalize on the value of hardwoods due to the wide range in values of the various species.

The land to be occupied by reservoirs can be broken down as follows: 700 acres of cleared land and approximately 6,100 acres of predominantly pine forest land, together forming the Monticello Reservoir area; and about 2,550 acres of established hardwood stands surrounding the existing Parr Reservoir. The loss of cleared land represents about 1% of the total agricultural land in Fairfield County, the loss of forested land is about 3% of the total forested land in Fairfield County.

Although only a very small percentage of the approximately 700 acres of cleared land in the project area is providing any income from agricultural products, it has been assumed that the total 700 acres produces income. A value of $50.00 per acre per year for agricultural land production is assumed. This would amount to $35,000 annually.

Pine forested land to be inundated totals about 6,100 acres. A conservatively highvalue for pine is assumed at $200 per acre per harvesting. Assuming that pine is harvested after 20 years growth, the pine yield value will equal $200 per acre per harvest or $10 per acre each year considering the harvesting is being done continuously. The value for the total 6,100 acres is $61,000 annually.

Hardwood inundated amounts to about 2,550 acres. A conservatively high value for hardwood of $200 per acre per harvesting is assumed. Also, assuming that hardwood is harvested after about 30 years growth, the hardwood yield value will equal $200 per acre per harvest, or $6.67 per year per acre considering the harvesting is being done continuously. The value for the total 2,550 acres is $17,000.

The total value of land use production for land inundated is $113,000 annually. If this value is capitalized at 8 percent, the value of lost production becomes about $1,400,000.

The impact on wildlife due to loss of forested habitat for reservoir impoundments was discussed in detail in Section 2.3.6.2 of the Environmental Report.

Biological surveys in the project area (Appendices A1 and B1) indicate 45 species of birds and 10 species of mammals. The bird species of most sport interest are the ducks, dove and quail found along the Parr

Reservoir waterway. Presently there are no indices of abundance available, however, surveys have not revealed high population levels. Hunting pressure appears light. Game mammals present are gray squirrel, cottontail rabbit and deer. These are not abundant in the area and little evidence of hunting has been seen.

Wildlife habitat will be removed by the proposed flooding of Monticello and Parr Reservoirs; however, this type of area is not unique in Fairfield county, nor are there concentrations of game animals in the project area.

The main coniferous species is the loblolly pine. Mixed forests of deciduous trees are most abundant along water courses in the lower areas. These are predominantly oaks, maples, hickory, dogwood and ash species. The greatest diversity of species is near the Frees Creek embayment.

Removal of the deciduous hardwood areas, particularly around Parr Reservoir, will have the greatest impact on wildlife habitat.

S2.6.3.13 Aesthetics

The evaluation of an aesthetically objectional or unpleasing scene is a difficult problem which is unquantifiable since it is subject to diverse points-of-view depending on the tastes of individuals.

The proposed facilities will be situated in a relatively remote, rural, and predominantly wooded and pasture area. The impact of the proposed project on aesthetics is discussed in Section 2.4.2 of the Environmental Report and procedures that will be taken to minimize visual impact are discussed in Section 2.3.6.3.

With respect to the aesthetic quality of the Summer Nuclear Station as compared to a fossil-fueled plant, it is generally considered that the visual impact of the fossil-fuel plant with its high stacks, plumes and fuel storage piles is greater than the nuclear facility.

The Summer Nuclear Station is not expected to have loud noises associated with its operation as compared to a fossil-fuel plant with its large storage, haul and switching facilities. It is believed that the highest level of noise above the natural background sounds will be during the construction phase of project; however, it would be only temporary.

S2.6.4 Environmental Enchancement and Benefits of Project

S2.6.4.1 Environmental Enhancement

As discussed in Section 2.3.6.3 of the Environmental Report, a Land Management Program will be undertaken by South Carolina Electric & Gas Company to alleviate any adverse effects of construction and to preserve or enhance the natural environment of its lands to the extent practicable. Programs of erosion control, timber management, wildlife management, landscaping and development of recreation potential will be undertaken.

The new Monticello Reservoir to be created will provide approximately 6,800 surface acres of water, an extensive shoreline, an area for aquatic life and a recreation area for people. The source of organisms in Monticello Reservoir will be from those brought up from Parr Reservoir, and although Monticello Reservoir will probably have a species diversity similar to that of Parr Reservoir, it can be expected to develop different species abundance due to the differing depth, current flow, and temperature characteristics. A fishing area or areas totaling about 150 to 250 surface acres will be established. They will be stocked with bream and largemouth bass in cooperation with the South Carolina Wildlife Resources Department, and an effort will be made to keep out other species of fish considered less desirable as sport fish. The fishing areas will be rather unique in the area, providing a different and qualitatively better habitat for sport fish. An estimation of the value of the fish produced in the fishing areas and Monticello Reservoir has been made based on pounds per acre produced in other South Carolina lakes (Ref. 8) and on dollar values per pound established in a 1970 report by the Pollution Committee, Southern Division of the American Fisheries Society. Table S2-9 gives the values reported for three lakes in South Carolina. Althrough an average value for fish of approximately $220/acre was arrived at for these other lakes, information from biological studies performed to date in Parr Reservoir suggests a lower value is more appropriate for Monticello Reservoir. The former studies were based on relatively clear lakes and on poisoning in cove areas where productivity may be expected to be greater than over the entire lake. A conservative value of 75 pounds per acre per year worth an average of $.50 per pound has been assumed for Monticello Reservoir. These estimates give a total production of about 495,000 pounds per year. A 33% reduction of this amount due to possible thermal, chemical and mechanical effects of the Summer Nuclear Station operation has been assumed leaving about 330,000 pounds worth about $165,000. The fishing areas will primarily have sport fish of higher value and because of greater water clarity will probably have a higher productivity of about 150 pounds/acre worth an average of $2.50 per pound. Using 200 acres as the size of these areas, this total fish resource is estimated at $75,000 annually.

The best estimate available for fishing pressure is from a survey being conducted by the South Carolina Wildlife Resources Department on eight major lakes of the State. The average number of fisherman-days per surface acre per year is estimated at about 3.3. This number of fisherman-days/acre/year is considered a reasonable estimate for fishing pressure on the developed fishing areas. The purpose of Monticello Reservoir is as a cooling impoundment and upper reservoir for the

TABLE S2-9

ESTIMATED VALUE/SURFACE ACRE FOR THE VARIOUS SPECIES FOUND IN LAKES WATEREE, MURRAY AND GREENWOOD

	Lake Wateree lb/acre	Lake Murray lb/acre	Lake Greenwood lb/acre	Average lb/acre	$/lb	Value $/acre
Sunfish	72	58	24.6	51.5	3.00	155.50
Crappies	--	7.8	3.1	3.6	2.50	9.00
Large Mouth Bass	8.2	13.7	14.2	12	2.50	30.00
White Catfish	15.8	7.4	4.0	9	1.00	9.00
Bullheads	.4	.6	1.9	1	.35	.35
Gizzard Shad	102.5	142.9	86.5	110.6	.15	16.65
Long-Nose Gar	--	.9	.1	.3	.25	.08
Shiners	1.7	--	.3	.6	.01	.01
Carp	4.3	9.3	--	4.5	.20	.90
Suckers	--	--	--	Trace	.30	--
TOTAL				193.1		221.49/acre

pumped storage facility; however, part of it will be available for fishing. Therefore, a value of one fisherman-day/acre/year is assumed for it. The value to fishermen is computed on the basis of $4.98 per fisherman-day as determined by the Bureau of Sport Fisheries and Wildlife (Ref. 7). The total potential fishing area consists of about 5,800 acres in Monticello Reservoir and about 200 acres in the fishing areas. About 800 acres of the Monticello Reservoir will be within the nuclear station restricted area. On this basis, there is a fisherman-value of about $32,170 per year. These values are approximations based on the best available data. Higher or lower values could result, depending on the data used and conditions assumed.

Other available water activities will include boating, water skiing and swimming.

In addition to fishing, various other recreational sites are being planned in the project area. Conversations with the South Carolina Department of Parks, Recreation and Tourism revealed there were no major parks or recreation areas in Fairfield County. Types of areas which are planned include parks, recreational activity areas, boat landings, and overlooks. Further development of the recreational potential of the area may be undertaken by the State of South Carolina.

The best estimate for attendance at the Monticello Reservoir recreational facilities are suggested by conversations with the South Carolina Department of Parks, Recreation and Tourism. In an adjoining county Chester State

Park with a 160 acre lake and facilities for picnicking, boating, and camping attracted approximately 60,000 user-days, during 1971, according to Parks Attendance Records Reports. Based on this attendance figure, and subtracting an estimated 6,500 fishing days (for which credit has previously been taken) and utilizing a value of $1.50 per user-day, the net annual value for recreation purposes is $80,000.

S2.6.4.2 Archeological and Biological Studies

Other benefits that will accrue as a result of the project will include the examination of four archeological sites in the area which will be funded by SCE&G. SCE&G is presently sponsoring phytoplankton studies in the project area by a graduate student at the University of South Carolina . Biological studies of aquatic and terrestrial species in the project area through a biological monitoring program is also being sponsored by SCE&G. At the present early stage of biological work a number of species of plants and animals have been verified as occuring in Fairfield county that have not appeared in the literature (Appendices A1 and B1).

S2.6.4.3 Educational Benefits

South Carolina Electric & Gas Company plans to construct an exhibit and educational center for the V. C. Summer-Fairfield Pumped Storage Facility. This center will provide the public with the opportunity to visit and learn about the project. It has been SCE&G's experience at other power plants and at the Carolinas-Virginia Tube Reactor project (now decommissioned) that youth, school, and other local groups request and receive permission to visit. SCE&G can assume that a significant number of people will wish to visit the center for this project; thus, it will serve as an educational facility.

The technology represented by this project and skills required of station personnel will enhance local interest in educational development; as an example, SCE&G has received inquiries from local parents in the project area requesting advice and information as to what education their children should pursue in order to be qualified for employment at the project.

S2.6.4.4 Taxes

The entire Summer-Fairfield Project lies within Fairfield County in South Carolina. Only the enlargement of Parr Reservoir will involve land in Newberry County. New industries such as power plants are exempted for five years from ordinary county taxes. Estimated taxes on the nuclear unit could range from $900,000 a year when the unit becomes taxable in 1978 for school purposes as well as for some federal and state levies, to approximately $1.3 million a year when the proposed nuclear unit will be fully taxable in 1983.

S2.6.4.5 Money Spent in the Area Due to the Project

The size of the project will result in the influx of many employees to the area. When Unit 1 of the nuclear station is completed, there will be approximately 63 full time employees; however, the greatest number of employees on the project will occur during the peak construction periods. Large payrolls during this time will result in money spent in the area which will increase the local gross income. The wage dollar spent will result in additional local gross income due to the wage multiplier effect.

Families will move into the site area due to the project. Both permanent homes and temporary housing facilities will result from the influx of employees. These people living near the project will spend a large portion of their income in the immediate area. Problems which will be created for local government by this influx of people include school facility loads, water and sanitary facilities requirements, and general increased requirements for local governmental services.

Winnsboro and Newberry, both about 15 miles away, and Columbia, about 30 miles away, are the closest existing areas which presently support retail and eating establishments. Due to the remoteness of the project from any major population centers, businesses will be drawn into the area. As more businesses appear, more money will be retained in the local area.

Interest in the project will result in money spent in the area by tourists. As can be seen at many other nuclear sites, the number of tourists can be significant. With people coming to the area to learn more about the project, the area should benefit from the increased travel of the public.

A project of this size will enhance the local gross income and provide a boost to the local economy.

S2.7 SUMMARY AND CONCLUSIONS

The decision-making process describing the benefits and costs and alternatives considered with regard to the proposed construction of the Virgil C. Summer Nuclear Station Unit 1 have been presented in Section S2.0. The technical and economic benefits of the power to be produced has been evaluated along with the environmental costs associated with the proposed project.

Studies and projections of power demands by SCE&G indicated the need for peaking and base load power. Alternative methods of providing this capacity were evaluated, and results of studies indicated the feasibility and advantages of a pumped storage-thermal electric generating power complex to provide both peaking and base load power at one site. Alternative sites were studied near the load center of Columbia, South Carolina, in an area which provided the required topography for project feasibility. The project site was selected based on consideration and balancing of economic and environmental factors. In Section S2.6.3, detailed evaluations were performed comparing the proposed Virgil C. Summer Nuclear Station with the alternative fossil-fueled plant to provide the base load for the power complex at the proposed site, considering both economic benefits and environmental costs. Finally, programs of environmental enhancement and other benefits of the proposed project were discussed.

The results of the nuclear vs. fossil fuel site analysis indicated a substantial economic benefit for nuclear generation. Environmental cost comparisons indicated a trade-off between nuclear and fossil-fueled generation. The Summer Station will discharge more waste heat to the environment, but since an off-stream cooling reservoir will be used as a heat sink, the impact on the Broad River, the natural body, is very small. The fossil-fueled plant would discharge some chemical contaminants into the air, and there would be a small effect on ambient air quality even though the plant would be designed to meet or exceed state air quality standards. Radionuclides would be discharged by the Summer Station, but the amounts released would only be a small fraction of the total background radiation and would be in compliance with AEC regulations. Aesthetically, the Summer Station would be more pleasing. The Summer Station would require a smaller commitment of natural resources. Weighing the technical and economic benefits with environmental costs, it has been concluded that the nuclear station represents a wiser use of man's and nature's resources.

The significant benefits and costs due to construction of the Virgil C. Summer Nuclear Station at the proposed site are summarized on Table S2-10. A study of the table indicates to SEC&G that the technical, economical, social, and environmental benefits of the proposed project that would accrue to the people of South Carolina outweigh the environmental costs.

TABLE S2-10

SUMMARY - BENEFITS - COSTS

COSTS	BENEFITS
1. Fish and Aquatic Organisms	
1.1 Primary Producers and Consumers Maximum Loss of 35,000 lb/day	
1.2 Fish	
Potential loss of the major portion of spawning area in Parr Reservoir; changing river habitat in 8 mile stretch of Broad River and approximately 4 miles of Frees Creek. Maximum estimated loss of $210,000 annually.	Creation of 6800 acre Monticello Reservoir. Establishment of fishing areas with 150-250 surface acres stocked with sport fish. Gain of fish in Monticello Reservoir and fishing area estimated at $240,000 annually.
2. Recreational	
Potential loss of fishing recreation in Parr Reservoir - estimated value $18,000 annually.	Gain of fishing recreation in Monticello Reservoir and fishing areas. Estimated value $32,000 annually.
	Establishment of park and recreational areas. Estimated value $80,000 annually.
3. Land Use	
Value of production from land removed from agricultural and forestry use. Estimated at $1,400,000 capitalized value.	

TABLE S2-10 (Con't)

COSTS	BENEFITS
4. Wildlife	
Habitat loss of 9400 acres consisting of mixed pine and deciduous hardwoods, including bottomlands.	Provision of wildlife refuge. Increased water fowl area, possibly attracting ducks to warmed water.
5. Biological Studies	
	Biological studies resulting in increased knowledge of biota. Documenting species and abundance of terrestrial and aquatic organisms of the area, many of which have not been previously reported.
6. Archeology	
Possible loss of 4 known archeological sites.	Funds for investigation of sites will be provided.
7. Economic Considerations	
	Capitalized value of choice of nuclear versus fossil estimated at $56,647,000.
	Taxes for Summer Station estmated as $47,000,000 over 33 years.

S3.0 TRANSPORTATION

S3.1 NEW FUEL

New fuel assemblies, consisting of pelletized uranium oxide encapsulated in zircaloy fuel rods, for the first core, and new fuel for several refueling regions will be shipped from the Westinghouse Nuclear Fuel Division Plant located about 10 miles southeast of Columbia on S. C. Highway No. 48. Trucks will probably be used to transport this new fuel over the approx. 40 miles to the site. Approximately 157 new fuel assemblies will be shipped onto the plant site initially. This will require about 16 truck shipments over a period of about 16 weeks. As the reactor requires refueling, additional new fuel assemblies will be shipped on site. Refueling will be required about once a year and about 55 new assemblies will be used. This will mean that about six additional truck shipments over a period of approximately 6 weeks prior to the refueling will be required. The new fuel assemblies will be shipped in containers which are approved by the Atomic Energy Commission and the Department of Transportation.

S3.2 IRRADIATED FUEL

Irradiated and spent fuel will be shipped to a licensed reprocessing plant in casks authorized by the Atomic Energy Commission and the Department of Transportation in accordance with applicable regulations. Spent fuel casks must be capable of withstanding, without loss of contents or shielding, the damage which might result from a severe accident. These containers will have been designed to protect their contents from damage during a hypothetical sequence of events consisting of a 30 foot drop onto an unyielding flat surface, followed by a 40 inch drop onto a 6 inch diameter steel bar. This is then followed by exposure to a 1475° F. heat source for 30 minutes, followed by immersion in water. The spent fuel casks will provide radiation shielding to limit the exposure of transport workers and the general public. Federal regulations governing the packaging and transportation of radioactive materials can be found in the Code of Federal Regulations. These federal regulations are administered by the U. S. Atomic Energy Commission and the Department of Transportation . Spent fuel will be shipped by truck and/or rail to a reprocessing plant. Truck casks are presently capable of holding two spent fuel assemblies per cask. One truck cask may be shipped per truck trip. Rail casks can hold about 10 spent fuel assemblies per cask with one cask shipped on a specially constructed rail car. It is anticipated that about 55 spent fuel assemblies will be shipped off site each year beginning with the first refueling period. If trucks are used exclusively, where will be about 28 shipments required per year, while exclusive rail cask use would require about 6 shipments per year.

At this time, no specific reprocessing plant has been chosen for the Summer Station spent fuel. However, the nearest proposed reprocessing plant is located near Barnwell, South Carolina, and it is estimated at approximately 100 miles from the station site.

S3.3 SOLID RADIOACTIVE WASTE

The solid waste disposal system of the Summer Station provides the capability of processing solid radioactive waste as follows:

a. Dry waste including · ;s, filters, clothing, paper and equipment.

b. Evaporator concentrates.

c. Spent resins.

d. Spent filter cartridges.

e. Processed chemical wastes.

Dry wastes are compacted into drums by a waste press and spent filter cartridges are packaged in shielded drums. All drummed solid wastes are provided with necessary shielding and monitored prior to off site shipment for disposal.

Evaporator concentrates and spent resins are pumped into shielded holding tanks. They may either be shipped as liquid waste or solidified and drummed.

The maximum amount of solid waste produced each year is expected to be approximately equivalent to the volume of 200, fifty-five gallon drums.

Depending on the radioactivity levels of the various solid wastes, they will be packaged in approved Type B containers or 55 gallon drums for shipment to a licensed radioactive waste burial site. No burial site has been chosen at this time for the radioactive wastes from the Summer Station.

S3.4 CONSTRUCTION MATERIALS AND EQUIPMENT

Virtually all equipment and materials for the Summer Station will be transported into the job site by rail and truck. Virtually all large components will be transported onto the job site by rail. A rail spur will be constructed from the Southern Railway Line, which runs along the east bank of the Broad River into the plant site, a distance of about 2.5 miles. Some barging into Charleston, South Carolina, or other nearby port, will be necessary for the largest components. Some modifications may be necessary to local bridges, roads and railroads for delivery of major components.

S3.5 CONCLUSIONS

Due to special packaging and shipping requirements set by the Atomic Energy Commission and the Department of Transportation, there is a high degree of assurance that there will not be any release of radioactive material. The safety record of the transportation of radioactive materials has been exceptionally good. Environmental effects should be limited to additional exhaust emissions from rail and/or highway vehicular traffic involved in transportation of materials and equipment for the Virgil C. Summer Nuclear Station, and the normal non-radioactive effects of any rail or vehicular accidents which might occur.

S4.0 ENVIRONMENTAL EFFECTS OF TRANSMISSION LINES

S4.1 INTRODUCTION

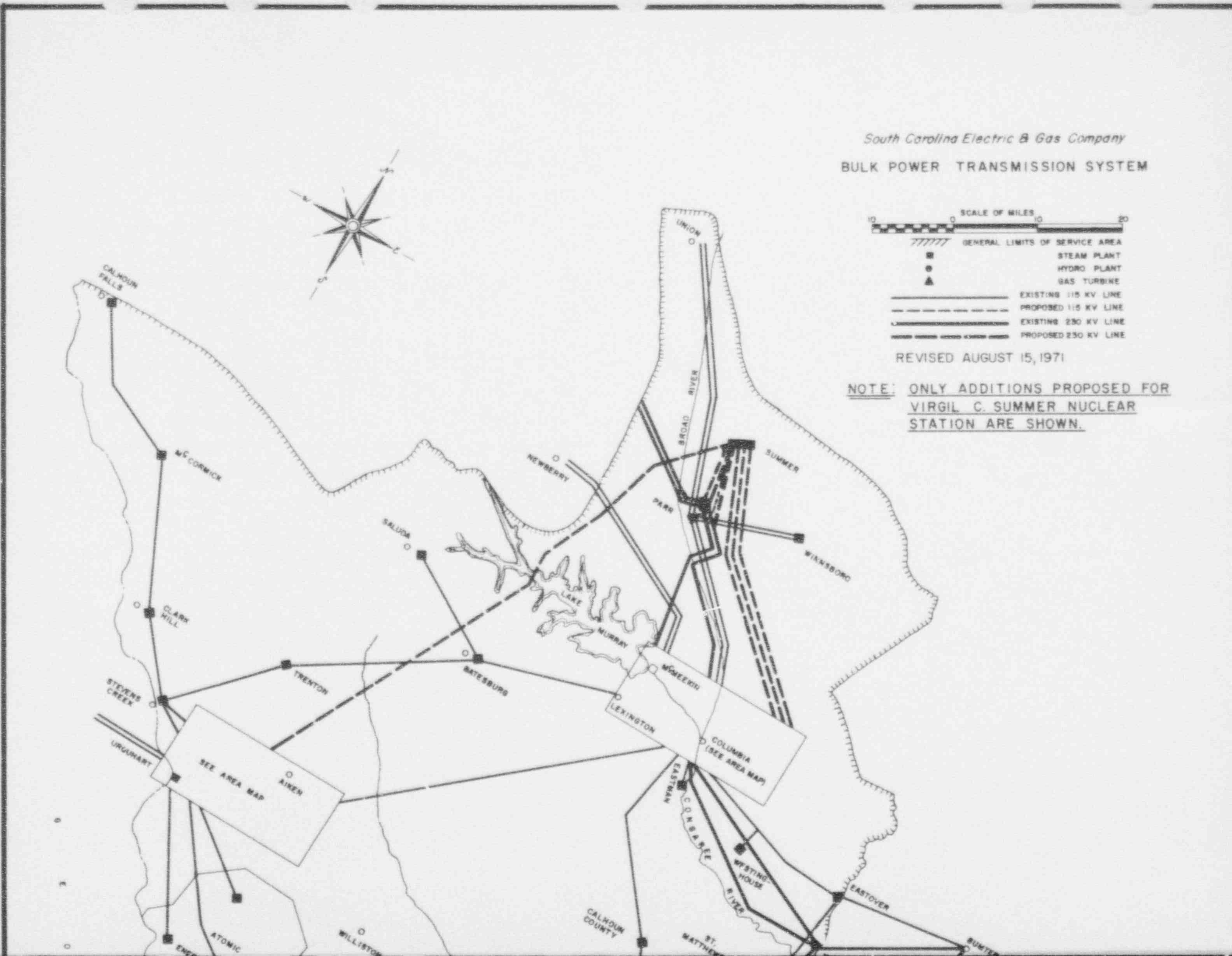
This section presents a general description of the environmental effects of transmission lines whose construction is necessitated by the additional electric power to be supplied by the proposed Virgil C. Summer Nuclear Station Unit No. 1.

The proposed lines to be constructed are (with approximate lengths):

1. Parr-Summer Safeguard 115 KV line (3 miles).
2. Summer-Denny Terrace No. 1 230 KV Line (3½ miles).
3. Summer-Parr (2 Circuits) 230 KV Lines (3 miles).
4. Summer-Pineland (2 Circuits) 230 KV Lines (28 miles).
5. Summer-Denny Terrace No. 2 230 KV Line (26½ miles).
6. Summer-Urquhart 230 KV Line (85 miles).

The proposed lines will start at the Summer Station Substation and terminate at existing substations or tie into the existing system grid. Preliminary locations of these lines are shown on Figures S4-1, S4-2, S4-3 and S4-4. Pertinent data regarding the planned transmission lines are presented on Table S4-1.

The general area along the proposed transmission line rights-of-way have been evaluated to ascertain the possible effects of construction on agricultural, forestry, residential, industrial, and recreational land use; and on the ecology and aesthetics of the general area in the vicinity of the proposed rights-of-way. Alternative routes will continue to be evaluated in order to provide for an optimum system consistent with environmental considerations.


South Carolina Electric & Gas Company
BULK POWER TRANSMISSION SYSTEM
SCALE OF MILES
10 0 10 20
GENERAL LIMITS OF SERVICE AREA
STEAM PLANT
HYDRO PLANT
GAS TURBINE
EXISTING 115 KV LINE
PROPOSED 115 KV LINE
EXISTING 230 KV LINE
PROPOSED 230 KV LINE
REVISED AUGUST 15, 1971
NOTE: ONLY ADDITIONS PROPOSED FOR VIRGIL C. SUMMER NUCLEAR STATION ARE SHOWN.
UNION
BROAD RIVER
SUMMER
PARR
WINNSBORO
NEWBERRY
SALUDA
LAKE MURRAY
CALHOUN FALLS
McCORMICK
CLARK HILL
STEVENS CREEK
TRENTON
BATESBURG
McMEEKIN
LEXINGTON
COLUMBIA (SEE AREA MAP)
URQUHART
SEE AREA MAP
AIKEN
EASTMAN
CONGAREE
RIVER
WESTING-HOUSE
EASTOVER
ATOMIC
CALHOUN COUNTY

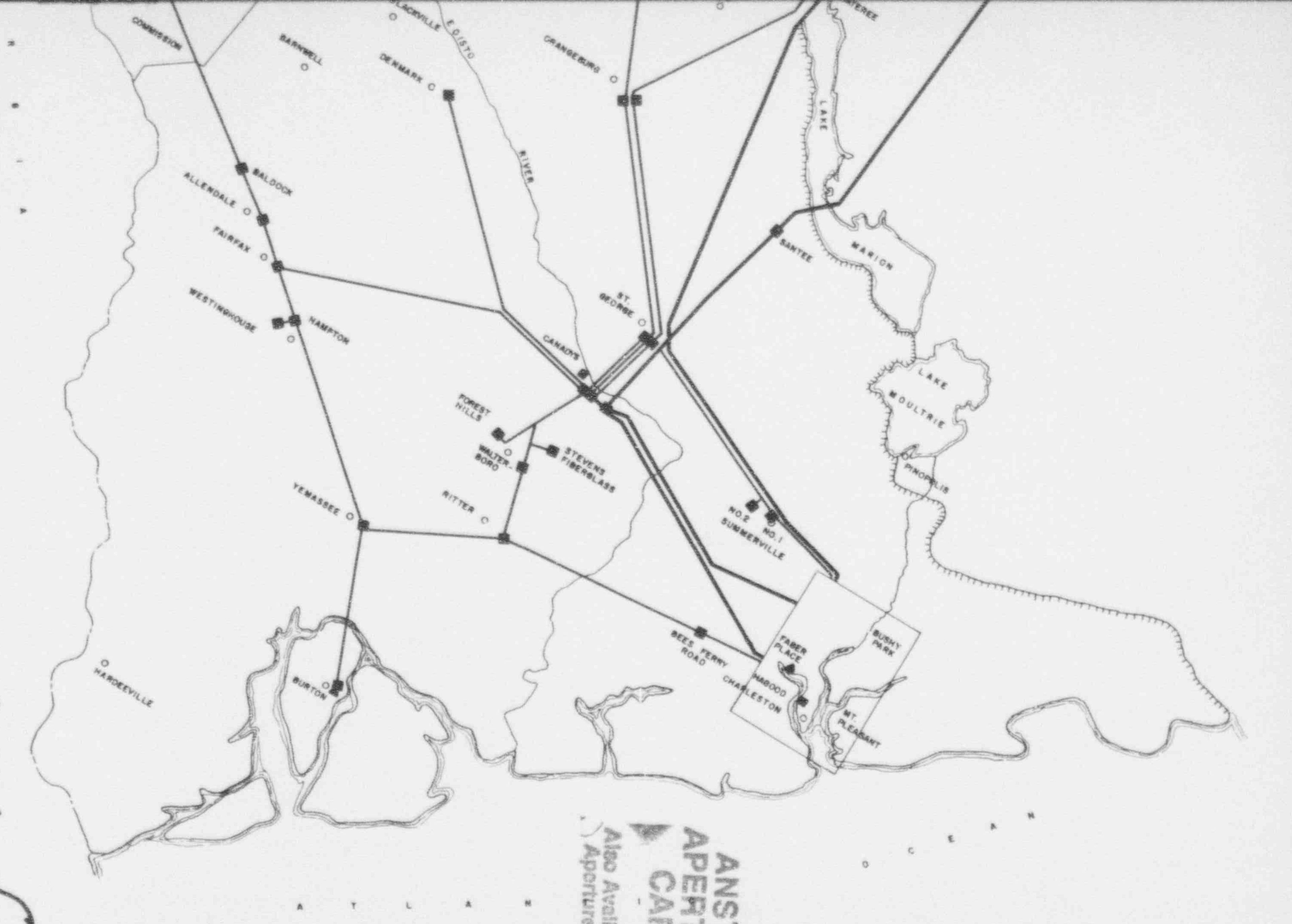
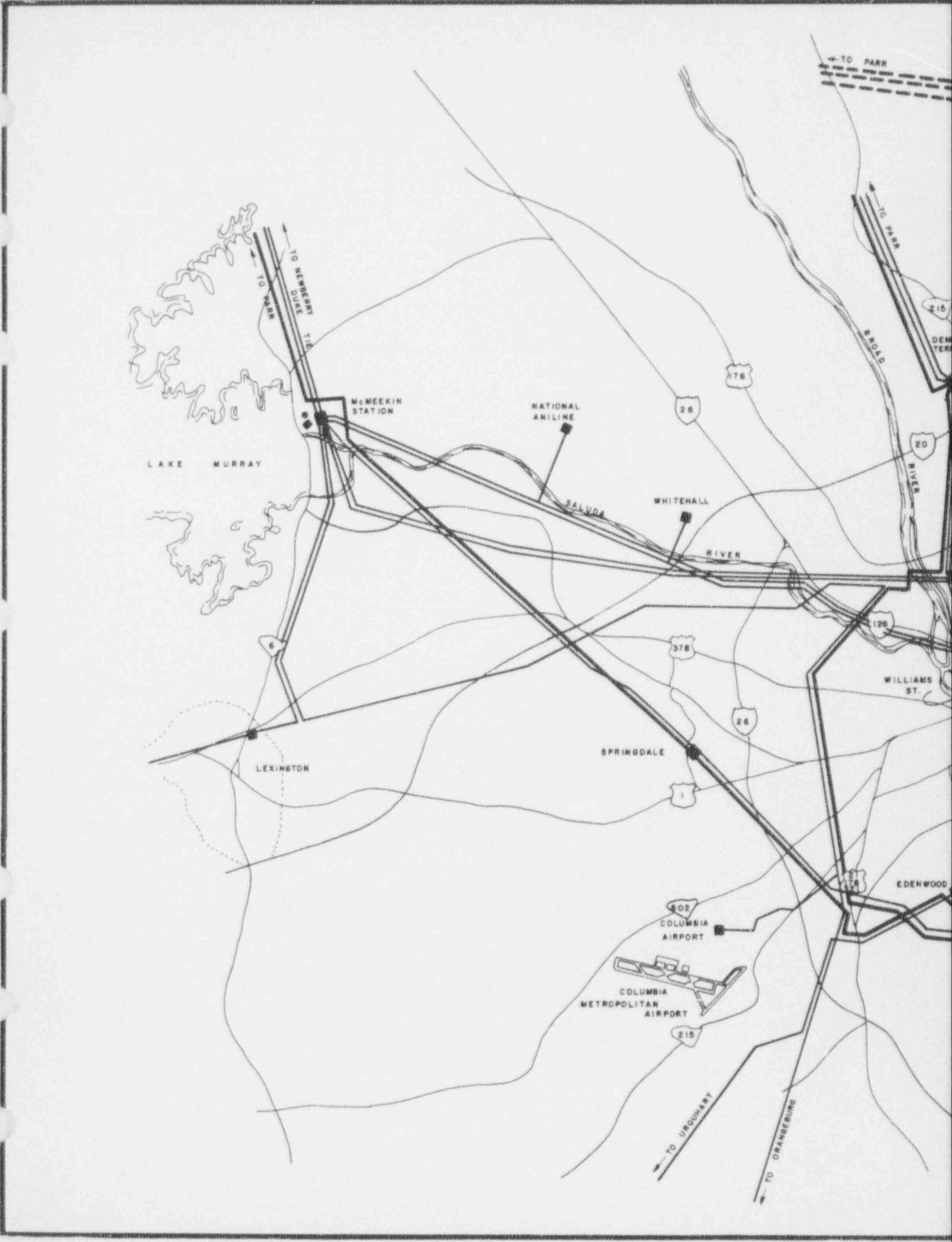
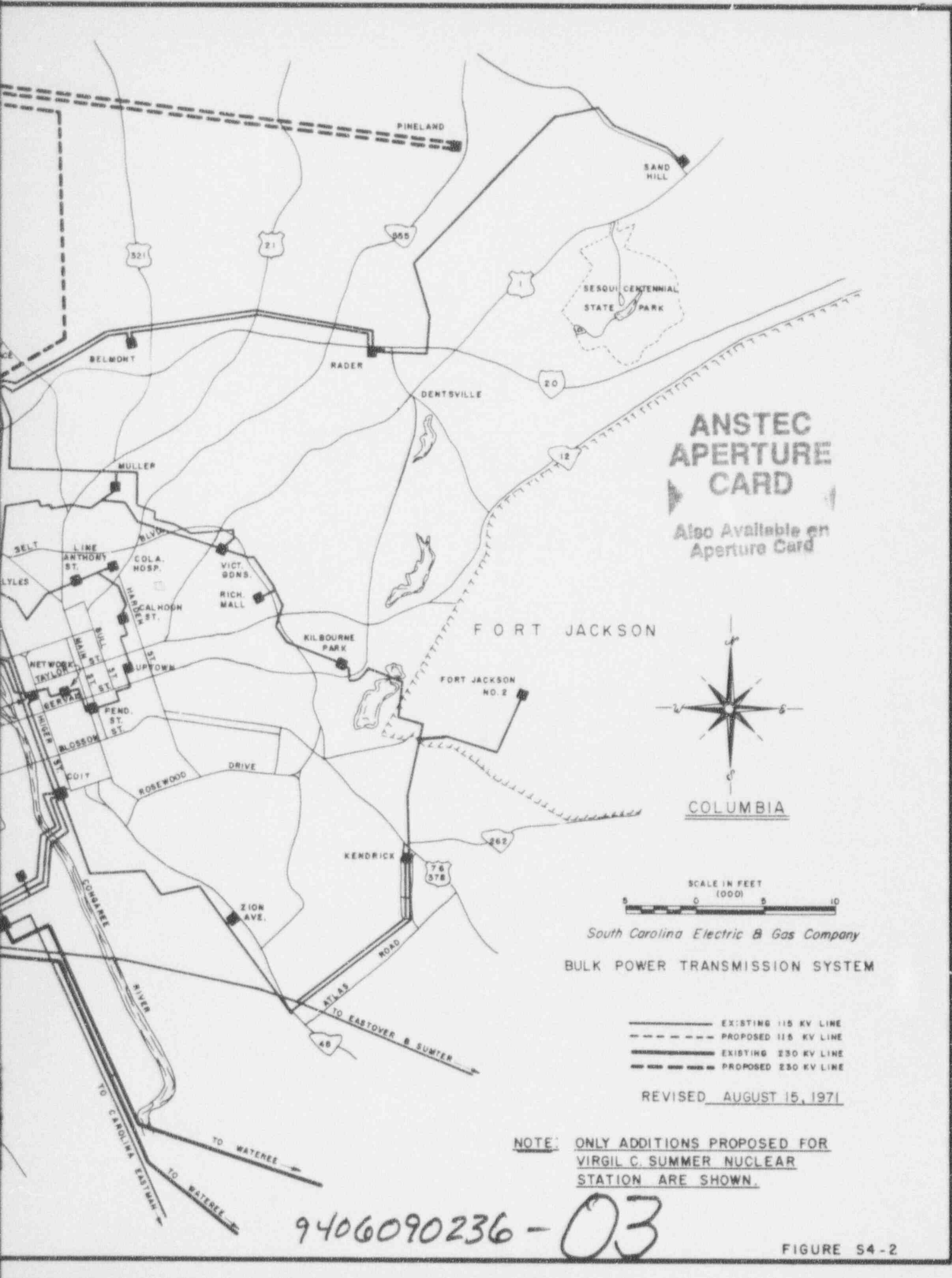


FIGURE S4-1

9406090236-02

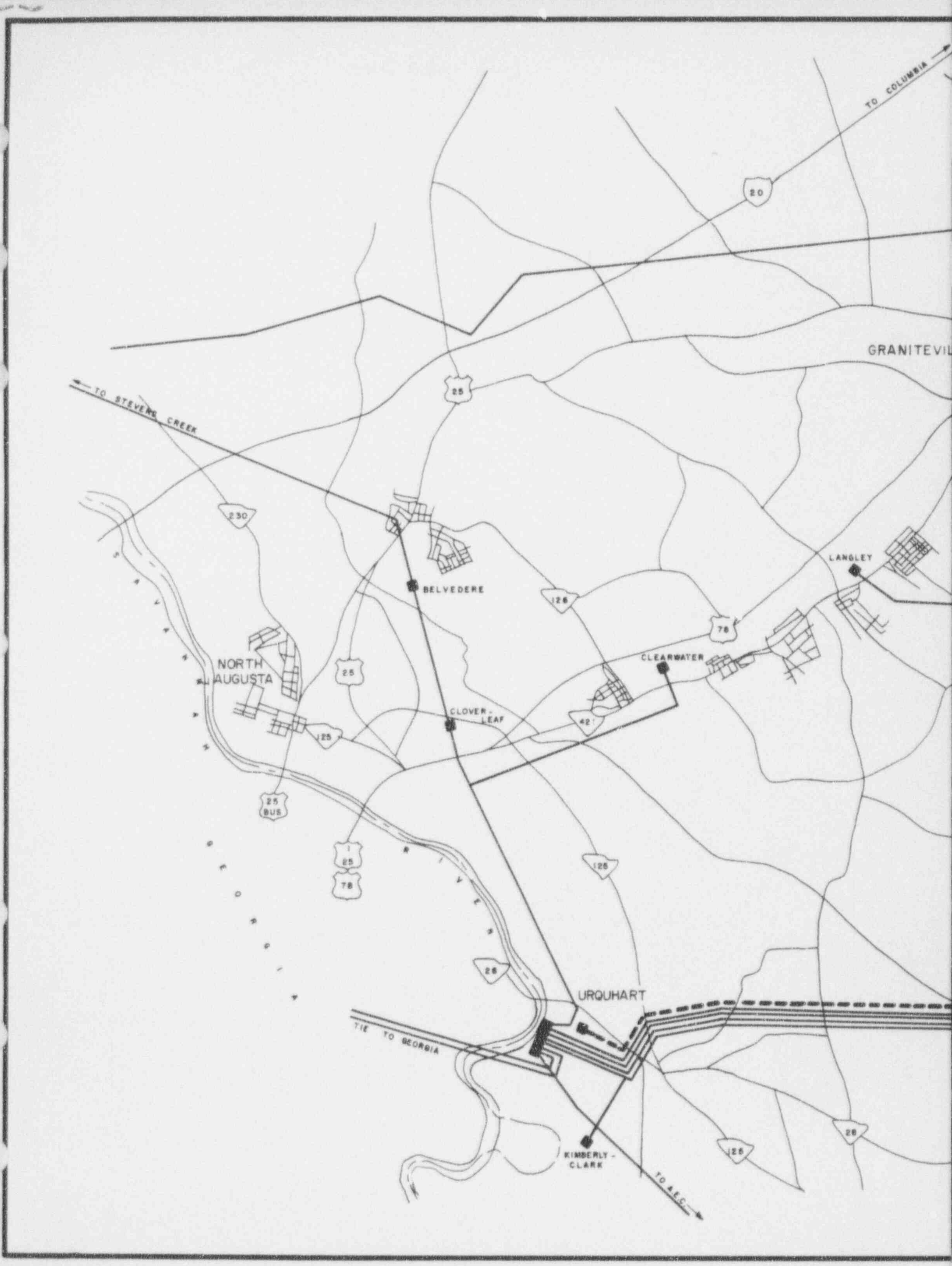


TO PARR
TO PARR
TO NEWBERRY
DUKE TIE
TO PARR
McMEEKIN
STATION
NATIONAL
ANILINE
LAKE MURRAY
SALUDA
WHITEHALL
RIVER
BROAD
RIVER
176
26
20
215
126
378
6
26
WILLIAMS
ST.
LEXINGTON
SPRINGDALE
1
EDENWOOD
302
COLUMBIA
AIRPORT
COLUMBIA
METROPOLITAN
AIRPORT
215
TO URQUHART
TO ORANGEBURG

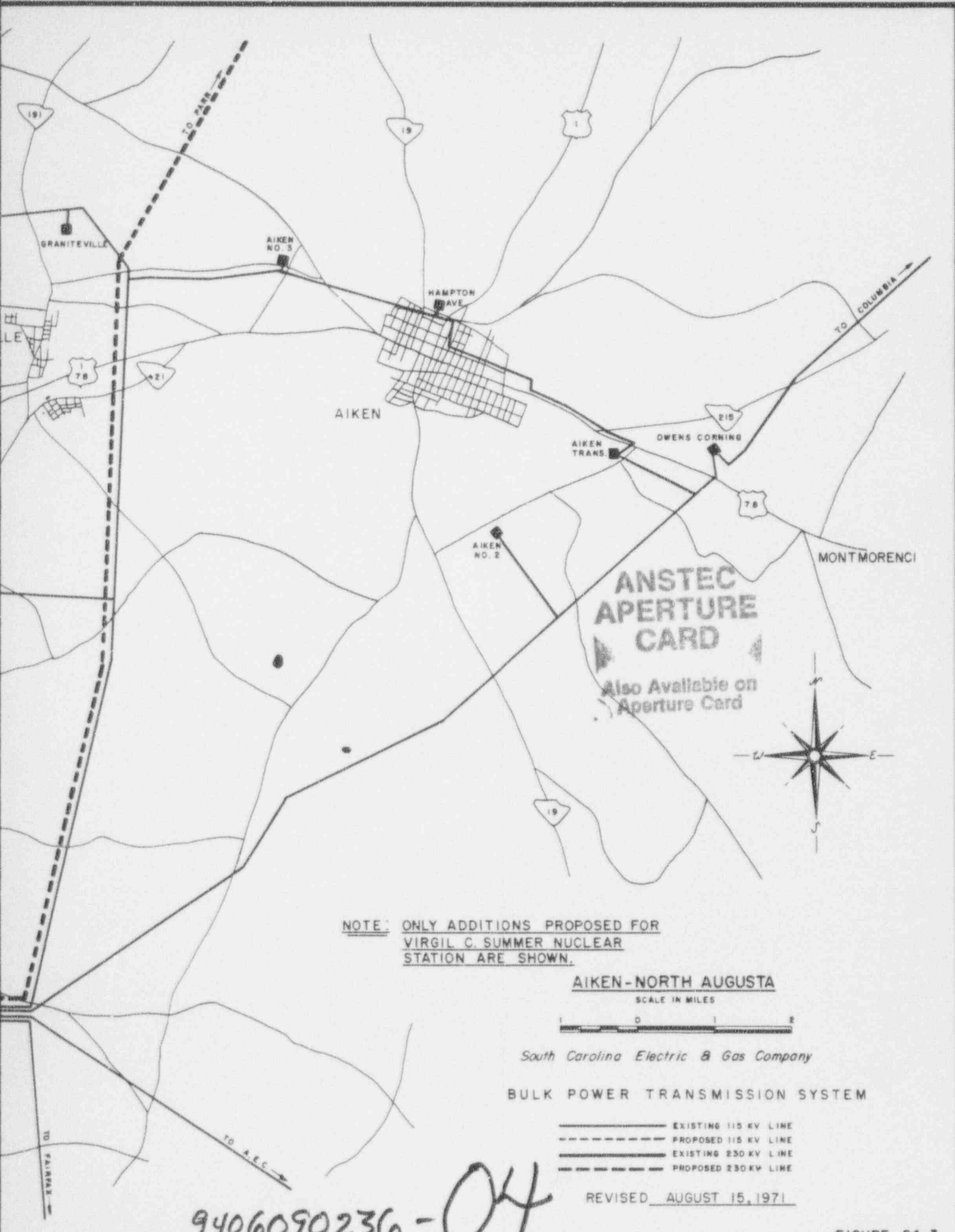


9406090236-03

FIGURE S4-2

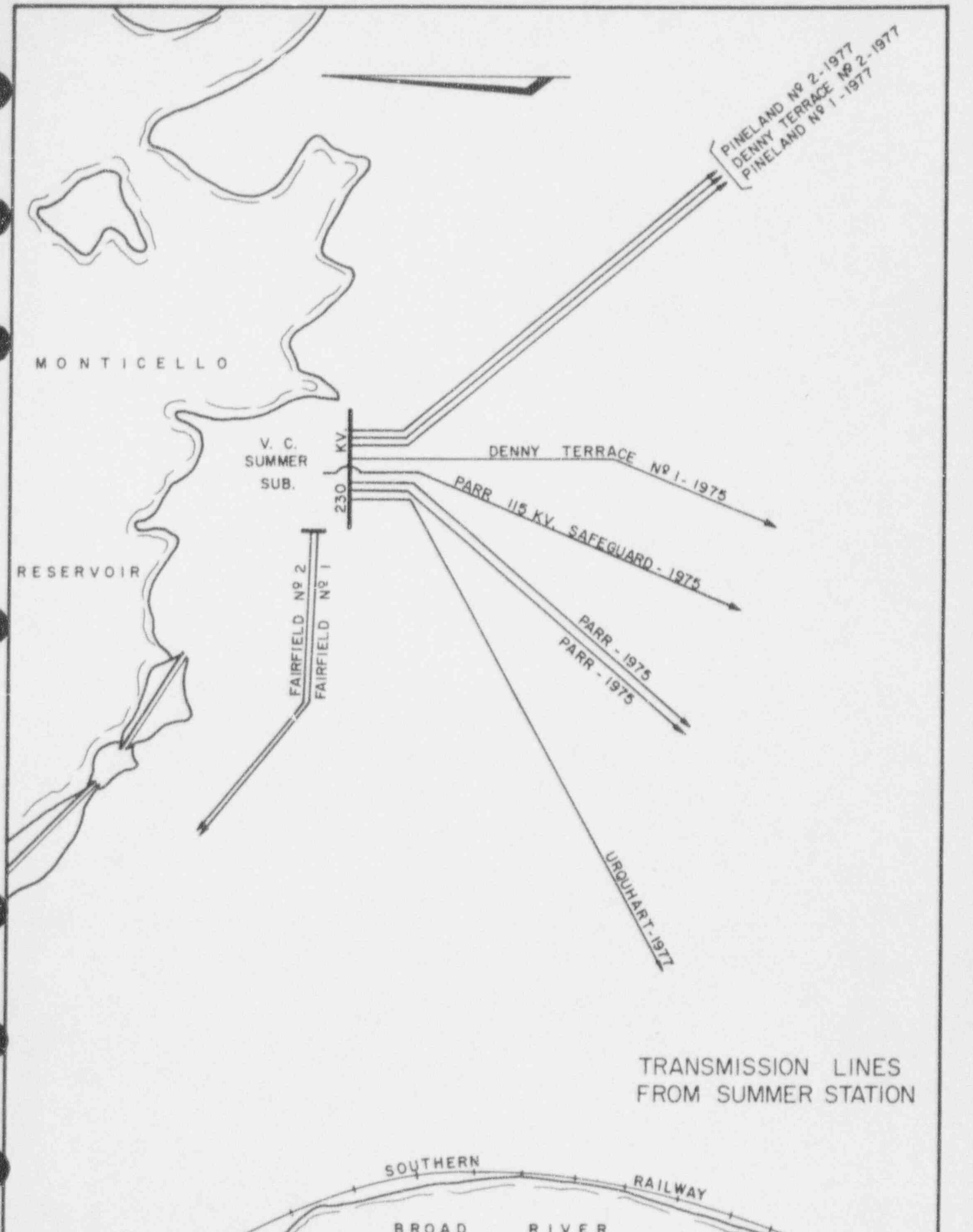


TO COLUMBIA
20
GRANITEVIL
TO STEVENS CREEK
25
230
BELVEDERE
126
78
LANGLEY
NORTH AUGUSTA
25
CLEARWATER
CLOVER-LEAF
421
125
25 BUS
1 25 78
SAVANNAH RIVER
GEORGIA
125
28
URQUHART
TIE TO GEORGIA
KIMBERLY-CLARK
TO A.E.C.
125
28



9406090236-04

FIGURE S4-3



TRANSMISSION LINES FROM SUMMER STATION

FIGURE S4-4

TABLE S4-1

TRANSMISSION LINE DATA

	Approx. Length of Line (Miles)	Right-of-Way Width (Feet)	Approx. Land Area Required (Acres)	Type of Pole or Tower	Approx. Number and Height of Poles or Towers	Type of Terrain
1. Parr-Summer Safeguard 115 KV Line	3	100	36	Wood H-Frame	8 Per Mile 60-65 ft.	Wooded, Hilly
2. Summer-Denny Terrace #1 Tie Line 230 KV	3½	100	42	Wood H-Frame	8 Per Mile 75-80 ft.	Wooded, Hilly
3. Summer-Parr (2 Circuits) Lines 230 KV	3	240[x]	87	Wood H-Frame	7½ Per Mile 75-80 ft.	Wooded, Hilly
4. Summer-Pineland (2 Circuits) Line 230 KV	19	240	553	Wood H-Frame	7½ Per Mile 75-80 ft.	Wooded and Open, Rolling
	9	100	109	Double Circuit Steel Towers	8 Per Mile 105-115 ft.	Wooded and Open, Rolling
5. Summer-Denny Terrace #2 Line 230 KV	19	xx		Wood H-Frame	7½ Per Mile 75-80 ft.	Wooded and Open, Rolling
	7.5	100	91	Wood H-Frame	7½ Per Mile 75-80 ft.	Wooded and Open, Rolling
6. Summer-Urquhart Line 230 KV	67	100	810	Wood H-Frame	7½ Per Mile 75-80 ft.	Wooded and Open, Rolling to Flat
	10	70[xxx]	85	Wood H-Frame	7½ Per Mile 75-80 ft.	Wooded and Open, Rolling to Flat
	8	Use existing R.O.W.		Double Circuit Steel Towers	8 Per Mile 105-115 ft.	Wooded and Open, Rolling to Flat

x Another Circuit Planned on This Right-of-Way for Another Future Project

xx Utilizes Same Right-of-Way as Summer-Pineland Line

xxx Parallels Existing Right-of-Way

Note: Minimum Ground Clearance Approximately 30 Ft. for All Lines

5-31-72

With the exception of an existing right-of-way where part of Line 6 will be constructed, practically none of the land along any of the proposed transmission line rights-of-way is currently owned by SCE&G.

A general description of the proposed transmission lines and their routes, the general characteristics of the areas through which the transmission lines pass, the possible environmental effects of these lines, and the provisions that SCE&G is and will be taking to minimize environmental impact is discussed in subsequent sections.

S4.2 TRANSMISSION LINE SITE DATA

S4.2.1 Transmission Lines in Project Area (Lines 1, 2, and 3)

S4.2.1.1 Location and Description

Three transmission line rights-of-way are planned in the project area. The approximately three-mile-long Parr-Summer Safeguard Line is a primary backup to the Virgil C. Summer Nuclear Station Unit No. 1 and will terminate at the existing Parr generating facilities, located southwest of the site along the Broad River. Two Summer-Parr 230 KV lines are approximately three miles long. These two lines will utilize the same right-of-way and terminate at the existing 230 KV substation at Parr. The approximately three and one-half mile long Summer-Denny Terrace No. 1 Tie Line will tie into the present Denny Terrace No. 1 Line near Parr.

S4.2.1.2 Population and Land Use

The proposed transmission lines will be constructed in a remote, rural area with no nearby residences and will not cross any highways or water courses. The closest community is Jenkinsville, a small unincorporated rural community, and the closest approach to houses by any of the transmission lines is about one mile. In Fairfield County, the total estimated population (1970 Census) was 19,999 with an average density of less than 30 people per square mile. No increase in population in the general county area is expected in the next forty years; in fact, a decrease is anticipated.

The area through which these lines will pass consists of hilly, rolling terrain which is forested. In Fairfield County, where these lines will be located, forest land occupies more than 80% of the total land area. Surface soils are typical of those encountered in the Piedmont region, and consist generally of stiff reddish-brown silts and clays. Maximum relief over the routes is on the order of 150 feet, ranging from Elevation 435 feet MSL to about Elevation 250 feet MSL at and near Parr.

No parks, national forests, or designated scenic, recreational or wildlife areas are near the proposed transmission line routes.

S4.2.1.3 Wildlife

The important game species in the region are deer, rabbit, squirrel, quail and dove. The area also contains other species including grouse, fox, mink, muskrat, opossum, otter, racoon and skunk. Forty-five species of birds are known in the project area. Water fowl utilize the Broad River as a nesting area. Wood ducks are considered resident species, and the Broad River is one of the major wood duck production areas in the Piedmont system. Detailed information regarding the wildlife in the area is presented in Appendices A1 and B1, which also includes descriptions of the aquatic biota. There are no known endangered species or unique habitats in the area.

S4.2.2 Summer-Pineland and Summer-Denny Terrace No. 2 Lines (Lines 4 and 5)

S4.2.2.1 Location and Description

The Summer-Pineland (2 Circuit) Lines will be approximately 28 miles long, running in a southeasterly direction and terminating at the Pineland Substation, located about six miles northeast of Columbia, the State capital. The Summer-Denny Terrace No. 2 Line will be constructed on the same right-of-way for about 19 miles. The remaining nine miles of the Summer-Denny Terrace Line will run in a generally southwesterly direction, terminating at the Denny-Terrace Substation, about two miles north of Columbia.

On the common right-of-way, the lines will generally run parallel to the Broad River, being about two to four miles east of the river. The lines will cross two state highways and a few unimproved and secondary roads, and will be generally parallel to State highway 215. The remaining portion of the Summer-Pineland lines will cross U. S. Highways 321 and 21 and a few other secondary roads. The remaining portion of the Summer-Denny Terrace No. 2 Line will cross State highway 215, a few secondary roads, and pass near Interstate 20 in order to tie into the Denny-Terrace Substation.

The lines will cross a few small creeks, the largest being the Little River, a tributary of the Broad River. The region through which the lines will be constructed generally consists of rolling terrain and is primarily forested. The lines will be constructed across wooded and open areas, and near Columbia, generally along, in and adjacent to low areas, such as creek bottoms and drainage areas. Surface soils in the area consist generally of stiff clays and silts on higher ground, and alluvial and/or swampy soils in creek bottoms and low areas. Maximum relief over the length of the lines is approximately 200 feet, grading lower away from the Summer Station.

S4.2.2.2 Population and Land Use

Most of the region through which the proposed transmission lines will be constructed is rural in nature and generally thinly populated. Columbia is the nearest city of any size, with a population of 113,542 (1970 Census). The population in the area around Columbia is expected to increase significantly in the future. Population statistics for the counties through which the transmission lines pass are as follows:

County	1970 Population	% Increase Since 1960	Average No. of Persons Per Sq. Mile
Fairfield	19,999	-3.4%	28.6
Richland (excluding Columbia)	120,326	16.8%	29.2

Forestry is the major land use with an average of about 65 per cent of the total lands in forest in the two-county area. Agricultural pasture plus crop land is the other major land use comprising an average of less than 20 per cent. Agricultural acreage is decreasing and is expected to decrease, especially in Richland County, where Columbia is located, due to increasing urbanization. Production from the crop land area of Fairfield County is rather low; in Richland County, the major crops include soybeans, oats, wheat, cotton, and other field crops. Livestock and livestock products are important commodities in both counties, and represent the major source of farm income.

Harbison State Forest is located across the Broad River from about a four mile segment of the planned transmission lines. The state forest is a minimum of five miles from the proposed lines. The transmission lines pass more than 0.6 miles from the Linrick Rural Recreation Area and Golf Course on Road 38 near Highway 215. No other parks, national forests or designated historic, recreational, wildlife or scenic areas are near the proposed right-of-way.

S4.2.2.3 Wildlife

Wildlife in the rural areas of the two-county region is typically the same as found in the site project area. There are no known endangered species or unique habitats.

S4.2.3 Summer-Urquhart Line (Line 6)

S4.2.3.1 Location and Description

The Summer-Urquhart Line will connect the Summer Station with the Urquhart Station at Beech Island, South Carolina, approximately 85 miles southwest of the proposed site. The first 67 miles will consist of new right-of-way, the next 10 miles would parallel an existing line and the final 8 miles will use existing rights-of-way.

The proposed line will cross over Interstates 26 and 20, and many other U. S., State and unimproved roads. The Broad River would be the major stream crossing, with many other crossings required over small creeks. The proposed line would also extend over the upper reaches of Lake Murray.

The proposed line would be constructed through predominantly rolling terrain, through forested and open areas, and agricultural lands.

Maximum relief over the proposed transmission line route is approximately 300 feet, varying from about Elevation 435 feet MSL at Summer Station to about Elevation 145 MSL at Urquhart Station. Surface soils vary from stiff silts and clays in the northern portion of the proposed transmission line, to sandy soils in the southern areas, to alluvial and swampy soils in creek bottoms and low areas.

S4.2.3.2 Population and Land Use

The three-county region (Newberry, Saluda, and Aiken Counties) through which the proposed transmission line will principally be constructed is predominantly rural. The largest cities within about five miles of the proposed transmission line include Batesburg, with a population of 4,036 (1970 Census), Graniteville, with a population of 1,127, and Gloverville, with a population of 1,682. Larger cities within about ten miles of the proposed transmission line are Aiken, (13,436) and Augusta, Georgia, including North Augusta (71,366). Population statistics of the three county region through which the transmission line will pass are as follows:

County	1970 Population	% Increase Since 1960	Average No. of Persons Per Sq. Mile
Newberry	29,273	-0.5%	46.2
Saluda	14,528	-0.2%	32.9
Aiken	91,023	12.3%	83.0

Forests occupy most of the land in the three-county region through which the line will pass, with agriculture the second major land use. The amount of forested land has generally increased in the period from 1958 to 1967 (years for which records are available), while the amount of potential agricultural land has decreased. Land use data for the three-county region is presented on Table S4-2. Major crops in the area include soybeans, peaches, and cotton and cotton seed; other vegetable and field crops are also produced. Livestock and livestock products comprise a major portion of the total farm income of these counties.

The proposed line will pass over the upper reaches of Lake Murray, a major recreational area. Otherwise, no parks, federal or state forests, or designated scenic,historic, wildlife or recreational areas are near the proposed right-of-way.

S4.2.3.3 Wildlife

Wildlife in the three-county region is similar to that found in the project area. As a result of continuing game management in Newberry and Saluda counties, deer herds and wild turkey are steadily increasing and the hunting of these species is generally good. Small game hunting in these areas is generally considered fair to good. There are no known endangered species or unique habitats in the three-county area.

S4.3 IMPACT OF TRANSMISSION CORRIDOR ON THE ENVIRONMENT

S4.3.1 Transmission Lines in the Project Area

S4.3.1.1 Impact on Present Population and Residential Land Use

The proposed transmission lines in the project area (Parr-Summer Safeguard Line, Summer-Denny Terrace No. 1 Tie Line and Summer-Parr (2 Circuits) Line) will be constructed through a hilly area that is remote from any residences. The closest approach of the proposed transmission lines to any residence in the area is approximately one mile. An increase in residential land use is not expected in the area;

TABLE S4-2

LAND USE DATA

		Newberry	Saluda	Aiken
Total County Land (Acres)		405,120	283,000	702,000
Federal Land (%)	1958	13.6	1.4	10.5
	1967	13.6	1.7	10.5
	Percent Change	0	+ .3	0
Urban & Build-Up (%)	1958	4.4	0.8	6.3
	1967	4.3	1.2	7.4
	Percent Change	- .1	+ .4	+ 1.1
Cropland (%)	1958	19.8	25.2	19.6
	1967	12.4	19.5	17.5
	Percent Change	- 7.4	- 5.7	- 2.1
Pasture (%)	1958	4.3	11.8	2.7
	1967	8.8	17.3	2.3
	Percent Change	+ 4.5	+ 5.5	- .4
Agricultural (Cropland plus Pasture)(%)	1958	24.1	37.0	22.3
	1967	21.2	36.8	19.8
	Percent Change	- 2.9	- .2	- 2.5
Forest (%)	1958	55.1	57.6	58.3
	1967	58.3	57.0	59.8
	Percent Change	+ 3.2	- .6	+ 1.5
Other Land (%)	1958	2.5	2.8	2.2
	1967	2.1	2.8	2.1
	Percent Change	- .4	0	- .1

rather, a slight decrease is expected due to population migrations to urbanized areas. The proposed lines, therefore, should have virtually no effect on the residences in the area from a safety, nuisance or aesthetic viewpoint.

S4.3.1.2 Impact on Agriculture

There are no agricultural activities in the area through which the transmission lines will pass. Therefore, there will be no impact on agriculture.

S4.3.1.3 Impact on Forestry

Approximately 80% of the land in the general area (Fairfield County) is forested. The proposed transmission lines will be constructed through entirely forested areas. Forestry products represent a significant source of income (24.3% in 1969) in the county from farm marketings, but the total land area required by the rights-of-way of the proposed lines will amount to less than 0.1% of the total forested land in the county. The main effects of clearing the rights-of-way through the forested area would be related to disturbance to a small part of the natural setting and resulting changes in the wildlife habitat.

S4.3.1.4 Impact on Wildlife

As a result of clearing of rights-of-way associated with construction of the transmission lines, there will be some unavoidable effects on wildlife habitat. These effects are not all necessarily adverse; in fact, some of the changes in the habitat may benefit certain wildlife species. For example, it is generally considered that the extensive growth of bushy vegetation on cut-over land following logging of major forests is a factor in helping to increase deer population. Similarly, the added edge created by clearing a corridor through heavily wooded areas will permit greater sunlight penetration and favor the growth of low growing weeds and woody plants that are important food sources to certain species.

There will be some impact on wildlife inhabiting the wooded areas to be cleared. A total of approximately 165 acres of generally pine forests would be cleared. Animals displaced would probably migrate into unoccupied "niches" in adjacent areas. Since the forest habitat disturbed is an insignificant amount of the total forested land in the area, this impact is considered practically nil.

S4.3.1.5 Impact on Aesthetics

Since the proposed transmission lines are in a remote area, well away from residences and do not cross any roads, the opportunities to view the line would be minimal. From this standpoint, the impact of the proposed transmission lines on aesthetics would be negligible. Nevertheless, SCE&G plans to make certain provisions in design and construction in order that the transmission lines would blend into the natural environment as much as possible. These procedures are discussed in Section S4.4.

S4.3.2 Summer-Pineland and Summer-Denny Terrace No. 2 Lines

S4.3.2.1 Impact on Present Population and Residential Land Use

The Summer-Pineland and Summer-Denny Terrace No. 2 transmission lines, for the most part, will pass through a rural area that is generally sparsely populated. With the exception of the areas where the lines terminate, near Columbia, the population density along the routes is less than 30 people per square mile. It is planned that the proposed transmission lines would generally be at least a few hundred feet away from existing residences, so that the lines should have virtually no effect from the safety or nuisance standpoint. Over most of the transmission line routes, populations are not expected to increase; thus the transmission lines are not expected to significantly affect future uses of land for residential purposes. Near the termination of both the Summer-Pineland and Summer-Denny Terrace No. 2 Lines near Columbia, increasing urbanization is expected to increase population densities.

S4.3.2.2 Impact on Agriculture

The proposed lines would be constructed over an insignificant amount of cultivated land, so that the effects on agriculture would be negligible.

S4.3.2.3 Impact on Forestry

Except near their termination points, practically all of the rights-of-way for the proposed lines would be constructed through forested areas As discussed in Section S4.3.1.5, forestry products represent a significant source of income in Fairfield County; but they are only a small source of income in Richland County. The estimated amount of forested land which would be removed for the proposed transmission line rights-of-way would be less than 800 acres, or less than two-tenths of 1% of the total forested land in the two counties through which the transmission lines will be constructed. From this standpoint, it is considered that the impact of the lines on forestry is slight. The main effects would be related to disturbance of the natural setting and resulting changes in wildlife habitat.

S4.3.2.4 Impact on Wildlife

Since the proposed line will be constructed primarily through forested areas, there will be a loss of wildlife habitat. The impact on wildlife would be essentially as discussed in Section S4.3.1.4.

S4.3.2.5 Impact on Aesthetics

It is believed that one of the most important impacts on the environment due to construction of the proposed lines will be related to aesthetics. An evaluation of this impact, however, is difficult to make, even in a qualitative manner. It is necessarily a subjective analysis and is unavoidably biased by individual backgrounds and experiences and there obviously can be many diverse points of view.

For the purpose of this evaluation the view of those persons who would consider a transmission line and related right-of-way treatment inherently unattractive and displeasing to the visual sense has been taken. The evaluation is further based on the premise that, regardless of an individual's opinion of transmission lines he must first see it in order to react; that is, it must be so apparent within his range of perception that he can not help but take note of its presence. Therefore, one method to evaluate the impact of transmission lines on aesthetics is to consider its ease of visibility from vantage points which would be ordinarily available to the largest proportion of people living in or traveling through the area. A second method is to evaluate the impact on aesthetics in terms of the design of transmission poles and towers and the effects of expected clearing and construction procedures employed along the proposed right-of-way. The former method is discussed in this section. Planned design and construction procedures are discussed in Section S4.4.

The ease with which people would be able to see the transmission lines varies with distances from the line and whether their views are screened by intervening hills, vegetation or other obstructions.

For the most part, the transmission lines would be constructed through a wooded area. A major portion of the lines parallel State Highway 215, along which much of the rural population lives. The proposed line would be sufficiently far away from the road so that passing motorists would not be able to see this portion of the lines. The lines would also in general be sufficiently set back from houses, with a "buffer" wooded area between the right of way and houses, such that the visual impact would be minimal. Furthermore, the heights of the wood H-frame poles which would be used along this portion of the lines are generally not as tall as the surrounding trees which would further screen the transmission lines.

The most significant visual impact of these lines would be at road crossings, and in the areas where the lines terminate at their respective substations near the Columbia metropolitan area, where more exposure to people is probable.

The proposed transmission lines would cross over several creeks, the major one being Little River. The visual impact at these crossings would be practically nil, since the crossings would be in remote areas and the creeks are generally not accessible to boating.

S4.3.3 Summer-Urquhart Line

S4.3.3.1 Impact on Present Population and Residential Land Use

The proposed transmission line will pass through a rural area that is generally thinly populated. The largest centers of population in the three-county area through which the transmission line will pass are Batesburg, Graniteville, Gloverville, Aiken and Augusta. However, the proposed line will be at least a few miles from the smaller towns and more than five miles from the larger cities so that very little impact is expected on the existing population. Increasing urbanization and future residential use of land near the larger cities of Aiken and Augusta could possibly encrouch close to the proposed transmission line right-of-way. Population densities in Newberry and Saluda Counties, through which about one half of the transmission line will pass, is less than fifty persons per square mile, and based on projections of census data, is not likely to increase significantly in the future. Because of the low populations, the proposed line should have little effect on residences in these two counties from a safety or nuisance viewpoint. It is judged that the impact on residential land use would be higher in Aiken County, especially around the larger population centers as a result of probable increase in urbanization. Even in these areas, the impact on present population and residential land use is not expected to be significant.

S4.3.3.2 Impact on Agriculture

The proposed transmission line will pass through a significant portion of agricultural land. (Table S4-2). Aside from the minor nuisance of operating farm machinery around the foundation of the poles, and the interference with aerial spraying of crops, there will be only a small loss of land from agricultural production.[1] Foundations of the wood poles that will predominatly be installed for the transmissionline do not take up much space.

Future damage to crops could occur during maintenance of the line. Routine maintenance expected is not likely to result in damage to crops or lands. Since it is not possible to predict the nature of the emergency repair work, this type of impact on agriculture cannot be evaluated. In any event, farmers will be compensated for damages caused by SCE&G during maintenance and repair operations.

S4.3.3.3 Impact on Forestry

A significant portion of the proposed transmission line will be constructed through forested areas (see Table S4-2). Forest products are not a significant source of farm income in the three-county area, so the removal of forested areas along the proposed right-of-way will not have a significant effect on the industry. The loss of forest land due to the construction of the transmission line is conservatively estimated to be about one percent of the total forested acreage in the three-county area. The primary impact would be that resulting from disturbance to natural settings and loss of wildlife habitat.

(1) This will be compensated by monetary consideration when right-of-way is acquired by South Carolina Electric & Gas Company.

S4.3.3.4 Impact on Wildlife

There will be some unavoidable effects on wildlife habitat due to the construction of the transmission line through forested areas. As indicated in Section S4.3.4, however, there are certain beneficial effects of clearing a corridor through heavily wooded areas. It would appear that the beneficial effects balance the adverse effects, especially since only a small portion of the total existing forested area would be removed and animals displaced could easily migrate into adjacent forested areas.

Only temporary disturbance to wildlife would be experienced in those areas where the proposed transmission lines would cross meadows and pastures, as regrowth would take place quite quickly.

Temporary adverse effects on wildlife could occur during construction of the proposed line, especially in or near water and swampy areas. Use of construction equipment in these areas would disturb the natural environment. Certain aquatic biota would probably be adversely affected; however, the impact would be temporary. Upon completion of construction, it is expected that the aquatic ecosystem would soon return to equilibrium.

S4.3.3.5 Impact on Aesthetics

The impact of a proposed transmission line on aesthetics has previously been discussed in Section S4.3.2.5. The proposed Summer-Urquhart line will cross the Broad River, the upper portion of Lake Murray, many other small creeks and associated swampy areas, two interstate highways, and many other primary and secondary roads. Thus, there would be many areas where the proposed transmission line could be viewed by individuals, even through major portions of the line will be constructed through forested areas where they will be concealed. Construction of the proposed line across open areas, although set back a distance from adjacent roadways, would still have a visual impact. Thus, for the Summer-Urquhart line, there will be a number of cases in which visual impact cannot be eliminated or minimized, with exposure to relatively large numbers of people. The degree of regard to aesthetics would predominatly be a function of the tastes of an individual viewer.

S4.4 DESIGN AND CONSTRUCTION PROCEDURES TO MINIMIZE ENVIRONMENTAL IMPACT

SCE&G is aware of its responsibilities to provide low cost, reliable electric power to meet the rising demand of its customers. At the same time, it is mindful of its obligations to provide the necessary facilities in a manner which will have a minimum effect on the environment. To this end, the Company has committed major expenditures to minimize emissions to the environment from existing plants, and is pledged to meet its environmental obligations with respect to the proposed Virgil C. Summer Nuclear Station Unit No. 1, as described in the Environmental Report and this supplemental report. SCE&G will continue in this spirit with respect to the construction of the proposed transmission lines required in connection with the Virgil C. Summer Nuclear Station Unit No. 1.

The proposed transmission lines will be designed and constructed by SCE&G using the Federal Power Commission Order No. 414 of November 27, 1970, "Protection and Enchancement of Natural, Historic, and Scenic Values in the Design, Location, Construction, and Operation of Project Works" as its guide (Ref. 9). Other than Lake Murray, the proposed transmission line rights-of-way will avoid historic places, natural landmarks and officially designated parks, scenic, wildlife and recreational lands.

Along approximately 90% of the rights-of-way of the proposed transmission lines, wood H-frame pole construction will be utilized. Since major portions of the rights-of-way will be through wooded areas, there will be maximum compatibility with the environs. Also, the generally low height of these poles (75-80 feet) would provide for maximum screening, thus reducing visual impact. Near Columbia and in certain other areas, steel towers will be utilized to minimize the amount of rights-of-way required and in this section eliminate the necessity of guys at angle points, which would encroach upon adjacent property. Where possible, densely populated areas will be avoided and rights-of-way will be sufficiently set back, a few hundred feet, from isolated houses to minimize nuisance and aesthetic impact. At all crossings of major roads, measures will be taken to avoid long tunnel views. Major water crossings, such as at Lake Murray, would be made at those locations which would minimize aesthetic impact. Precautions will be taken to assure that construction activities along the rights-of-way in the vicinity of streams will not lead to erosion, sedimentation or other disturbances that would affect water quality.

SCE&G is presently conducting an experiment in screen planting. A vegetative program will be implemented particularly in areas where the corridor transects roadsides. Plantings of selected species in these areas will be accomplished to improve the aesthetics, and provide wildlife with cover, food and the highly important travel lanes, connecting one wooded area or kind of habitat with another. Where applicable, plantings ould be arranged with taller plants along the edge of the right-of-way and their successively smaller plants and grass along the centerline.

S4.5 CONCLUSIONS

For the most part, the construction of the transmission lines will have very little impact on land use. Agriculture is generally of low to medium intensity. Where the line crosses crop land, the area removed from production is insignificant.

There also should be no significant direct impact on residential land use, with the exception that the space occupied by the rights-of-way will preclude construction of houses in the immediate right-of-way.

The impact due to clearing of rights-of-way through forested areas is judged to be slight. The total amount of forested land to be removed is insignificant compared to the total amount of forested areas, and its effect on the production of commercial forest products is negligible. The greatest impact would be the disturbance of the natural setting due to removal of trees in forested areas.

Removal of trees will force some species of wildlife to find new homes, but the areas through which the transmission lines will pass appear to have the necessary habitat conditions and capac.ty to support greater wildlife populations than now present. Much of the disturbance associated with construction of the lines in open areas is only temporary, as regrowth of weeds and brush in the rights-of-way will take place quite quickly and good cover for birds and small animals will likely be restored at the end of one full season's growth. The vegetation that will volunteer within, and along the edges of the rights-of-way in forested areas is apt to be more favorable in terms of supplying food to wildlife. As discussed in Section S4.4, vegetative programs will be developed to provide screening of the lines and to obtain more ideal habitat for desired wildlife species.

Probably the one factor that will be most affected by the construction of the transmission lines will be the quality of aesthetics. The rights-of-way selected will utilize available natural screening of the line from the view of most travellers in the area by use of vegetation, high ground, or a sufficiently great distance to reduce visual impact. There will be certain instances where aesthetic impacts cannot be avoided or minimized. It is believed that such isolated cases will be balanced by the benefits of low cost, reliable, electric power resulting from the construction of the proposed transmission facilities.

S5.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

S5.1 INTRODUCTION

This section evaluates the environmental impact of postulated accidents and occurrences which may occur, however remote, during the operating life of the Virgil C. Summer Nuclear Station. The evaluation follows the guidelines given in the AEC document "Scope of Applicants' Environmental Reports with Respect to Transportation, Transmission Lines, and Accidents" issued on September 1, 1971. The results of this evaluation reveal that the consequences of the postulated accidents and occurrences have no significant adverse environmental effects.

The postulated accidents and occurrences are divided into the nine accident classes identified in the AEC guide of September 1, 1971 as shown in Table S5.1-1. The environmental impact of the postulated incidents is evaluated using assumptions in the analyses as realistic as the state of knowledge permits. Past operating experience has been considered in selecting the assumptions, and the analyses are based on those conditions that are expected to exist if the postulated accident were to occur. The radiological consequences of an accident are evaluated on the basis that the most probable meteorological conditions, as calculated from the CVNPA tower meteorology data, and the population distribution toward the end of plant life exist at the time of an accident.

In the following pages, a typical accident for each class is described and its consequences evaluated. Where only one accident example is considered in a class, the postulated accident was selected from consideration of several possible accidents in that class. Consideration of the nine classes reveals that these classes can be conveniently grouped on the basis of their likelihood of occurrence as follows:

TABLE S5.1-1

CLASSIFICATION OF POSTULATED ACCIDENTS AND OCCURRENCES

NO. OF CLASS	DESCRIPTION	EXAMPLE(S)
1	Trivial Incidents	Small spills Small leaks inside containment
2	Misc. Small Releases Outside Containment	Spills Leaks and pipe breaks
3	Radwaste System Failures	Equipment failure Serious malfunction or human error
4	Events that release radio-activity	Fuel failures during normal operation. Transients outside expected range of variables.
5	Events that release radio-activity into secondary system	Class 4 & Heat Exchanger Leak
6	Refueling accidents inside containment	Drop fuel element Drop heavy object onto fuel Mechanical malfunction or loss of cooling in transfer tube
7	Accidents to spent fuel outside containment	Drop fuel element Drop heavy object onto fuel Drop shielding cask - loss of cooling to cask Transportation incident on site
8	Accident initiation events considered in design-basis evaluation in the Safety Analysis Report	Reactivity transient Rupture of primary piping Flow decrease - Steamline break
9	Hypothetical sequences of failures more severe than Class 8	Successive failures of multiple barriers normally provided and maintained

S5.1.1 CLASS 1 THROUGH CLASS 5

This group deals with events which may occur at one time or another during the life of the plant. The compilation of a complete list of events with their corresponding frequency which fall in this group is not practical. The environmental impact of each event, as will be shown later, is very small. Throughout plant operating life, a record of the magnitude and consequences of each event is maintained and the cumulative effect of subsequent occurrences is evaluated. This procedure will give timely identification of any possible cumulative effects or trends leading to unacceptable environmental effects. This will also allow corrective actions (such as equipment repair, changes in procedure, frequent inspection, temporary plant shutdown, etc.) to be taken before a significant adverse impact on the environment can be imposed.

Postulated occurrences for Classes 2 through 5 are considered in the following pages. Class 1 events are considered as small spills or small leaks inside the containment. Release to the environment, if any, would be insignificant. Therefore, these events are not considered because of their trivial consequences, as indicated in the AEC guidelines.

S5.1.2 CLASSES 6 AND 7

This group deals with refueling and fuel handling accidents inside and outside the containment. Detailed procedures are provided to handle irradiated fuel properly. The probability of such accidents is small; however, considering the large number of fuel assemblies handled during the life of the plant, an incident falling in this category could conceivably occur during the plant life. The consequences of such an accident, as shown in the subsequent pages, have no significant adverse impact on the environment.

S5.1.3 CLASS 8

This class includes those accidents with very small probabilities of occurrence that are not expected to occur during the life of this plant and whose initiation events are considered in the Safety Analysis Report (SAR), available in the public record.

Each accident is treated separately in the following pages. The treatment consists of a brief description of the accident, a summary of the steps taken in the design, manufacturing, installation and operation to essentially eliminate the possibility of its occurrence, a list of the most significant assumptions used in the analyses and the results of the dose calculations. The accident consequences are evaluated by using the analytical models described in the SAR. The basic difference between the SAR evaluations and those presented in this section is represented by the values of the parameters used as input in the analytical models. The SAR analyses are based on extremely conservative input parameters while the analyses performed in this report are based on realistic assessments of the performance of the nuclear plant safeguards.

It can be concluded that accidents falling in this class have no significant adverse environmental effects because:

a. Hypothetical SAR types of accident initiation events are not expected to occur during the life of this plant because of the numerous steps taken in design manufacture, construction, operation, and maintenance to prevent them, and

b. The expected environmental consequences if any one of the accidents were to occur are even below the limits considered safe for normal operation (10 CFR 20).

S5.1.4 CLASS 9

This accident class involves hypothetical sequences of failures more severe than Class 8, i.e., successive failures of multiple barriers normally provided and maintained.

Considering, as an example, the rupture of a Reactor Coolant System pipe, Class 8 covers the case of this initiation event and expected performance of plant safeguards. Class 9, on the contrary, would consider the initiation event, i.e., rupture of a Reactor Coolant System pipe plus, hypothetically deteriorated performance of plant safeguards, for example, failure of outside power supply, and/or failure of a diesel, and/or failure of a high head safety injection pump, and/or failure of a low head safety injection valve, and/or failure of a containment spray pump, and/or failure of a containment spray valve, etc. This chain of failures can, theoretically, be carried as far as an individual's imagination can go.

The Safety Analysis Report contains studies on the consequences of many successive failures. The likelihood of the combination of the initiation event and these successive failures is extremely remote. The consequences, as presented in the SAR, are within the allowable limits for remote probability accidents (10 CFR 100 limits).

The occurrence of successive failures as presented in the SAR or beyond is so remote that its environmental risk is extremely low. Hence, it is not necessary to discuss these multiple barrier failures in the present report, as indicated in the AEC guide published on September 1, 1971.

S5.2 METEOROLOGY AND POPULATION DISTRIBUTIONS

In order to arrive at a realistic assessment of the consequences of an accidental release of radioactivity, it is necessary to determine:

a. The probability of a specific location being affected.

b. The appropriate (most probable) dilution factor of the location is affected.

c. The population around the site that is affected by the accident.

In this analysis, the consecutive hourly weather data at Parr, South Carolina have been evaluated to determine the probability of a specific location being affected and the appropriate dilution factors for the vicinity of the Summer Station out to 50 miles. Since little change in population is expected over the 40 year life of the station, the year 2010 projected population distribution is considered representative as far as the determination of the most probable accidental man-relative concentrations (man-seconds per cubic meter).

S5.2.1 THE PROBABILITY OF A LOCATION BEING AFFECTED

The probability of a location being affected is dependent upon two factors. One is the duration of the accident; and the other is the direction of the location from the accidental release. Table S5.2-1 presents the percentage probabilities of locations being affected for accidents of durations of two hours, one day, or 30 days for each of the sixteen compass directions pointing away from the Virgil C. Summer Nuclear Station (Summer Station).

TABLE S5.2-1

PROBABILITY OF A SECTOR BEING
AFFECTED BY AN ACCIDENTAL RELEASE
OF 2 HOURS, 24 HOURS, OR 30 DAYS DURATION

SECTOR AFFECTED	2 HOURS	24 HOURS	720 HOURS
SSW	5.97 %	33.62 %	100 %
SW	9.21	40.28	100
WSW	11.31	41.21	100
W	9.08	39.63	100
WNW	5.12	29.47	100
NW	4.39	23.64	98.44
NNW	7.45	36.41	100
N	12.09	47.17	100
NNE	9.33	47.30	100
NE	10.04	46.81	100
ENE	12.76	53.14	100
E	21.30	64.47	100
ESE	10.65	54.81	100
SE	6.97	42.16	100
SSE	8.02	43.44	100
S	8.74	42.23	100
Average Prob.	9.53 %	42.86 %	99.90 %

S5.2.2 THE MOST PROBABLE DILUTION FACTORS

There are wide variations in the dilution factors which can affect a location from an accidental release. The "most probable" dilution factor may be defined as the median value of these factors, each of which has been averaged over the duration of the release. Table S5.2-2 presents such dilution factors as a function of accident duration and of distance from the release point.

S5.2.3 THE POPULATION DISTRIBUTION FOR THE YEAR 2010

The population distribution near the V. C. Summer Plant has been taken from Figures 2.2-2 and 2.2-4 of the PSAR and is presented in Table S5.2-3. These data are from the year 2010 projections. The sector values in the reference have been adjusted by averaging and interpolation to give values which conform to the sectors affected by the observable wind directions.

S5.2.4 THE MAN-RELATIVE CONCENTRATION VALUES

The dilution factors of Table S5.2-2 have been multiplied by the population distributions in Table S5.2-3 to give the "man-relative concentration" (man seconds per cubic meter) in Table S5.2-4 for the two hour, Table S5.2-5 for the 24 hour, and Table S5.2-6 for the 30 day accidental release. On the left side of each table the percentage probabilities of the sector being affected are repeated from Table S5.2-1.

Tables S5.2-4, S5.2-5, and S5.2-6 present the median of the dilution factors determined under the following assumptions:

a. Each hour of the year an accidental release occurs.

b. The relative concentrations following each release are calculated for each hour and accumulated in the sectors toward which the wind is blowing for that hour. At the end of the accident, the relative concentrations which are accumulated in each sector are averaged, sector by sector, for the duration of the accident.

c. For each accident duration a frequency distribution is established of the sector by sector average relative concentration values for each accidental release. Finally the median value of these average dilution factors is selected. In selecting this median, the sector averages which are zero are ignored.

d. For each accident duration, the number of zero averages in each sector are determined to provide the frequency with which the sector is affected.

TABLE S5.2-2

MOST PROBABLE DILUTION FACTORS* IF A LOCATION IS AFFECTED BY AN ACCIDENTAL RELEASE

DISTANCE (MILES)	2 HOURS	24 HOURS	720 HOURS	
1.0	1.2E-05	3.0E-06	1.8E-06	(Site Boundary)
1.5	6.1E-06	1.5E-06	8.9E-07	
2.5	2.72E-06	6.7E-07	3.97E-07	
3.5	1.62E-06	3.97E-07	2.36E-07	
4.5	1.12E-06	2.76E-07	1.64E-07	
7.5	5.51E-07	1.35E-07	8.04E-08	
15	2.15E-07	5.3E-08	3.14E-08	
25	1.09E-07	2.68E-08	1.59E-08	
35	7.09E-08	1.74E-08	1.03E-08	
45	5.18E-08	1.27E-08	7.55E-09	

* $\frac{X}{Q}$, seconds/cubic meter

TABLE S5.2-3

THE POPULATION DISTRIBUTION IN THE VICINITY OF THE VIRGIL C. SUMMER NUCLEAR STATION PROJECTED FOR THE YEAR 2010

SECTOR	DISTANCE IN MILES 1.5	2.5	3.5	4.5	7.5	15	25	35	45
NNE	0	14	39	30	210	2,007-1/4	6,311.5	8,645-3/4	36,474-1/4
NE	19.5	46	23	7.5	173.5	2,957.5	2,687.5	11,158	30,958
ENE	26.5	53.5	17.5	18	261.6	3,658	3,393-1/4	8,804-1/4	25,468-1/4
E	14	21.5	10.5	26	344	4,358.5	4,099	6,450.5	19,978.5
ESE	25	9	7	35	247	8,291	90,858.5	21,457-3/4	16,680-3/4
SE	18	23	16	19.5	202.5	12,223.5	177,618	36,465	13,383
SSE	0	14	9	0	265.5	12,760-1/4	105,956	26,128-1/4	10,862-1/4
S	0	0	27	32.5	589.5	13,297	34,294	15,791.5	8,341.5
SSW	0	0	43	46.5	826.5	7,673.5	18,958-1/4	11,013.5	8,650
SW	0	0	41	35.5	615.5	2,050	3,622.5	6,235.5	8,958.5
WSW	0	0	32	37.5	608.5	6,448-1/4	3,207.5	12,130.5	26,229.5
W	0	5.5	18	34	547	10,846.5	2,782.5	18,025.5	43,500.5
WNW	0	5.5	11	30.5	350	6,184-3/4	5,127.5	17,473	27,190
NW	0	0	0	12.5	302	1,523	7,472.5	16,920.5	10,879.5
NNW	0	0	0	23	240.5	1,290	8,704	11,527	26,435
N	0	0	23	53	235.5	1,057	9,935.5	6,133.5	41,990.5

TABLE S5.2-4

MAN-RELATIVE CONCENTRATIONS FOR 2 HOUR ACCIDENTAL RELEASES

SECTOR	PROBABILITY OF SECTOR BEING AFFECTED PERCENT	DISTANCE IN MILES 1.5	2.5	3.5	4.5	7.5	15	25	35	45
NNE	9.3	0	3.81E-5	6.32E-5	3.36E-5	1.16E-4	4.32E-4	6.88E-4	6.13E-4	1.89E-3
NE	10.0	1.19E-4	1.25E-4	3.73E-5	8.40E-6	9.56E-5	6.36E-4	2.93E-4	7.91E-4	1.60E-3
ENE	12.8	1.62E-4	1.455E-4	2.835E-5	2.02E-5	1.44E-4	7.86E-4	3.70E-4	6.24E-4	1.32E-3
E	21.3	8.54E-5	5.85E-5	1.70E-5	2.91E-5	1.895E-4	9.37E-4	4.47E-4	4.57E-4	1.03E-3
ESE	10.6	1.525E-4	2.45E-5	1.13E-5	3.92E-5	1.36E-4	1.78E-3	9.90E-3	1.52E-3	8.64E-4
SE	7.0	1.10E-4	6.26E-5	2.59E-5	2.18E-5	1.12E-4	2.63E-3	1.936E-2	2.585E-3	6.93E-4
SSE	8.0	0	3.81E-5	1.46E-5	0	1.46E-4	2.74E-3	1.155E-2	1.85E-3	5.63E-4
S	8.7	0	0	4.37E-5	3.64E-5	3.25E-4	2.86E-3	3.74E-3	1.12E-3	4.32E-4
SSW	6.0	0	0	6.97E-5	5.21E-5	4.55E-4	1.65E-3	2.07E-3	7.81E-4	4.48E-4
SW	9.2	0	0	6.64E-5	3.98E-5	3.39E-4	4.41E-4	3.95E-4	4.42E-4	4.64E-4
WSW	11.3	0	0	5.18E-5	4.20E-5	3.35E-4	1.39E-3	3.50E-4	8.60E-4	1.36E-3
W	9.1	0	0	2.92E-5	3.81E-5	3.01E-4	2.33E-3	3.03E-4	1.28E-3	2.25E-3
WNW	5.1	0	1.50E-5	1.78E-5	3.42E-5	1.93E-4	1.33E-3	5.59E-4	1.24E-3	1.41E-3
NW	4.4	0	1.50E-5	0	1.40E-5	1.66E-4	3.27E-4	8.145E-4	1.20E-3	5.64E-4
NNW	7.4	0	0	0	2.58E-5	1.325E-4	2.77E-4	9.49E-4	8.17E-4	1.37E-3
N	12.1	0	0	3.73E-5	5.94E-5	1.30E-4	2.27E-4	1.08E-3	4.35E-4	2.175E-3

TABLE S5.2-5

MAN-RELATIVE CONCENTRATIONS FOR 24 HOUR ACCIDENTAL RELEASES

SECTOR	PROBABILITY OF SECTOR BEING AFFECTED PERCENT	DISTANCE IN MILES 1.5	2.5	3.5	4.5	7.5	15	25	35	45
NNE	47.3	0	9.38E-6	1.55E-5	8.28E-6	2.835E-5	1.06E-4	1.69E-4	1.50E-4	4.63E-4
NE	46.8	2.93E-5	3.08E-5	9.13E-6	2.07E-6	2.34E-5	1.57E-4	7.20E-5	1.94E-4	3.93E-4
ENE	53.1	3.98E-5	3.58E-5	6.95E-6	4.97E-6	3.53E-5	1.94E-4	9.09E-5	1.53E-4	3.23E-4
E	64.5	2.10E-5	1.44E-5	4.17E-6	7.18E-6	4.64E-5	2.31E-4	1.10E-4	1.12E-4	2.54E-4
ESE	54.8	3.75E-5	6.03E-6	2.78E-6	9.66E-6	3.33E-5	4.39E-4	2.435E-4	3.73E-4	2.12E-4
SE	42.2	2.70E-5	1.54E-5	6.35E-6	5.38E-6	2.73E-5	6.48E-4	4.76E-3	6.34E-4	1.70E-4
SSE	43.4	0	9.38E-6	3.57E-6	0	3.58E-5	6.76E-4	2.84E-3	4.55E-4	1.38E-4
S	42.2	0	0	1.07E-5	8.97E-6	7.96E-5	7.05E-4	9.19E-4	2.75E-4	1.06E-4
SSW	33.6	0	0	1.71E-5	1.28E-5	1.12E-4	4.07E-4	5.08E-4	1.92E-4	1.10E-4
SW	40.3	0	0	1.63E-5	9.80E-5	8.31E-5	1.09E-4	9.71E-5	1.08E-4	1.14E-4
WSW	41.2	0	0	1.27E-5	1.035E-5	8.21E-5	3.42E-4	8.60E-5	2.11E-4	3.33E-4
W	39.6	0	3.685E-6	7.15E-6	9.38E-6	7.38E-5	5.75E-4	7.46E-5	3.14E-4	5.52E-4
WNW	29.5	0	3.685E-6	4.37E-6	8.42E-6	4.725E-5	3.28E-4	1.37E-4	3.04E-4	3.45E-4
NW	23.6	0	0	0	3.45E-6	4.08E-5	8.07E-5	2.00E-4	2.94E-4	1.38E-4
NNW	36.4	0	0	0	6.35E-6	3.25E-6	6.84E-5	2.33E-4	2.01E-4	3.36E-4
N	47.2	0	0	9.13E-6	1.46E-5	3.18E-5	5.60E-5	2.66E-4	1.07E-4	5.33E-4

TABLE S5.2-6

MAN-RELATIVE CONCENTRATIONS FOR 30 DAY ACCIDENTAL RELEASES

SECTOR	PROBABILITY OF SECTOR BEING AFFECTED PERCENT	DISTANCE IN MILES 1.5	2.5	3.5	4.5	7.5	15	25	35	45
NNE	100	0	5.56E-6	9.20E-6	4.92E-6	1.69E-5	6.30E-5	100E-4	8.91E-5	2.75E-4
NE	100	1.74E-5	1.83E-5	5.43E-6	1.23E-6	1.39E-5	9.29E-5	4.27E-5	1.15E-4	2.34E-4
ENE	100	2.36E-5	2.12E-5	4.13E-6	2.95E-6	2.10E-5	1.15E-4	5.40E-5	9.07E-5	1.93E-4
E	100	1.25E-5	8.54E-6	2.48E-6	4.26E-6	2.77E-5	1.37E-4	6.52E-5	6.64E-5	1.51E-4
ESE	100	2.225E-5	3.57E-6	1.65E-6	5.74E-6	1.99E-5	2.60E-4	1.44E-3	2.21E-4	1.26E-4
SE	100	1.60E-5	9.13E-6	3.78E-6	3.20E-6	1.63E-5	3.84E-4	2.82E-3	3.76E-4	1.01E-4
SSE	100	0	5.56E-6	2.12E-6	0	2.13E-5	4.01E-4	1.68E-3	2.69E-4	8.20E-5
S	100	0	0	6.37E-6	5.33E-6	4.74E-5	4.18E-4	5.45E-4	1.63E-4	6.30E-5
SSW	100	0	0	1.01E-5	7.63E-6	6.645E-5	2.41E-4	3.01E-4	1.13E-4	6.53E-5
SW	100	0	0	9.68E-6	5.82E-6	4.95E-5	6.44E-5	5.76E-5	6.42E-5	6.76E-5
WSW	100	0	0	7.55E-6	6.15E-6	4.89E-5	2.02E-4	5.10E-5	1.25E-4	1.98E-4
W	100	0	2.18E-6	4.25E-6	5.58E-6	4.40E-5	3.41E-4	4.42E-5	1.86E-4	3.28E-4
WNW	100	0	2.18E-6	2.60E-6	5.00E-6	2.81E-5	1.94E-4	8.15E-5	1.80E-4	2.05E-4
NW	98.4	0	0	0	2.05E-6	2.43E-05	4.78E-5	1.19E-4	1.74E-4	8.21E-5
NNW	100	0	0	0	3.77E-6	1.93E-05	4.05E-5	1.38E-4	1.19E-4	2.00E-4
N	100	0	0	0	8.69E-6	1.89E-04	3.32E-5	1.58E-4	6.32E-4	3.17E-4

S5.3 EVALUATION OF CLASS 2 EVENTS

S5.3.1 DISCUSSION OF CLASS 2 EVENTS

Class 2 events include spills and leaks from equipment outside the containment. Small valve leaks and pipe leaks may be expected during the lifetime of the plant. There is expected to be a low level of continuous leakage from components such as valve packing and stems, pump seals, flanges, etc. Infrequent increases in leakage from specific components might occur; however, these would be detected by operators and/or inplant monitoring and appropriately repaired to minimize any potential off-site effect.

S5.3.2 DESCRIPTION OF REPRESENTATIVE CLASS 2 EVENT

A significant valve and/or pipe leak in the reactor coolant letdown line may occur during the lifetime of the plant. A representative example of such an occurrence would be a leak in the volume control tank sampling line which would allow a fraction of the contents of the volume control tank to be released. Were such a leak to occur, the Radiation Monitoring System would detect the activity and with appropriate operator action the release could be limited to 10 percent of the noble gas contained in the tank. The event used to evaluate the environmental effect is defined as the release to the outside atmosphere of 10 percent of the noble gas activity in the volume control tank.

S5.3.3 DISCUSSION OF REMOTENESS OF POSSIBILITY OF VOLUME CONTROL TANK RELEASE

The volume control tank is designed to ASME III, Class 2 with a normal internal operating pressure of approximately 15 psig.

The volume control tank design philosophy provides for level alarms, pressure relief valves and automatic tank isolation and valve control to assure that a safe condition is maintained during system operation.

Quality control in the design, manufacture, and installation introduces a high degree of reliability and confidence to further assure that no failure in this system will occur.

Since the volume control tank is not subject to high pressure or stress and is vented to a closed system, an accidental release from the tank is considered very remote.

S5.3.4 ANALYSIS AND EVALUATION OF VOLUME CONTROL TANK RELEASE

S5.3.4.1 Assumptions

The following assumptions are used in the evaluation of the environmental effect of the release of the volume control tank activity.

a. The activity in the tank is based on 0.2 percent equivalent fuel defects.

b. Within two hours after initiation of a noble gas activity release from the volume control tank, 10 percent of the tank noble gas inventory is released. Iodine release is negligible.

c. Immediately after the noble gas activity escapes from the volume control tank, it is released from the auxiliary building at ground level to the outside atmosphere. Holdup in the auxiliary building is expected, thus reducing even further the environmental effect of this occurrence. However, no credit is taken in the analysis.

d. Natural decay is neglected after the activity is released to the outside environment.

S5.3.4.2 Justification for Assumptions

a. The 0.2 percent defect level is based on reactor operating experience with WPWR Zircaloy fuel to date.

b. Nonvolatile fission product concentrations are greatly reduced as the reactor coolant is passed through the purification demineralizers. An iodine removal factor of at least 10 is expected in the mixed bed demineralizers, and an iodine partition factor of the order of 10,000 is expected between the liquid and vapor phase.

c. The released noble gas will be detected by the plant vent monitor and cause an alarm in the control room. Once the operators have been alerted, the leak can be detected and isolated to hold the activity release to 10 percent of the total noble gas inventory of the volume control tank.

S5.3.4.3 Doses at the Site Boundary and Total Population Dose (Man-Rem)

The parameters used to calculate the noble gas activity in the volume control tank are given in Table S5.3-1. Based on these parameters, 10 percent of the total noble gas activity in the tank, which is assumed to be released instantaneously to the environment, is 46.6 curies of equivalent Xe-133.

The whole body dose at the site boundary, as calculated by the method shown in Section S5.10, is 0.0394 mrem from the released noble gas activity, while the total population dose is 0.374 man-rem.

TABLE S5.3-1

PARAMETERS FOR COMPUTING VOLUME CONTROL TANK SPECIFIC ACTIVITY OF EQUIVALENT Xe-133

1.	Core thermal power, MWt	2914
2.	Fraction of fuel containing clad defect	0.002
3.	Reactor coolant liquid volume, cu ft	9107
4.	Reactor coolant average temperature, ^{o}F	580
5.	Purification flow rate (maximum), gpm	60
6.	Volume control tank volumes	
	a. Vapor, cu ft	120
	b. Liquid, cu ft	180
7.	Fission product escape rate coefficients:	
	a. Noble gas isotopes, sec^{-1}	6.5×10^{-8}
8.	Reactor coolant system equilibrium activities	

Isotope	μCi/cc
Kr-85	0.008
Kr-85m	0.30
Kr-87	0.20
Kr-88	0.60
Xe-133	4.60
Xe-133m	0.10
Xe-135	0.80

S5.4 EVALUATION OF CLASS 3 EVENTS

S5.4.1 DISCUSSION OF CLASS 3 EVENTS

Class 3 events cover equipment malfunction and human error which may result in the release of activity from the Waste Processing System. The malfunction of a valve or the inadvertant opening of a valve by an operator may cause such a release. This type of event is expected to occur infrequently during the operation of the plant.

S5.4.2 DESCRIPTION OF REPRESENTATIVE CLASS 3 EVENT

The major collection point for activity outside the containment is the gaseous waste section of the Waste Processing System. A representative example of a Class 3 event would be a malfunction or error which would allow initiation of activity release from a waste gas decay tank. This activity would leak into the auxiliary building atmosphere and pass through the plant vent to the outside atmosphere. The plant vent monitor would detect this radiation and transmit an alarm signal to the control room. The event used to evaluate the environmental effect is defined as the release of 10 percent of the noble gas activity in a waste gas decay tank to the outside atmosphere.

S5.4.3 DISCUSSION OF REMOTENESS OF POSSIBILITY OF A GAS DECAY TANK RELEASE

The gas decay tanks contain the gases vented from the reactor coolant system and the volume control tank. Because of the conservative design, quality assurance, the close monitoring and sampling throughout the system, and since the gas decay tanks are not subjected to any high pressures or stresses and they are of ASME III, Class 3 design, an accidental release from any of the tanks is highly unlikely.

For these reasons the release of 10 percent of the noble gas stored in the gas decay tank is considered to represent accidents and occurrences falling in this class.

S5.4.4 ANALYSIS AND EVALUATION OF GAS DECAY TANK RELEASE

S5.4.4.1 Assumptions

The following assumptions are used in the evaluation of the environmental effect of the release of activity from the waste gas decay tank.

a. 0.2 percent fuel defects.

b. Within two hours after initiation of noble gas activity release from the gas decay tank, 10 percent of the noble gas is released.

c. Immediately after the noble gas activity escapes from the waste gas decay tank it is released at ground level from the auxiliary building to the outside atmosphere.

d. Natural decay is neglected after the activity is released to the outside environment.

S5.4.4.2 Justification for Assumptions

a. The 0.2 percent equivalent fuel defect level is based on reactor operating with W PWR's.

b. The plant vent monitor will detect the noble gas activity being released to the outside atmosphere and cause closure of the waste gas control valve and annunciate in the control room. This alerts the operators and the leak can be detected and isolated to hold the activity release to 10 percent of the total noble gas activity in a waste gas decay tank.

S5.4.4.3 Doses at Site Boundary and Total Population Dose (Man-Rem)

The noble gas activity released to the environment is given in Table S5.4-1. From this activity release the whole body dose at the site boundary is 0.976 mrem and the total population dose is 9.27 man-rem.

TABLE S5.4-1

NOBLE GAS ACTIVITY RELEASE

Isotope	Activity (Curies)
Xe-133	1237.0
Xe-133m	12.1
Xe-135	15.0
Kr-85m	2.32
Kr-85	1264.0
Kr-87	0.4
Kr-88	2.74

S5.5 EVALUATION OF CLASS 4 EVENTS

S5.5.1 DISCUSSION OF CLASS 4 EVENTS

This is described as those events that release radioactivity into the primary system. Examples given include assumptions of fuel failures during normal operation and transients outside expected range of variables.

The nuclear steam supply system is designed so that it may operate with an equivalent 1 percent fuel defect. The defect level averaged over the life of the plant will be much less than the design value as shown by the experience of similar plants to date. The occurrence of a fuel defect in itself will not result in any environmental impact because of the multiple barriers provided in the Westinghouse pressurized water reactor. Nevertheless, this occurrence may result in activity levels which could affect the consequences in other accident classes which are evaluated in other appropriate sections of this report. Operational transients for the plant such as turbine trip, load changes, rod withdrawals and any other conceivable transient within accident conditions covered in other classes are not expected to increase the defect level. The Safety Analysis Report demonstrates this as follows:

S5.5.2 ANALYSIS AND EVALUATION OF FUEL DEFECTS

S5.5.2.1 Assumptions for Termination of Transients

A plant transient could result in an uncontrolled addition of reactivity. Assuming the source and intermediate range alarms are ignored, a transient will be terminated by the following automatic Safety Features:

(Note: These may be found in the PSAR Section 14).

S5.5.2.2 Justification for Assumptions

PSAR Section 14.

S5.5.2.3 Consequences

None from this class.

S5.6 EVALUATION OF CLASS 5 EVENTS

S5.6.1 DISCUSSION OF CLASS 5 EVENTS

The Class 5 events are defined as those accident events that transfer the radioactivity in the reactor coolant into the secondary system through steam generator tube leakage, with a fraction of the transferred radioactivity in turn being released into the environment through the condenser off-gas. Radioactivity releases into the environment resulting from the events in this class require a concurrent occurrence of two independent events of fuel defects and steam generator tube leakage. Since the concurrent occurrence of these two independent events is remote, significant radioactivity release to the environment is unlikely. However, if the fuel defects and steam generator tube leakage do occur concurrently, these concurrent faults at worst would be evaluated continuously in terms of plant secondary system activity technical specification limits and corrective steps taken before any limit is approached.

S5.6.2 DESCRIPTION OF CLASS 5 EVENTS - FUEL DEFECTS WITH STEAM GENERATOR TUBE LEAKAGE

In the event of fuel defects with a concurrent steam generator tube leakage, the secondary system would contain fission products and radioactive corrosion products. The degree of fission product transport into the secondary side is a function of the amount of defective fuel in the core and the primary-to-secondary leak rate. These parameters also determine the radioactivity releases from the secondary system if the plant were to continue to operate under these off-normal conditions. Since the condenser off-gas effluent is monitored with a radiation monitor, it would alarm upon the steam generator tube leakage and the resultant radioactivity releases. The blowdown is terminated upon receipt of a high radiation signal. In addition, the steam generator liquid sample monitor provides backup information to indicate primary-to-secondary leakage. The operator must evaluate secondary system activity in terms of the plant technical specifications. If the primary-to-secondary leak rate and the resultant releases are insignificant, the operator may continue to operate the plant until a convenient time is available to shut down and repair the leaking steam generator.

S5.6.3 DISCUSSION OF REMOTENESS OF POSSIBILITY OF AN OFF-NORMAL OPERATIONAL RELEASE

An off-normal operational release requires fuel defects and a simultaneous steam generator tube leakage. Since the occurrence of these two events are not related to each other, the possibility of an off-normal release resulting from these two independent events are very remote.

In addition, the radiation level of the condenser off-gas discharge and steam generator liquid are monitored and any excessive gaseous or liquid releases would be detected by the monitor system and terminated by the operator.

To conservatively represent events in Class 5, it has been assumed, for the purpose of analysis, that full power operation with 1 gpm primary-to-secondary leakage and 0.2 percent equivalent fuel defects is continued for 80 hours.

S5.6.4 ANALYSIS AND EVALUATION OF OFF-NORMAL OPERATIONAL RELEASE

S5.6.4.1 Assumptions

An analysis has been performed of possible releases of radioactivity from the secondary system in the event of fuel defects with concurrent steam generator tube leakage. The analysis is based on the following assumptions:

a. 0.2 percent defective fuel

b. The primary-to-secondary leak rate is 1 gpm

c. No steam generator blowdown during off-normal operation and the condenser off-gas discharge is the only release.

d. The period of off-normal operation is 80 hours at full power.

e. The atmospheric dispersion factor at site boundary used in the dose calculation is the most probable 24 hour value.

f. Secondary system decontamination factors:

Steam generator water to steam

$$DF = 10 \ \frac{\mu c/gm \text{ SG water}}{\mu c/gm \text{ Steam}} \quad \text{(all halogens)}$$

$$DF = 1 \ \frac{\mu c/gm \text{ SG water}}{\mu c/gm \text{ Steam}} \quad \text{(all noble gases)}$$

Steam to condenser off-gas

$$DF = 10^4 \ \frac{\mu c/gm \text{ Steam}}{\mu c/cc \text{ Air}} \quad \text{(all halogens)}$$

g. No noble gas accumulated in the steam generator water since these are continuously released from the condenser off-gas system.

h. Air flow rate through the condenser off-gas system is 120 scfm.

S5.6.4.2 Justification for Assumptions

The first assumption is based on plant operating experience to date. The second assumption is a conservative one well within the leak-rate which can be detected and result in remedial action. The third assumption is based on the fact that the steam generator blowdown is terminated within a few minutes of institution of the off-normal operation. The off-normal operation therefore will not result in blowdown release. The off-normal operation at full power of the fourth assumption is the maximum off-normal operational time with no blowdown on the basis of steam generator solids limitations. The operator can shut the plant down sooner if the releases are excessive. Assumption "e" is based on the site meteorological data. Assumption "f" is based on the reference:

Styrikovich M. A., Martynova O. I., Katkovska K. Ya., Dwbrovskii I. Ya., Smrinova I. N. "Transfer of Iodine from Aqueous Solutions to Saturated Vapor," Translated from Atomnaya Energiya, Vol. 17, No. 1, P. 45-49, July, 1964.

For assumption "h", the condenser off-gas flow rate of 120 scfm is a system parameter.

S5.6.4.3 Doses at Site Boundary and Total Population Dose (man-rem)

The activity released from the reactor coolant to the secondary system is given in Table S5.6-1. With the above assumptions the thyroid dose and the whole body dose at the site boundary resulting from the condenser off-gas release are .0041 mrem and 0.0388 mrem, respectively. The total population whole body dose is 0.354 man-rem.

TABLE S5.6-1

ACTIVITY RELEASE FROM REACTOR COOLANT TO SECONDARY SYSTEM

Isotope	Curies
Mo-99	4.93
I-131	2.07
I-132	.785
I-133	3.38
I-134	.512
I-135	1.85
Cs-134	.218
Cs-137	1.09
Xe-133	25.1
Xe-133M	.545
Xe-135	4.36
Kr-85M	1.635
Kr-85	.0436
Kr-87	1.09
Kr-88	3.27

S5.7 EVALUATION OF CLASS 6 EVENTS

S5.7.1 DISCUSSION OF CLASS 6 EVENTS

Accidents which fall into accident Class 6 are: fuel element mishandling and mechanical malfunctions or loss of cooling in the transfer tube.

The only event in this accident class which may possibly result in a release of radioactive gases from a fuel assembly is the mishandling of a fuel element. The fuel handling procedures are such that no objects can be moved over any fuel elements being transferred or stored. A loss of cooling in the transfer tube will not cause the cladding of a fuel assembly to be damaged. The residual heat generated by the assembly will be removed by natural convection.

S5.7.2 DESCRIPTION OF CLASS 6 EVENT - REFUELING ACCIDENT INSIDE CONTAINMENT

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in the equivalent of one row of fuel rods in the assembly being damaged. The subsequent release of radioactivity from the damaged fuel element will bubble through the water covering the assembly, where most of the radioactive iodine will be entrained, and be released to the containment atmosphere.

S5.7.3 DISCUSSION OF REMOTENESS OF POSSIBILITY OF A FUEL HANDLING ACCIDENT INSIDE CONTAINMENT

The possibility of the postulated fuel handling incident is remote due to the administrative controls and physical limitations imposed on fuel handling operations. All refueling operations are conducted in accordance with prescribed procedures under the direct surveillance of personnel technically trained in nuclear safety. In addition, before any refueling operations begin, verification of complete rod cluster control assembly insertion is obtained by tripping each rod individually to obtain indication of rod drop and disengagement from the control rod drive mechanisms. Boron concentration in the coolant is raised to the refueling concentration and verified by sampling. Refueling boron concentration is sufficient to maintain the clean, cold, fully loaded core subcritical with all rod cluster assemblies withdrawn. The refueling cavity is filled with water meeting the same boric acid specifications.

After the vessel head is removed, the rod cluster control drive shafts are removed from their respective assemblies. A spring scale is used to verify that the drive shaft is free of the control cluster as the lifting force is applied.

The fuel handling manipulators and hoists are designed so that fuel cannot be raised above a position which provides adequate shield water depth for the safety of all operating personnel. This safety feature applies to handling facilities in both the containment and in the spent fuel pit area.

Adequate cooling of fuel during underwater handling is provided by convective heat transfer to the surrounding water. The fuel assembly is immersed continuously while in the refueling cavity or spent fuel pit. Even if a spent fuel assembly becomes stuck in the transfer tube, natural convection will maintain adequate cooling.

Two Nuclear Instrumentation System source range channels are continuously in operation and provide warning of any approach to criticality during refueling operations. This instrumentation provides a continuous audible signal in the containment, and would annunciate a local horn and a horn and light in the plant control room in the unlikely event that the count rate increased above a preset low level.

Refueling boron concentration is sufficient to maintain the clean, cold, fully loaded core subcritical by at least 10 percent $\Delta\rho$ with all rod cluster control assemblies inserted. At this boron concentration the core would also be more than 2 percent $\Delta\rho$ subcritical with all control rods withdrawn. The refueling cavity is filled with water meeting the same boric acid specifications.

Special precautions are taken in all fuel handling operations to minimize the possibility of damage to fuel assemblies during transport to and from the spent fuel pit and during installation in the reactor. All handling operations on irradiated fuel are conducted under water. The handling tools used in the fuel handling operations are conservatively designed and the associated devices are of a fail-safe design. In addition the motions of the cranes which move the fuel assemblies are limited to a low maximum speed.

The design of the fuel assembly is such that the fuel rods are restrained by grid clips which provide a total restraining force on each fuel rod. If the fuel rods are in contact with the bottom plate of the fuel assembly, any force transmitted to the fuel rods is limited due to the restraining force of the grid clips. The force transmitted to the fuel rods during fuel handling is not sufficient to breech the fuel rod cladding. If the fuel rods are not in contact with the bottom plate of the assembly, the rods would have to slide against the 60 pound friction force. This would absorb the shock and thus limit the force on the individual fuel rods.

After the reactor is shut down, the fuel rods contract during the subsequent cooldown and would not be in contact with the bottom plate of the assembly.

Considerable deformation would have to occur before the rod would make contact with the top plate and apply any appreciable load on the fuel rod. Based on the above, it is considered unlikely that any damage would occur to the individual fuel rods during handling. If one assembly is lowered on top of another, no damage to the fuel rods would occur that would breech the integrity of the cladding.

Refueling operation experience that has been obtained with Westinghouse reactors has verified that no fuel cladding integrity failures have occurred during any fuel handling operations involving over 50 reactor years of W PWR operating experience in which more than 2200 fuel assemblies have been loaded or unloaded.

S5.7.4 ANALYSIS AND EVALUATION OF FUEL HANDLING ACCIDENT INSIDE CONTAINMENT

S5.7.4.1 Assumptions

The following assumptions are postulated for a calculation of the fuel handling accident:

a. The accident occurs at 100 hours following the reactor shutdown; i.e., the time at which spent fuel would be first moved.

b. The accident results in the rupture of the cladding of the equivalent of one row of fuel rods (15/204).

c. The damaged assembly is the one that had operated at the highest power level in the core region to be discharged.

d. The power in this assembly, and corresponding fuel temperatures, establish the total fission product inventory and the fraction of this inventory which is present in the fuel pellet-cladding gap at the time of reactor shutdown.

e. The fuel pellet-cladding gap inventory of fission products in these rods will be released to the spent fuel pit water at the time of the accident.

f. The spent fuel pit water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reactions. A decontamination factor of 760 for the halogens is used in this analysis.

g. A small fraction of fission products which are not retained by the water are dispersed into the containment.

h. After isolation of the containment, the radioactive gases in the containment are leaked from the containment to the environment at a small leak rate. The amount of activity leaked from the containment is assumed negligible compared to that escaping from the purge line during the first five minutes prior to isolation.

S5.7.4.2 Justification for Assumptions

a. It is approximately 100 hours after shutdown that the first fuel assembly is removed from the core. The time delay between shutdown and removal of the first assembly is due to the time required to depressurize the reactor coolant system, remove the vessel head and other refueling procedures.

b. Analyses have shown that mishandling of a spent fuel assembly is not expected to result in damage of the cladding of any fuel rods in the assembly. The impact of a spent fuel element onto a sharp object may result in the breech of the cladding of some fuel elements in the assembly. The rupture of the equivalent of one row of fuel elements is considered to be a conservative upper limit.

c. The highest powered assembly in the discharged region would have the largest quantity of radioactivity in the fuel pellet-cladding gap of all the assemblies to be discharged.

d. The quantity of radioactivity in the fuel pellet-cladding gap is dependent on the power level and temperature distribution of the assembly (WCAP-7518L updated and proportioned for power).

e. Since all fuel handling operations are conducted under water, the release of any radioactive gases from a damaged assembly would be in the form of bubbles to the water covering the assembly.

f. An experimental test program was conducted by Westinghouse to evaluate the extent of iodine removal as the halogen gas bubbles rise to the surface of the pool from a damaged irradiated fuel assembly.

g. The radioactive gases remaining in the bubbles when they reach the surface of the pool, are released to the atmosphere atop the pool.

h. Any increase in radioactivity concentrations in the containment will be detected by the radiation monitors. Upon high radiation signal the purge line from the containment will be isolated. It is conservatively estimated that the purge line will be isolated within five minutes following a refueling accident which releases radioactivity into the containment.

i. Since the pressure in the containment will be atmospheric at the time of the postulated accident and no pressure rise is expected due to the accident, the leak rate from the containment is expected to be near zero.

S5.7.4.3 Doses at Site Boundary and Total Population Dose (man-rem)

The activity released to the pool as a result of this accident is given in Table S5.7-1. The doses at the site boundary from a refueling accident inside the containment are 2.40 mrem thyroid and 0.370 mrem whole body. The total population dose from this accident is 3.51 man-rem whole body.

TABLE S5.7-1

ACTIVITY RELEASE TO POOL

Isotope	Curies Released
I-131	439.5
I-133	17.1
I-135	8.13×10^{-3}
Xe-133	683.2
Xe-133M	5.6
Xe-135	.157
Kr-85M	2.37×10^{-6}
Kr-85	136.7
Kr-87	-
Kr-88	-

Note: Activity released to pool is independent of whether accident occurs inside containment or in fuel building.

S5.8 EVALUATION OF CLASS 7 EVENTS

S5.8.1 DISCUSSION OF CLASS 7 EVENTS

Accidents which fall into accident Class 7 are: Mishandling of fuel element, dropping of heavy object onto fuel, dropping of shielding cask or loss of cooling to cask or a transportation incident on site.

The only event in this accident class which could possibly result in a release of radioactive gases from a fuel assembly is the mishandling of a fuel element. The fuel handling procedures are such that no heavy objects can be moved over any fuel elements being transferred or stored. The shielding and shipping casks are designed to be dropped with no subsequent damage to the cask or the assembly. The spent fuel is not moved off site until 90-120 days after refueling. By this time most of the major contributing isotopes to the thyroid and whole body dose have decayed to a negligible level.

S5.8.2 DESCRIPTION OF CLASS 7 EVENT - REFUELING ACCIDENT OUTSIDE CONTAINMENT

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in the equivalent of one row of fuel rods in the assembly being damaged. The subsequent release of radioactive gases from the damaged fuel element will bubble through the water covering the assembly, where most of the iodine will be entrained, and be released to the spent fuel building. The activity is then exhausted to the environment via the plant vent.

S5.8.3 DISCUSSION OF REMOTENESS OF POSSIBILITY OF A FUEL HANDLING ACCIDENT OUTSIDE CONTAINMENT

A fuel handling incident outside the containment is considered to be equally as remote as that inside the containment. The administrative controls and physical limitations imposed on fuel handling operation are essentially the same as those described for the Class 6 events. As described earlier, the fuel handling manipulators and hoists are designed so that the fuel assembly is continuously immersed while in the spent fuel pit. In addition, the design of storage racks and manipulation facilities in the spent fuel pit is such that:

a. Fuel at rest is positioned by positive restraints in an eversafe, always subcritical, geometrical array, with no credit for boric acid in the water.

b. Fuel can be manipulated only one assembly at a time.

c. Violation of procedures by placing one fuel assembly in with any group of assemblies in racks will not result in criticality.

In summary, those factors which are discussed under Section S5.7.3 regarding remoteness of possibility of fuel handling accidents within the containment also apply here.

S5.8.4 ANALYSIS AND EVALUATION OF REFUELING ACCIDENT OUTSIDE CONTAINMENT

S5.8.4.1 Assumptions

a. The identical assumptions (a) through (h) of Section S5.7.4.1 are also postulated for calculation of the fuel handling accident outside the containment.

b. The radioactive iodine released from the fuel handling building is reduced by a factor of 100 due to presence of a charcoal filter in the fuel handling building exhaust system.

S5.8.4.2 Justification for Assumptions

a. The justification for the identical assumptions given in Section S5.7.4.1 are the same as given in Section S5.7.4.2.

b. The manufacturer's rated charcoal filter efficiency verified by tests is 99.97 percent.

S5.8.4.3 Doses at Site Boundary and Total Population Dose (man-rem)

The activity released to the pool as a result of this accident is the same as that provided in Table S5.7-1 for Class 6 events.

The doses at the site boundary from a refueling accident outside the containment are .024 mrem thyroid and 0.370 mrem whole body. The total population dose from this accident is 3.51 man-rem whole body.

S5.9 EVALUATION OF CLASS 8 EVENTS

S5.9.1 DISCUSSION OF CLASS 8 EVENTS

Accidents considered in this class are loss of coolant, steam line break, steam generator tube rupture, rod ejection, and ruptures of the waste gas decay tank and the volume control tank. These extremely unlikely accidents are used, with highly conservative assumptions, as the design basis events to establish the performance requirements of engineered safety features. For purposes of this environmental report, the accidents are evaluated on a realistic basis that these engineered safeguards will be available and will either prevent the progression of the accident or mitigate the consequences.

S5.9.1.1 Loss of Coolant (LOCA)

a. Description of Class 8 Event - Loss of Coolant

A LOCA is defined as the loss of primary system coolant due to a rupture of a Reactor Coolant System (RCS) pipe or any line connected to that system. Leaks or ruptures of a small cross section would cause expulsion of the coolant at a rate which can be accommodated by the charging pumps. The pumps would maintain an operational water level in the pressurizer permitting the operator to execute orderly shutdown. A small quantity of the coolant containing fission products normally present in the coolant would be released to the containment.

Should a break occur beyond the capacity of the charging pumps, depressurization of the RCS causes fluid to flow from the pressurizer to the break resulting in a pressure decrease in the pressurizer. Reactor trip occurs when the pressurizer low pressure set point is reached. The Emergency Core Cooling System (ECCS) is actuated when the pressurizer low pressure and low level set points are reached. Reactor trip and ECCS actuation are also provided by a high containment pressure signal. These countermeasures limit the consequences of the accident in two ways:

- Reactor trip and borated water injection supplement void formation in causing rapid reduction of the core thermal power to a residual level corresponding to the delayed fission product decay.
- Injection of borated water ensures sufficient flooding of the core to limit the peak fuel cladding temperature to well below the melting temperature of Zircaloy-4 in addition to limiting average core metal-water reaction to substantially less than 1 percent.

Before the reactor trip occurs, the plant is in an equilibrium condition, i.e., the heat generated in the core is being removed via the secondary system. Subsequently, heat from decay, hot internals, and the vessel is transferred to the RCS fluid and then to the secondary system. The ECC signal terminates normal feedwater flow to the steam generators by closing the main feedwater line isolation valves and initiates auxiliary feedwater flow by starting the motor driven auxiliary feedwater pumps. If off-site power is available, steam may be dumped to the condenser, depending on the size of the break. The secondary flow aids in the reduction of Reactor Coolant System pressure. If the Reactor Coolant System pressure falls below the setpoint, the passive accumulators inject borated water due to the pressure differential between the accumulators and the reactor coolant loops.

While the ECCS prevents fuel clad melting, as a result of the increase in cladding temperature and the rapid depressurization of the core some cladding failures may occur in the hottest regions of the core. Some of the volatile fission products contained in the pellet-cladding gap may be released to the containment. These fission products, plus those present in that portion of the primary coolant discharged to the containment, are partially removed from the containment atmosphere by the spray system and plateout on the containment structures. Some of the remaining fission products in the containment atmosphere will be slowly released to the external environment through minute leaks in the containment during the time when the containment pressure is above atmospheric pressure. These minute leaks could be expected to be choked by water and water vapor although credit for this was not taken in evaluating releases.

b. <u>Discussion of Remoteness of Possibility of Loss of Coolant</u>

The rupture of a reactor coolant pipe or a pipe connected to it is not expected to occur, because of very careful selection of design, construction, operation and quality control requirements. A very strict and detailed "Quality Assurance Program" is provided to make sure that the specific requirements are met during the various stages of design, construction, erection, and fabrication.

The reactor coolant system is designed to withstand the "design basis earthquake" at the site and assure capability of shutdown and maintain the nuclear facility in a safe condition. Pressure-containing components of the reactor coolant system are designed, fabricated, inspected and tested in conformance with the applicable codes. The design loads for normal operational fatigue and faulted conditions are selected by conservatively predicting the type and number of cycles that the plant is expected to experience as described in the PSAR. Also, essential equipment is placed in a structure which is capable of withstanding extraordinary natural phenomena, such as tornado, flooding condition, high wind or other natural phenomena.

The materials and components of the reactor coolant system are subjected to thorough non-destructive inspection prior to operation and a preoperational hydro test is performed at 1.25 times the design pressure.

The plant is also operated under very closely controlled conditions to ensure that the operating parameters are kept within the limits assumed in the design. The concentration of oxygen (≤ 0.10 ppm) is kept to low levels so that the integrity of the reactor coolant system is assured under all operating conditions. The reactor pressure vessel is paid particular attention because of the shift in nil ductility transition temperature (NDTT) with irradiation. Therefore, technical specification limits are imposed on the maximum heatup and cooldown rates to make sure that the vessel wall temperature is above the NDTT whenever the stresses become significant. Materials of construction are selected for the expected environment and service conditions in accordance with the appropriate code requirements.

It is expected that for pipes of the size, thickness, and material used in the RCS significant leakage will occur before catastrophic failure. The plant is provided with various means of detecting leakage from the reactor coolant system. The sensitivity of these leak detection systems gives reasonable assurance that a small leak will be detected and repaired before it reaches the size that will cause failure.

Furthermore, provisions are made for periodically inspecting, in-situ, all the areas of relatively high stress in order to discover potential problems before significant flaws develop. The inspection processes vary from component to component and include such inspection techniques as visual inspection, ultrasonic, radiographic and magnetic partical examinations. This in-service inspection program (as described in the PSAR) provides additional assurance of the continuing integrity of the Reactor Coolant System.

To further demonstrate the adequacy of the reactor coolant system, certain abnormal conditions are analyzed in detail in the PSAR.

Those credible transients which could cause pressure surges have been considered in the design by:

- Reactor protection system trips
- Incorporation of relief and safety valves in the pressurizer and appropriate sizing of the steam side safety and relief valves.

These ensure that the system pressures and temperatures attained under expected modes of plant operation or anticipated system interactions, will be within the design limits giving further assurance that a rupture of the Reactor Coolant System is very remote.

c. <u>Analysis and Evaluation of Loss-of-Coolant Accident</u>

1. <u>Assumptions</u>

The analysis for this accident is based on:

(a) Only activity in the fuel pellet-clad gap ($\sim$1.5 percent of core halogen and 1.2 percent of core noble gases) gap would be available for release.

(b) Fuel clad perforation ranges from zero for small breaks to a maximum of 70 percent. The fuel rods represented in this 70 percent, however, generate $\sim$90 percent of the core power, so that $\sim$90 percent of the total gap inventory would be released.

(c) Of the fission product activity, which is released from the gap, 25 percent of the halogens and 100 percent of the noble gases are initially available for leakage from the containment; of the halogens, 95 percent is in the elemental form and 5 percent is in the organic form.

(d) The spray effectiveness is 18.7 hr^{-1} for elemental iodine removal, and there is no removal for organic iodine.

(e) The containment leak rate is 0.1 volume percent per day for the first 24 hours and 0.05 volume percent per day for the next 30 days.

2. Justification for Assumptions

(a) Fission product diffusion through the fuel pellet is a temperature dependent process. Since the reactor has been made subcritical, fissioning ceases and the pellet temperature begins to drop from the operating value almost immediately. The gap activity represents 1-1/2 years of operation. The additional fission product diffusion to the gap after the accident is negligible.

(b) Extensive analyses of the core behavior during a LOCA, based on theoretical and experimental evidence, have been performed. These analyses are reported in the PSAR.

(c) As used in the model in TID 14844, 25 percent of the released iodine is considered available in the containment atmosphere after plate-out on reactor internals and containment structures and entrainment in the coolant and condensed steam.

Data presented in the PSAR indicate that little organic iodine is released from the fuel.

(d) The calculation of the spray effectiveness for iodine removal is based on the drop diffusion model developed by L. F. Parsly.[1]

---

(1) L. F. Parsly, "Design Considerations of Reactor Containment Spray Systems, Part VII", ORNL-TM-2412, Part VII, Oak Ridge National Laboratory.

The effects of liquid phase resistance, steam condensation, and drop coalescence are accounted for in the model. The input parameters for the spray evaluation are based on conservative estimates of the expected performance of the spray system.

(e) A comprehensive program of containment testing will be carried out including pre-operational weld inspection by radiography and liquid penetrant, and individual and integral leak testing of penetrations and the whole containment building.

Post operational leak rate tests are conducted periodically to ensure that the integrity of containment is maintained.

3. Doses at Site Boundary and Total Population Dose

With the above assumptions and the available activity data of Table S5.9-1 the thyroid dose and the whole body dose at the site boundary are calculated to be 32.6 mrem and 0.61 mrem, respectively. The total population whole body dose is 5.74 man-rem.

TABLE S5.9-1

*ACTIVITY AVAILABLE FOR RELEASE FROM COOLANT TO CONTAINMENT

Basis: 0.2 percent fuel defects prior to accident plus additional activity release from fuel following LOCA.

Isotope	Curies
I-131	9.25×10^5
I-132	1.59×10^5
I-133	7.00×10^5
I-134	1.70×10^5
I-135	3.63×10^5
Xe-133	1.75×10^6
Xe-133M	2.93×10^4
Xe-135	4.61×10^5
Kr-85M	6.46×10^4
Kr-85	1.45×10^5
Kr-87	7.72×10^4
Kr-88	1.41×10^5

* Total Inventory in Reactor Coolant System

S5.9.1.2 Steam Line Break

a. Description of Class 8 Event - Steam Line Break

A rupture of a steam line is assumed to include any accident which results in an uncontrolled steam release from a steam generator. The release can occur due to a break in a pipe line or due to a valve malfunction. The steam release results in an initial increase in steam flow which decreases during the accident as the steam pressure falls.

The following systems limit the potential consequences of a steam line break:

1. Safety Injection System actuation on:
   - (a) Coincident pressurizer low pressure and low level;
   - (b) High differential pressure between steam lines;
   - (c) High steam flow in any two steam lines in coincidence with either low-low Reactor Coolant System average temperature or low steam line pressure in any two steam lines;
   - (d) High containment pressure.
2. The overpower reactor trips (nuclear flux and ΔT) and the reactor trip occur upon actuation of the Safety Injection System.
3. Redundant isolation of the main feedwater lines. Sustained high feedwater flow would cause additional cooldown, thus, in addition to the normal control action which will close the main feedwater valves, any safety injection signal will rapidly close all feedwater control valves, trip the main feedwater pumps, and close the feedwater pump discharge valves.

4. Trip of the fast acting steam line isolation valves on high containment pressure signals.

Each steam line has a fast closing isolation valve. These valves prevent blowdown of more than one steam generator for any break location even if one valve fails to close. For example, for a break upstream of the isolation valve in one line, closure of either the valve in that line or the isolation valve in the other lines will prevent blowdown of the other steam generators.

If there are no steam generator tube leaks (Class 5), there would be no fission product release to the atmosphere from this accident. With tube leaks, a portion of the equilibrium fission product activity in the secondary system will be released. In addition, some primary coolant with its entrained fission products will be transferred to the secondary system as the reactor is cooled down. The steam is dumped to the condenser, and the noble gases transferred from the primary system would be released through the condenser off-gas system.

b. <u>Discussion of Remoteness of Possibility of a Steam Line Break Accident</u>

A steam line break is considered highly unlikely. The steam system valves, fittings and piping are conservatively designed according to ANSI B31.1. The piping is a ductile material completely inspected prior to installation. After installation, the entire system undergoes hydrostatic testing and inspection, and hot functional testing. This test is designed to uncover any flaws that may exist in the piping, fittings or valves.

In addition to pre-operational tests to ensure the steam system integrity, during operation the water in the secondary side of the steam generators is held within chemistry specifications to control deposits and corrosion inside the steam generators and steam lines. A chemical treatment is used to prevent the formation of free caustic which would cause this corrosion. The phenomena of stress-corrosion cracking and corrosion fatigue are not generally encountered unless a specific combination of conditions (i.e., combination of susceptible alloy, aggressive environment, stress and time) is present. The steam system is designed to avoid any critical combination of these conditions.

With this combination of conservative design, quality control and assurance, pre-operational testing, and control over steam chemistry the potential for a steam line break is minimal.

c. Analysis and Evaluation of Steam Line Break

1. Assumptions

The analysis for this accident is based on:

(a) An equilibrium radioactivity in the secondary system of 0.2 percent equivalent fuel defects with a 20 gpd steam generator leakage prior to event.

(b) No additional fuel defects or additional releases from fuel occur due to the accident.

(c) Primary to secondary leakage of 20 gpd occurs for 8 hours after the accident.

(d) The break occurs outside the containment.

(e) The condenser (and thus off-site power) is available for steam dump after the faulted line is isolated.

2. Justification for Assumptions

(a) The fuel defect level and steam generator leak rate are derived from operating experience with Westinghouse pressurized water reactors.

(b) Fuel rods will not have a minimum DNBR (Departure from Nucleate Boiling Ratio) of less than 1.3, and thus there is no clad damage.

(c) Eight hours is required for an orderly cooldown and depressurization of the primary system. Primary-secondary coolant transfer occurs for this time period.

3. Doses at Site Boundary and Total Population Dose

With the above assumptions and the activity data of Table S5.9-2, the thyroid dose and the whole body dose at the site boundary are calculated to be 0.00865 mrem and 0.0000125 mrem respectively. The total population whole body dose is 0.00012 man-rem.

TABLE S5.9-2

EQUILIBRIUM ACTIVITY DISTRIBUTION

Basis: 0.2 percent defective fuel and 20 gal/day leak prior to event.

No fuel damage following accident.

Isotope	Primary Side Concentration μc/cc	Secondary Side Concentration μc/cc
Mo-99	.904	$.306 \times 10^{-3}$
I-131	.38	1.36×10^{-4}
I-132	.144	1.46×10^{-4}
I-133	.62	1.78×10^{-4}
I-134	.094	$.438 \times 10^{-5}$
I-135	.34	$.658 \times 10^{-4}$
Cs-134	.04	1.48×10^{-5}
Cs-137	.2	7.40×10^{-5}
		Noble Gas Release Rate μc/sec
Xe-133	4.6	.552
Xe-133M	.1	.12
Xe-135	.8	.96
Kr-85M	.3	.36
Kr-85	.008	.0096
Kr-87	.2	.24
Kr-88	.6	.72

S5.9.1.3 Steam Generator Tube Rupture

a. Description of Class 8 Event - Steam Generator Tube Rupture

This accident consists of a complete single tube break in a steam generator. Since the reactor coolant pressure is greater than the steam generator shell side pressure, contaminated primary coolant is transferred into the secondary system. A portion of this radioactivity would be vented to the atmosphere through the condenser off-gas. The sequence of events following a tube rupture is as follows:

1. The operator will be notified within seconds by the condenser off-gas vent monitor of a radioactivity release.
2. Pressurizer water level will decrease for one to four minutes before an automatic low pressure trip occurs. Seconds later, low pressurizer level will automatically complete the safety injection actuation signal.

Automatic actions and cooldown procedures are as follows:

(a) Automatic boration by high head safety injection pumps.

(b) Restoration of discernible fluid level in the pressurizer by safety injection pump operation.

(c) Operator-controlled reduction of safety injection flow to permit the RCS pressure to decrease below the setting of the lowest affected steam generator safety valve.

(d) Operator-controlled steam dumping to the condenser in order to: (1) reduce the reactor coolant temperature; (2) maintain primary coolant subcooling equivalent to a suitable overpressure; (3) minimize steam discharge from the affected steam generator.

Isolation of the affected steam generator will be achieved by:

(a) Identifying the affected steam generator by observation of rising liquid level and use of the liquid sample activity monitor.

(b) Closing the steamline isolation valve connected to the affected steam generator.

(c) Securing the auxiliary feedwater flow to that steam generator.

(d) Blowdown from all steam generators is terminated at the start of accident.

b. <u>Discussion of Remoteness of Possibility of Steam Generator Tube Rupture</u>

The potential for failure of a steam generator tube is considered minimal. The steam generator tube is constructed out of a highly ductile material - Inconel 600. Further, based on ultimate strength at design temperature, the calculated bursting pressure of a steam generator tube is in excess of 3050 psi, compared to the maximum operating differential pressure the tube wall sees of about 1100 psi. This margin applies to the longitudinal failure modes. An additional factor of two applies to ultimate pressure strength in an axial direction tending to resist double-ended failure.

It is expected that rupture would be preceeded by cracking, which failure would be induced by fretting, corrosion, erosion or fatigue. This type of failure is of such a nature as to produce tell-tale leakage. The activity in the secondary system is continuously monitored via the condenser off-gas discharge and periodic sampling, and continued unit operation is not permitted if the leakage exceeds technical specification limits. As a result, any failure of this nature would be detected before the large safety margin in pressure strength is lost and a rupture develops.

Finally, in over 400,000 tube years for Westinghouse built steam generators, there have been no gross tube ruptures. This experience, combined with stringent quality control requirements in the construction of the generator tubes and constant monitoring of the secondary system renders the likelihood of a steam generator tube rupture highly remote.

c. Analysis and Evaluation of Steam Generator Tube Rupture

1. Assumptions

The analysis of this accident is based on:

(a) Activity in primary coolant based on 0.2 percent equivalent fuel defects. The accident will cause no additional fuel damage.

(b) 126,000 pounds of primary coolant are carried over to the secondary side.

(c) An iodine partition factor of 10 $\frac{\mu c/gm\ water}{\mu c/gm\ steam}$ in the steam generator.

(d) The faulty steam generator is isolated within 30 minutes.

(e) An iodine partition factor of 10^4 $\frac{\mu c/gm\ steam}{\mu c/cc\ air}$ in the condenser.

2. Justification for Assumptions

(a) The 0.2 percent defect level is based on average reactor operating experience with W PWR Zircaloy fuel. No clad damage is anticipated as described in the PSAR.

(b) The steam generator leakage is based on plant operating experience with W PWR Inconel steam generators. The 126,000 pounds of primary coolant carryover is based on the amount of time it takes for the primary system pressure to come into equilibrium with the secondary side, as described in the PSAR.

(c,d) The iodine partition factors in the steam generator and condenser are based on the following reference:

Styrikovich M. A., Martynova O. I., Katkovska K. Ya., Dwdrovskii I. Ya., Smrinova I. N. "Transfer of Iodine from Aqueous Solutions to Saturated Vapor", Translated from Atomnaya Energiya, Vol. 17, No. 1, P. 45-49, July, 1964.

(e) The 30 minute steam generator isolation time is based on estimates on the time it would take for the operator to identify the faulted steam generator from the instrumentation provided in the control room, and effect isolation.

3. Doses at Site Boundary and Total Population Dose

With the above assumptions and the activity data of Table S5.9-2, the thyroid dose and the whole body dose at the site boundary are calculated to be 0.00016 mrem and 0.065 mrem respectively. The total population whole body dose is 0.620 man-rem.

S5.9.1.4 Rod Ejection Accident

a. Description of Class 8 Event - Rod Ejection Accident

A highly unlikely rupture of the control rod mechanism housing, creating a full system pressure differential acting on the drive shaft, must be postulated for this accident to occur. The resultant reactor core thermal power excursion is limited by the Doppler reactivity effects of the increased fuel temperature and terminated by a reactor trip actuated by a high neutron flux signal.

The operation of a plant with chemical shim control is such that the severity of an ejection accident is inherently limited. Normally there are only a few control rods in the core at full power. Proper positioning of the rods is monitored by a control room alarm system. There are low and low-low level insertion monitors with visual and audio signals. Operating instructions require boration at low level alarm and emergency boration at the low-low alarm. By utilizing the flexibility in the selection of control rod cluster groupings, radial locations, and axial positions as a function of load, the design minimizes the peak fuel and clad temperatures for the worst ejected rod.

No clad melting occurs as a result of this accident. Activity in the primary coolant is released to the containment. There, sprays and plateout partially reduce the airborne fission product concentration. Fission products escaping to the external environment do so through minute leaks in the containment structure.

b. Discussion of Remoteness of Possibility of a Rod Ejection Accident

A failure of a control rod mechanism housing sufficient to allow a control rod to be rapidly ejected from the core is considered very remote. Each control rod drive mechanism housing is completely assembled and shop tested at pressures higher than normal operating pressures. On-site, the mechanism housings are individually hydrotested at higher than operating pressures as they are installed, and checked during the hydrotest of the completed Reactor Coolant System.

Stress levels for the mechanism are not affected by anticipated system transients at power, or by the thermal movement of the coolant loops. The latch mechanism housing and rod travel housing are each a single length of forged type-304 stainless steel. This material exhibits excellent notch toughness at all temperatures that will be encountered.

Finally, periodic inspections of the housings are made during the plant lifetime to ensure against defects.

Because of the conservative design, the number of pre-operational tests, the material of construction and the periodic inspection program, the potential of a rod ejection accident is considered minimal.

c. Analysis and Evaluation of Rod Ejection Accident

1. Assumptions

The analysis for the accident is based on:

(a) Activity in primary coolant due to 0.2 percent equivalent fuel defects.

(b) All activity in the coolant prior to accident is assumed to be released to the containment.

(c) The remaining assumptions are the same as for the LOCA.

2. Justification for Assumptions

(a) The 0.2 percent equivalent fuel defect is based on W PWR reactor operating experience with Zircaloy fuel clad. Based on the expected value of the ejected rod worth and beginning of life (i.e., low feedback values), approximately 2 percent of the fuel rods fall below a DNBR of 1.3 and no rods fall below a DNBR of 1.0. It is therefore concluded that no rods will suffer clad perforations during the transient.

(b) The amount of coolant is based on the time it takes to reduce the primary system pressure to ambient. Since the coolant activity has been in equilibrium with 0.2 percent fuel defects, the additional activity released to the coolant during the time it takes to depressurize the system is minimal.

(c) The remaining justifications are the same as for the LOCA.

3. Doses at Site Boundary and Total Population Dose

With the above assumptions and the data of Table S5.9-3, the thyroid dose and the whole body dose at the site boundary are calculated to be 0.00000204 mrem and 0.000000181 mrem, respectively. The total population whole body dose is 0.00000170 man-rem.

TABLE S5.9-3

ACTIVITY IN REACTOR COOLANT

Basis: 0.2 percent defective fuel prior to event. No fuel damage following accident.

Isotope	μCi/cc in Coolant
I-131	0.38
I-132	.144
I-133	.62
I-134	.094
I-135	.34
Xe-133	4.6
Xe-133M	.1
Xe-135	.8
Kr-85M	.3
Kr-85	.008
Kr-87	.2
Kr-88	.6

S5.9.1.5 Waste Gas Decay Tank Rupture

a. Description of Class 8 Event - Waste Gas Decay Tank Rupture

The postulated accident is the gross structural failure of a Waste Gas Decay Tank.

The decay tanks contain the gases vented from the reactor coolant system, the volume control tank, and the liquid holdup tanks. Sufficient volume is provided in these tanks to store the gases evolved during reactor operation.

b. Discussion of the Remoteness of Possibility of a Waste Gas Decay Tank Rupture

Most of the gas received by the waste processing system during normal operation is cover gas displaced from the chemical and volume control system and consists mostly of hydrogen and nitrogen. Special precautions are taken throughout the system to prevent in-leakage of oxygen-carrying gases. Out-leakage from the system is minimized by using diaphragm valves, bellows seals, self contained pressure regulators and soft-seated packless valves throughout the radioactive portions of the system.

During operation, the contents of the gas decay tanks are processed by a hydrogen-oxygen recombiner. This recombiner contains a hydrogen-oxygen analyzer which monitors the gases to insure that they are kept within preset limits. Alarms are provided to warn the operator if the preset values are exceeded.

Since the components of the waste gas system are not subjected to any high pressures or stresses and they are of ASME III, Class 3 design, rupture or failure of any of the components is highly unlikely.

Because of the conservative design, extensive quality assurance, the close monitoring, and sampling throughout the system, and the fact that the system components are not subjected to high pressure or stresses, an accidental release of waste gases is highly unlikely.

c. Analysis and Evaluation of Waste Gas Decay Tank Rupture

1. Assumptions

The analysis for this accident is based on:

(a) Operation with 0.2 percent equivalent fuel defects

(b) Noble gas release only

2. Justification for Assumptions

(a) The equivalent 0.2 percent fuel defect level is based on W PWR operating experience with Zircaloy fuel.

(b) Non volatile fission product concentrations are greatly reduced as the coolant is passed through the purification demineralizers. An iodine removal factor of 10 is expected in the mixed bed demineralizers, and an iodine partition factor of the order of 10,000 is expected between the liquid and vapor phase. Based on the above information and operating experience at Yankee-Rowe and Saxton, activity stored in a gas decay tank consists of that from the noble gases released from the processed coolant and only negligible quantities of less volatile isotopes.

3. <u>Doses at Site Boundary and Total Population Dose</u>

With the above assumptions and the data of Table S5.9-4, the whole body dose at the site boundary is calculated to be 9.76 mrem. The total population whole body dose is 92.7 man-rem.

TABLE S5.9-4

ACTIVITY RELEASE FROM GDT

Basis: Complete release of one gas decay tank gaseous contents over a two hour period assuming 0.2 percent defects.

	Curies
Xe-133	12,370
Xe-133M	121
Xe-135	150
Kr-85M	23.2
Kr-85	12,640
Kr-87	4
Kr-88	27.4

S5.9.1.6 Volume Control Tank Rupture

a. Description of Class 8 Event - Volume Control Tank Rupture

The accident is the sudden and total structural failure of the volume control tank, releasing the contents to the atmosphere. The volume control tank is in the Reactor Coolant System letdown line and contains primary coolant. Its function is to regulate the primary coolant volume as the fluid expands and contracts with temperature changes. It is physically located in the auxiliary building. Any leakage is collected by the building sump and pumped to the liquid waste system. The sump and basement volume are sufficient to hold the entire tank contents without overflowing to areas outside the building.

b. Discussion of Remoteness of Possibility of Volume Control Tank Rupture

The volume control tank is designed to withstand an internal pressure of 75 psig. The normal internal operating pressure is approximately 15 psig. Level alarms, pressure relief valves, and automatic tank isolation and valve control assure that safe conditions are maintained during system operation. Since the volume control tank is not subjected to high pressures or stresses and is designed to ASME III, Class 2, structural failure of the tank is considered very remote. No similar tanks have failed in W PWR operating experience.

c. Analysis and Evaluation of Volume Control Tank Rupture

1. Assumptions

This accident analysis is based on:

(a) Plant operation with 0.2 percent equivalent fuel defects

(b) Noble gas release only

(c) Tank inventory based on noble gas equilibrium values.

2. Justification for Assumptions

(a) The 0.2 percent equivalent fuel detect level is based on W PWR operating experience with Zircaloy fuel.

(b) Non-volatile fission product concentrations are greatly reduced as the coolant is passed through the purification demineralizers. An iodine removal factor of 10 is expected in the mixed bed demineralizers, and an iodine partition factor of the order of 10,000 is expected between the liquid and vapor phase.

3. Doses at Site Boundary and Total Population Dose

With the above assumptions and scaling of the data of Table S5.3-1 the whole body dose at the site boundary is calculated to be 0.394 mrem. The total population whole body dose is 3.74 man-rem.

S5.10 CALCULATIONAL METHODS AND TABLE OF DOSES FOR EACH CLASS

For each of the accident classes considered in this report, the site boundary thyroid and whole body doses were computed. The total body dose includes the beta skin dose contribution. In addition, the total dose to the total population within a 50 mile radius of the site was analyzed for each accident class using the meteorological and population data.

The models used to compute the thyroid, whole body and population doses are presented below. They are taken from Chapter 7 of Meteorology and Atomic Energy. Gamma and beta energies are derived from the Table of Isotopes, Lederer, Hollander, and Perlman.

a. Thyroid Dose

The thyroid dose at the site boundary was computed using the equation:

$$\text{Thyroid Dose} = (\chi/Q)_{S.B.} \times \overline{B} \times \sum_i A_i \times DCF_i$$

where: A_i = Activity release to the environment of isotope i

DCF_i = Dose conversion factor isotope i

$\overline{B}$ = average breathing rate of the average man

$(\chi/Q)_{S.B.}$ = χ/Q at the site boundary as given in Section S5.2

b. Whole Body Dose

The whole body dose, including the beta contribution, at the site boundary was computed using the equation for a semi infinite spherical cloud as given by:

$$\text{Whole Body Dose} = \chi/Q \sum_i A_i \left[0.25\,\overline{E}_{\gamma_i} + 0.23\,\overline{E}_{\beta i}\right] E_{\beta_i}$$

where: A_i = activity released to the environment of isotope i

$\overline{E}_{\gamma_i}$ = Gamma energy of isotope i

$\overline{E}_{\beta_i}$ = Beta energy of isotope i

$(\chi/Q)_{S.B.}$ = χ/Q at the site boundary as given in Section S5.2

c. Population Dose

The total population dose was computed using the equation:

$$\text{Population Dose} = \left[\sum_r \sum_\phi \left(\frac{\chi}{Q}\right)_{r,\phi} P_{r,\phi} \right] \left[\sum_i A_i \left[0.25\, \overline{E}_{\gamma,i} + 0.23\, \overline{E}_{\beta i}\right]\right]$$

where:

A_i, $\overline{E}_{\gamma_i}$ and $\overline{E}_{\beta_i}$ are the same as given for the total body dose model, and

$\chi/Q_{r,\phi}$ = the χ/Q for a given sector (ϕ) and distance (r) as given in Section S5.2

$P_{r,\phi}$ = the population estimate for a given sector (ϕ) and distance (r) as given in Section S5.2

The releases from a plant are monitored by the environmental monitoring system which provides additional information which would indicate any inadvertent exposures.

The following Table S5.10-1 summarizes the thyroid, whole body and population doses for each class of accident.

TABLE S5.10-1

TABLE OF DOSES FROM EACH ACCIDENT CLASS

ACCIDENT CLASS	DESCRIPTION	SITE BOUNDARY THYROID DOSE (mrem)	SITE BOUNDARY WHOLE BODY DOSE DOSE (mrem)	POPULATION DOSE (man-rem)
2	10% Vol. Control Tank Release	-------	0.0394	0.374
3	10% Gas Decay Tank Release	-------	0.976	9.27
5	Steam Generator Leak	0.0041	0.0388	0.354
6	Fuel Handling in Containment	2.40	0.370	3.51
7	Fuel Handling Outside Containment	0.024	0.370	3.51
8.a.	LOCA, Large Break	32.6	0.610	5.74
8.b.	Steam Line Break	0.00865	0.0000125	0.00012
8.c.	Steam Generator Tube Rupture	0.000163	0.0653	0.620
8.d.	Rod Ejection LOCA	0.00000204	0.000000181	0.00000170
8.e.	100% Gas Decay Tank Release	-------	9.76	92.7
8.f.	100% Vol. Control Tank Release	-------	0.394	3.74

S5.11 CONCLUSIONS

Based on the evaluations of the various postulated accidents and occurrences in Sections S5.3 through S5.9 and the resultant radiological results as tabulated in Section S5.10, it is concluded that the environmental impact from these accidents and occurrences are insignificant and inconsequential. In fact the maximum man-rem realistically established as a result of any accident is well within the increment of exposure to the general public corresponding to variations in natural background.

REFERENCES

1. "The Energy Resources of the Earth," Scientific American, Vol. 224 (No. 3), pp. 61-70, September 1971.
2. "Coal Resources of the United States - January 1, 1967," Combustion, Vol. 43 (No. 6), pp. 9-11, December 1971.
3. "Energy and Power," Scientific American, Vol. 224 (No. 3), pp. 37-49, September 1971.
4. Statement Why Point Beach Unit No. 1 Operating License Should Not Be Suspended Pending Completion of NEPA Environmental Review, October 1971. Wisconsin Electric Power Company and Wisconsin-Michigan Power Company, Point Beach Nuclear Plant, Unit No. 1.
5. Environmental Report, Parr Hydroelectric Project, FPC Project No. 1894, Plate No. 9.
6. Spencer, S. L. (Chairman), Monetary Values of Fish, Prepared by the Pollution Committee, Southern Division, American Fisheries Society, 1970.
7. National Survey of Fishing and Hunting, 1965, Resource Publication No. 27, United States Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.
8. "Fisheries Investigations in Lakes and Streams," South Carolina Wildlife Resources Department, 1970.

9. "FPC Guidelines for the Protection of Natural, Historic, Scenic, and Recreational Values In the Design and Location of Rights-of-Way and Transmission Facilities," Electric Power Transmission and the Environment.

CONTENTS

SUPPLEMENT NO. 2 TO THE ENVIRONMENTAL REPORT

VIRGIL C. SUMMER NUCLEAR STATION

2S INTRODUCTION

The following information is submitted as Supplement Number 2 to the Virgil C. Summer Nuclear Station Environmental Report. This information is submitted as requested by Mr. Daniel R. Muller's letter dated May 15, 1972, answering questions attached to that letter.

2SA HEAT DISSIPATION AND RELATED WATER SYSTEMS

2SA.1 QUESTION: Provide a design description of the present cooling water outlet structure for the Summer Station. Describe alternate plant outflow designs to eliminate the holdup time in the discharge basin and to control the dispersion of the thermal discharges from the once-through cooling system.

The present concept for the condenser cooling water system consists of an intake structure located on the south shore of Monticello Reservoir which withdraws cooling water and pumps it through the main condensers within the turbine building. As it passes through the main condensers the cooling water is heated approximately 25°F; it then flows to Monticello Reservoir via 2300 feet of pipe and an approximately 1700 foot long tailbay-canal system. The discharge into this tailbay will be through a concrete discharge structure which serves to prevent erosion in the immediate vicinity of the pipe outlet. In the canal the cooling water flows at approximately 1.5 fps; at the terminus of the canal the cross sectional area increases resulting in a drop in the discharge velocity and a minimization of mixing of the heated water with cooler reservoir water. The ability of the canal configuration to provide the desired stratification is presently being model tested at Alden Research Laboratories in Holden,Massachusetts, as part of their overall study of the hydraulic-thermal performance of the pumped storage, nuclear station complex.

If the discharge pipe were routed directly to Monticello Reservoir rather than into the tailbay-canal system, the time of travel from the main condenser to Monticello Reservoir could be reduced due to the higher design velocity for pipes compared to canals; however, this increased velocity results in disruption of the desired thermal stratification at the outlet. The choice of the tailbay-canal scheme resulted from an economic comparison with direct routing of pipes. Due to the presence of the Class 1 Service Water Pond and the natural location of the jetty (Page 2SA9-1), the total distance of travel to Monticello Reservoir cannot be significantly reduced.

2SA.2 QUESTION: Provide information on the travel time through the condenser cooling system, particularly from the point of contact with the heated water until discharge from the outfall into the proposed Lake Monticello.

With this present design of the main cooling system, the time of travel from the point of contact with heat in the condensers to the point of discharge to the main portion of Monticello Reservoir is 22.9 minutes. The time of travel from the main condenser to the entrance of the tailbay is 4.6 minutes; the remaining time being required to flow at a relatively low velocity through the tailbay and discharge canal.

2SA.3 QUESTION: Provide representative data on the temperature differences between the Parr Reservoir and the proposed Lake Monticello, including the monthly maximum, minimum and average water temperatures. Include the expected equilibrium temperatures and surface depth isotherms in Lake Monticello.

Figures 2SA.3-1 through 2SA.3-3 show the estimated average temperatures in the Monticello Impoundment and the Parr Reservoir for each month of the year. Figure 2SA.3-1 shows the temperatures for an average temperature year, Figure 2SA.3-2 for a maximum temperature year and Figure 2SA.3-3 for a minimum temperature year.

The data for the average Broad River temperature was based on recorded temperatures at the intake to the Parr Steam Station for the years 1943 to 1970 inclusive. The average Broad River monthly temperature was obtained by averaging each month of the above recorded years. The minimum and maximum Broad River temperatures were obtained by using the lowest and the highest temperatures recorded during that time span.

Based on preliminary model studies the average temperature difference between the Monticello Impoundment and the Parr Reservoir would be approximately 3°F. These studies were conducted with 2440 cfs Broad River flow, full plant load at the Fairfield Pumped Storage plant and 2-unit operation of the nuclear plant with a condenser temperature rise of 25°F.

The surface isotherms from the test are indicated in Figures 2SA.3-4 through 2SA.3-6. Vertical profiles are shown in Figures 2SA.3-7 through 2SA.3-9 for 11 different locations in the Monticello Impoundment.

The vertical profiles indicate that stratification exists throughout most of the Monticello Impoundment with the exception of the area near the pumped storage intake. The largest temperature gradients are located from elevation 410 to the water surface. The average surface temperature gradient is in the order of 11°F and the average temperature gradient at elevation 410 is 4.1°F. The average temperature gradient of the total volume of the impoundment is 4.7°F.

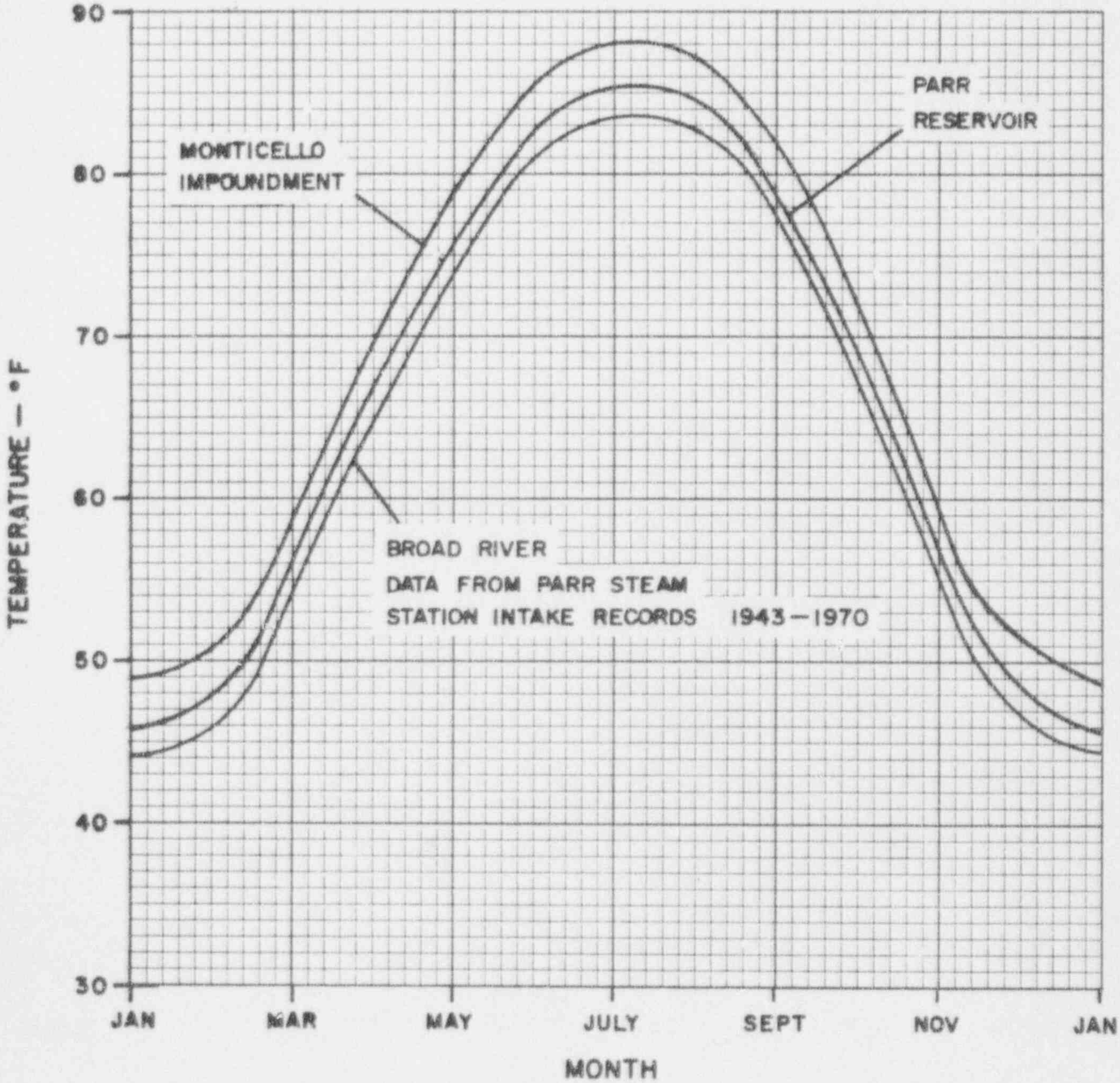


Figure 2SA.3-1

Expected average temperatures at Parr Hydroelectric Project

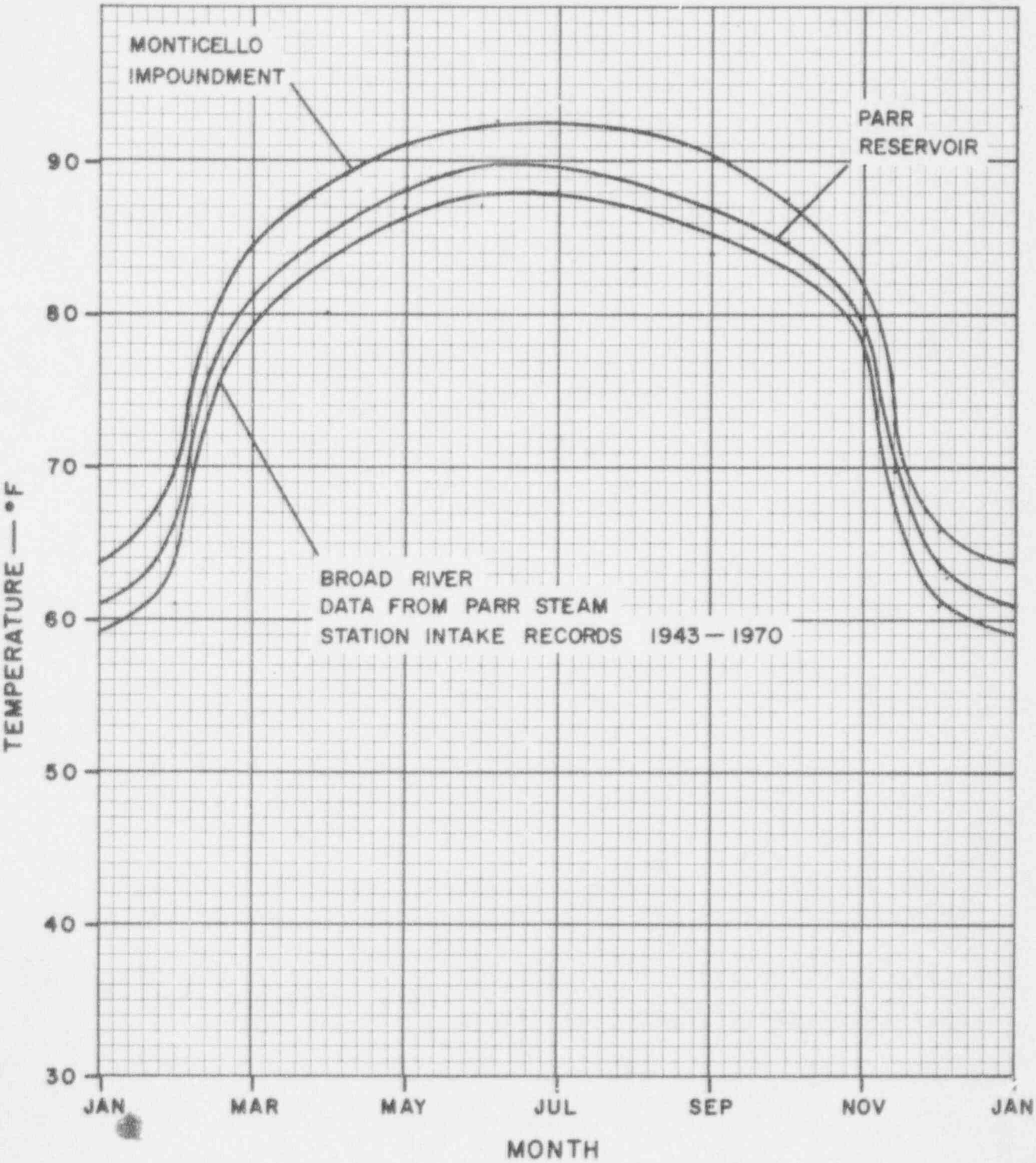


Figure 2SA.3-2

Expected maximum temperatures at Parr Hydroelectric Project

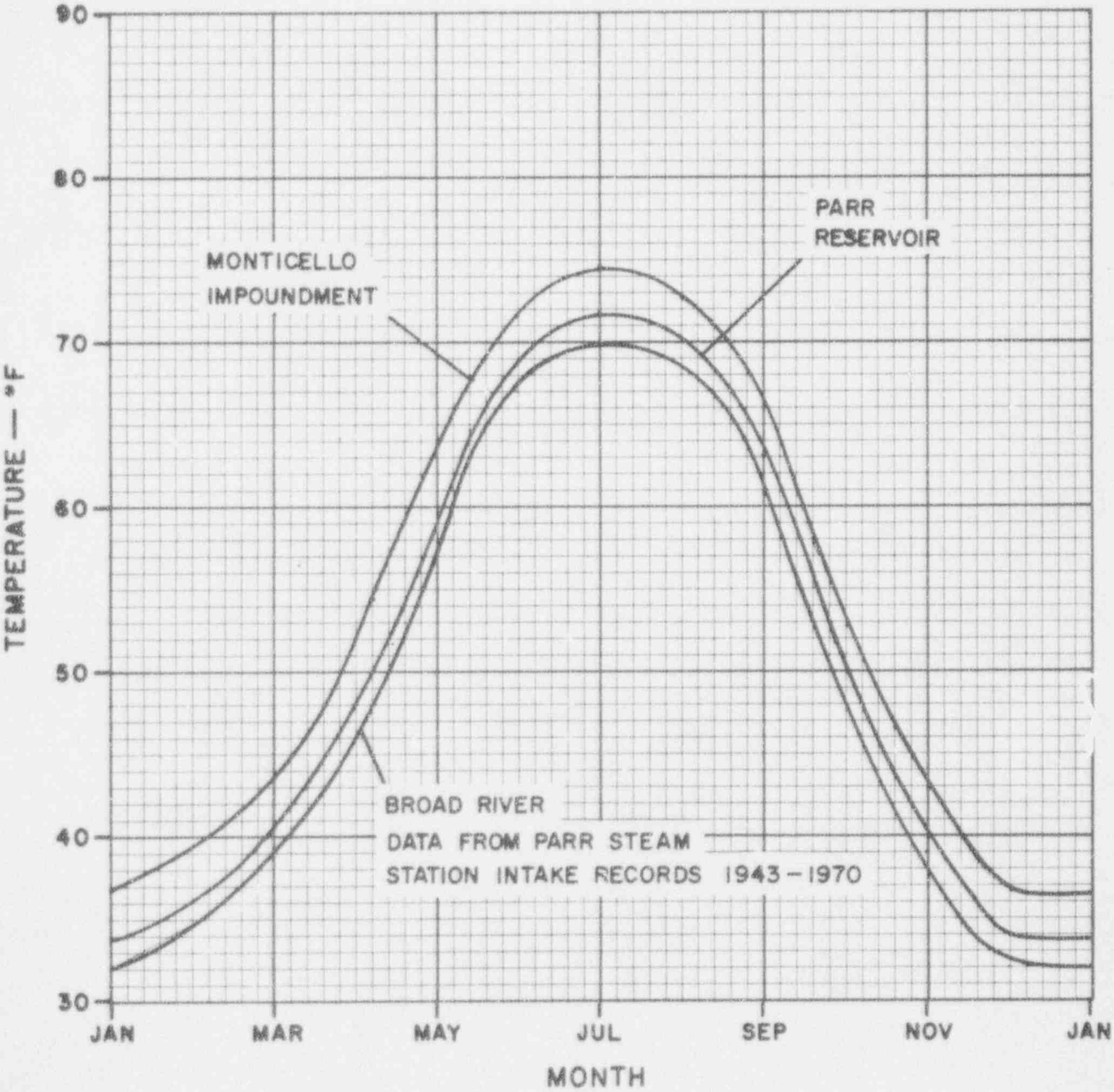


Figure 2SA.3-3

Expected minimum temperatures at Parr Hydroelectric Project

ARL

PARR RESERVOIR

INFLOW 2440 cfs
OUTFLOW 2440 cfs

PUMPED STORAGE PLANT

PUMPING FLOW 36,552 cfs for 9.6 hrs
GENERATING FLOW 43,863 cfs for 8 hrs
SLACK for 6.4 hrs

PUMPED STORAGE PLANT SCHEDULE
PROTOTYPE HOURS
0 6 12 18 24
GENERATE | PUMP | SLACK

NUCLEAR PLANT

NUMBER OF UNITS 2
TOTAL FLOW 1,060,000 GPM
PLANT TEMPERATURE RISE 24.8 °F

MONTICELLO IMPOUNDMENT

TEST NO. 33 DATE 2 NOV. 71

INITIAL WATER TEMPERATURES 65.2 °F
REFERENCE WATER TEMPERATURE 67.5 °F

AIR DRY BULB TEMPERATURE 69.2 °F
RELATIVE HUMIDITY 94 %

ISOTHERMS AT SURFACE

MODEL SCALE IN FEET
0 2 4 6 8 10

PROTOTYPE SCALE IN FEET
0 500

MODEL STUDY
PARR HYDROELECTRIC PROJECT
SOUTH CAROLINA ELECTRIC & GAS CO.

Figure 2SA.3-4

Typical Surface Isotherms at the End of Pumping Mode

ARL

PARR RESERVOIR

INFLOW 2440 cfs
OUTFLOW 2440 cfs

PUMPED STORAGE PLANT

PUMPING FLOW 36,552 cfs for 9.6 hrs
GENERATING FLOW 43,863 cfs for 8 hrs
SLACK for 6.4 hrs

PUMPED STORAGE PLANT SCHEDULE
PROTOTYPE HOURS
0 6 12 18 24
GENERATE | PUMP | SLACK

NUCLEAR PLANT

NUMBER OF UNITS 2
TOTAL FLOW 1,060,000 GPM
PLANT TEMPERATURE RISE 24.8 °F

MONTICELLO IMPOUNDMENT

TEST NO. 33 DATE 2 NOV. 71

INITIAL WATER TEMPERATURES 65.2 °F
REFERENCE WATER TEMPERATURE 67.5 °F

AIR DRY BULB TEMPERATURE 69.2 °F
RELATIVE HUMIDITY 94 %

ISOTHERMS AT SURFACE

MODEL SCALE IN FEET
0 2 4 6 8 10

PROTOTYPE SCALE IN FEET
0 5000

MODEL STUDY
PARR HYDROELECTRIC PROJECT
SOUTH CAROLINA ELECTRIC & GAS CO.

Figure 2SA.3-5

Typical Surface Isotherms at the End of Generating Mode

ARL

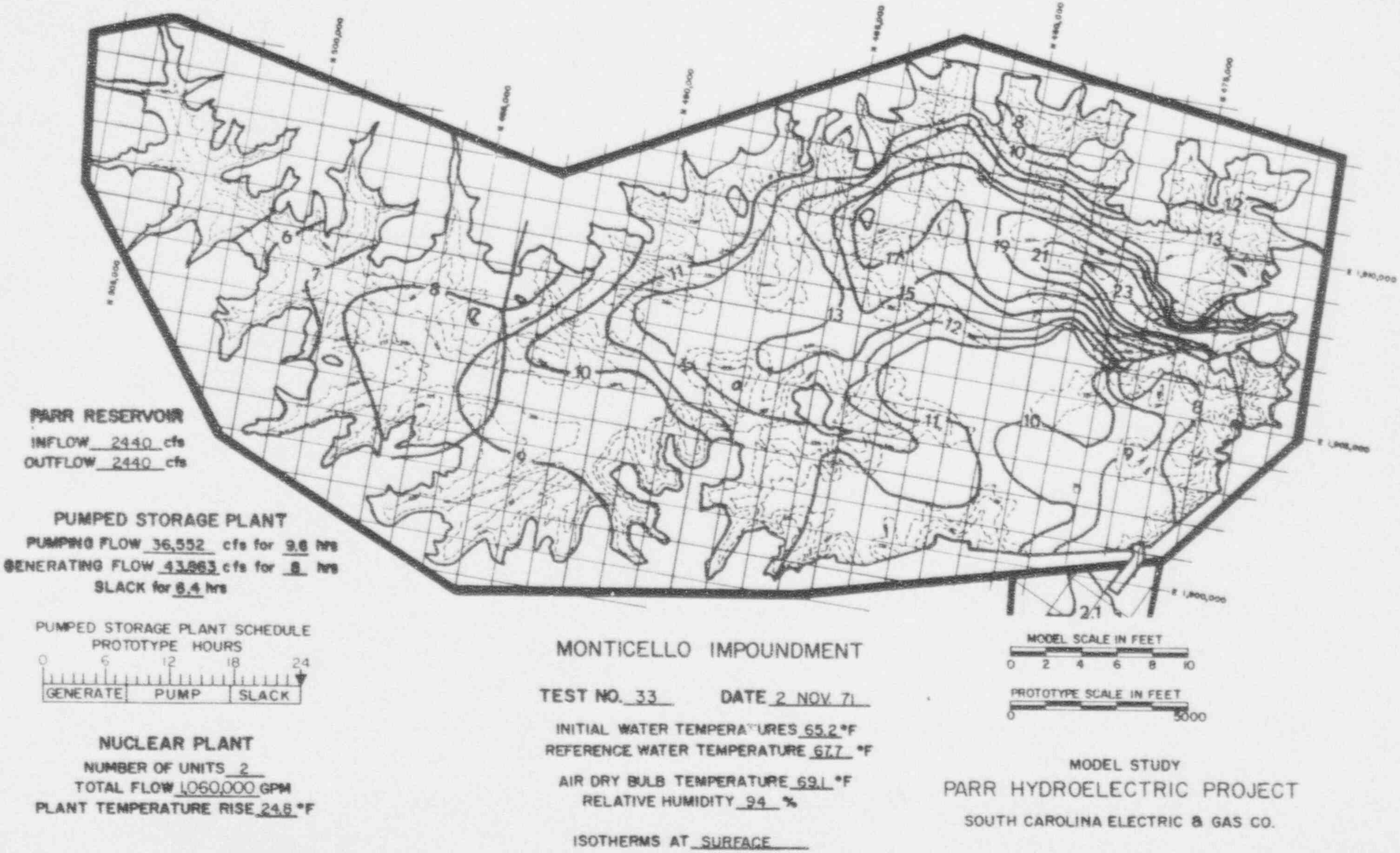


Figure 2SA.3-6

Typical Surface Isotherms at the End of Slack Period

ARL

VERTICAL TEMPERATURE PROFILES
MONTICELLO IMPOUNDMENT

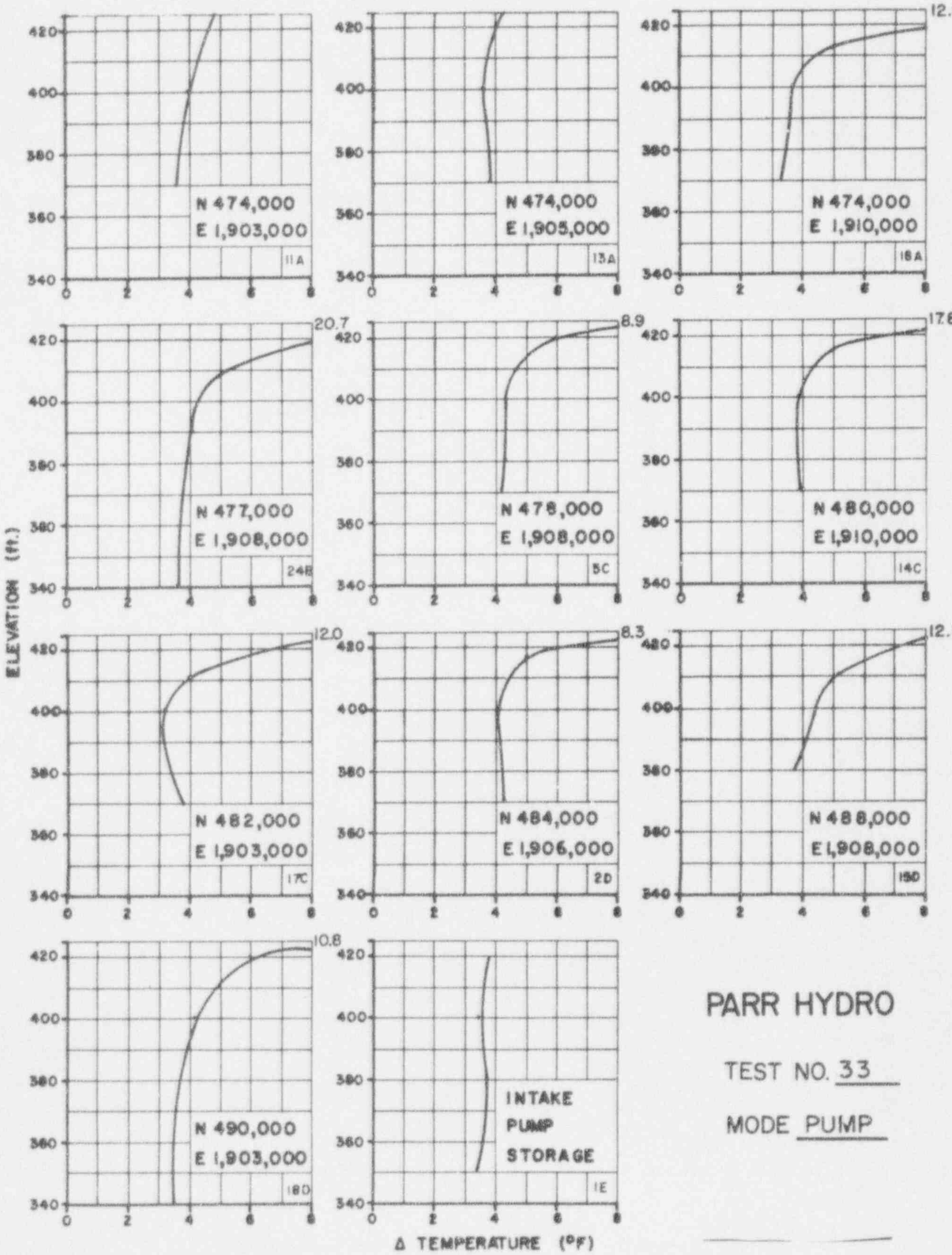


Figure 2SA.3-7 Typical Vertical Temperature Profiles at the End of Pumping Mode

ARL

VERTICAL TEMPERATURE PROFILES
MONTICELLO IMPOUNDMENT

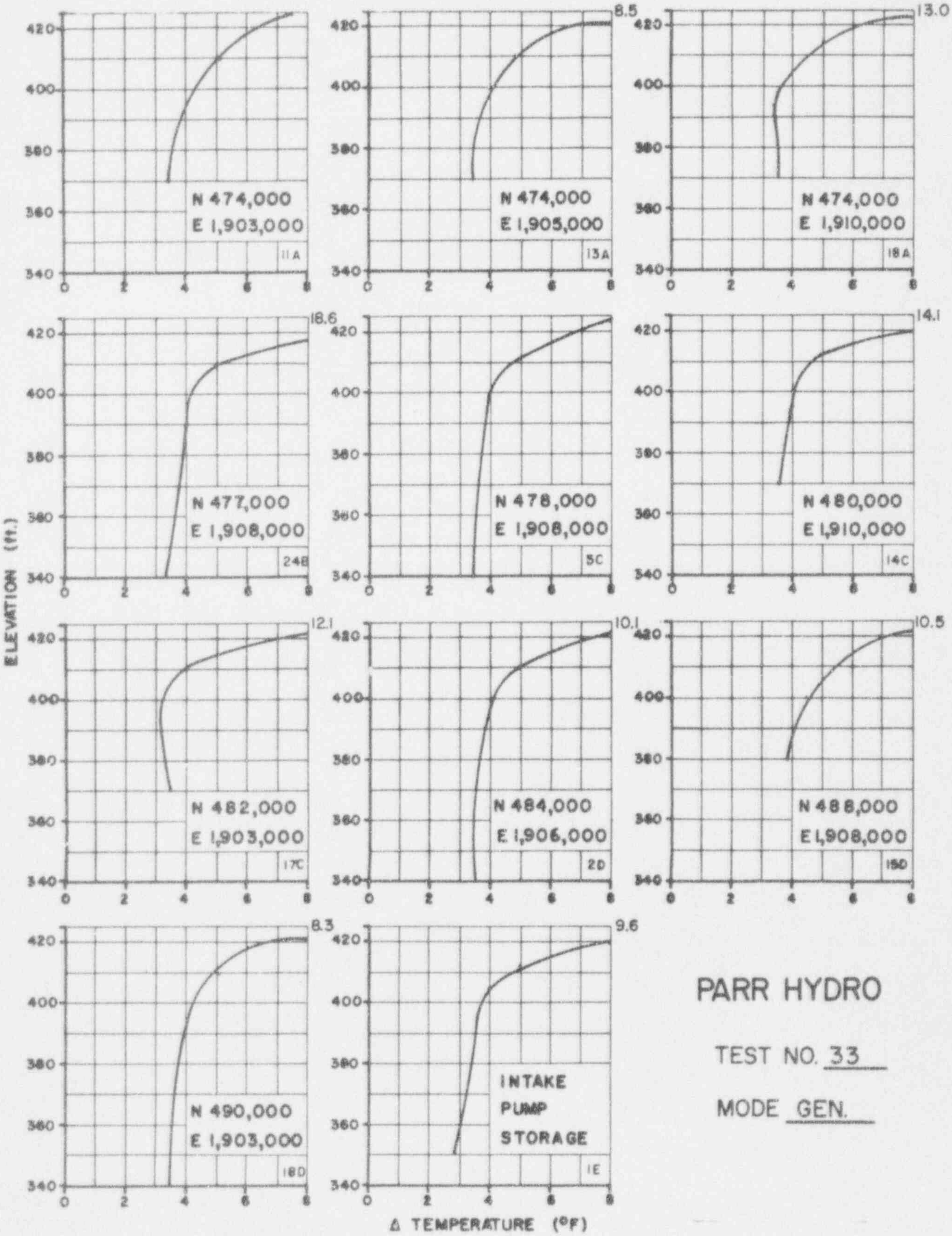


Figure 2SA.3-8 Typical Vertical Temperature Profiles at the End of Generating Mode

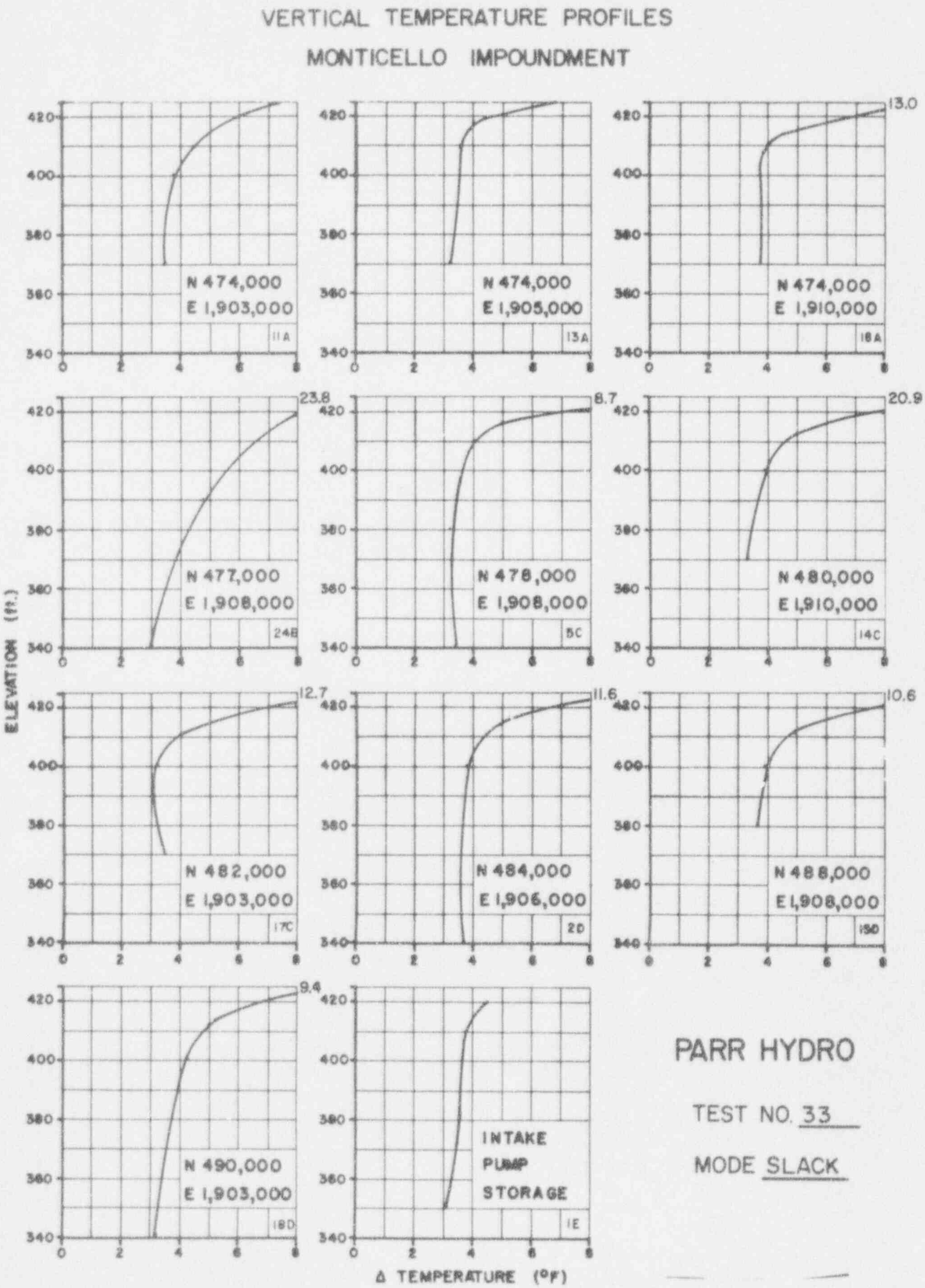


Figure 2SA.3-9 Typical Vertical Temperature Profiles at the End of the Slack Period

ARL

2SA.4 QUESTION: Provide data on the monthly maximum, minimum and average stream flows between the two water bodies and indicate how the outflow between the lake and the reservoir contributes to surface circulation of the lake.

South Carolina Electric & Gas Company expects the maximum monthly mean for stream flow between Monticello and Parr Reservoirs to be 11,973 CFS and to occur during the peak month of August. The minimum monthly mean stream flow will be approximately 5000 CFS and will occur in April. The monthly mean average flow is approximately 7000 CFS. The flow would be zero when the pumped storage plant is shut down.

Figures 2SA.4-1 and 2SA.4-2 show the surface circulation in the Monticello Impoundment when the pumped storage plant is under full load, Figures 2SA.4-3 and 2SA.4-4 for the average plant load and Figure 2SA.4-5 when the pumped storage plant is shut down.

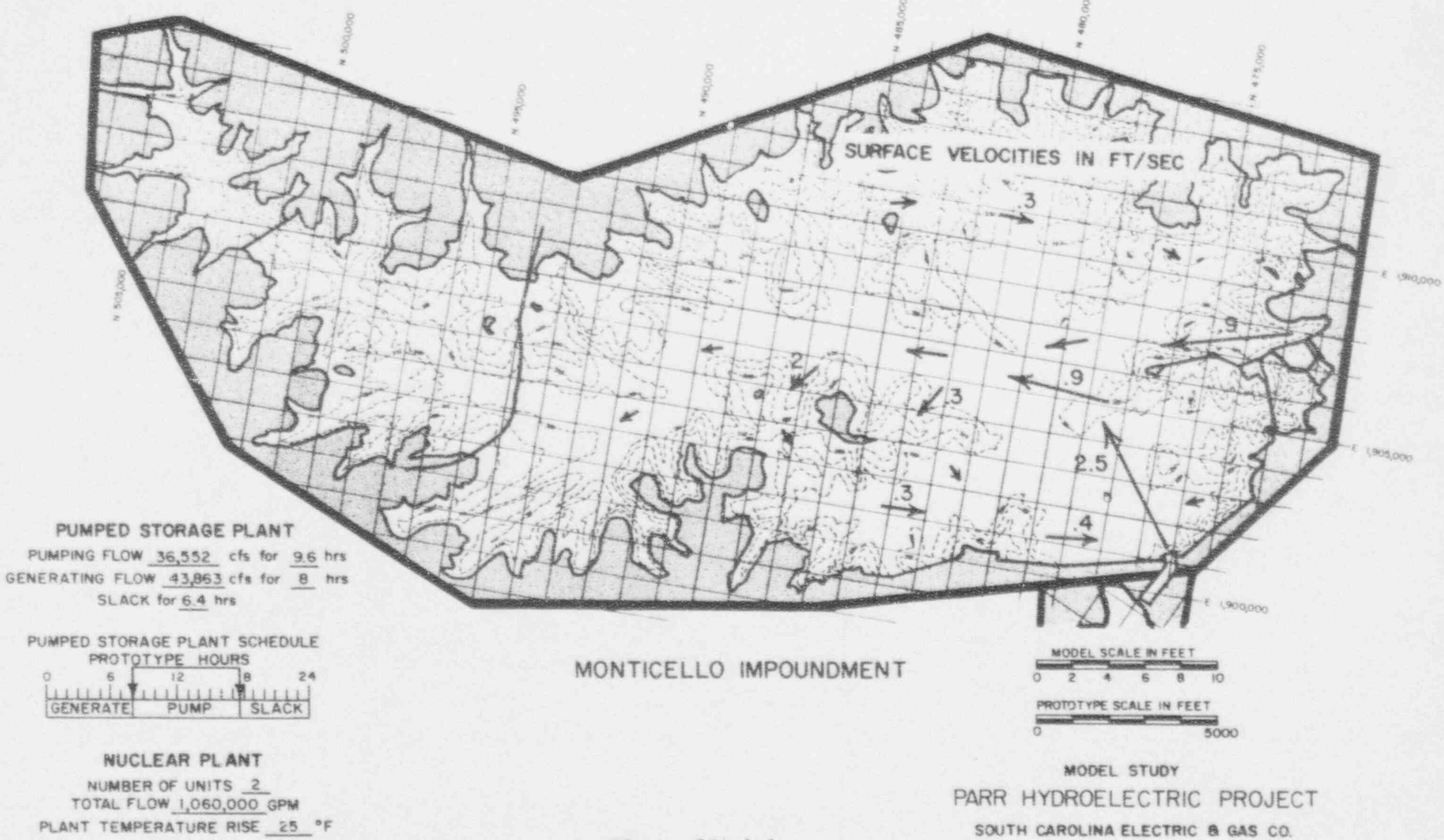


Figure 2SA.4-1

Surface Circulation Patterns During Pumping Mode
Fairfield Pumped Storage Plant at Maximum Load

ARL

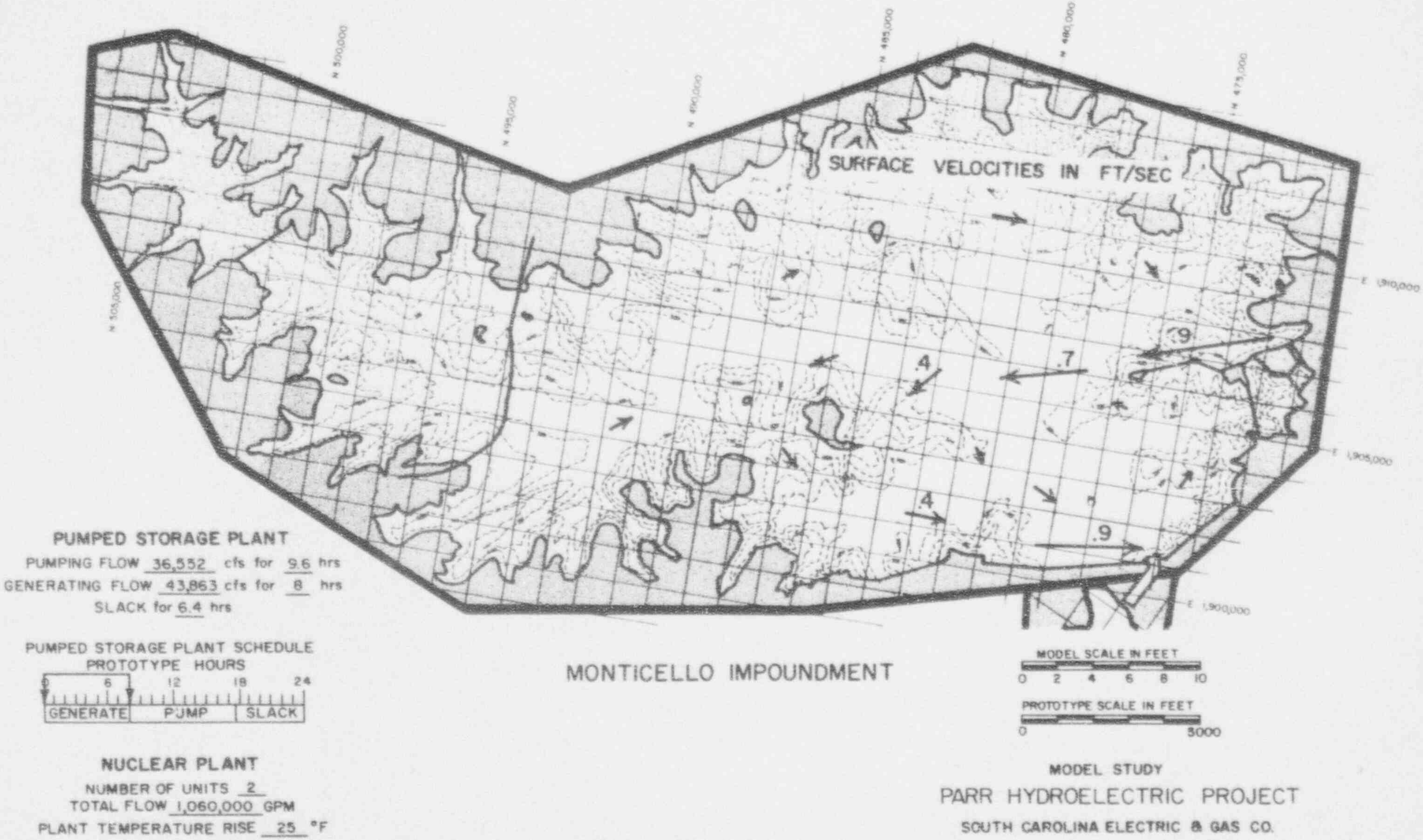
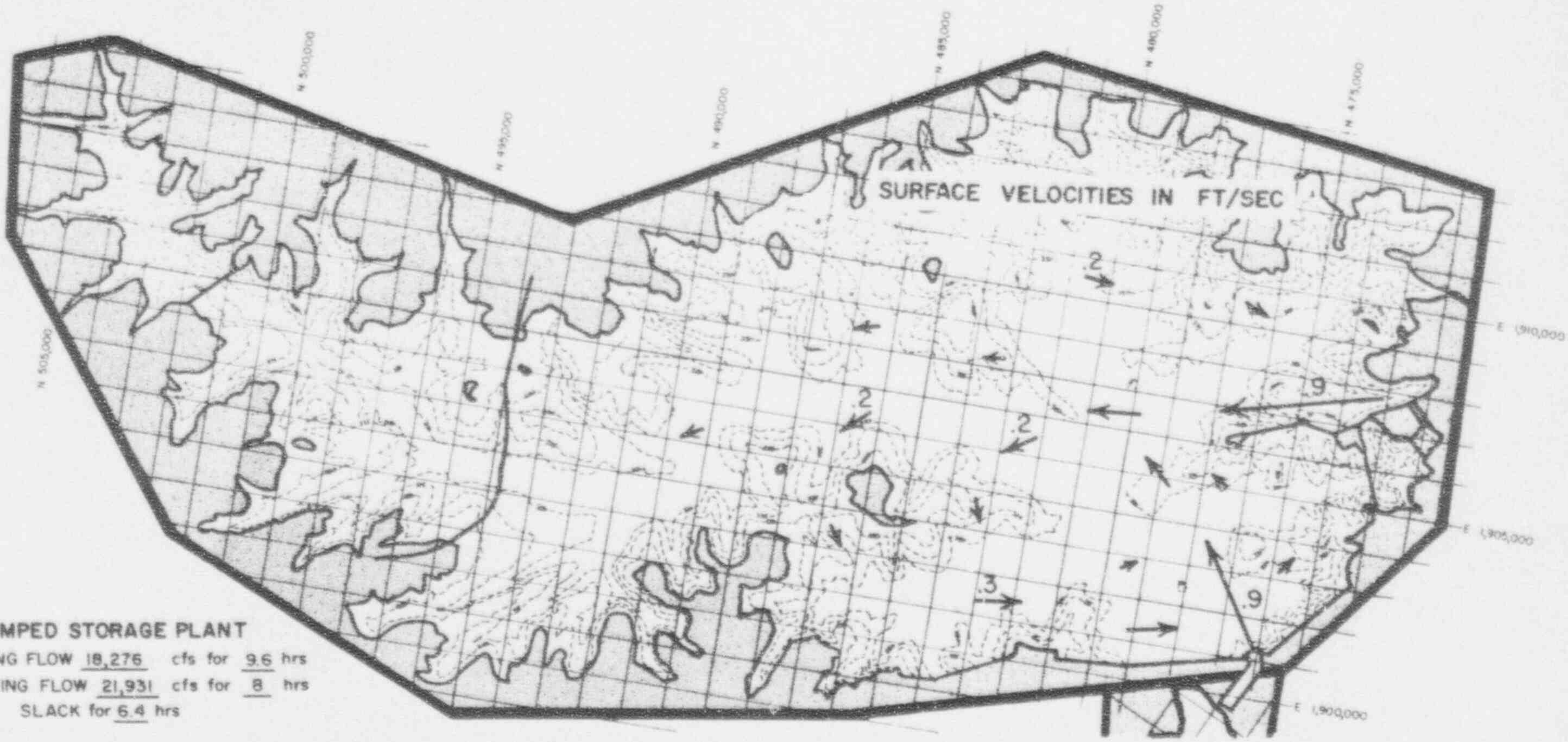


Figure 2SA.4-2

Surface Circulation Patterns During Generating Mode
Fairfield Pumped Storage Plant at Maximum Load

ARL



PUMPED STORAGE PLANT

PUMPING FLOW 18,276 cfs for 9.6 hrs

GENERATING FLOW 21,931 cfs for 8 hrs

SLACK for 6.4 hrs

PUMPED STORAGE PLANT SCHEDULE
PROTOTYPE HOURS

0 6 12 18 24

GENERATE | PUMP | SLACK

NUCLEAR PLANT

NUMBER OF UNITS 2

TOTAL FLOW 1,060,000 GPM

PLANT TEMPERATURE RISE 25 °F

MONTICELLO IMPOUNDMENT

MODEL SCALE IN FEET
0 2 4 6 8 10

PROTOTYPE SCALE IN FEET
0 5000

MODEL STUDY

PARR HYDROELECTRIC PROJECT

SOUTH CAROLINA ELECTRIC & GAS CO.

Figure 2SA.4-3

Surface Circulation Patterns During Pumping Mode
Fairfield Pumped Storage Plant at Average Load

ARL

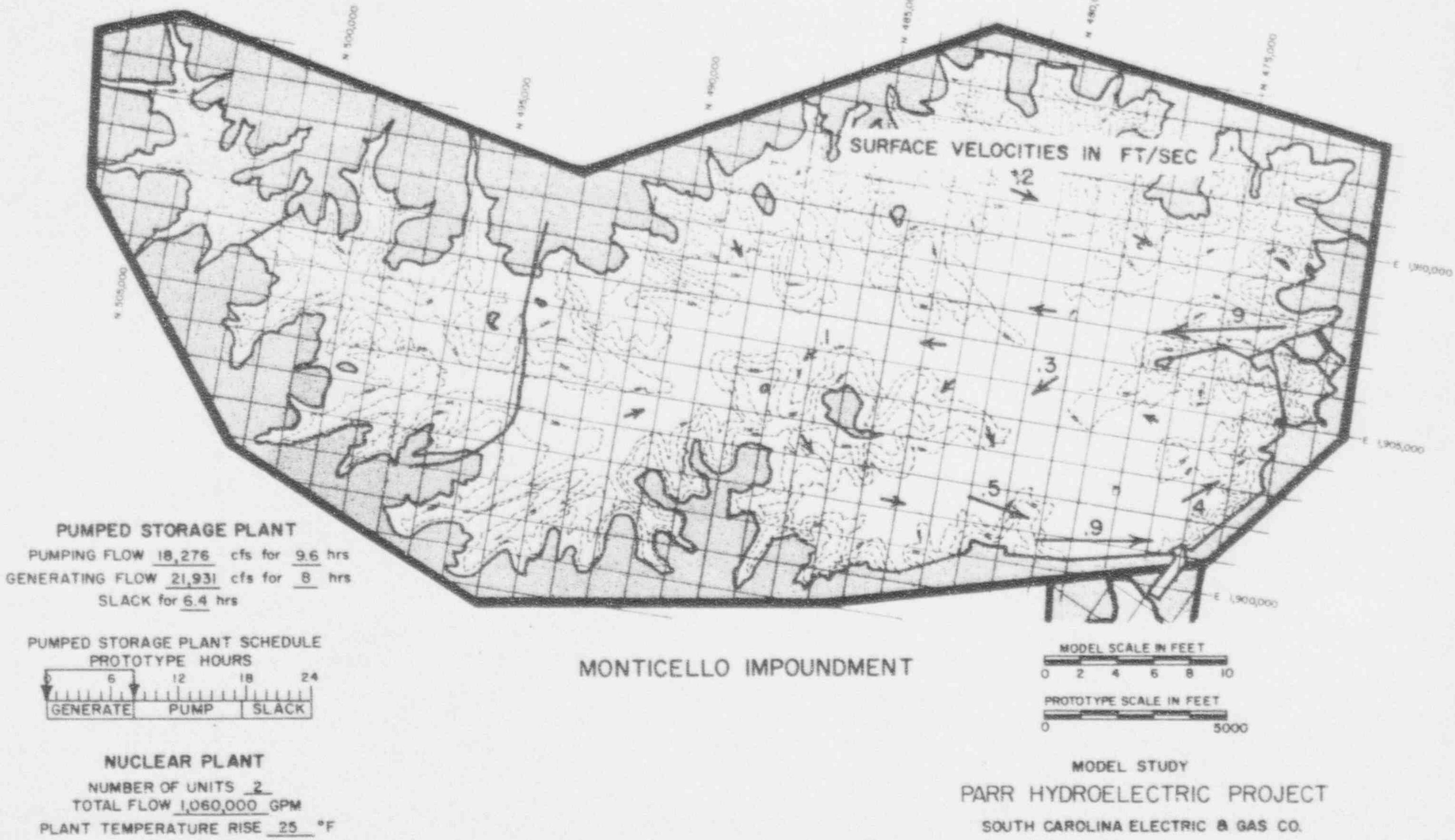


Figure 2SA.4-4

Surface Circulation Patterns During Generating Mode
Fairfield Pumped Storage Plant at Average Load

ARL

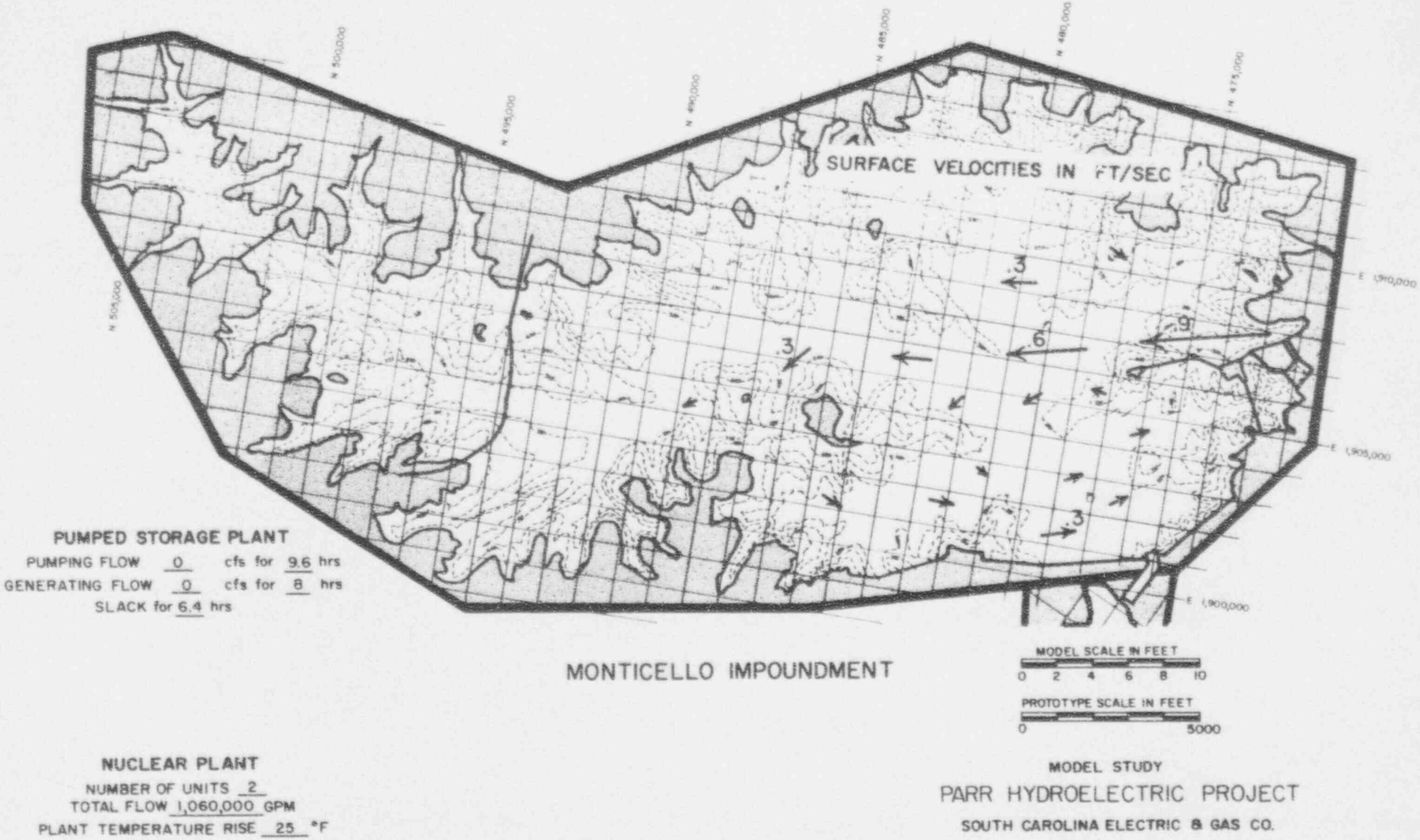


Figure 2SA.4-5

Surface Circulation Patterns
Fairfield Pumped Storage Plant Shut Down

2SA.5 QUESTION: Describe the expected behavior of Lake Monticello during different times of the year, such as the turnover frequency and stratification formation. If lake stratification prevents turnover and becomes permanent, provide information on the areas of the lake where dissolved oxygen may differ between different lake strata. Supply data on this effect on the dissolved oxygen in the water discharged from the lake to the reservoir and in the reservoir itself.

Most of the Monticello Impoundment would be subject to permanent thermal stratification during operation. This is a designed feature of the impoundment and has been verified by extensive operational testing of the model facility at Alden Laboratories. Vertical temperature profiles measured at ten locations indicate that the thermocline would lie somewhere between the 400 ft. and 410 ft. elevations. The only region where a distinct stratification was not observed was near the Fairfield Pumped Storage intake-discharge structure. In this region, partial mixing of epilimnetic and hypolimnetic layers was observed by visually following the diffusion of dye injected at various points in the ARL model. During the generation mode, the patterns of dye movement indicated that water from all levels in the partial mixing zone would enter the intake structure, although the largest portion appeared to be drawn from the upper levels. During the pumping mode, surface currents moved away from the point of discharge while hypolimnetic water in the Frees Creek channel moved slowly into the partial mixing zone. Thus, hypolimnetic layers which may be oxygen deficient would be gradually brought into a region where some mixing with the upper layers and eventual discharge into the Parr Reservoir would occur.

On the basis of these observations the water discharged into Parr Reservoir through the pumped storage facility would be composed of aerated surface waters mixed with up to about 40 percent of potentially oxygen deficient lower level waters derived from the partial mixing zone. The ΔT measurements in the Monticello Impoundment and in the pumped storage tailrace tend to corroborate this estimate, eg. a ΔT of 8°F at the intake surface corresponding to a ΔT of about 4°F in the completely mixed discharge water. Assuming that the minimum dissolved oxygen (D.O.) concentration in the surface waters reaching the pumped storage intake would be 7.0 mg/l and that the minimum average D.O. in the partial mixing zone would be 3.0 mg/l, the water entering the Fairfield intake would contain at least 5.4 mg/l D.O.

The actual D.O. concentrations to be expected in the hypolimnion of the Monticello Impoundment depend upon the quality and quantity of organic matter available for biological degradation. Organic material would be contributed both by phytoplankton-zooplankton productivity in the surface waters and by pre-existing Flora remanents on the bottom sediments. The BOD exerted by organic material and the resulting reduction in D.O. depend on many complex factors including the various rates of biological degradation for different materials and the residence time of water in the hypolimnion prior to entering the partial mixing zone. At present there is insufficient data on which to base a realistic estimation of these factors, however, the rapid reaeration of water in the pumped storage tailrace would maintain at least 6.0 mg/l D.O. entering Parr Reservoir from the Monticello Impoundment.

The water quality of the Broad River entering the reservoir will also exert a considerable influence on the D.O. concentrations, particularly at times of relatively high flow. The D.O. values in the Broad River measured at

Blair during the period of 8-31-71 to 4-26-72 showed an average of 9.1 mg/l with a minimum of 6.0 mg/l occurring in August. Minimum values of 6.0 mg/l and 5.0 mg/l were also measured at Parr (near the Steam Plant Intake) and Richtex respectively on the same day. Below Parr Dam no additional decrease in D.O. is expected even though the maximum temperature reached may be 2°F higher than the average Parr Reservoir temperature. The combined physical aeration afforded by the Fairfield pumped storage hydro generator, the Parr Hydro generator, and the Parr Dam Spillway would more than compensate for the oxygen deficient water withdrawn from the hypolimnion of Monticello Impoundment and help to maintain adequate D.O. levels in the downstream Broad River.

2SA.6 QUESTION: The inlet and outlet flow into Parr Reservoir may be expected to give a backflow to the reservoir system. The Broad River is also turbid. Evaluate the anticipated extra turbidity of Lake Monticello and Parr Reservoir by the back and forth motion from operation of the pumped storage facility and from the possible erosion of the shorelines of the lake as the water elevation fluctuates. Describe precautions taken against excess turbidity from construction, particularly dredging activities and the extent of maintenance dredging anticipated.

According to the South Carolina Water Resources Commission, the 4500 square mile drainage basin of the Broad River above the Parr Reservoir contains some of the most soluable soils of the entire state. As surface run-off develops the flow of this river, the soil particles are entrained and as a result, the river becomes extremely muddy and turbid in appearance.

The constituents of the water that produce the turbidity or muddy appearance do not come from the banks of the river tributaries or the river itself, but in majority from the terrain composing the drainage basin. This material, after being transported to the main river channel, remains in suspension or drops out to the river bottom, depending on the velocity of the river and the terminal settling velocity of the particles. Since the river channel has not meandered significantly over the past, it is obvious that any solids which may drop to the bottom are eventually swept away by flood currents.

The existing banks of the Broad River in the area of Parr Reservoir are relatively stable as observed by inspection. The maximum slopes of Parr Reservoir banks between elevations 257 and 266 is approximately 1:5. These are fairly steep natural slopes, and in general, these slopes are steeper than those of Monticello Reservoir.

Natural slopes will be cut above the high water mark; however, these slopes should remain stable and should not be affected by these daily fluctuations which occur at a very slow rate. Wave action is much more devastating than the fluctuation of the reservoir, and its affect on the erosion of the slopes is not expected to contribute significantly to the turbidity of Monticello or Parr Reservoirs.

Parr Reservoir will have a maximum width of approximately 4100 feet with the average being about 1900 feet. Monticello Reservoir is nearly 3 times as long as it is wide. Both reservoirs are located lengthwise in valleys which are at angles of approximately 90° with the prevailing wind direction. The average wind speed is 7.09 mph, while the wind velocity does not exceed 6 mph 57% of the time. Due to the relative positions of the reservoirs to wind direction, no significant shoreline erosion is anticipated from wave action.

During construction, SCE&G will consult with the USDA Soil Conservation Service in order to cope with matters of erosion control within the lands of our project. The dredging work anticipated for the Fairfield Pumped Storage tailrace canal will include spoil areas located behind spoil dams with an overflow device located away from the spoil entrance to minimize velocity entrainment, etc.

2SA.7 QUESTION: Assess the significance of erosion of the shores on Lake Monticello and Parr Reservoir during the life of the Summer Station as the water elevation fluctuates. Provide information on stabilization of critical regions of the shoreline.

At present, plans call for clear cutting the Parr Reservoir from elevation 257 up to one (1) foot above the high water mark (clear cut up to elev. 267 feet) to reduce the amount of large trees and debris going to the hydro powerhouses. Areas along the railroad right-of-way that are subject to erosion will be covered with rip-rap to prevent erosion and to maintain the right-of-way.

Present plans include the cutting of the shoreline between elevations 415 and 426 around Monticello Reservoir. Erosion control will be studied in conjunction with the USDA Soil Conservation Service. Specific measures will be planned to provide erosion protection in critical areas at the dams, the nuclear plant, or elsewhere where erosion might endanger important structures. These critical areas will in most cases be protected with a cover of rip-rap.

The following table summarizes the anticipated protection for the shoreline areas in the vicinity of the nuclear station. Since the Service Water Pond for the nuclear power plant is a safety related structure, the rip-rap protection is somewhat more extensive on shorelines that protect this pond.

ANTICIPATED SHORELINE PROTECTION IN VICINITY
OF SUMMER NUCLEAR STATION

Shoreline Description	Riprap Thickness	Protected Elevation Range
WITHIN SERVICE WATER POND		
West Fill Embankment	24"	415 to 435
Natural Shoreline	24"	415 to 435
North, East, South Dams	24"	415 to 438
MONTICELLO RESERVOIR SHORELINE		
North of Nuclear Plant Site	36"	410 to 438
North, East, South Dams	36"	410 to 438
	18"	Toe of Dam to 410
Island Between North and East Dams and Natural Shoreline Between East Dam and Discharge Canal	36"	410 to 438
Jetty (both sides)	36"	410 to crest

Clear cutting of the reservoirs' shoreline will result in erosion of the exposed banks. Experience at other pumped storage reservoirs indicates that after a period of initially active erosion the shorelines tend to stabilize and erosion activity is greatly reduced. The exact quantities of sediment that may be added to the reservoirs are not known (See 2SA.8). However, the major impact of increased sediment load would be its effect on aquatic biota. Due to the turbid nature of the Broad River it is not anticipated that the increased turbidity resulting from the fluctuating water levels will have a major impact on the biota.

2SA.8 QUESTION: Provide calculations showing the rate and depth of silting fill-in of Lake Monticello due to the daily pumping of the turbid water of the Broad River. Supply the basis for calculations of the silting rate and re-entrainment. Provide data for measured values of turbidity of both ends of the Parr Reservoir and copies of records on how the silting has filled in the Parr Reservoir over the years. If available, provide data on silting from other nearby lakes for basis of comparison.

A summary of suspended solids content as measured in the Broad River above Parr Reservoir at Blair, below Parr Reservoir at Richtex, and at the Parr Dam, with samples taken over a seven month period, is given in Table 2SA.8-1. The average values of suspended solids over the seven month period in these locations are shown. A conservative figure of 45 PPM of suspended solids is used in calculations to determine the rate and depth of silting fill-in of Monticello Reservoir. It is assumed that 36,552 cu ft/sec of water will be pumped 360 days a year for 9.6 hours a day. It is conservatively assumed that 100% of suspended solids entering Monticello Reservoir via the Fairfield Pumped Storage Facility will settle and remain in Monticello Reservoir. It is further assumed that most of the settlement will occur beyond the intake structure in the deepest levels first. These calculations yield 19,600 acre feet of silting fill-in per 50 years.

The base of the intake structure to the Fairfield Pumped Storage Facility as shown in Figure 2.2-10 of the PSAR, is at elevation 365 feet. Figure 2.2-12 of the PSAR shows that the lake volume below 365 feet is more than 100,000 acre feet. Therefore, at 11,600 acre feet of fill-in per 50 years, it is considered that silting fill-in of Monticello Reservoir will not be a problem.

Figure 25 of Appendix 2C of the PSAR gives data on the shape of vertical temperature profiles of Monticello Reservoir. These profiles indicate that at elevations below 380 feet the water temperature will be essentially constant. Therefore, it is considered that raising the bottom elevation at this estimated silting rate will not significantly affect temperature conditions in the water above the silted bottom during the lifetime of the V. C. Summer Nuclear Station.

The Parr Reservoir was completed in May of 1914. No profiles of the original shape are available, but it is believed that the deepest point was about 30 feet below the top of the dam and was located near the dam. A set of depth readings made recently in the vicinity of the Parr Dam is shown in Table 2SA.8-2.

Turbidity data for the Parr Reservoir is presently not available. No data is now available on silting from other nearby lakes. We have requested from the Savannah office of the Corps of Engineers silting data pertaining to the Hartwell Reservoir and the Clark's Hill Reservoir.

TABLE 2SA.8-1

SUSPENDED SOLIDS IN THE BROAD RIVER
(PARTS PER MILLION)

Date	At Blair	At Parr Dam	At Richtex
Oct. 12, 1971	45	63	45
Oct. 26, 1971	126	117	173
Nov. 9, 1971	39	33	33
Nov. 30, 1971	2	1	1
Dec. 14, 1971	47	38	28
Jan. 5, 1971	9	7	5
Jan. 19, 1972	29	3	22
Feb. 7, 1972	5	8	8
Feb. 16, 1972	55	39	46
March 8, 1972	39	37	33
March 31, 1972	69	72	108
April 12, 1972	21	8	21
April 26, 1972	8	7	7
Average of Above	38.0	33.3	40.8

TABLE 2SA.8-2

PARR RESERVOIR PROFILES JUNE 1971
(Depth in Feet Below Top of Dam)

RIVER FLOW → READINGS AT 5' INTERVALS

DAM

4.1	4.2	4.6	4.7	5.0	5.0	5.1	5.8	6.0	8.0
4.5	4.6	4.5	4.7	4.8	5.0	5.9	6.9	7.0	8.0
4.7	4.9	5.0	5.0	5.0	5.5	7.8	8.8	13.2	11.0
4.9	5.1	5.1	5.1	5.3	7.0	9.2	12.5	14.5	14.0
5.0	5.2	5.2	6.3	5.5	6.0	9.5	13.0	14.0	15.0
5.6	5.8	5.5	6.1	6.2	7.9	11.0	12.3	15.0	16.1
5.6	5.8	6.0	7.0	7.3	7.5	10.5	13.1	16.0	16.5
5.6	5.7	5.7	5.8	6.1	11.2	11.0	12.2	15.8	16.5
5.9	6.1	6.4		7.0	8.0	11.2	13.1	16.8	17.0
6.0	6.1	6.2	6.4	7.1	10.0	11.8	14.1	17.2	17.7
6.3	6.1	6.3	6.5	7.0	10.0	12.1	15.0	17.7	18.0
6.2	6.3	6.5	6.5	7.3	10.0	13.9	14.8	18.0	18.1
6.2	6.1	6.0	6.2	7.0	10.0	13.0	14.3	18.0	18.2
6.0	6.2	6.0	6.0	7.8	11.2	13.8	15.0	18.6	18.6
6.0	6.0	5.9	6.0	8.0	11.0	13.0	15.1	18.2	18.4
6.1	6.1	6.2	6.2	9.2	9.1	13.9	16.7	18.2	18.0
6.7	6.6	6.9	6.8	8.8	9.1	12.0	16.0	18.0	18.0
6.9	6.9	7.0	6.9	7.0	9.0	14.0	17.5	18.0	18.0
7.1	7.0	7.0	7.0	6.8	8.9	12.8	16.0	18.0	18.0
7.0	6.9	7.0	6.9	6.9	7.8	12.2	16.0	17.0	17.5
7.0	7.0	7.0	7.0	6.9	7.0	11.5	15.2	16.8	17.1
7.2	7.0	6.9	6.8	6.7	7.0	11.5	15.0	15.0	15.7
7.1	7.0	7.9	7.8	7.8	7.5	12.0	14.3	14.2	14.1
7.0	6.9	6.8	6.7	6.6	8.0	12.6	14.3	14.3	14.0
7.0	6.9	6.8	6.8	6.8	7.9	13.0	14.2	14.1	14.1
7.0	7.0	6.8	6.7	6.5	8.0	10.5	13.8	14.1	14.0
7.0	6.9	6.8	6.5	6.5	8.0	10.0	13.5	14.1	14.0
7.0	7.0	6.8	6.7	6.5	7.0	9.5	13.0	14.0	13.9
		6.8	6.5	6.5	7.0	8.6	12.0	13.8	13.8
7.4		6.9		6.5	6.5	8.0	11.0	13.3	13.2
7.1	7.1	7.0		6.6	6.4	6.9	10.4	12.9	13.0
5.5		6.2		6.7	6.3	7.5	9.0	11.1	12.0
4.7		5.0		5.7	6.4	6.7	7.5	10.3	11.0
4.0		4.0		4.4	5.0	6.7	7.0	8.5	10.0
3.5		3.8		4.0	4.3	5.3	7.0	7.1	9.0
3.0		4.3		3.4		4.0	5.2	6.5	8.1
							4.0	5.4	7.0
							3.5	4.0	4.0

Dam Elevation 257.1'

READINGS AT 8' INTERVALS

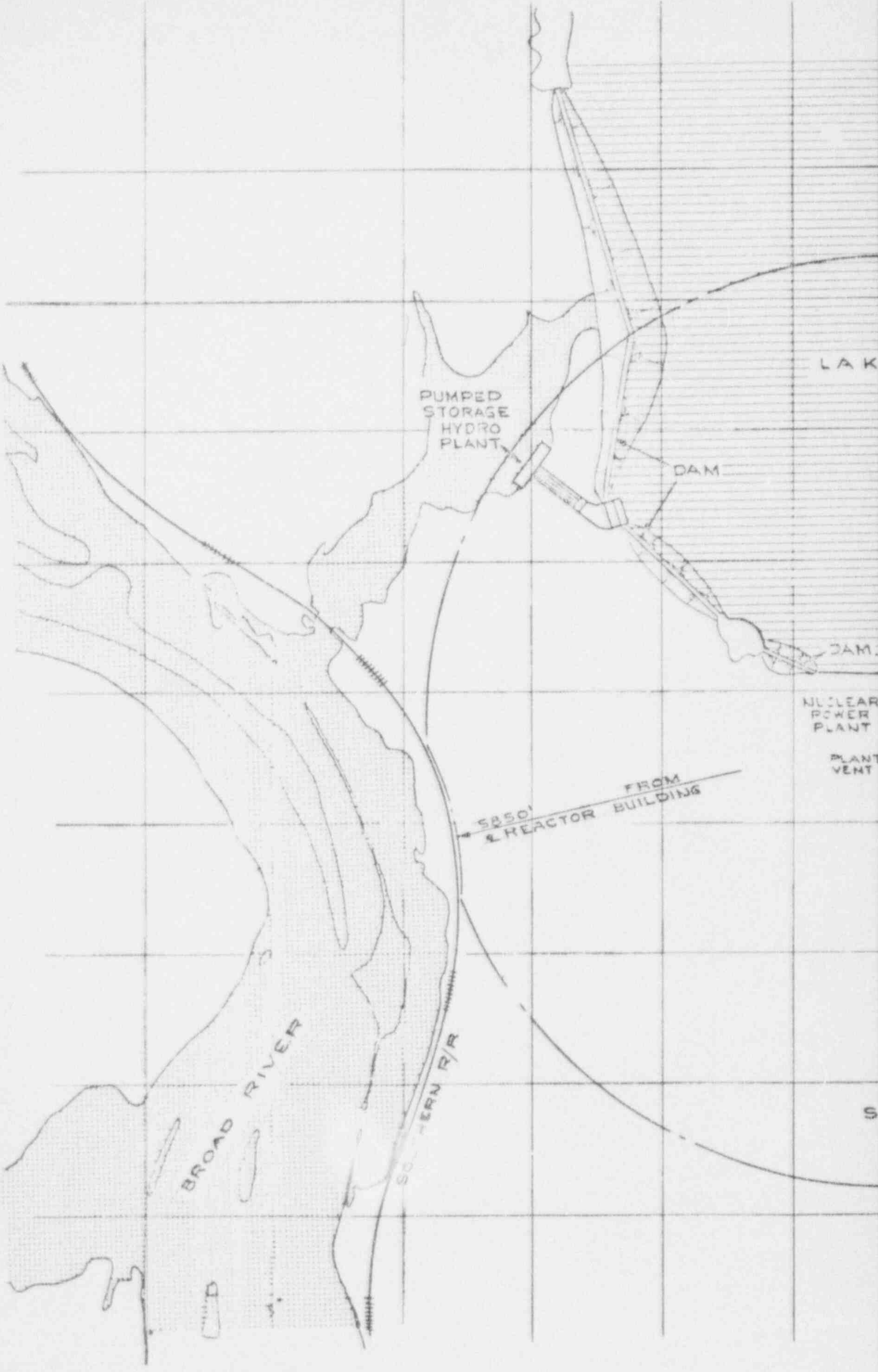
8'

West Edge of Dam

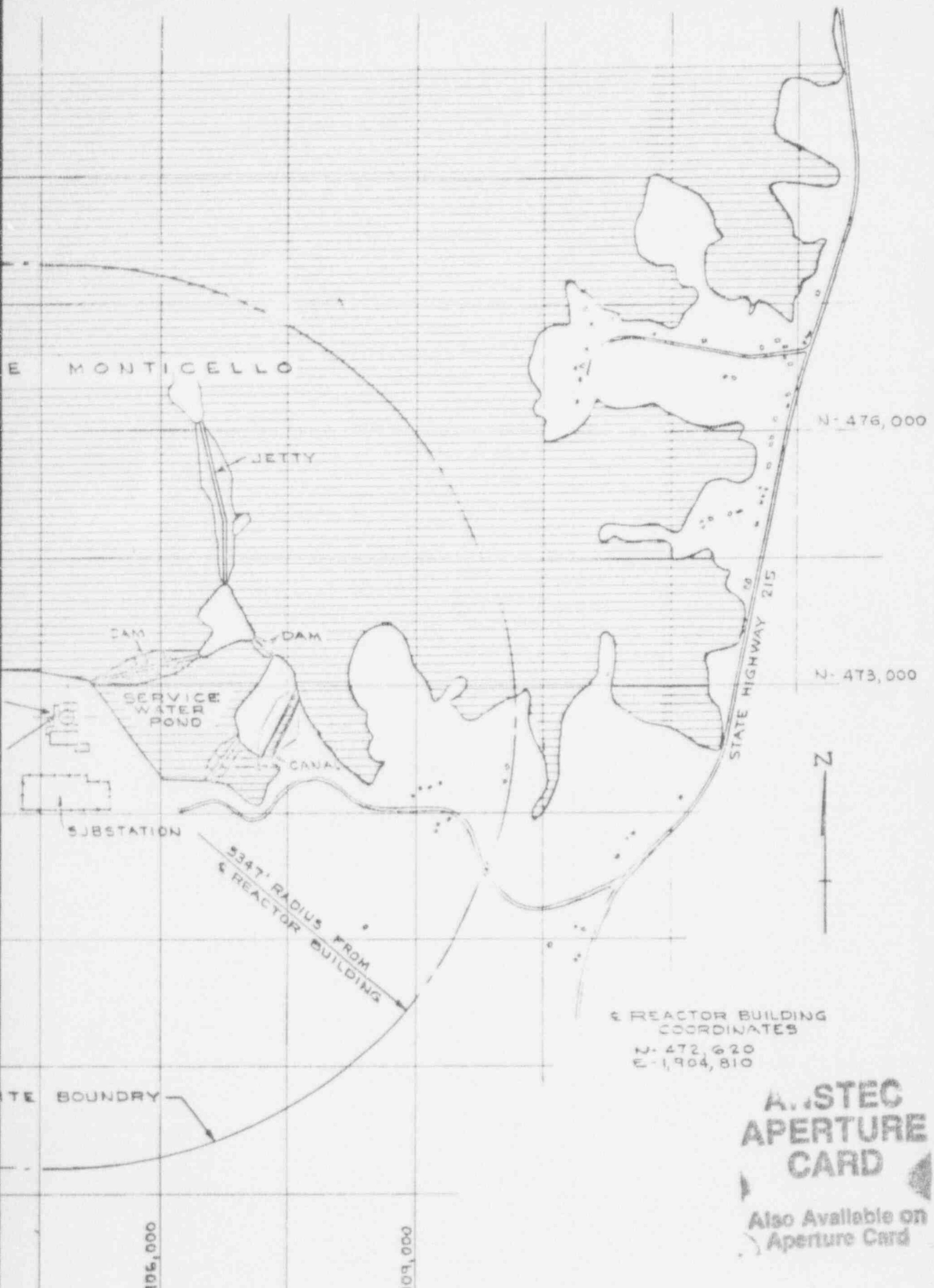
← North

2SA.9 QUESTION: Describe the location and design of the baffle to be used in Lake Monticello.

To prevent recirculation of heated effluent from the main condensers back to the intake of the circulating water system, the model studies performed at the Alden Research Laboratories have shown a need for a barrier within the reservoir. A jetty which would extend from the island at the northeast corner of the Service Water Pond along a natural ridge to another island at approximately N 476,750; E 1,906,100 would provide this recirculation barrier. Studies are presently underway concerning the most economic design of this 2,000 ft. long structure; consideration is being given to an earthfill structure protected by riprap as described on page 2SA7-2 or a sheet pile barrier. Tentively the top of the jetty will be about elevation 430. Figure 2SA9-1 shows the approximate location of the jetty.



LAK
PUMPED
STORAGE
HYDRO
PLANT
DAM
DAM
NUCLEAR
POWER
PLANT
PLANT
VENT
5850' FROM
℄ REACTOR BUILDING
BROAD RIVER
S



ANSTEC APERTURE CARD

Also Available on Aperture Card

FIGURE 2SA.9-1

9406090236-05

2SA.10 QUESTION: Provide operating costs and descriptive data (dimensions and operational characteristics) of cooling towers or other cooling systems which could be alternatives to the Summer Station once-through cooling system and would be functional as an alternative to the Summer site.

As is discussed in the Supplement to the Environmental Report, the development of Monticello Reservoir for dual use as the upper reservoir of the pumped storage facility and as the cooling impoundment for Summer Station, is necessary for the economics of the total development. It is not possible to separate out the Summer Station and provide cooling towers as a heat rejection alternate. However, the following is given as information.

Discussions with a cooling tower manufacturer during the evaluation studies for Summer Station provide the following parameters as appropriate for wet natural draft cooling towers for a nuclear unit of the approximate size of Summer Station Unit 1. These parameters are based on the level of commercial technology available at the time of the evaluation.

Number of Towers	2	Diameter at Base	360'
Range	28°F	Height	291'
Approach	18°F	Separation between tower centerlines	500'
Design Wet Bulb	78°F		

The additional annual operating costs of this cooling tower complex above those for the cooling impoundment are estimated to be in excess of $500,000. This estimate considers loss of capability and energy due to degradation in turbine-generator performance and additional auxillary power requirements, maintenance and water treatment.

2SB SITE, METEOROLOGICAL, AND RADIOLOGICAL CONSIDERATIONS

2SB.1 QUESTION: Provide estimates of the downwind extent of possible steam fogs, including assumptions used and calculations made of the estimates.

Steam fog is a phenomenon that tends to dissipate upon moving beyond the warm water surfaces which create it. It usually consists of alternate patches of fog in the updrafts created by the warm water, and patches of clearer air in the down drafts which complete the local circulation cells and which are fed by the drier air aloft. Thus, the very processes which create steam fog over a reservoir, i.e. colder air moving over the warmer water surfaces, also create thermal instability in the layer containing the fog. Thus, when the steam fog moves beyond the warm water surfaces, the fog is normally dissipated by two processes which act together. The first is a vertical mixing with the drier air aloft which is induced by the wind and the thermal instability which has been created. The second process is horizontal mixing of the alternating patches of updraft, moist air and of downdraft drier air. The frequencies of steam fog which are postulated in Appendix B, ER, refer, therefore, only to the formation and existence of these fogs over the reservoir surfaces themselves. The frequency of steam fogs which persist and move out beyond the reservoir is very much lower than the values in this Appendix.

The special conditions which create the possibility of the occurrence of steam fog moving beyond the reservoir are those conditions which either inhibit or render ineffective the two processes mentioned above; i.e. the vertical mixing with drier air aloft, and the horizontal mixing of the alternative patches of warm moist updraft air with the drier downdraft air.

Vertical mixing of the low thermally unstable fog layer with drier air aloft is inhibited when all the following conditions pervail:

1. The steam fog forms under a "capping" ground inversion. This occurs at night under clear skies in certain weather conditions. A pasquill F or G condition before the air moves over the water is probably required.
2. The capping inversion persists in spite of the establishment of an adiabatic (saturated) lapse rate in the warmed air beneath the inversion. For large ponds like the Monticello Reservoir the water-temperature must not exceed the equivalent potential temperature of the top of the inversion.

Hotizontal mixing of the alternating patches of updraft air and downdraft air may be ineffective in dissipating the steam fog when the following conditions prevail:

1. The pond water temperatures are very high relative to ambient air temperatures. This requirement permits very large vapor pressure differences between air and water and deposits a large excess of water droplets in the warm updrafts. Thus, horizontal mixing of updraft and downdraft air does not "dry out" the fog. It should be noted that a pond with these very high temperatures cannot be as large as the Monticello Reservoir. In that event the high temperatures would destroy the capping inversion.
2. Terrain features constrain the horizontal mixing processes. Byers[1] points out that steam fog "occurs over rivers, often when the air has been cooled by radiation, and tends to form radiation fog near the river as well as steam on the river."

---

1. Byers. General Meteorology. McGraw Hill, 1959.

The rising ground around the valleys is undoubtedly a key factor in this predilection of steam fog for valleys. None of the standard references on fog describe steam fogs that leave their source regions except in river valleys, although many references describe the common occurrence of steam fog due to lakes and reservoirs.

In addition to the special conditions required for steam fog to leave its source region, it must of course, form before it can leave and conditions for its formation must also prevail. These include the items listed in Appendix B, ER.

In summary the following conditions must prevail, or steam fog cannot form and then persist and move out from the Monticello Reservoir.

1. The water must be 5 degrees F. warmer than the air with relative humidity at least 90% or 10 degrees F. warmer with relative humidity between 75 to 90 percent.
2. Wind speed must be less than or equal to 3 mph.
3. Pasquill F or G must prevail.
4. The water temperature may not exceed the equivalent potential temperature of the top of the inversion.
5. The pond temperatures must be relatively high, as in early autumn.

When these conditions do exist concurrently the steam fog will normally be restricted to the 3200 acres comprising the land areas of the drainage basin plus, of course, the 6800 over water acres.

The necessary concurrent data do not exist to permit calculations of the frequency and extent of the steam fogs which may persist and move beyond the reservoir.

A judgment evaluation of the area meteorology permits the following conclusions:

1. Steam fog moving significantly beyond the limits of the reservoir will not exceed 10% of the steam fog occurrences.
2. The steam fogs moving beyond the reservoir will be essentially limited to the overall drainage basin in which the reservoir lies.

2SB.2 QUESTION: Estimate the frequency and duration of temperatures below 32°, 25° and 20°F throughout the winter.

See attached Table 2SB.2-1. This table is based on evaluation of available data from the Carolinas Virginia Tube Reactor meteorological tower at Parr, South Carolina. Data from the Columbia, South Carolina, weather station shows the following:

Mean Number of Days, Temperature

Month	Max. 32° F and below	Min. 32° F and below	Min. 0° F and below
January	1	18	0
February	*	18	0
March	0	7	0
April	0	1	0
-			
October	0	1	0
November	0	10	0
December	0	14	0

*Less than one-half.

TABLE 2SB.2-1

FREQUENCY AND DURATION OF TEMPERATURES AT PARR, SOUTH CAROLINA

(1964 THROUGH 1967)

	TEMPERATURE MEASURED LESS THAN OR EQUAL TO									
	32°F			25°F			20°F			
Month	Avg. No. of Days	Min. Hours Duration	Max. Hours Duration	Avg. No. of Days	Min. Hours Duration	Max. Hours Duration	Avg. No. of Days	Min. Hours Duration	Max. Hours Duration	No. of Months in Sample
January	19	1	66	9	1	43	3	1	15	2
February	13	1	37	7	1	16	3	1	10	3
March	15	1	14	3	1	10	1	1	3	3
April	3	1	13	*	1	10	*	1	5	3
-	-	-	-	-	-	-	-	-	-	-
October	4	6	12	1	1	4	0	0	0	1
November	12	1	14	2	1	3	0	0	0	1
December	18	1	17	10	1	12	2	4	8	2

* Less than one-half

2SB.3 QUESTION: Provide information on the effect of the presence of Lake Monticello on the local humidity climatology. Include dewpoint data. Provide a joint frequency distribution of relative humidity, temperature, and wind speed.

The reservoir will add moisture to the atmosphere by evaporation. The net change in the local humidity climatology, however, can only be assessed by a comparison of the reservoir evaporation rate with the rate of evaporation-transpiration from the wooded area that the reservoir will replace.

Evaporation from the Monticello Reservoir is estimated by the use of the Meyer equation for evaporation[1] because this equation gives the highest evaporation rates at lower wind speed, and its application is therefore appropriate to this region and is conservative. This equation is:

$$M = C\,(.349)\left(1 + \frac{W}{10}\right)(Pw - Pa)\ \text{lbs/day-ft}^2$$

where: C is a constant for a given location and ranges from 10 to 15 depending on depth and exposure of the water under study as well as the frequency of the available meteorological measurements. For surface accumulation, C is taken near the higher value whereas for large deep bodies of water, C is taken near the lower limit.

M is lbs of water evaporated per square foot day.

W is the monthly average wind speed value from measurements made at the nearest Weather Station about 25 feet above the surface, mph.

Pw is the saturated vapor pressure corresponding to the temperature of the water at some specified point near the surface, psia.

Pa is the water vapor pressure of the atmospheric air measured at the same height and averaged in the same way as the wind speed, psia.

Evaporation rates from the reservoir are estimated for the two months January and July. These months will show the minimum and maximum monthly average values.

For January

Predicted Reservoir Temperature = 49.4° F

Mean January Temperature at Columbia, S. C. [2] = 46.9° F

Mean January Wind Speed at Columbia, S. C. = 7.0 mph

Mean January Relative Humidity at Columbia, S. C. = 70%

C = 15

Pw = .174 psia

Pa = .111 psia

$$M = 15(.349)\ (1 + 7/10)\ (.174 - .111)$$
$$= .561 \text{ lbs/day ft}^2$$

For July

Predicted Reservoir Temperature = 92.7° F

Mean July Temperature at Columbia, S. C. = 81.6° F

Mean July Wind Speed at Columbia, S. C. = 6.7 mph

Mean July Relative Humidity at Columbia, S. C. = 78%

C = 15

Pw = .760

Pa = .417

$$M = 15(.349)(1 + 6.7/10)(.760 - .417)$$
$$= 2.999 \text{ lbs/day ft}^2$$

Evaporation rates from the Reservoir are converted to inches per month to permit comparisons with evaporation transpiration data as follows:

Evaporation Rates from the Monticello Reservoir

January	3.3 inches per month
July	17.5 inches per month

Evaporation-transpiration data for wooded areas near Parr, South Carolina are not available. Nor are the data for the vicinity of Franklin, North Carolina, which are available, representative of the Parr site because of the every large difference in rainfall occurring at Parr and Franklin. The best data concerning evaporation-transpiration for the Parr area is that general area data which does not distinguish between wooded and open vegetation, as follows:

Evaporation and Transpiration[4]

Normal Annual	35 inches per year
July	7 inches per month

It is apparent that the evaporation rates from the reservoir surfaces are between two and three times the rates from the forested areas which these surfaces will replace.

The added moisture will of course increase the relative humidity of the air downwind from the reservoir. However, as can be seen from the Meyer equation, the higher evaporation rates occur during periods of higher wind speeds and lower relative humidities. Thus during periods of higher evaporation rates, the additional moisture from the reservoir is being dispersed through a larger air volume and into drier air, thereby reducing its effects on the humidity climatology of the downwind regions.

It is our opinion that the frequency of measurable effects of the reservoir on local humidity will be limited to a narrow region, such as one-half mile, around the reservoir and will be small.

Within close proximity to the reservoir there will be an increase in the frequency of higher humidities, the extent of which is not known.

We also believe it is impossible to accurately predict numerical values of these changes. Data from empirical studies of similar reservoirs are needed.

Date on the dew points observed at Columbia, S. C. are provided as follows:

Dew Point, ^{o}F

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
31.6	30.0	38.1	49.3	57.4	66.3	70.1	69.3	64.3	55.1	40.0	37.5

These data represent averaged monthly dew points for a five year period.

1. An Engineering - Economic Study of Cooling Pond Performance. Littleton Research and Engineering Corporation for Environmental Protection Agency. U. S. Government Printing Office.

2. Local Climatological Data for Columbia, South Carolina. U. S. Department of Commerce, Environmental Science Services Administration, Asheville, N. C.

3. National Atlas of the United States. Department of Commerce, Weather Bureau. U. S. Government Printing Office, Washington, D. C. 1960.

4. Climatic Atlas of the United States. Stephen S. Visher, Harvard University Press, Cambridge. 1966.

COLUMBIA, SOUTH CAROLINA
Columbia AP

TABLE 2SB.3-1

A TEMPERATURE AND WIND SPEED–RELATIVE HUMIDITY OCCURRENCES:

WIND	0-4 M.P.H.						5-14 M.P.H.						15-24 M.P.H.						25 M.P.H. AND OVER						TOTAL OBS.
REL HUMID / TEMP (°F)	UNDER 30	30-49%	50-69%	70-79%	80-89%	90-100%	UNDER 30	30-49%	50-69%	70-79%	80-89%	90-100%	UNDER 30	30-49%	50-69%	70-79%	80-89%	90-100%	UNDER 30	30-49%	50-69%	70-79%	80-89%	90-100%	
109/105							1	+					+												1
104/100	+	1					3	7					1	1											11
99/ 95	1	9	1				6	65	3				1	8	+										92
94/ 90	1	17	16				13	151	74				2	21	7					+					301
89/ 85	1	20	45	5			15	145	205	8	+		3	20	23	1				+	+				489
84/ 80	3	15	57	43	12	1	18	123	207	101	19	+	5	25	19	5	1	+	+	1	1	+			657
79/ 75	4	13	40	63	106	71	20	85	139	111	153	58	9	22	28	9	6	2	1	1	1		+		940
74/ 70	6	13	34	44	95	266	25	73	110	74	110	170	12	19	28	11	10	9	1	1	1	+		3	1113
69/ 65	7	16	28	37	66	157	28	73	87	71	88	134	12	22	21	15	16	12	1	1	2	1	1	+	895
64/ 60	6	18	32	27	58	136	26	77	76	53	78	135	10	25	16	9	11	16	1	1	+				808
59/ 55	5	21	42	30	53	111	22	81	80	44	50	112	6	21	17	6	6	12	+	1	1	+	+	+	722
54/ 50	3	21	43	33	50	105	17	83	86	42	40	81	5	26	16	5	5	9	+	1	1	+		+	673
49/ 45	3	15	40	40	58	91	12	66	84	42	36	85	2	18	16	5	4	5		1	1	+	+	+	623
44/ 40	1	12	33	35	63	80	5	49	72	29	31	69	2	12	15	5	4	5			+	+		+	523
39/ 35	+	8	27	29	62	79	2	31	62	27	25	33	1	8	9	1	1	5	+		+			+	411
34/ 30	+	4	17	29	48	72	2	22	37	13	14	21	1	5	4	1	1	2			+		+	+	293
29/ 25		1	10	16	36	30	+	7	22	5	4	4		2	1	+	+	+							138
24/ 20		+	4	6	21	9		2	9	1	1	1		+	1										56
19/ 15			1	2	9	1		1	3	1	+			+	+	+									19
14/ 10			+		1			+	1	+															2
09/ 05					+						+														+
TOTAL	40	203	469	438	740	1209	212	1140	1357	620	650	905	71	253	219	74	65	77	3	8	8	2	1	4	8767

Occurrences are number of hourly readings for the average year based on the ten year period 1951-1960.

2SB.4 QUESTION: Provide information on studies made on alternative sites in which economic and environmental considerations have been taken into account. Consider sites far from the present site and include updated information on the possibility of off-shore sites. Provide cost figures for site locations near the sea, near Charleston, James Island, Sullivan Island or other locations.

The selection of a power generating site requires an analysis of numerous factors. Such factors include: availability of suitable land from both a surface (topographic) and subsurface (soils, geology, seismology) standpoint; population and land use characteristics of the surrounding area; a sufficient water supply for cooling requirements; proximity to load centers, transmission lines, railroads, and highways; location relative to items of historical and cultural significance; relative economics of site development; and the facility's impact on the environment.

For a method of power generation to be considered for utilization, the technology must be commercially available at the time the studies are being made. During the time in which the site for the Summer Station was selected, the technology for utilization of off-shore sites was not commercially available, therefore the use of off-shore sites was not considered.

The long range plans for electric utility power generating facility siting are based on identification of potential load center growths and subsequent analysis of sites capable of supplying these load centers.

A 1967 system study identified Parr, Bushy Park (Charleston), and Wateree Station as areas near load centers where electrical generation facilities would be required in the near future. A preliminary evaluation of the suitability of these areas for nuclear station siting was made.

Among others, this evaluation considered the following general items:

1. General practicality and comparative costs of installing and operating an 800 MWe nuclear unit at each of these areas.
2. Practicality of a multiple unit development from the viewpoint of layout, activity release, and circulating water.
3. An evaluation of the economics of possible heat rejection systems to counteract low flow conditions or thermal pollution problems at each area.
4. An evaluation of nuclear safety requirements and estimated costs covering possible additional containment, waste disposal facilities, additional land, or other engineered safety feature systems recommended for each area.
5. An investigation of the seismic and geologic characteristics of the areas insofar as they could affect plant cost and licensability.
6. Special problems such as reactor vessel and steam generator transportation to the area or possible flooding conditions.
7. Locations relative to the system transmission grid for transmission of power from the area to the system load centers, and the additional transmission facilities which would be required.

Plot plans were developed and structural criteria were established as a basis for cost estimating and the determination of layout practicality.

The heat rejection systems were based on use of river water cooling. Supplemental cooling facilities in the form of natural draft cooling towers were then utilized in one of the following three basic arrangements:

1. Downstream cooling of the circulating water discharge was considered where adequate river flow is available.
2. An open cycle recirculation system was used where the river flow is inadequate to supply the condenser requirements for a relatively

small percentage of the time.

3. A closed cycle cooling tower system was considered where river flows are inadequate a major portion of the year.

A statistical analysis of river flow, river temperature, and atmospheric conditions served as a basis for the plant performance evaluation.

Nuclear safety analyses, and costs for engineered safeguards for each site were examined with regard to (a) the radiation dose vs distance characteristic that would result from the assumed maximum credible accident, (b) the discharge of radioactive gases to the environment and (c) the discharge of radioactive liquid wastes to the rivers. A preliminary seismic and geologic evaluation was prepared because of the seismic history of the area.

The conclusions of this preliminary evaluation were as follows:

1. The Parr and Wateree areas are both acceptable locations for the installation of nuclear units, with a preference given to Parr over Wateree. Although the Bushy Park Site has potential economic advantages as a result of heat rejection system economics and the transportation of heavy components, it or other service area sea coast sites probably would pose economic penalties with regard to seismic design criteria.
2. All three areas are considered to be suitable for the addition of a second 800 MWe nuclear unit from the viewpoint of site layout, activity release, and circulating water requirements. The latter requirement would probably result in a completely closed cycle cooling tower system for Wateree area.

The continuing studies which led to the selection of the present site for the Virgil C. Summer Nuclear Station are discussed in Environmental Report Sections 2.5.4 and S2.5.

The 1967 cost estimates for nuclear plant construction are as follows:

1967 COST SUMMARY

Item	Parr	Wateree	Bushy Park
1. Base Price	87,707,000	87,707,000	87,707,000
2. Additions for each site	11,209,000	10,706,000	10,544,000
3. Intangible items incl. startup and interest	19,300,000	19,200,000	19,100,000
Total Excluding Escalation	118,216,000	117,613,000	117,351,000
Total Including Escalation	127,206,000	126,563,000	126,281,000
4. Evaluated Charges	4,000,000	4,601,000	2,136,000
Total Evaluated Cost	131,206,000	131,164,000	128,417,000
Total Cost Diff.	2,789,000	2,747,000	BASE

A duplicate of our existing coal fired unit was placed at Wateree site to provide for rapid expansion of the system capability required during the early 1970's. An oil fired unit is under construction at the Bushy Park site to provide generation capacity in the Charleston load center area.

2SB.5 QUESTION: Provide a copy of the referenced material from Reference No. 2 of Appendix B.

The following Table No. 2SB.5-1 provides the referenced material.

TABLE 2SB.5-1

DETERMINATION OF EQUILIBRIUM TEMPERATURES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVE.
CLIMATOLOGICAL DATA*													
Relative Humidity													
1:00 A.M.	81	79	76	76	82	84	86	88	87	87	83	81	82
7:00 A.M.	85	85	83	81	82	83	86	89	90	90	68	85	86
1:00 P.M.	54	52	48	45	46	49	52	53	55	49	47	52	50
7:00 P.M.	68	64	57	53	56	61	66	68	71	71	69	70	65
Average	72	70	66	64	66	69	72	74	76	74	72	72	71
Air Temperature, °F													
Dry Bulb (T_a)	46.9	48.4	54.4	63.6	72.2	79.7	81.6	80.5	75.3	64.7	53.7	46.4	64.0
Wet Bulb	42.8	44.0	48.5	56.2	64.5	71.9	74.5	73.9	69.8	59.5	49.0	42.8	58.0
Dew Point	38.5	39.6	43.2	50.8	60.0	68.0	72.0	71.5	67.5	57.0	45.0	38.5	54.3
Air Vapor Pressure, mm Hg	6.0	6.2	7.3	10.0	13.4	17.8	19.7	19.6	17.0	11.7	7.6	5.9	11.0
Wind Velocity, MPH	7.1	7.7	8.4	8.7	7.0	6.9	6.8	6.1	6.4	6.1	6.4	6.5	7.0
EQUILIBRIUM TEMPERATURE CALCULATIONS †													
Assumed Percent Clear Sky, p	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	
Clear Sky Hs, $(Hs)_{cs}$ (Fig. 2-5)	1160	1500	2000	2430	2810	2940	2880	2650	2250	1780	1320	1100	
$Hs = (Hs)_{cs} \times p$, Btu/ft^2·day	1102	1425	1900	2308	2669	2793	2736	2517	2137	1691	1254	1045	
C (Fig. 2-5)	0.577	0.585	0.616	0.652	0.683	0.705	0.710	0.708	0.693	0.658	0.613	0.575	
Ha, Btu/ft^2·day (Eq. 2-1, rev)	1786.1	1835.4	2031.0	2339.3	2650.0	2939.9	3024.4	2992.9	2794.0	2403.2	2017.0	1773.9	
Har = 0.03 Ha	53.59	55.1	60.9	70.2	79.5	88.2	90.7	89.8	83.8	72.1	60.5	53.2	
Hsr = 0.05 Hs	55.1	71.3	95.0	115.4	133.5	139.7	136.8	125.9	106.9	84.6	62.7	52.3	
Hr = Hs+Ha-Hsr-Har, Btu/ft^2·day	2779.6	3134.1	3775.0	4462.2	5106.5	5505.0	5532.9	5294.7	4740.8	3937.5	3147.8	2713.4	
Assumed Temperature Range, °F	40-50	50-60	50-60	70-80	80-90	80-90	80-90	80-90	80-90	60-70	50-60	40-50	
K (Fig. 3-4, rev)	85.0	102	105	153	171	170	169	162	165	111	96	83	
F(K) = (K - 15.7)/K	0.815	0.846	0.850	0.897	0.908	0.908	0.907	0.903	0.904	0.858	0.836	0.810	
E_1 = (Hr - 1801)/K	11.51	13.07	18.80	17.39	19.3	21.8	22.08	21.57	17.82	19.25	14.03	10.99	
E_2 (Fig. 3-5, rev)	22.0	18.8	21.2	16.5	14.9	16.4	16.8	16.6	15.5	20.9	20.8	21.8	
E_3 (Fig. 3-5, rev)	19.9	25.9	27.7	43.5	53.3	56.8	58.2	58.2	56.2	39.3	28.1	19.8	
$M = E_1 + F(K)(E_2 + E_3)$	45.7	50.9	60.4	71.2	81.3	88.2	90.1	89.1	82.6	70.9	54.9	44.7	
(M - E) (Fig. 3-6)	1.3	1.25	1.7	1.6	1.9	2.3	2.4	2.45	2.05	2.25	1.55	1.2	
E = M - (M - E), °F	44.4	49.6	58.7	69.6	79.4	85.9	87.7	86.7	80.6	68.6	53.4	43.5	

* Recorded at Columbia, S. C. Mean values for 19 year period or longer.

† Heat Exchange in the Environment, Dr. John E. Edinger and Dr. John C. Geyer, Johns Hopkins University, Cooling Water Studies for Edison Electric Institute Research Project RP-49

2SB.6 QUESTION: To estimate radiation exposures to man, provide the extent of recreational use of the Broad River below the plant discharge.

Any radionuclides which are released from the plant will be diluted with water from Monticello Reservoir and subsequently mixed with waters of the Broad River and Parr and Monticello Reservoirs (Section 2.3.7, ER) before the radionuclides move downstream past Parr Dam. The next major source of dilution water will be the Saluda River, some 31 miles downstream of Parr Reservoir. This 31 mile reach of the Broad River is the area considered as "below the plant discharge".

Estimates of recreational water users for Monticello and Parr reservoirs have been provided in the Supplement to the Environmental Report Section S2.6.4. Approximately 6000 acres of Monticello Reservoir will be available for recreational fishing. Presently there is no reservoir and no usage. Anticipated usage based on 1 angler day/acre/year is 6000 angler days per year. Approximately one-half of the expanded Parr Reservoir is downstream of the pumped storage discharge point and will receive radionuclides. This would include about 2,100 surface acres if the average water depth is used to calculate surface acres available for fishing. Because of the large drawdown and potential deleterious effects on the Parr fishery, it is anticipated that there will be less fishing pressure on Parr Reservoir. A value of 0.75 fishing days/acre/year would give an annual value of about 1,600 angler days.

Recreational use of the Broad River below Parr Reservoir has not been determined. Conversations with regional game protectors and biologists have indicated the use of fishing recreation is slight, however no quantification in terms of angler days per year is available. Angler use of the area between the Columbia diversion dam and the confluence of the Broad and Saluda Rivers (a distance of about 1.7 miles) can be expected to have a higher use rate than the other portions of the Broad River because of the seasonal movements of striped bass (*Morone saxatilis*) into this area. Further upstream movement is prevented by the dam. There is also an undertermined small amount of hunting for waterfowl along the Broad River, but no quantification of hunting days is available.

Fishing and hunting represent the only significant recreational use of the Broad River between the plant discharge and the confluence with the Saluda River.

2SB.7 QUESTION: For estimating the radiation dose from iodine-131, provide information on the direction and distance to the nearest dairy herds. Include data on the number density and location of milk cows that could be located closer to the site than the nearest commercial dairy farm.

The South Carolina State Board of Health Radiological Lab indicated six dairy herds within 11.2 miles of the nuclear site. These herds are listed in Table 2SB.7-1 along with distance, direction and location relative to the nuclear site.

The average density of non-commercial milk cows for Fairfield, Newberry and Richland Counties is shown on Table 2SB.7-2. Based on these numbers, an estimate of the number of milk cows located closer to the site than the nearest commercial dairy farm (5.7 miles) was made.

TABLE 2SB.7-1

NEAREST COMMERCIAL DAIRY HERDS TO THE SITE

OWNER	DISTANCE FROM SITE (MILES)	DIRECTION	LOCATION
Graham	5.7	W	Newberry County - On S. C. County Highway 98, approximately 1 mile east of junction with County Highway 97.
Shealy	6.7	W	Newberry County - On S. C. County Highway 97, approximately .5 mile north of junction with County Highway 98.
Graham	7.3	WNW	Newberry County - On S. C. County Highway 272, at the split junction with County Highway 351.
Alewine	7.6	SW	Newberry County - Just north of I-26, at junction of S. C. County Highway 320 and unimproved road.
Felker	10.3	NW	Newberry County - On S. C. State Highway 34, approximately .5 mile west of junction with County Highway 572.
Parks	11.2	NE	Fairfield County - On S. C. County Highway 22, approximately .75 mile east of junction with County Highway 53.

TABLE 2SB.7-2

DENSITY OF NON-COMMERCIAL MILK COWS*

	Fairfield County	Newberry County	Richland County
Total No. of Cows	852	5963	2272
Commercial Milk Cows	668	5493	1827
Non-Commercial Milk Cows	184	470	445
Average Density of Non-Commercial Milk Cows per Square Mile	.26	.74	.59

Based on the data presented above, we have estimated the location of milk cows that could be located closer to the site than the nearest commercial dairy farm.

NO. OF NON-COMMERCIAL MILK COWS

Distance	Fairfield County	Newberry County	Richland County
1-2 Miles	2	0	-
2-3 Miles	3	3	-
3-4 Miles	4	5	-
4-5 Miles	4	7	1

*1964 United States Census of Agriculture (South Carolina), Volume 1 - Part 27, U. S. Department of Commerce, Bureau of Census (Agriculture Division)

2SC CHEMICAL AND SEWAGE DISCHARGES

2SC.1 QUESTION: Provide information on the maximum, minimum, and average concentrations, the amounts discharged, and discharge rates of all chemicals discharged to the holdup basin and Lake Monticello during plant startup and operation.

The waste discharge description listed on the following pages represent the best present estimates of materials and quantities in streams to be discharged into Monticello Reservoir.

As the project equipment is purchased, more exact data will become available and will allow updating of these quantities.

STEAM GENERATOR BLOWDOWN

A. Composition

Dissolved Solids content, mg/l	1000 Max 100 Avg 50 Min
PO_4 content, mg/l	40 Max 15 Avg 10 Min

B. Flows

Average Daily Flow, Gals/D	144,000
Maximum Daily Flow, Gals/D	259,000
Minimum Daily Flow, Gals/D	29,000
Dissolved Solids Rate, Lbs/D, (Max, Avg, Min)	600,120,60
PO_4 Rate, Lbs/D (Max, Avg, Min)	30,20,10
Discharge Rate, GPM	180
Cooling Water Discharge Rate, GPM	530,000

The blowdown will be cooled and discharged into the circulating water discharge or recycled for secondary cycle makeup.

FLOOR DRAINS AND OIL CONTAMINATED WASTES

A. Composition

These wastes are comprised of floor washings, fire water, small oil spillage, major oil spillage in the event of equipment rupture. Pump-out of diked areas containing oil storage vessels will be to this system and is another oil source. Estimated final effluent BOD is 37± 30 mg/l. All water will flow to a gravity oil water separator sized for maximum flow. the free oil separated is to be collected for off-site removal. Beyond the separator the water should not exceed 100 mg/l of oil, and the BOD should not exceed 150 mg/l. The free oil separated water will be oxidation ponded and the final effluent BOD_5 is estimated at 37 mg/l based on 75 percent BOD removal.

B. Final Effluent Flows

Average Daily Flow, Gals/D	20,000
Maximum Daily Flow, Gals/D	30,000
Minimum Daily Flow, Gals/D	10,000
Average BOD_5 Rate, Lbs/D	62
Maximum BOD_5 Rate, Lbs/D	167
Minimum BOD_5 Rate, Lbs/D	6
Pumping Rate, GPM (Sized to handle fire system water)	2-3000

ION EXCHANGE WASTE

A. Composition

Primarily sodium sulfate	
Dissolved solids content, mg/l	8700± 2500

This waste will be properly neutralized to 7±1 pH and discharged into the cooling water discharge line.

B. Flows per Unit

Average Daily Flow Gals/D	13,300
Maximum Average Flow Rate Gals/D	15,900
Minimum Average Flow Rate, Gals/D	10,700
Average Dissolved Solids Rate, Lbs/D	962
Maximum Dissolved Solids Rate, Lbs/D	1,490
Minimum Dissolved Solids Rate, Lbs/D	552
Actual Pumping Rate, GPM	250
Cooling Water Discharge Rate, GPM	530,000

START UP WASTES

A. Composition and Volume

The plant systems will be flushed with plain water. The resulting waste may contain welding scale, rust and other debris. Total volume is estimated at 10-20 million gallons. The stream will be routed to the floor drain system for solids settling by means of a settler and ponding.

A phosphate detergent mixture will be used to clean out various equipment. The total estimated quantity of this waste including a follow-up water flush is 600,000 gals. The contaminants and their concentrations are estimated to be as follows:

1. Trisodium phosphate, mg/l 670
2. Detergent, mg/l 330

Treatment of this waste will consist of the following:

1. Collect the waste.
2. Add alum or lime to precipitate PO_4 to reduce the soluble PO_4 content to less than 5 mg/l.
3. Route the supernatant to the floor drain system oxidation pond and/or the sanitary system at a rate that will be compatible with the excess available capacity of the systems to be used.

4. The precipitated phosphate will be removed for landfilling.

All flushing oils will be collected for suitable off-site removal and disposal.

2SC.2 QUESTION: Describe the sewage disposal system and its location including the location of the field tile.

The sanitary waste treatment system consists of the following components arranged in series.

1. Collection sump/or sumps with lift pumps.
2. Forced main to treatment plant.
3. Comminuter
4. Clay lined mechanically aerated pond of minimum 10 days retention time.
5. Clay lined stabilization pond loaded at 20 pounds of BOD_5 per surface acre per day.
6. Chlorination contact tank sized for ½ hour contact at maximum flow.
7. Weir
8. Discharge of effluent to Monticello Reservoir. See Plate 4, ER for approximate system location.

2SD ECOLOGY

2SD.1 Describe the details of the land tract with the U. S. Forest Service which will serve to improve or establish a wildlife habitat. Describe actions anticipated to improve the wildlife habitat for ducks, deer and turkeys.

According to preliminary data, the increased elevation of Parr Reservoir may flood certain properties of the U. S. Forest Service located upstream near Terrible Creek. Plans have been drawn for a waterfowl habitat area on Terrible Creek and development is expected soon. SCE&G has made contact with the U. S. Forest Service concerning the possible effects of the project on this development. Further discussions will be held as project plans are solidified, and SCE&G will cooperate with the U. S. Forest Service on a value for value land exchange as found mutually agreeable.

Plans for improving waterfowl habitat await the completion of detailed land surveys in the area of Parr Reservoir. It is expected that several sites usable for selective planting and for the creation of greentree reservoirs will be located.

Habitat for deer, turkeys and other land animals will be improved by the planting of appropriate understory vegetation in cleared right-of-way areas. This margin or "edge" of cleared land will provide a greater variety and abundance of food and cover for the wildlife than was previously available.

2SD.2 QUESTION: Provide information on the present turkey population in the Frees Creek-Parr Reservoir area.

The following information is based on conversations with a South Carolina Wildlife Resources Department District Biologist. The wild turkey is considered to be an abundant game bird in Fairfield County. The area of of Frees Creek is believed to be good to excellent turkey range within the Central Piedmont although the seasonal abundance of the wild turkey in the Frees Creek area and/or the "Central Piedmont Management Unit" has not been estimated. Turkey that presently occur within the Frees Creek area are "spillover" from adjacent U. S. National Forest land where the re-introduction of turkey took place during 1953-1956. This "spillover" is fairly recent. The Biologist states that he observed a flock of 20 turkey composed of hens and juvenile males in the area of Frees Creek approximately three weeks prior to the 1972 spring turkey hunting season.

According to the Project Leader in Wild Turkey Research for South Carolina Wildlife, an average abundance of wild turkey on excellent South Carolina turkey range is 12 to 20 birds per square mile (640 acres). However, this value may be greater than 20 during late summer through winter than families aggregate, or less than 12 in spring when the adult individuals segregate to breed and/or nest. It is probable that an annual average of 15 turkeys per square mile is a reasonable estimate for the Frees Creek area at the present time.

2SD.3 QUESTION: Provide the hunter success-ratio in Fairfield and Richland Counties for ducks, turkey, deer and varmints. Estimate the number of hunters in the area.

As far as we have been able to determine estimates of the number of ducks, turkey, deer and other game species bagged per unit of time (effort) or bagged per hunter have not been made by the South Carolina Wildlife Resources Department. However, based on conversations with department personnel it is expected that estimates of hunter success for most species of game will be available in the future, and will provide more accurate estimates of the hunting conditions in the site area.

A rough estimate of the number of hunters in the area was derived by the following method. Hunting Licenses sold to residents and non-residents by the South Carolina Wildlife Resources Department indicates that the maximum number of licenses sold during one annual period (1968-69) in Fairfield, Newberry, and Richland Counties was 16,086. This number represents 5.6 percent of the total combined population (1970 census) for the three counties. The population within the 5 and 10 mile radius (E.R. pp. 2.3.1-10) of the facility was multiplied by the 5.6 percent to obtain an estimate of hunters. This yields 356 hunters in a 10 mile radius and 68 hunters in the 5 mile radius.

2SD.4 QUESTION: Large areas will be subject to daily drawdowns during operation, exposing the surface daily to both aquatic and terrestrial conditions. Describe the vegetation and estimate the area of the surface to be exposed during the daily drawdown in Lake Monticello and the Parr Reservoir.

A present little data is available on species, abundance, and distribution of aquatic vascular plants. Collections have begun and will be emphasized during 1972. The following species have been indentified from along the edge of Parr Reservoir:

FAMILY	GENUS	COMMON NAME
Cyperaceae	*Scirpus* sp.	Bullrush
Typhascae	*Typha* sp.	Cattail
Polygonaceae	*Polygonum* sp.	Smartweed
Haloragidaceae	*Potamogenton* sp.	Water Milfoil
Navadaceae	*Potamogenton* sp.	Pond Weed
Hypericaceae	*Hypericum* sp.	St. Johns-wort

Qualitative observations indicate vasular vegetation is not abundant along the shoreline.

The area to be exposed was estimated from graphs of water level vs surface acres (Figures 2.2-11 and 2.2-12 in the PSAR). In Monticello Reservoir maximum pool level will be to elevation 425 feet. Normal drawdown will be to elevation 420.5 feet. This will expose approximately 400 acres based on water surface area charts. Corrections for slope in the reservoir will increase the acreage slightly.

In Parr Reservoir maximum pool level will be about elevation 266 feet. Normal drawdown will be to elevation 257 feet. This will expose approximately 2300 acres.

2SD.5 QUESTION: Estimate the area in the proposed Lake Monticello impoundment that will be clearcut before filling.

The area in the proposed Monticello Reservoir impoundment that will be clear cut before filling is estimated to be 800 acres.

2SD.7 QUESTION: Estimate the proportion of the increase in the area in hardwoods to be inundated by the expanded Parr Reservoir and the proportion of the area forested in hardwood by formation of the proposed Lake Monticello.

An estimate of the proportion of the area that will be inundated by Monticello and Parr Reservoirs which is forested by deciduous trees is as follows:

Area	Proportion
Lake Monticello	15% Deciduous
	9% Mixed Deciduous and Pine
	24%
Parr Reservoir	70% Deciduous
	6% Mixed Deciduous and Pine
	76%

The proportions were determined by planimetry from aerial photographs taken in November of 1970 by the U. S. Geological Survey.

2SD.8 QUESTION: Through your consultant, provide a summary of the data on the ecology of Frees Creek.

Frees Creek is a small tributary of the Broad River flowing into the Frees Creek embayment of Parr Reservoir. The stream originates near the intersection of Highways 215 and 347 and drains an area of approximately 17 square miles.

In contrast to the Broad River, Frees Creek is generally a clear-running stream. The creek muddies during heavy rain but returns quickly to a clear condition. Water sources of the creek are from surface water drainage within the basin and springs or seeps in the upper part of the stream. Except in the very uppermost portion of the basin, Frees Creek flows year round. Run-off records are not available; however, an estimate of average run-off of Frees Creek was made by comparing the ratio of run off and drainage area of Broad River to that of Frees Creek, (Page 2.3.2-2). On this basis the daily run off is estimated to average approximately 24 CFS.

During moderate to low flow conditions the stream is characterized by a width on the order of 4 meters or less, and an average depth on the order of 10-15 centimeters. Shallow pools and shallow riffles are the pattern. Riffles predominate, and pools are generally no deeper than 30 cm. Some larger pools are present in the uppermost reaches. The bottom consists primarily of coarse sand. Some rock is exposed in the creek bottom near the bridge crossing at Highway 99. Other than near the bridge there is little rock exposed in the streambed.

Based on limited observations, summer stream temperatures are generally cooler than that of Parr Reservoir. This is probably due to the influence of springs and the shaded character of the stream as it passes through areas of dense deciduous tree growth or understory.

A sampling station for benthic organisms has been established along a 500 meter reach near the Highway 99 bridge. Qualitative sampling techniques have revealed 18 species of insects (larval & nymphal forms) in 7 orders and one species of decapod crustacean in the stream. No molluscs were found.

Food supply is largely from leaves, twigs, and debris that drop or are washed into the stream along with terrestrial insect life. Qualitative sampling indicates benthic organisms are not abundant, and primary production would be expected to be quite low in the heavily shaded environment.

A thorough survey of fish populations in the Creek is planned but is not completed. Observations from qualitative sampling indicate few fish, as would be expected with a poor benthic food supply and little protective habitat. The possible seasonal use of the stream by fish from Parr Reservoir has not been thoroughly evaluated, although conversations with local people and knowledge of the spawning habits of many of the species in Parr Reservoir would dictate against this use.

2SD.9 QUESTION: Describe the effects of pumping of the hydroelectric pumped storage facility on the formation of aquatic ecosystems in Lake Monticello. Describe the formation of the fishing area in Lake Monticello, the factors affecting its size, and methods used to sort out the desirable fish from the undesirable fish. Describe your plans for stocking the lake. Include information on the effects of the once-through cooling system of the Summer Plant of the aquatic biota (i.e., entrainment of larvae and eggs), particularly when Lake Monticello is at its maximum and minimum water elevation.

(a) The effects of the pumping facility may influence formation of aquatic ecosystems in Lake Monticello by 1) interchanging water of possibly different physical and chemical characteristics between Parr and Monticello reservoirs, 2) allowing the interchange of plankton and small fish between the two lakes, 3) destroying some larger fish in the passage between the lakes, and 4) causing fluctuations of the shoreline in Lake Monticello.

There is insufficient data from similar facilities to accurately predict the effect of pumping, combined with thermal stress on the aquatic ecosystem in Monticello Reservoir. In addition, effects of water fluctuations on Parr Reservoir will affect the ecosystem in Monticello since they are integrally related. The kinds of changes and some indications of magnitude of effect have been discussed in the Environmental Report (2.3.6-17 to 2.3.6-19) and in the Supplement to the Environmental Report (Section S2.6). Further definitive information is not available at this time.

(b) The fishing area in Monticello Reservoir will be created by the construction of a dam which will also provide the roadbed for relocated Route 99 across Monticello Reservoir. Thus, the relocation of the highway is a prime factor in determining the size of the fishing area. The relocation of this highway has not yet been determined.

Periodically there will be make up water required from Monticello Reservoir to offset the effects of evaporative losses on the upper fishing lake. The limited times of interconnection between the fishing area and the lower part of Monticello Reservoir will assist in the control of the amount of undesirable fish in the area. At the present time, the requirement for other methods of reducing or eliminating entrance of undesirable fish into the upper lake have not been determined. Several methods are available and the final decision will be made in consultation with the South Carolina Wildlife Resources Department.

Presently it is anticipated that the upper reservoir will be stocked with bream (Lepomis Macrochious) and large mouth blackbass (Micropterus Salmoides). The final decision on species and stocking ratios will be made in consultation with the Wildlife Resources Department.

(c) Information on the possible effects of once through cooling on entrainment of organisms has been discussed in the Environmental Report (2.3.6.1) and in the Environmental Report Supplement (S2.6.3-2 to 3-4).

Water for cooling the nuclear plant will be withdrawn from Lake Monticello at a depth of 35 feet below high water elevations or 30.5 feet below low water elevation. The difference of 4.5 feet at these depths is not expected to make any significant biological difference.

2SE POWER NEEDS AND COST-BENEFIT ANALYSIS ON CONSTRUCTION EFFECTS

2SE.1 QUESTION: Supply information on the reserve capacity during the summer peak period that the Southeast Electrical Reliability Council considers to be reasonable for the Virginia-Carolinas Subregion.

The Southeastern Electric Reliability Council (SERC), to our knowledge, has not issued information to the VACAR Subregion regarding what it considers a reasonable generation reserve level to be. As has been indicated by FPC guidelines, South Carolina Electric & Gas Company considers a reserve level equal to its largest generating unit or 20% of estimated peak load, whichever is the greater, to be adequate.

2SE.2 QUESTION: Provide information on a survey made to assess the impact of construction on the nearby communities.

The site is in a remote area and even though some of the construction workers will establish temporary homes in nearby communities, past experience has shown that the majority of the construction force will locate in the larger towns within a 25-mile radius.

An estimated 7.5 million man hours will be required to construct Summer Station and the related projects in this development. At the peak of construction, in the summer of 1975, approximately 1800 construction workers will be employed in addition to 150 professional and technical employees. This will be a gradual buildup from a starting force of about 200 employees. At the manpower peak, approximately 1000 workers will be assigned to the Summer Station and the balance to the other projects.

Based on information developed by the contractor on other projects, it is estimated that 1800 construction workers will mean about 5110 more people in the area. An employment analysis by the contractor on similar projects has shown that a minimum of 30% of the work force will be employed locally (within a 25 mile radius). These additional people will tend to disperse over a 25-mile radius from the job site, usually living in the larger towns. The studies provide estimates of an increase of 1000 school children, approximately 700 additional trailer spaces and about 1000 more telephones. In addition, the work force will have an impact which will create 35 more retail establishments and about 760 supporting jobs. It is estimated that each 100 construction workers results in an annual payroll in excess of one-million dollars with resulting economic benefits to the community.

With the work force living in many communities within a 25-mile radius, the impact and benefits will be widely distributed. In addition, the gradual buildup of the construction force will lessen the impact on communities providing services.

2SE.3 QUESTION: Discuss the economic incentives, penalities, and trade-offs for using the higher temperature differential of 25°F with 10^6 gallons per minute of cooling water rather than a lower temperature differential, across the condenser, for example, 15°F. It was found that the early results from the Alden model tests suggested that at 25°F Δt across the condenser would result in water flowing at a lower temperature at the outfall of the Fairfield Hydroelectric Station than for the case when a 15°F Δt existed across the condenser, i.e., 1.6°F versus 4.1°F at the outfall. However, in the Alden Progress Report of December 1971, a temperature rise of 3.9°F at the Fairfield Hydroelectric Station outfall resulted under similar conditions for a 25°F temperature rise across the condenser. This represents an insignificant change from the early case of the 15°F Δt.

The condensers for the Summer Nuclear Plant are required to transfer 6.632×10^9 BTU/hr/unit to the condenser cooling water. Figure 2SE.3-1 shows the flow versus condenser temperature rise necessary to satisfy this transfer rate.

It can be seen that for a 25F temperature rise the flow is 530,000 gpm/unit compared to 883,000 gpm/unit for a 15F temperature rise.

The economics of the system are such that the capital costs and the operating costs of the circulating water pumps over the life of the plant would be less with the higher temperature rise across the condenser. The capital costs of the condenser, piping and related operational equipment should also be less for the higher temperature rise.

Since less water is handled with the higher temperature rise condensers a smaller percentage of the organisms are subjected to excursions through the condenser. Figure 2SE.3-2 shows the daily water handled as a percentage of the Monticello Impoundment volume versus condenser temperature rise.

Some of the water may circulate through the condenser system more than once during the course of the day due to the flow patterns in the reservoir.

However, some of the water remote from the plant circulating water intake and discharge may never pass through the condensers. With higher condenser flows due to reduced temperature rises the probability of affecting remote waters is increased since the higher momentum of the circulating water discharge would tend to cause more of the impoundment to be in motion.

In addition to handling less water the higher temperature rise condenser results in lower surface temperatures in the far field region. (Figure 2SE.3-3). This is due to the increase in the heat transfer rate (Figure 2SE.3-4) [1] with the increase in condenser temperature rise. The result is that near the discharge point a higher temperature gradient exists between the surface water and the atmosphere and consequently the rate of heat transfer to the atmosphere is much greater.

The lower water temperature in the far field region (Figure 2SE.3-3) also means that the organisms and plant life in the far field region will be exposed to lower temperatures.

The critical evaluation of economic incentives that directs condenser design to 25°FΔT is to avoid the necessity of additional helper cooling equipment assisting the Monticello impoundment to permit maximum output of two nuclear stations and uninterrupted operation of Fairfield pumped storage facility. The key economic justification of the entire project is firmly based on combining the nuclear plants circulating water cooling requirements with a pumped storage impoundment excluding all other mechanical means of supplementing circulating water cooling for the nuclear plants. The engineering considerations involved with optomizing project design required minimizing the total environmental impact of the entire project while conforming to applicable state standards. The state of South Carolina specifies limits in the Water Classification Standards System (approved by the U. S. Environmental Protection Agency - December 23, 1971) that will not permit a water user causing a monthly average water temperature increase of more than 5°F in flowing water and 3°F in reservoirs after a zone of adequate mixing (although Parr Reservoir behaves as a river, S. C. Electric & Gas Company is considering this body of water as a reservoir); therefore, thermal model testing by Alden Laboratories was focused on developing a heat rejection condition from the basic design considerations that would guarantee continuous operation of the project while not exceeding state water quality standards and utilizing the Monticello Impoundment as the principal component of heat rejection equipment.

Alden Laboratories initially examined assorted heat rejection arrangements, as described in their progress report of December 29, 1971, (Appendix 2C, PSAR) to develop the operating temperature that would minimize environmental impact and meet established state standards. This investigation was necessary in order for dependent engineering and environmental work to progress. The results of Alden's initial investigation revealed that Monticello Impoundment would have to be stratified to permit adequate heat dissipation to avoid exceeding state standards, that the more rapid heat dissipations followed higher temperature differentials across the nuclear condensers, and that a 25°FΔT should be used for design to avoid possibilities of exceeding state standards.

S. C. Electric & Gas Company has been questioned concerning the use of

25°FΔT instead of 15°FΔT due to data included in the Alden Progress Report indicating a 4.1°F rise in the Parr Reservoir for 15°FΔT and 3.9°F rise for 25°FΔT. The total work of Alden Laboratories in developing a recommendation for 25° FΔT across the condenser is not clearly indicated in this progress report. The model study tests referenced in the question are of different parameters of river flow, initial water temperatures and climatic conditions and therefore in our opinion should not be compared for strict evaluation of condenser ΔT.

Thermal test involved with this initial work positively indicated that a 25° ΔT produced a necessary decrease in the total thermal effect in contrast to a 15°Δ T.

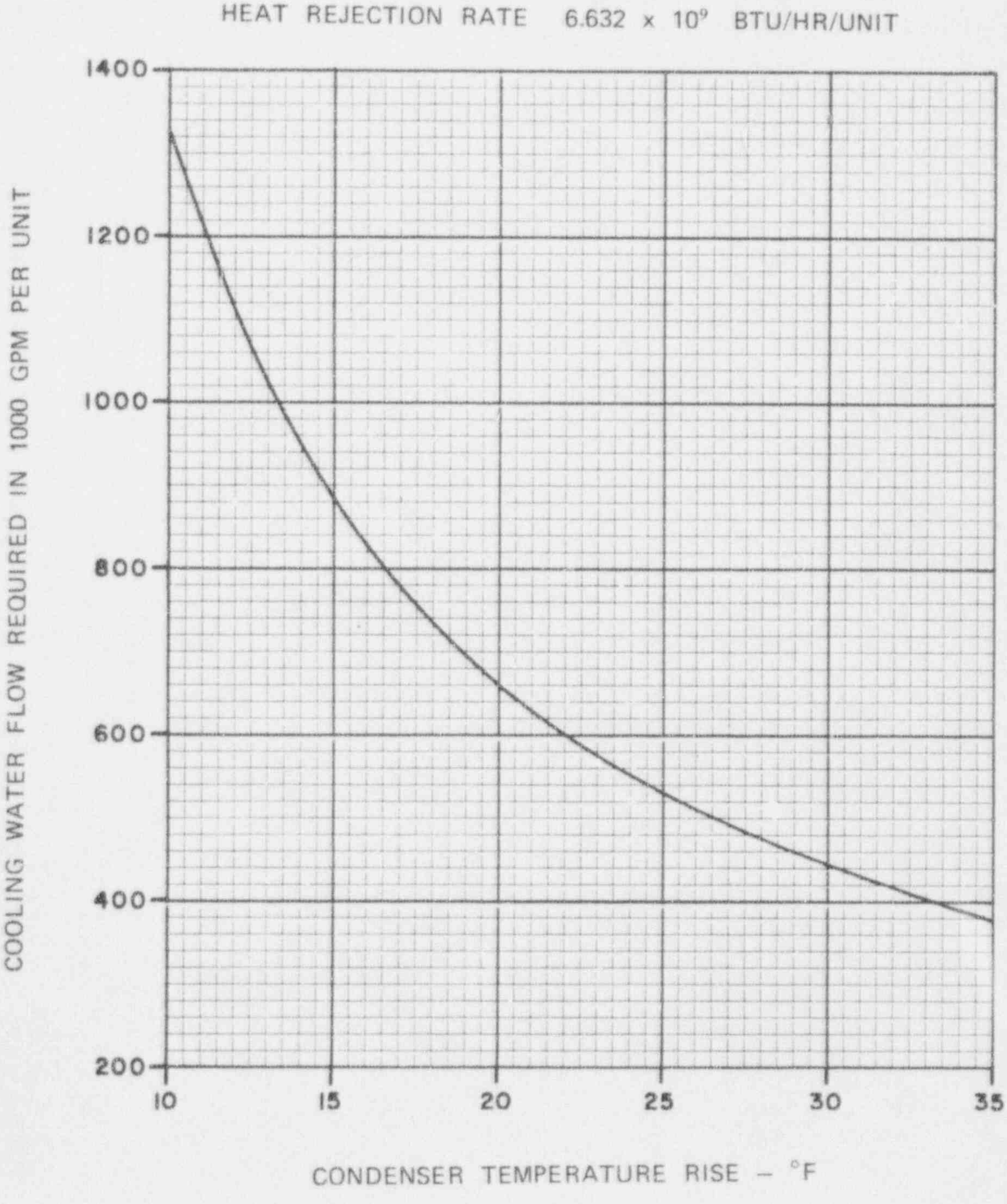
ARL has considered these as well as other test runs and from their experience of performance interpretation and required results recommends the 25°FΔT across the nuclear plant condensers.

Design of the project is well advanced with a condenser ΔT at 25°F. S. C. Electric & Gas Company has consulted with the State Pollution Control Authority concerning this design parameter and both parties agree upon this temperature differential as appropriate to avoid undesirable operating conditions.

Following initial test to determine design conditions Alden Laboratories are proceeding with a program of thermal tests to refine design concepts and to develop a family of curves for initial water temperatures and river flows.

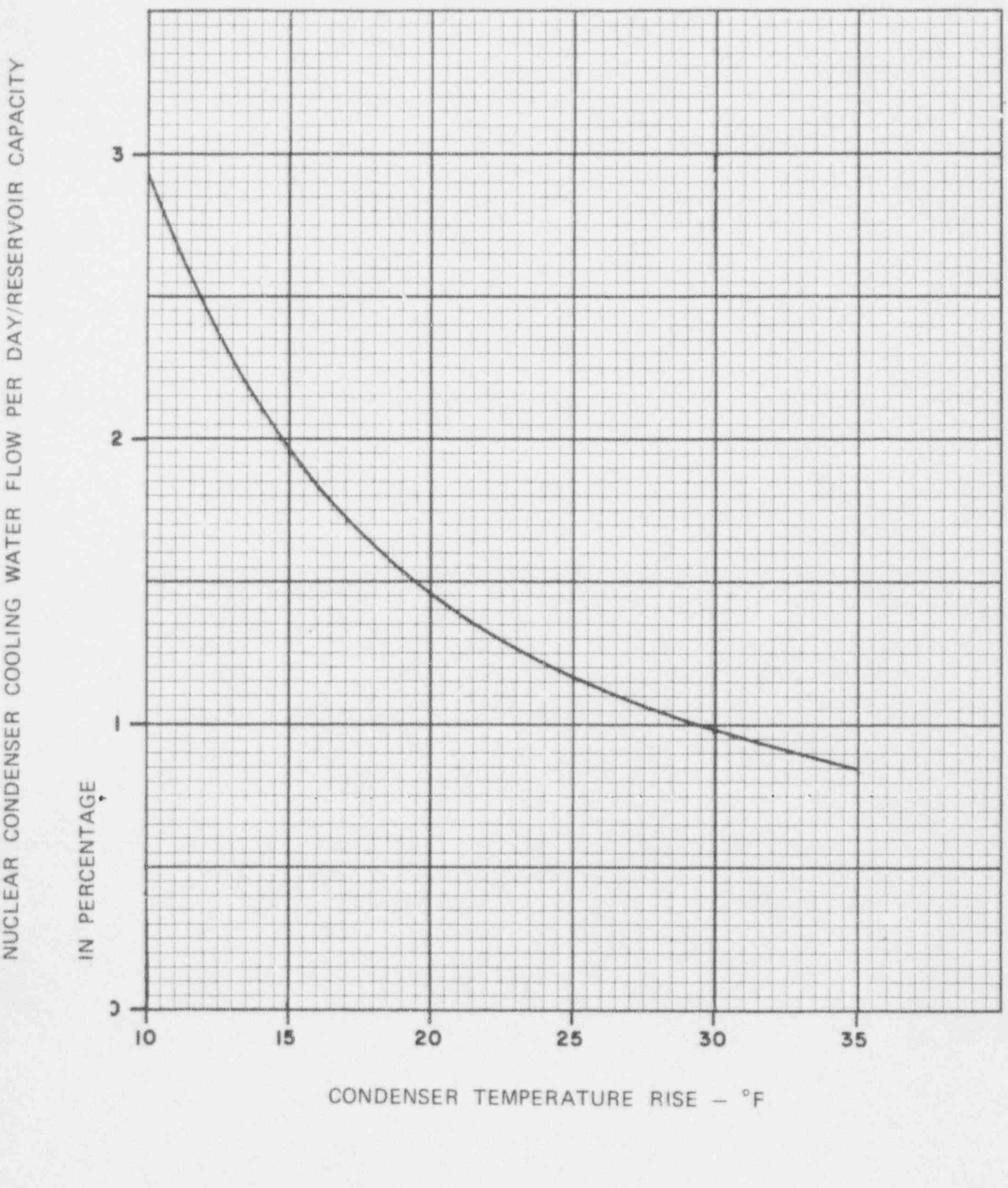
---

1. Brady, D. K., Graves, W. L., Jr., Geyer, J. C. "Surface Heat Exchange at Power Plant Cooling Lakes" The Johns Hopkins University, Research Project RP-49, November 1969

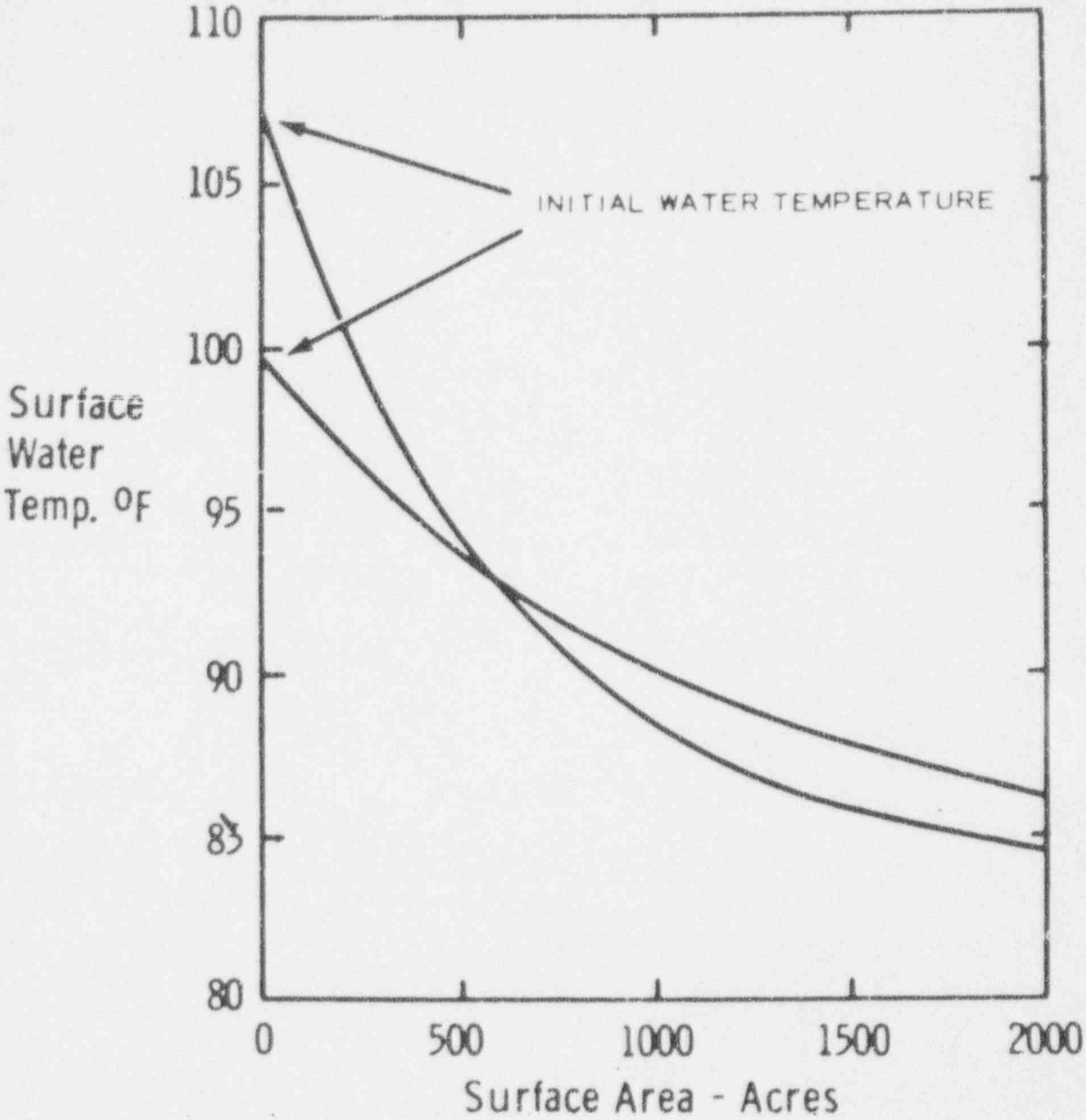


Condenser Flow Per Unit Versus Condenser Temperature Rise

FIGURE .2SE.3-1



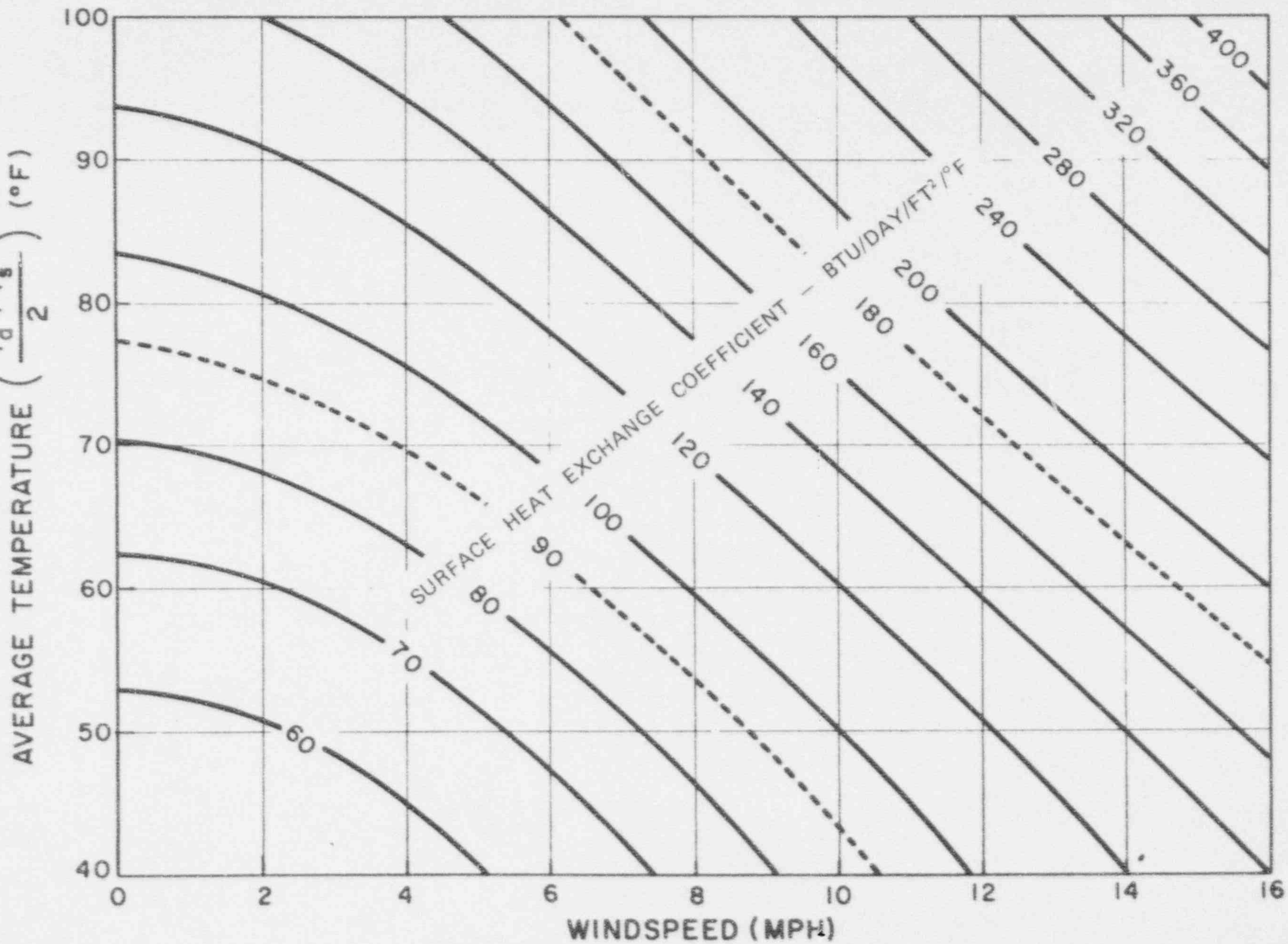
Plant Flow Per Day as a Percentage of the Monticello Impoundment Volume Versus Condenser Temperature Rise



Surface Water Temperature Cooling Curves For Identical Heat Rejections And Surface Area But At Different Initial Water Temperatures

Typical Cooling Curves Showing Surface Effects of Higher Temperature Rise Condenser

FIGURE 2SE.3-3



Design Chart for Surface Heat Exchange Coefficient

FIGURE 2SE.3-4

2SF ENVIRONMENTAL APPROVALS AND CONSULTATIONS

2SF.1 QUESTION: Furnish a list of agencies from which required approvals or permits have been obtained or will be obtained and report the status of each permit. Include the status of the application for the permit under the Water Quality Improvement Act and that under Section 13 of the Refuse Act of 1899. Provide copies of these permits, if available.

The following is a list of most of the Local, State, and Federal agencies from which South Carolina Electric & Gas Company intends to obtain permits and certifications. Each agency is followed by a listing of the permits which will be applied for from that agency.

Local

1. Fairfield County Auditor's Office:

   (a) Building permit for construction of major structures.

State

1. South Carolina Pollution Control Authority - Water Section:

   (a) Letter of Water Quality Certification.

   (b) Effluent Discharge Permit.

   (c) Sewage Disposal System Permit.

   (d) Industrial Waste Permit.

2. South Carolina Pollution Control Authority - Air Section:

   (a) Permit for heating boiler and diesel-generator emissions.

3. State Board of Health - Radiological Health Department:

   (a) Permit for radioactive sources used during construction.

4. Public Service Commission:

   (a) Certificate of Public Convenience and Necessity for the Summer Nuclear Station and associated transmission lines.

5. South Carolina Highway Department:

   (a) Permits for oversize, overweight, and overlength loads.

   (b) Permit for any entrance roads to state highway system.

Federal

1. Federal Aviation Agency:

   (a) Permit for any structures over 200 ft. tall.

2. Atomic Energy Commission:

   (a) Nuclear Station Construction Permit.

   (b) Nuclear Station Operating License.

   (c) Nuclear Station Operating Personnel Licenses.

3. Corps of Engineers:

   (a) Refuse Discharge Permit.

Application was filed with the Atomic Energy Commission on June 30, 1971 for a Nuclear Station Construction Permit. On that date, the Preliminary Safety Analysis Report was submitted for review. This review is currently in process.

All other applications have not yet been filed, but will be filed at the appropriate time.

2SF.2 QUESTION: Furnish a list of agencies which will approve the applicant's construction of dams, the formation of Lake Monticello, and the pumped storage facility. Provide information as to the status of these approvals.

The following is a list of known Local, State, and Federal agencies from which South Carolina Electric & Gas Company intends to obtain permits and certifications for the Parr Hydroelectric Project 1894. Each agency is followed by a listing of the permits which will be applied for from that agency.

Local

1. Fairfield County Auditor's Office:

   (a) Building permit for construction of major structures.

State

1. South Carolina Pollution Control Authority - Water Section:

   (a) Application for permit to construct - This will include effluent discharge and sewage disposal.

2. South Carolina Pollution Control Authority - Air Section:

   (a) Open burning permit.

3. State Board of Health - Radiological Health Department:

   (a) Permit for radioactive sources used during construction.

4. Public Service Commission:

   (a) Certificate of Public Convenience and Necessity.

5. South Carolina Highway Department:

   (a) Permits for oversize, overweight, and overlength loads. (as required)

   (b) Permit for any entrance roads to State Highway system. (as required)

Federal

1. Federal Power Commission:

   (a) A new License for Project No. 1894.

2. Corps of Engineers:

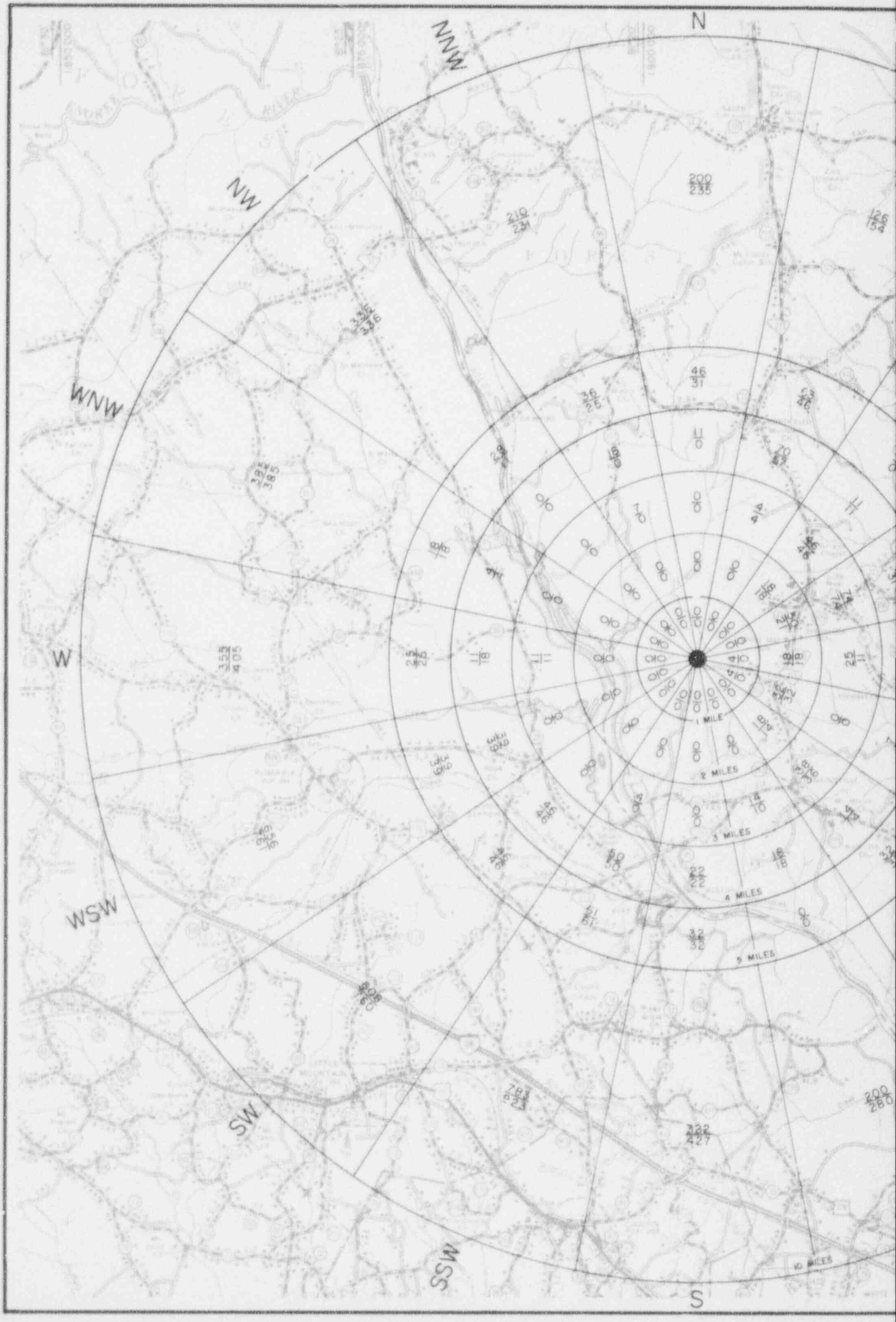
   (a) Refuse Discharge Permit (Section 13 of the River and Harbor Act of 1899)

SCE&G has filed an Amended Application for New License for Parr Hydroelectric Project No. 1894 with the F.P.C. (Original filing date Sept. 1971). All other applications have not yet been filed, but will be filed at the appropriate time.

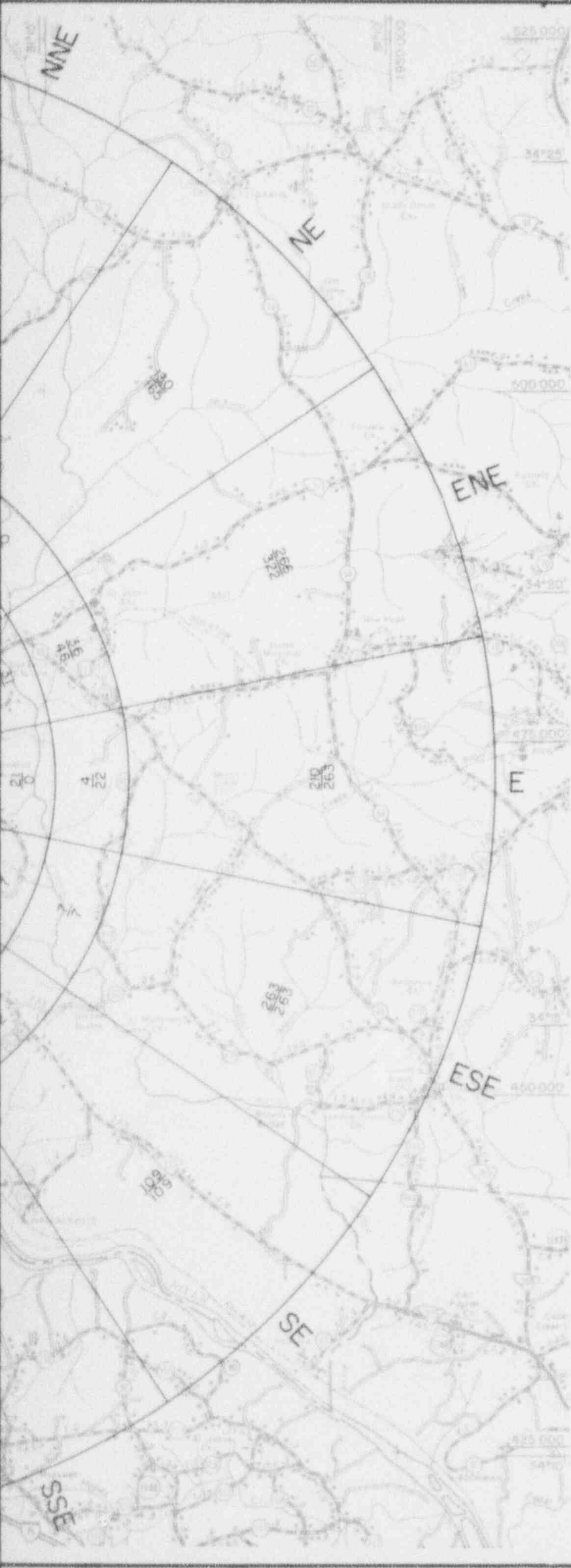
3S RADIOLOGICAL IMPACT OF PLANT

3S.1 QUESTION: Examination of the population data presented in the Environmental Report indicates that the data are unusable to determine the radiological impact of the plant due to the lack of alignment of the directional sectors. In the first 10 miles there are 16 sectors which are bounded by the cardinal compass points. With this arrangement, there is no way to utilize the meteorological data centered on the compass points with the population data. Provide population data for the first 10 miles, reoriented so as to be centered on the compass points. Redistribute the data out to 50 miles so they are divided into 16 sectors.

Figure 3S.1-1 presents population data divided into 16 sectors centered on the cardinal compass points for the first 10 miles from the reactor building. Figure 3S.1-2 presents population data out to a distance of 50 miles, divided into 16 sectors.



N
NNW
NW
WNW
W
WSW
SW
SSW
S
1 MILE
2 MILES
3 MILES
4 MILES
5 MILES
10 MILES



N

KEY:

21 ESTIMATED 1970 POPULATION
49 ESTIMATED 2010 POPULATION

NOTE:

RADIUS IN MILES		1	2	3	4	5	10
ACCUMULATIVE TOTAL	1970	8	144	365	738	1,211	6,350
	2010	0	103	295	612	1,053	7,072

REFERENCE:

THE BASE FOR THIS MAP WAS PREPARED FROM ENLARGED PORTIONS OF THE FOLLOWING SOUTH CAROLINA STATE HIGHWAY DEPARTMENT, GENERAL HIGHWAY MAPS: LEXINGTON COUNTY 1958, REVISED 1970, NEWBERRY COUNTY, 1961, REVISED 1970, FAIRFIELD COUNTY 1962, REVISED 1970, AND RICHLAND COUNTY 1963, REVISED 1969.

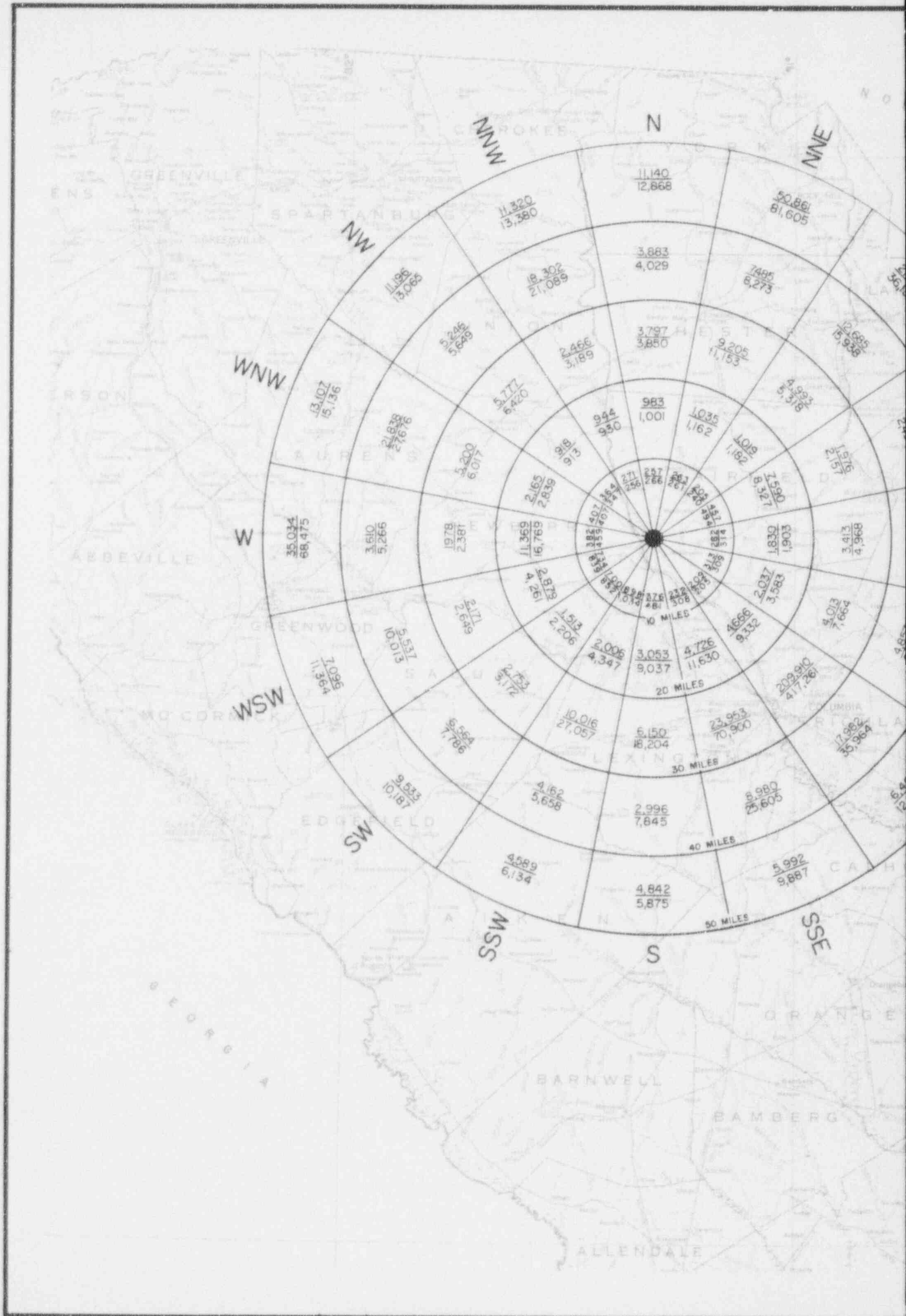
STATUTE MILES

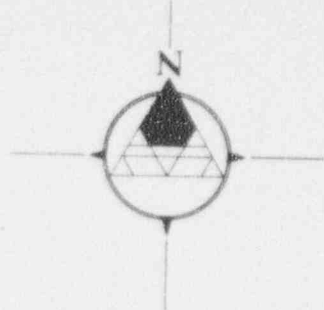
1 0 1 2

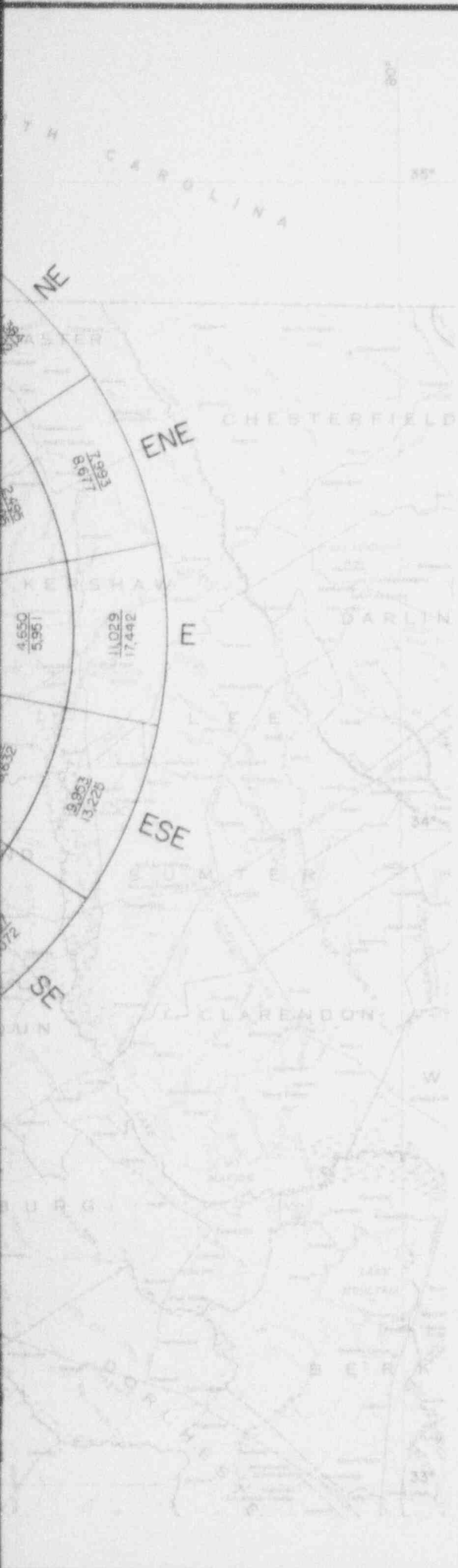
PRESENT AND FUTURE
POPULATION DISTRIBUTION
0 TO 10 MILES
FROM REACTOR BUILDING

9406090236 - 06

FIGURE 3S.1-1


N
NNE
NNW
NW
WNW
W
WSW
SW
SSW
S
SSE
10 MILES
20 MILES
30 MILES
40 MILES
50 MILES
CHEROKEE
GREENVILLE
SPARTANBURG
LAURENS
ABBEVILLE
GREENWOOD
MC CORMICK
EDGEFIELD
LEXINGTON
COLUMBIA
AIKEN
BARNWELL
BAMBERG
ALLENDALE
ORANGE
GEORGIA
11,140
12,868
50,861
81,605
11,320
13,380
3,883
4,029
7485
6,273
11,196
13,065
18,302
21,089
5,246
5,649
3,797
3,850
9,205
11,153
2,466
3,189
13,107
15,136
5,777
6,420
983
1,001
944
930
1,035
1,162
21,838
27,676
1,019
1,182
5,200
6,017
918
913
1,976
2,157
2,165
2,839
7,590
8,327
35,034
68,475
3,610
5,266
1978
2,381
11,369
16,769
1,830
1,903
3,413
4,968
2,878
4,261
2,037
3,583
2,171
2,649
1,513
2,206
4,013
7,664
4666
9,332
5,537
10,013
2,006
4,347
3,053
9,037
4,726
11,630
7,096
11,364
2,753
3,172
209,910
417,261
10,016
27,057
6,150
18,204
23,953
70,900
17,982
35,964
6,564
7,786
9,533
10,187
4,162
5,658
2,996
7,845
8,980
25,605
4,589
6,134
4,842
5,875
5,992
9,887





KEY

200 ESTIMATED 1970 POPULATION
400 ESTIMATED 2010 POPULATION

NOTE:

RADIUS IN MILES		10	20	30	40	50
ACCUMULATIVE TOTAL	1970	6,350	55,083	352,854	484,126	705,662
	2010	7,072	86,494	678,854	876,723	1,212,307

REFERENCE:

THE BASE FOR THIS MAP WAS PREPARED FROM A PORTION OF USGS STATE OF SOUTH CAROLINA, BASE MAP, 1970.

STATUTE MILES
10 0 10 20

PRESENT AND FUTURE POPULATION DISTRIBUTION 0 TO 50 MILES FROM REACTOR BUILDING

9406090236-07

FIGURE 3S.1-2