U.S. Atomic Energy Commission
Docket No. 50-261

ENVIRONMENTAL REPORT

Carolina Power & Light Company

H.B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2

H. B. ROBINSON
STEAM ELECTRIC PLANT
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ENVIRONMENTAL REPORT
TABLE OF CONTENTS

H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
ENVIRONMENTAL REPORT
LIST OF TABLES

ENVIRONMENTAL REPORT
LIST OF TABLES (Continued)

H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
ENVIRONMENTAL REPORT
LIST OF FIGURES

LIST OF FIGURES (Continued)

1.0 INTRODUCTION

On July 31, 1970, the AEC issued to Carolina Power & Light Company a facility operating license DPR-23 which permitted operation of the H. B. Robinson Unit No. 2 at a power level not to exceed 5 MWt. The unit attained initial criticality on September 20, 1970. The low power level restriction was removed on September 23, 1970 and CP&L was authorized to operate the unit at power levels not to exceed the licensed power level of 2,200 MWt. The unit was declared to be in commercial operation on March 7, 1971 and has provided 1,473,666 MW-hr. of net electrical output for the CP&L system as of November 1, 1971.

On September 9, 1971, the Atomic Energy Commission caused to be published in the FEDERAL REGISTER (36 F.R. 18071) a revision of Appendix D of its regulation in 10 CFR Part 50, which became effective upon publication. Revised Appendix D is an interim statement of Commission policy and procedure for the implementation of the National Environmental Policy Act of 1969 (NEPA). The revised Appendix D is divided into five sections. Section A deals with the basic procedures for implementing NEPA, while Sections B, C, and D deal with procedures applicable to certain categories of permits or licenses already issued or for which applications are pending. Section E defines the categories of proceedings in which the Commission will consider and determine whether a permit or license already issued should be suspended pending completion of the NEPA environmental review and sets out the factors to be considered by the Commission in making its determinations.

This Environmental Report is submitted in response to Section B of the revised Appendix D. It discusses and assesses the various environmental implications of the operation of the H. B. Robinson Unit No. 2. The report also includes additional background information describing the site, the environmental monitoring programs and the components and systems of the unit related to the analysis of the environmental impact of the facility. The operating history of the unit to date is also discussed in the report to demonstrate the unit's compatability with the environment and its ability to operate with no significant adverse effects on the environment.

1.1 SUMMARY

CP&L is an electric utility which serves an approximately 30,000 square mile area in North Carolina and South Carolina. This area includes a substantial portion of the Coastal Plain and lower Piedmont regions of North Carolina and South Carolina and an area of western North Carolina in and around the City of Asheville. Electric service is rendered to over 200 communities with populations of over 500 persons. In addition, CP&L provides wholesale service to 24 municipal electric systems, 18 rural electric cooperatives and 2 privately owned utilities. The estimated total population in the territory served by CP&L is in excess of 2,800,000 persons.

The operation of the Robinson Unit No. 2 is essential to the ability of CP&L to meet its load requirements. The decision to construct the unit was based on CP&L's load projections in 1965 which indicated that a unit of this size was required to meet system load requirements in 1970 and beyond. The Robinson Unit No. 2 is CP&L's largest generating unit constituting approximately 16% of its generating capability. With reserve margins in the Virginia-Carolina territory smaller than desirable to assure a reliable power supply for the territory, the energy supplied by the unit is also important to neighboring utility systems.

The H. B. Robinson Plant site is in northeastern South Carolina 56 miles ENE of Columbia, the state capital. The location is about 25 miles NW of Florence and about 35 miles NNE of Sumter, S. C. The site is located on the southwestern corner of Lake Robinson which was impounded in the late 1950's to furnish cooling water for the Robinson Plant, both the initial 185 MWe fossil unit that was placed in service in 1960 and future plant additions. The total site area including Lake Robinson is more than 5,000 acres. Farming is the predominant activity in the sparsely populated environs of the plant site. The region is gently rolling and is not subject to severe persistent inversions.

The H. B. Robinson Unit No. 2 is a nuclear generating unit designed to produce initially 2200 MWt and 739 MWe of gross power. The unit is expected to be capable of an ultimate output of 2300 MWt. All steam and power conversion equipment, including the turbine generator, is designed to permit generation of 769 MWe of gross power.

The nuclear power plant incorporates a closed-cycle pressurized water Nuclear Steam Supply System and a Turbine-Generator System both provided by the Westinghouse Corporation. Equipment includes systems for the processing of radioactive wastes, handling of fuel, electrical distribution, cooling, power generation structures, and all other on-site facilities required to provide a complete and operable nuclear power plant.

The Nuclear Steam Supply System consists of a pressurized water reactor, Reactor Coolant System, and associated auxiliary fluid systems. The Reactor Coolant System is arranged as three closed reactor coolant loops connected in parallel to the reactor vessel, each containing a reactor coolant pump and a steam generator. An electrically heated pressurizer is connected to one of the loops. The reactor core is composed of uranium dioxide pellets enclosed in Zircaloy tubes with welded end plugs.

The plant is equipped with systems for processing radioactive gaseous and liquid wastes. Radioactive fluids enter the Waste Disposal System and are collected in sumps and tanks until determination of treatment is made. The system design and operation are characteristically directed toward minimizing releases to unrestricted areas. The bulk of radioactive liquid waste is processed and retained inside the plant by the Chemical and Volume Control System recycle train, while radioactive gases are held up in gas decay tanks a suitable period of time for decay. All discharge routes are appropriately monitored and safety features are incorporated to preclude releases in excess of 10 CFR 20 and Appendix I of 10 CFR 50.

Several engineered safety features have been incorporated into the reactor containment design to reduce the consequences of postulated accidents. These safety features include a Safety Injection System; an Air Recirculation Cooling System; and a Containment Spray System.

The inherent design of the pressurized water, closed-cycle reactor significantly reduces the quantities of fission products which might be released to the atmosphere. Four barriers exist between the fission product accumulation and the environment. These are the uranium dioxide fuel matrix, the fuel cladding, the reactor vessel and coolant loops, and the reactor containment building.

The major structures of the nuclear plant are the Reactor Containment Building, Auxiliary Building, Turbine Building, and Fuel Handling Building. These structures provide an aesthetically pleasing appearance. The unit condensers are cooled by water taken from Lake Robinson which then is returned to the lake by a 4.2 mile discharge canal to provide an effective cooling system.

There has been no opposition to the construction or operation of Robinson Unit No. 2. From the inception of the project, CP&L has worked with numerous Federal, State, and Local governmental agencies in an effort to assure compatibility of the unit with its environs. CP&L will continue to cooperate with appropriate governmental agencies to ensure that all provisions of applicable permits and licenses are met.

The impact of the operation of Unit No. 2 on the environment has been assessed with regard to land use, water use, heat dissipation, chemical discharges, sanitary wastes, biological effects, radioactive discharges, aesthetics, transportation, transmission lines, and postulated accidents. Although the assessment has indicated that some impact in these areas will be experienced, the efforts which CP&L has expended to reduce these impacts will assure compatibility with the environment.

CP&L considered various factors in arriving at the decision to construct an additional generating unit at the Robinson Plant. Evaluation was made of the need to provide electrical service to its customers, the possibility of importing power to meet the requirements, the type of generating unit to be installed, cooling water requirements, and alternate sites. A nuclear addition to the Robinson Plant was the most feasible alternative for providing the required generation.

Figure 1.1-1 is an aerial photograph of the plant taken in October 1971, showing fossil Unit No. 1 and nuclear Unit No. 2. This photograph illustrates the minimum aesthetic impact on the environs created by the nuclear unit and indicates the progress in eliminating construction effects.

The construction and operation of the Robinson Unit No. 2 necessarily involves the commitment and use of certain natural resources. However, Robinson Unit No. 2 represents a reasonable commitment of resources consistent with benefits to be derived from its operation. The resulting cost/benefit analyses confirms the environmental responsibility shown in the design, construction and operation of the H. B. Robinson Unit No. 2.

2.0 BACKGROUND INFORMATION

2.1 SITE DESCRIPTION

2.1.1 Location

The site is located in the western corner of Darlington County, South Carolina, on the southwest shore of Lake Robinson about 4.5 miles WNW of Hartsville. The location is about 25 miles NW of Florence, about 35 miles NNE of Sumter and about 56 miles ENE of Columbia, South Carolina. Coordinates of the site are latitude 34° 24.2' N and longitude 80° 09.5' W. The Universal Transverse Mercator (UTM) coordinates are 3,806,800 meters north and 577,500 meters east. Its location is shown in Figure 2.1-1. The North Carolina-South Carolina border is 28 miles north of the site and the Atlantic Ocean is about 88 miles to the southeast.

Initial development of the Robinson Plant site began in 1957 with the construction of Unit No. 1, a 185 MWe fossil unit which was placed in commercial operation in 1960. Development of the site anticipated future expansion of the plant and included the construction of Lake Robinson built to accommodate a total plant capacity of 1200 MWe. Figure 2.1-2 is an aerial photograph depicting the site boundaries and details of the site which totals more than 5,000 acres (including the lake). The nuclear plant is located on the shore of Lake Robinson adjacent to the coal-fired Unit No. 1.

2.1.2 Topography

The Robinson Plant is on the southern edge of the Sand Hills region of South Carolina. General topography of the region within a 50-mile radius of the plant is shown in Figure 2.1-3. This region is typified by rolling hills interspersed with water courses and covered with wooded areas which can be seen in Figure 2.1-3 and Figure 2.1-4 which is a topographic map covering the area within a 5-mile radius of the plant. To the south and east of the site, the terrain becomes flat and swampy in the coastal plain.

Lake Robinson, a principal feature of the site, is about 4,000 feet wide at the plant and about 7-1/2 miles long at its high water elevation of 222 ft. m.s.l. Minimum lake elevation is 210 ft. m.s.l. Land surface surrounding the lake rises to about 40-50 feet above the maximum lake elevation. The surrounding terrain reaches an elevation of 510 ft. m.s.l. about 5 miles northeast of the site.

2.1.3 Population

Figure 2.1-1 shows the location of population centers of over 25,000 people within a radius of 100 miles of the site. On the basis of population projections, Florence (25 miles SE), 1970 population of 25,997 is the only center within a 50-mile radius of the site. Other population centers of 25,000 or more are Columbia (56 miles WSW) with 113,542 people and Charlotte, North Carolina (67 miles NW) with 241,178 according to the 1970 census.

Figure 2.1-5 shows the 1966 and projected (1976 and 1986) population distribution in 16 directional sectors centered on the site and within 1, 2, 3, 4, and 5-mile radii. Figure 2.1-6 shows similar information for 1966, 1976, and 1986 population distributions for 10, 20, 30, 40, and 50 miles. The 0-5 mile population area indicated by an asterisk is derived from Figure 2.1-5 and is included in all sector totals.

The nearest off-site residence is 1,400 feet south of the plant while the nearest residence across the lake is approximately 4,200 feet east.

The current population estimates in Figure 2.1-5 are based on house counting from February 1964 aerial photographs, and 1970 census data on household occupancy for Hartsville (urban) and Darlington County 53,642 (1970) (rural). The 1970 census of Hartsville yielded 8,017 people as compared to 6,302 (1960 census) and 5,658 (1950 census). Population projections for the years 1976 and 1986 were derived from a study of past trends and probable future industrial, commercial, residential and recreational development performed by Southern Bell Telephone Company in the areas they serve. Hartsville and its immediate environs are expected to reach 25,000 during the 40-year lifetime of H. B. Robinson Unit 2. Outside of the Bell Telephone Company's service area, projections were based on data obtained from the South Carolina Development Board which used the Decennial Census data. In every case, the largest estimated projections of county population growth, based on the appropriate decades, were used for the data presented in Figure 2.1-6.

2.1.4 Land Use

Regional Land Use

Darlington County, in which the site is located, and the adjacent counties of Chesterfield, Kershaw and Lee are predominantly rural. Agriculture accounts for approximately 40-73 percent of the total county acreage with individual farms ranging in average size from 100 to 175 acres. Principal crops are cotton, tobacco, soybeans, sweet potatoes, oats, watermelons, peaches, corn, wheat and peanuts. Agricultural receipts in the four-county area amounted to about $40,000,000 in 1961 and 1962 according to the South Carolina Crop Reporting Service of the U. S. Department of Agriculture.

One third of the workers in the four-county area were engaged in manufacturing operations; about one quarter were occupied in agriculture; about one quarter in the retail and service industry with the remainder in all other occupations. Lee County varied from this generalization in that about half of their workers were in agriculture and about one sixth in manufacturing.

Typical industries within an eighteen-mile radius of the site are listed in Table 2.1-1.

Local Land Use

The region within a radius of five miles of the site is devoted primarily to agriculture. Within one-half mile of the site, 25 homes are occupied, with the nearest residence about 1,400 feet south of the plant. North of the site, Chesterfield county has truck farming with some soybeans, butterbeans, and tomatoes grown. About 3,000 acres of watermelons are currently grown in the Sand Hills State Forest 4.2 miles to the north of the plant. The nearest dairy farms, presently in operation, are 7 miles to the east and 9 miles to the southwest of the site.

A spur track of the Seaboard Coast Line Railroad branches off the main line from McBee to Hartsville and passes 1,600 feet west of the site and connects with another main line of the railroad in Florence, South Carolina. Coal for H. B. Robinson Unit No. 1 is delivered over this spur on the average of three trains per week. There is no passenger traffic on this spur track.

The activities on the site will include those normally associated with the operation of conventional and nuclear power units. There are no residences or agricultural activities inside the 1,400-foot exclusion distance.

A modern, attractive Information Center is located on the site. The Center, which is open to the public free of charge, contains numerous exhibits and displays on nuclear energy and the production of electricity, including a large-scale model of the Robinson Nuclear Plant. Film and slide presentations are presented to regularly scheduled groups, and a picnic area is available adjacent to the Center. The Center is a modern, architecturally pleasing structure, built of brick and wood, and contains a 100-seat auditorium for presenting programs to large groups.

Recreational Land Use

Hartsville, five miles ESE of the site, is bordered on the north by Prestwood Lake, a small industrial impoundment downstream of Lake Robinson. Prestwood Lake was built on Black Creek to serve the Sonoco Products Company, which manufactures various paper products. The lake is also used for fishing, boating, and swimming.

The creation of 2250-acre Lake Robinson some ten years ago created a large recreational attraction for the residents of surrounding areas. A variety of water-based activities which were very limited, if not nonexistent prior to creation of the lake, are available to the public and large numbers of people have taken advantage of the opportunities for boating, swimming, water skiing, and fishing. Since the impoundment of Black Creek to form the lake, a bass-bluegill fishery has developed. As with the Information Center, all recreational use of Lake Robinson is open to the public free of charge. Because of the easy access to the lake, and its attractiveness as a center for water sports it is expected that residents of Hartsville and the surrounding area will continue to take advantage of Lake Robinson's recreational value.

2.1.5 Meteorology

The climate in the Lake Robinson area is relatively temperate with the Appalachian Mountain chain some 150 miles to the northwest frequently acting as a buffer for winter storms. Summers are hot and humid with temperatures in excess of 100°F occurring during a few days. Winters usually are mild with a few cold waves during which the temperature drops below 20°F. The annual precipitation cycle has a mid-summer maximum and a fall minimum. A secondary maximum occurs in late winter and early spring and a secondary minimum occurs in late spring. Thunderstorms and tropical storms account for most of the summer rains. Maximum recorded rainfall in 24 hours was 6.36 inches during a tropical storm in October 1954. Snow flurries occur, but snow accumulation is rare; however, sleet or freezing rain does occur at least once each winter.

Rainfall records collected from 1929 through 1966 indicate that the average yearly rainfall is 46.65 in. per year. A maximum yearly rainfall of 60.71 in. was recorded in 1937 and a minimum of 31.64 in. in 1951. A maximum monthly rainfall of 19.28 in. was recorded in September 1945 and a minimum of 0.00 in. in October 1944.

Extreme mile winds (defined as a one mile passage of wind with the highest speed for a day) are 47 mph with a probability of 0.50 per year (a recurrence interval of once in two years); a fifty-year recurrence interval is associated with an 80 mph wind (a probability of 0.02 per year); a 100-year recurrence interval is associated with an 85 mph wind (a probability of 0.01 per year).

The probability of a tornado striking any given point within the one-degree square which includes the site is .000582, or one tornado every 1,708 years. During the 52-year period from 1916 through May 23, 1968, twenty-three tornadoes were reported within 30 miles of the site, but only one was reported within five miles. This tornado occurred on April 12, 1961 at 5:10 p.m. with a 40-yard track width and one-half mile length, and resulted in one death. Property damage was estimated to be between $5,000 and $50,000.

Since 1871 five hurricanes have passed within 25 miles of the plant site. They occurred on October 3, 1877, September 12, 1878, October 12, 1885, July 1, 1886, and September 29, 1896. No other storms have been recorded in the site region with wind speeds of hurricane intensity (74 mph).

The distribution of wind direction at the site is somewhat bimodal with prevailing wind direction from the northeast quadrant (Figure 2.1-7). Winds are from the north 11.4 percent of the time and from the north-northeast 10.3 percent of the time. A secondary maximum frequency of wind direction is from the southeast quadrant. Winds are from the south-southwest 8.1 percent of the time and from the southwest 8.5 percent of the time. The high percentage of north and northeasterly winds may be a result of the effect of Lake Robinson on local meteorology. Average wind speed is approximately 5.8 miles per hour. Low wind speeds ($\leq$ 3 mph) occurred in each season of the year; however, the frequency of low wind speed conditions increased during the winter. Low wind speeds occurred 3.67 percent of the time.

Persistences of winds at the site for the one-year period of record are characterized in Figure 2.1-8. Wind persistence exhibits a bimodal distribution similar to wind directions. The most persistent winds were of 19 hours duration from the north-northeast under neutral and slightly stable atmospheric conditions. Winds from the south-southwest persisted for 18 hours under slightly unstable and neutral conditions.

An assessment of atmospheric stability at the site was made based on data collected in Florence, South Carolina, and on data collected at the site. These data were analyzed according to methods described by Holland and Slade. Hourly surface observations from both Florence and on-site stations were analyzed for seasonal stability, dispersion (X/Q) calculations and persistence.

Analysis of data collected at the site indicated that slightly stable or stable conditions exist 31.2 percent of the time, neutral conditions exist 36.4 percent of the time, and unstable conditions exist 32.4 percent of the time. Stability occurrences are fairly uniform throughout the year, with slightly higher frequencies of stable conditions during the winter. This is consistent with the higher frequencies of low wind speeds which also reach peak values during the winter.

An estimate of the atmospheric diffusion on an annual basis was obtained from frequency of occurrence of wind speeds and directions and concurrent stability conditions. The average X/Q distribution was calculated using a computer code, WINDVANE, developed by NUS Corporation.

Site meteorology was reviewed by the U. S. Atomic Energy Commission and its meteorological consultants. Data from the site was accepted as representative of the site area.

2.1.6 Geology

The Robinson plant is located in the Coastal Plain physiographic province approximately 15 miles southeast of the Piedmont province. As shown on Figure 2.1-9, the site lies in the northcentral portion of South Carolina, adjacent to the Orangeburg Scarp. The Orangeburg Scarp is a dividing line between the upper and lower coastal plain. The site is situated in recent alluvial soils, underlain by late Cretaceous sediments, underlain in turn by pre-Cambrian crystalline rock.

The major structural features of the region include Triassic grabens (down-faulted basins) and the Cape Fear Arch, a basement ridge which trends southeastward from the Fall Line to the Atlantic Coast just northeast of the North Carolina-South Carolina Boundary. The Cape Fear Arch has caused the overlying Coastal Plain sediments to dip away from its structure, thereby modifying the normal regional dips on its flanks.

It should be noted that the site has been extensively reviewed by the U. S. Geological Survey and the U. S. Coast and Geodetic Survey (seismology group) who found it to be geologically and seismologically acceptable for a nuclear power plant. The site also complies with the USAEC seismic design criteria.

The test boring program, refraction surveys, and laboratory tests, when combined, present the following picture of the subsurface and geologic site conditions:

The Piedmont crystalline basement rock at the site is overlain with approximately 460 feet of unconsolidated coastal plain sediment. These sediments are comprised of about 30 feet of surface alluvium over 430 feet of the Tuscaloosa formations. The Tuscaloosa formation consists of light-colored feldspathic and slightly micaceous quartz and interbedded with red, purple, gray and brown silty and sandy clay. The alluvium and portions of the Tuscaloosa formation occurring near the surface exhibit lenses of compressible material; and for this reason, piles were selected for the support of all major structures.

The subsurface materials encountered in the test borings drilled at the site are completely consistent with recent alluvium and Tuscaloosa formations encountered throughout the vicinity. Discontinuities within the strata are sedimentary, and no structural deformation is apparent in the Tuscaloosa formation in the site area. The Tuscaloosa is about 400 feet thick and overlies an eroded slightly sloping surface of Piedmont crystallines. The Piedmont may be somewhat weathered near the surface.

Triassic basins are known in the area; however, it is believed that the likelihood of a Triassic basin at the site is quite small. The basement rock at the site is the Piedmont and is considered to be crystalline since the results of the seismic surveys indicate a high velocity material at a depth consistent with the depth of Piedmont crystallines encountered in wells in the area. Figure 2.1-10 is a graphic presentation of the subsurface materials.

In general, the upper alluvial sands and gravels are moderately compact. Layers of compressible material occur in the upper 30 to 50 feet. Because of the quantity of fines in the sand and gravel, it could not be considered free-draining material. The underlying Tuscaloosa contains generally compact relatively incompressible sands and firm to hard clayey soils. Several strata of cemented sandstone were encountered in the borings at depths of roughly 90 to 100 feet.

From a geological standpoint, the Tuscaloosa is considered to be an unconsolidated sediment. From an engineering point of view, however, the materials are firm and compact and provide good foundation support for the construction. The materials range in texture from a hard or compact soil to a soft rock.

2.1.7 Seismology

A study of the possibility of the existence of faults was made during the geologic study of the area. No active faulting was apparent.

No faulting is apparent in the unconsolidated sediments of the Coastal Plain. The underlying basement rocks are effectively masked by more than 400 feet of sediments at the site and cannot be directly observed below the Fall Zone. However, faulting in the basement complex is known from exposures above the Fall Zone and cores from scattered borings drilled through the Coastal Plain sediments.

Faulting of the Triassic Period is evident along the edge of the Deep River Basin, which extends from the vicinity of Durham, North Carolina, into South Carolina near Chesterfield. The precise location of the fault border near Chesterfield is unknown because of the cover of Coastal Plain sediments.

Other Triassic basins are known to exist below the Coastal Plain. Deep borings at the Savannah River Nuclear Facility near Barnwell, South Carolina, and in Florence, South Carolina, have penetrated Triassic rocks.

Suspected Triassic rocks have been encountered below Summerville and Sumter. A magnetometer survey inferred a basin below Florence and Dillon, paralleling the trend of the Deep River Basin. Triassic basins in this area are down-faulted grabens and, therefore, bounded by faults.

Another major fault in the region is the Blue Ridge Scarp. This scarp forms the Southeastern boundary of the Appalachian Province. However, it is more than 120 miles to the northwest and not likely to significantly affect the site.

A definite alignment of earthquake epicenters can be seen parallel to the Blue Ridge Scarp in the mountains of western North Carolina. The Charleston earthquakes may have been associated with a Triassic graben below the Summerville area, and the smaller earthquake of 1959, near McBee, may be associated with faulting along the Deep River Basin.

Most shocks with an intensity greater than V in the region have manifested themselves in a narrow zone in the Applachian Province paralleling the Blue Ridge Scarp. Figure 2.1-11 indicates all earthquakes in the region with a Modified Mercalli Intensity of V or greater. Many other smaller earthquakes have been experienced in the Carolinas, but poor records and lack of damage gives them little significance in this study.

The largest earthquake in this region occurred at Charleston in August, 1886. Charleston is approximately 120 miles south of the site. This shock had an intensity of about Modified Mercalli IX at the epicenter and it is estimated that this shock had a magnitude of 6-1/2 to 7 at the site with epicentral acceleration of 0.25g to 0.30g. However, damage was confined to a relatively small area and no permanent scars remain to give testimony to the shock. Aftershocks of the main earthquake had intensities ranging up to Modified Mercalli VII.

Another shock (Modified Mercalli VII) occurred in the Charleston area in 1912. Succeeding shocks from 1914 to the present appear to have decreased in intensity and in the affected area. The last shock in 1960 (Modified Mercalli V) was felt over only 3500 square miles.

An earthquake of Intensity Modified Mercalli VII-VIII occurred in Union County, South Carolina, on New Year's Day in 1913. This is the second largest shock in the Carolinas, and its epicenter lies about 90 miles from the site.

In 1959, an earthquake of Intensity Modified Mercalli V-VI occurred about 15 miles from the site in the vicinity of McBee. No permanent effects of this shock are noted in the literature or in a geologic reconnaissance, although it is presumed to have been felt at the site. It is estimated that this shock had a magnitude no greater than 4.5 at the site with an epicentral acceleration of well under 0.10g.

Except for the aforementioned trend of epicenters paralleling the Blue Ridge, there is no apparent trend of other epicenters in the region. Most of the smaller historical shocks were reported in scattered population centers. The seismicity of the region is generally moderate. Of those shocks that do occur, only two earthquakes with epicenters outside of the Charleston area have had intensities exceeding VI.

The only earthquake to occur in South Carolina in 1966-1967 was in Orangeburg County at 0504 on October 23, 1967. The intensity was judged to be about IV at Ridgeville and Summerville.

Only one earthquake of intensity V or greater has ever been recorded within 50 miles of the site. This was the shock which occurred near McBee in 1959. The epicenters of two other shocks are located within 100 miles of the site. The epicenter of the 1913 earthquake in Union County (Modified Mercalli VII-VIII) was approximately 90 miles from the site and the epicenter of the 1945 Lake Murray shock (Modified Mercalli VI) was approximately 70 miles distant. Damage was slight in both epicentral areas and nonexistent at the site.

While the aforementioned shocks were probably felt in the locality of the site, no damaging effects were experienced. The amplitude of ground motion at the site would not cause damage to any reasonably well-built structure. In addition this site is located in Zone 1 of the Uniform Building Codes' Map & Equal Seismic Probability. Zone 1 is characterized as a zone of light earthquake activity which would result in minor damage. Therefore, on a historical basis, it would appear that the site will not experience damaging earthquake motion during the life of the planned facilities.

The sediments underlying the site are quite thick and undisturbed. The surface of the buried crystallines is an ancient eroded one, and active faults are unknown in the vicinity of the site.

On the basis of historical data, it is expected that the site area could experience a shock in the order of the 1959 McBee shock once during the life of the plant. This shock could be as far distant as in 1959 or perhaps closer. On a conservative basis, magnitude 4.5 earthquake was selected with an epicentral distance of less than ten miles. This earthquake is the design earthquake and although the probable ground acceleration would be 0.07 to 0.09g, a value of 0.1g was used.

To provide an adequate margin of safety, a maximum earthquake ground acceleration of 0.2g was selected for the hypothetical earthquake. It is important to note that even if an earthquake comparable to the Charleston shock were to occur 35 miles from the site, the ground acceleration would not exceed 0.2g.

2.1.8 Hydrology

Surface Water Hydrology

A principal feature of the site is Lake Robinson, developed in the late 1950's as a cooling water reservoir for the Robinson Plant. The lake is impounded by an earth dam on Black Creek approximately 5 miles northwest of Hartsville, South Carolina. Black Creek is a tributary of the Pee Dee River and has its headwaters in the vicinity of Pageland, S. C. The creek flows in a southeasterly direction to its confluence with the Pee Dee River, approximately 8 miles upstream of Peedee, S. C. At the Lake Robinson dam, the creek drains a watershed of 173 square miles. A smaller impoundment of approximately 250 surface acres lies ESE of the site near Hartsville. The impoundment, known as Prestwood Lake, is also located on Black Creek and was constructed in 1895. The lake is utilized by Sonoco Products Company as an integral part of their industrial complex, which is located adjacent to the lake.

The regional watershed is typified by low relief and meandering streams. Runoff in the Black Creek basin, while slightly greater than that of the Pee Dee River basin, is typical of other watersheds in the Coastal Plains.

Inflow to Lake Robinson has been monitored and recorded continuously by the U. S. Geological Survey since October 1959, at a gaging station 5.3 miles northeast of McBee, S. C. Records of flow for the October 1959-September 1969 period are tabulated in Table 2.1-2.

The stream flow record of Black Creek at McBee has been extended to 35 years by using the records of the Lynches River at Effingham, S. C., to estimate the mean monthly discharges in Black Creek for the period October 1929 to September 1959. The Lynches River is located in the valley immediately west of the Black Creek watershed. Rainfall, topography and soil conditions within the two basins are comparable. Total inflow to Lake Robinson during this period has been calculated from the estimated McBee flows using the correlation between flow at McBee and total lake inflow, which also have been developed for the period of record. From this analysis, the calculated average and minimum monthly inflows into Lake Robinson are 169 and 21 cfs, respectively.

During the 10-year period of stream flow record of Black Creek at McBee, the maximum peak flow occurred on October 18, 1964, and on June 18, 1969, and had an instantaneous peak discharge of 1100 cfs. Other maximum instantaneous peak discharges recorded during the period of record were 804 cfs in 1960, 840 cfs in 1961, 906 cfs in 1962, 678 cfs in 1963, 888 cfs in 1965, 670 cfs in 1966, 715 cfs in 1967, and 635 cfs in 1968. The maximum flow of record in the area since 1891 occurred in September 1945.

Based on the computed relationship between peak flows recorded in Black Creek at McBee and in the Lynches River at Bishopville, and on the recorded peak discharge of the September 1945 flood at Bishopville, it is estimated that the peak discharges in Black Creek during this flood were about 3000 cfs at McBee and about 5100 cfs at the site of the Lake Robinson dam. Table 2.1-4 shows estimated and recorded flows in excess of 1700 cfs in Black Creek for the period 1891-1969.

The Lake Robinson dam and spillway are designed to pass a flow of 40,000 cfs at a lake level of 221.67 feet, which is about 8 feet less than the height of the dam and about 3 feet less than the plant grade. To check the capacity of the dam and spillway to handle the maximum peak flow which might conceivably occur during the life of the project, an analysis has been made of the peak flow which would result from the Probable Maximum Precipitation for the area.

A design unit hydrograph for the drainage area above the dam was prepared from the McBee gaging station records and the Probable Maximum Precipitation for the area was taken from charts prepard by the Hydrometeorological Section of the Weather Bureau. The analysis produced a peak flood discharge into the lake of 39,000 cfs, a flow well within the flood capacity of the Lake Robinson dam and spillway.

Ground Water Hydrology

The principal ground water aquifer in the vicinity of the Robinson Plant is the Tuscaloosa formation. This formation consists of feldspathic and slightly micaceous quartz sand interbedded with impure clay and kaolin. The kaolin occurs in lenticular bodies which extend laterally for several square miles and have a maximum thickness of 30 to 40 feet. In some areas, the presence of this kaolin is responsible for a perched water condition in the overlying sands.

At the site, about 30 feet of surface alluvium overlies the Tuscaloosa formation. This formation then extends approximately 430 feet to the crystalline basement rocks.

Ground water occurs in the Tuscaloosa formation under both water table and artesian conditions. Under water table conditions, the water surface is unconfined (under atmospheric pressure) and is free to move in a vertical direction. Under artesian conditions, the water in the aquifer is confined under a relatively impermeable layer of material, and hydrostatic pressure causes the ground water to rise above the bottom of the confining layer when the aquifer is penetrated.

Water in the shallow aquifers is generally unconfined, and since the water table is usually fairly close to the surface, recharge of the shallow aquifers is by direct percolation and seepage of precipitation. In the deeper aquifers, ground water is usually artesian. Recharge to an artesian aquifer is controlled in a large measure by the difference in the head of the water in the artesian aquifer and the head of the water in aquifers above or below.

Recharge to artesian aquifers can take place in out-crop areas, although studies to date indicate that the Tuscaloosa formation receives most of its recharge by leakage from overlying aquifers and actually discharges in the out-crop areas.

The direction of ground water movement is normal to the piezometric contours, and movement occurs from points of higher potential to points of lower potential. Water recharging the aquifer moves down the hydraulic gradient to discharge into the overlying strata in areas where the head is lower or where there are piezometric lows. The discharge is controlled both by water moving toward piezometric lows along rivers and by water moving down the dip, with discharge occurring by upward leakage into the Black Creek valley. Thus, the piezometric low of the Black Creek valley results in a net ground water discharge rather than a net recharge to the Tuscaloosa formation aquifer.

Data collected by the U. S. Geological Survey indicate that the static head of ground water in the Tuscaloosa formation is about 330 feet above mean sea level at Bethune, South Carolina, and that the gradient in the area is approximately 2.9 feet per mile. The plant site is about 10 miles down the dip of the formation from Bethune; therefore, the static head of the ground water underlying the site should be approximately 300 feet above mean sea level, or about 80 feet above the normal level of Lake Robinson. This situation indicates that there is little if any recharge to the Tuscaloosa formation aquifer from the ground surface at the plant site.

The Tuscaloosa is a permeable formation, and in several areas of the coastal plain, individual wells yield up to 2000 gpm. Wells in the site area that have been developed in this formation are usually artesian. Potable water usage from ground water in the areas around the site is obtained primarily from artesian wells; and all of the domestic water used in the vicinity of the plant is artesian in origin. Table 2.1-5 shows the municipal and industrial ground water usage within a 20-mile radius of Lake Robinson.

TABLE 2.1-1

TYPICAL INDUSTRIES IN REGION

Company	Product	Town and Location
		CHESTERFIELD COUNTY
Catarrh Feed Mill	Animal Feed	Angelus, 17 miles NW
W.A. Clark Gin & Fertilizer Co.	Fertilizer Mixing	Angelus, 17 miles NW
Mar Mac Manufacturing Company	Fabricated Structural Metal Products	McBee, 7 miles NW
McBee Chip & Machine Company	Wood Chips	McBee, 7 miles NW
Tenner Bros., Inc.	Wine	Patrick, 15 miles NNE
MAFCO Textured Fibers	Textile Fibers	McBee, 7 miles NW
		DARLINGTON COUNTY
American Can Company Dixie Cup Division	Paper Cups, Containers and Lids	Darlington, 17 miles WSW
Asphalt Products, Inc.	Asphalt	Darlington, 17 miles WSW
Bonnoitt's Mill, Inc.	Meal, Grits and Animal Feed	Darlington, 17 miles WSW
City Ice & Fuel Co.	Ice	Darlington, 17 miles WSW
Coca Cola Bottling Company	Soft Drinks	Darlington, 17 miles WSW
Darlington Construction Co.	Ready Mixed Concrete	Darlington, 17 miles WSW
Darlington Monument Works	Monuments and Concrete Products	Darlington, 17 miles WSW
Darlington Roller Mills	Flour and Animal Feeds	Darlington, 17 miles WSW
Darlington Veneer Co.	Veneer Products	Darlington, 17 miles WSW
Diamond Hill Plywood Co.	Plywood	Darlington, 17 miles WSW
General Instruments	Capacitors, Electrical Products	Darlington, 17 miles WSW
Hunt Food - Southern Cotton Oil Division	Cottonseed Oil	Darlington, 17 miles WSW
Modern Print Shop	Commercial Job Printing	Darlington, 17 miles WSW
News & Press, Inc.	Newspapers	Darlington, 17 miles WSW
Perfection Gear Co.	Gears, Gearhouse Assemblies	Darlington, 17 miles WSW
Sherman Manufacturing Co.	Ladies' House Dresses	Darlington, 17 miles WSW
Boyd Vault Co.	Concrete Burial Vaults	Hartsville, 5 miles WSW
Carolina Refractories Co.	Plastic Fire Brick	Hartsville, 5 miles WSW

TABLE 2.1-1 (Continued)

Company	Product	Town and Location
		DARLINGTON COUNTY (Cont.)
Carolina Colonial Corporation	Bearings	Hartsville, 5 miles WSW
Hartsville Mills	Textile Fibers, Cotton	Hartsville, 5 miles WSW
Hartsville Chemical Co.	Agricultural Pesticides	Hartsville, 5 miles WSW
Hartsville Machine Shop	General Machine Shop	Hartsville, 5 miles WSW
Hartsville Manufacturing Co.	Dresses	Hartsville, 5 miles WSW
Hartsville Oil Mill	Cottonseed Oil, Meal, Shortening	Hartsville, 5 miles WSW
Hartsville Poultry Co.	Poultry Processing	Hartsville, 5 miles WSW
Hartsville Publishing Co.	Newspapers, Job Printing	Hartsville, 5 miles WSW
Hartsville Woodcraft	Public Buildings Furniture	Hartsville, 5 miles WSW
Hucks Bakers	Bakery Products	Hartsville, 5 miles WSW
Hughes Roof & Sheet Metal Co.	Sheet Metal Products	Hartsville, 5 miles WSW
International Minerals & Chemical Corp.	Fertilizer	Hartsville, 5 miles WSW
Moores Heat & Sheet Metal Co.	Sheet Metal Products	Hartsville, 5 miles WSW
Pacolet Industries	Broadcloth and Oxford	Hartsville, 5 miles WSW
Pee Dee Hatchery	Poultry Processing	Hartsville, 5 miles WSW
Porter's Service Press	Commercial Job Printing	Hartsville, 5 miles WSW
Sonoco Products Co.	Paper Tubes, Fiber Pipe, Paper Drums, Cones, Formic Acid and Miscellaneous Chemicals	Hartsville, 5 miles WSW
Texlin Co.	Linen Yarns	Hartsville, 5 miles WSW
Lamar Knitting Mills	Hosiery	Lamar, 17 miles S
Klopman Mills, Inc.	Textile Printing & Dyeing	Society Hill, 18 miles NNE
American Manufacturing Co.	Ladies Garments	Lamar, 17 miles S
Maynard Lumber Co.	Furniture & Wood	Society Hill, 18 miles NNE
Rock Hill Concrete Co.	Ready Mix Concrete	Hartsville, 5 miles WSW
Triple City Iron Works	Steel Fabrication	Hartsville, 5 miles WSW

TABLE 2.1-2

BLACK CREEK FLOW NEAR McBEE, S. C. *
(CFS)

	1959-1960	1960-1961	1961-1962	1962-1963	1963-1964	1964-1965	1965-1966	1966-1967	1967-1968	1968-1969
Oct.	353	133	81	56.9	59.9	347	146	73.5	71.2	124
Nov.	225	118	117	153	121	195	164	71.9	100	166
Dec.	191	134	167	119	187	242	131	96.4	166	137
Jan.	251	149	219	217	300	207	200	149	256	158
Feb.	411	272	225	214	297	306	227	164	140	273
Mar.	318	264	285	237	340	342	262	127	144	271
Apr.	338	286	200	135	246	256	165	75.5	97.7	261
May	188	228	74.3	115	127	128	172	90.5	73.8	165
June	134	200	108	114	110	181	79.9	45.3	71.5	272
July	150	151	66.4	81.4	195	204	49.4	62.1	132	201
Aug.	512	203	55.2	68.9	168	264	63.2	191	47.4	244
Sept.	142	140	80.8	68.5	210	138	68.5	128	26.7	216
Max. Daily	734 (4/7)	750 (2/26)	846 (3/13)	651 (1/22)	770 (3/18)	1020 (10/18)	560 (3/6)	630 (8/26)	615 (1/13)	1,010 (6/18)
Max. Instant	804 (4/7)	840 (2/26)	906 (3/13)	678 (1/22)	1070 (3/17)	1100 (10/18)	670 (3/6)	715 (8/26)	640 (1/13)	1,100 (6/18)
Min. Daily	91 (7/23)	72 (9/30)	26 (9/4)	26 (8/20)	39 (10/15)	68 (5/7)	31 (8/3)	24 (6/20)	22 (9/25)	22 (10/3)
Min. Instant	88 (7/23)	72 (9/30)	26 (9/4)	24 (8/20)	38 (10/22)	65 (5/8)	30 (8/3)	23 (6/21)	21 (9/25)	21 (10/3)
Mean Daily	237	189	139	131	197	234	144	106	111	207

* Water Resources Data For South Carolina, U. S. Geological Survey

TABLE 2.1-3

BLACK CREEK FLOW NEAR HARTSVILLE, S. C.*
(CFS)

	1960-1961	1961-1962	1962-1963	1963-1964	1964-1965	1965-66	1966-1967	1967-1968	1968-1969
Oct.	198	152	126	118	458	213	137	139	180
Nov.	164	181	214	172	255	222	143	166	201
Dec.	191	251	174	253	316	197	156	253	191
Jan.	222	302	317	417	281	283	257	358	234
Feb.	342	319	299	403	396	304	258	218	362
Mar.	375	389	320	457	473	349	197	218	413
Apr.	404	281	197	330	349	231	128	166	301
May	308	148	169	194	208	260	153	128	214
June	288	166	167	161	271	152	105	130	308
July	229	138	150	276	268	113	132	192	218
Aug.	274	125	123	247	356	117	269	109	328
Sep.	222	151	127	275	212	121	212	79.7	231
Max. Daily	817 (2/26)	830 (3/14)	850 (1/21)	878 (3/18)	906 (10/19)	626 (3/7)	668 (8/26)	692 (1/12)	658 (6/25)
Max. Instant	1060 (2/25)	860 (3/14)	950 (1/22)	896 (3/18)	924 (10/19)	668 (3/7)	692 (8/26)	760 (1/12)	792 (6/24)
Min. Daily	143 (11/12)	101 (9/5)	105 (8/18)	96 (10/24)	136 (6/7)	80 (9/17)	76 (6/21)	64 (8/31)	82 (10/4)
Min. Instant	143 (11/12)	98 (9/14)	103 (8/19)	94 (11/1)	134 (6/7)	79 (9/15)	70 (6/21)	64 (8/31)	66 (10/7)
Mean Daily	267	216	198	275	320	213	179	180	264

* Water Resources Data For South Carolina, U. S. Geological Survey

TABLE 2.1-4

ESTIMATED BLACK CREEK PEAK FLOWS IN EXCESS OF 1700 CFS (1891-1964)

Month & Year	Estimated Peak Flows in CFS
9/1893	1800
8/1894	2200
10/1894	2000
1/1895	1900
2/1899	2300
4/1900	2100
6/1901	2300
2/1903	2100
8/1908	3700
2/1912	2000
7/1916	3000
2/1921	2000
3/1922	2400
1/1925	2300
9/1928	3200
9/1928	3600
10/1929*	3200
4/1936*	2900
3/1939*	2400
3/1944**	2200
9/1945**	5100
12/1948**	1900
9/1953**	2600

Flow peaks are based on gage heights in Lynches River at Effingham recorded by the U. S. Weather Bureau, except as noted below:

*Based on flows in Lynches River at Effingham as recorded by the U. S. Geological Survey.

**Based on flows in Lynches River at Bishopville as recorded by the U. S. Geological Survey.

TABLE 2.1-5

MUNICIPAL AND INDUSTRIAL GROUND WATER USAGE
WITHIN 20-MILE RADIUS FROM LAKE ROBINSON

Location & No. of Wells		Depth Feet	Total Yield Gpm
McBee	3	188-190	65
Society Hill	3	157-360	305
Darlington	5	305-570	2,655
Hartsville	10	155-460	4,000+
Lamar	1	285	Unknown
Bishopville	2	200	350+
Darlington County	7	155-220	900+

2.2 GENERAL PLANT DESCRIPTION

2.2.1 Introduction

The H. B. Robinson Unit No. 2 reactor is a pressurized light water moderated and cooled system. The unit is designed to produce initially 2200 MWt, and 739 MWe of gross electrical power. The unit is expected to be capable of an ultimate output of 2300 MWt. All steam and power conversion equipment, including the turbine generator, is designed to permit generation of 769 MW of gross electrical power.

The nuclear power plant incorporates a closed-cycle pressurized water Nuclear Steam Supply System and a Turbine-Generator System utilizing dry and saturated steam. Equipment includes systems for the processing of radioactive wastes, handling of fuel, electrical distribution, cooling, and all other on-site facilities and structures required to provide a complete and operable nuclear power plant.

The inherent design of the pressurized water, closed-cycle reactor significantly reduces the quantities of fission products which could be released to the atmosphere. Four barriers exist between the fission product accumulation and the environment. These are the uranium dioxide fuel matrix, the fuel cladding, the reactor vessel and coolant loops, and the reactor containment. The consequences of a breach of the fuel cladding are greatly reduced by the ability of the uranium dioxide lattice to retain fission products. Escape of fission products through a fuel cladding defect would be contained within the pressure vessel, loops and auxiliary systems. Breach of these systems or equipment would release the fission products to the reactor containment where they would be retained. The reactor containment is designed to retain these fission products under the most severe accident conditions.

Several engineered safety features have been incorporated into the reactor containment design to reduce the consequences of a loss of coolant incident. These safety features include a Safety Injection System; an Air Recirculation Cooling System; and a Containment Spray System. The Safety Injection System will automatically deliver cooling water to the reactor core in the event that there is a loss of coolant. The Air Recirculation Cooling System rapidly depressurizes the containment following a loss of coolant, while the Containment Spray System's function is to depressurize the containment and remove elemental iodine from the atmosphere.

2.2.2 Structures

The major structures are a Reactor Containment, Auxiliary Building, Turbine Structure, and Fuel Handling Building. A general plan of the building arrangement is shown on Figure 2.2-1.

Reactor Containment

The reactor containment structure is a reinforced concrete vertical cylinder with pre-stressed steel tendons in the vertical wall, a reinforced concrete hemispherical dome and supported on soil supported steel pipe friction piles. The reactor containment completely encloses the entire reactor and reactor coolant system and ensures that an acceptable upper limit for leakage of radioactive materials to the environment will not be exceeded even if a gross failure of the reactor coolant system were to occur. It also provides adequate radiation shielding for both normal operation and accident conditions.

The reactor containment system provides a highly reliable, essentially leak-tight barrier against the escape of fission products. The containment vessel penetrations are continuously pressurized. Pipes penetrating the containment which could become a potential path for leakage to the environment following a loss of coolant accident are designed with a vertical leg which provides a water seal. In most of these pipes, water always is present to provide a liquid seal at the valve seats. For those where the water seal may not always be present, a redundant automatic system which does not rely on outside electrical power is provided to rapidly inject seal water betwcen the valve seats. The operation of the system can be monitored after the accident and provisions are included for manually replenishing the seal water if required. These provisions minimize leakage to the environment.

Auxiliary Building

The Reactor Auxiliary Building contains such facilities as the emergency diesel generators, boric acid and waste evaporators, residual heat exchangers, the solid waste handling room, and the control room for Units 1 and 2.

Complete supervision of both the reactor and turbine generator is accomplished from the control room. Units 1 and 2 share the control room located as an integral part of the Unit No. 2. The control room for the combined plant is approximately 40' x 40'. The control boards are arranged to give maximum distance between operator areas and preclude interference between them. The annunciators and alarms for the two units are in opposite corners of the room and have different audible tones which make them distinguishable to the operators.

The waste disposal control board is located in the Auxiliary Building, in the vicinity of the boric acid and waste evaporators. This board permits the auxiliary operator to control and monitor the processing of wastes from a central location in the same general area where equipment is located.

Fuel Handling Building

The Fuel Handling Building houses most of the Fuel Handling System including new fuel storage area and spent fuel pool. The building also contains gas decay tanks, hold-up tanks, the "hot" machine shop, and spent fuel cask loading area. The spent fuel storage pit is connected to the reactor cavity by the refueling canal. The refueling canal and spent fuel storage pit are reinforced concrete structures with a seam-welded stainless steel liner.

The reactor is refueled with equipment designed to handle spent fuel under water from the time it leaves the reactor vessel until it is placed in a cask for shipment from the site. Underwater transfer of spent fuel provides an optically transparent radiation shield, as well as a reliable source of coolant for removal of decay heat.

Turbine Structure

The turbine generator is installed on a turbine structure. The turbine is a tandem-compound, 3-element, 1,800 rpm unit having 44-inch exhaust blading in the low pressure elements. Four combination moisture separator-reheater units are employed to dry and superheat the steam between the high and low pressure turbines.

The turbine condensers and steam moisture separators are also located in the turbine structure. The condensers are cooled with water from Lake Robinson. Water is brought in through the intake structure on the lake; and after cooling use, it is delivered to the discharge canal shared with Unit 1.

2.2.3 Reactor

The reactor for the H. B. Robinson Unit 2, furnished by Westinghouse, is of the pressurized water type shown in Figure 2.2-2. The Robinson Nuclear Steam Supply System is similar to a number of pressurized water reactors which have been operating successfully and safely for years and have generated many millions of kilowatt hours of energy in the United States.

The reactor core is a three-region core. The fuel rods are cold worked zircaloy tubes containing slightly enriched uranium dioxide pellets. The core fuel is loaded in three regions with new fuel being introduced into the outer region, moved inward in a checkerboard pattern at successive refuelings and discharged from the inner region to the spent fuel storage.

The uranium dioxide fuel is enclosed in zircaloy tubes with welded end plugs which provide the second barrier against the release of fission products. The uranium dioxide lattice itself acts as the first barrier against the release of fission products.

The control rods consist of groups of individual absorber rods which are held together with a spider at the top end and actuated as a group. The absorber material used in the control rods is silver-indium-cadmium alloy. In addition to normal control, provisions are also made for the rapid simultaneous insertion of all control rods for the rapid shutdown of the reactor.

The reactor core is contained within a reactor pressure vessel, which constitutes the third barrier against the release of fission products.

2.2.4 Reactor Coolant System

The water in the core serves as a moderator to slow down high energy neutrons generated in the fission process, as a neutron reflector, and for cooling the reactor core. The Reactor Coolant System consists of three similar heat transfer loops connected in parallel to the reactor vessel. Each loop contains a circulating pump and a steam generator. The system also includes a pressurizer, pressurizer relief tank, connecting piping, and instrumentation necessary for operational control and protection. The Reactor Coolant System transfers the heat generated in the core to the steam generators where steam is generated to drive the turbine generator.

Coolant enters the reactor vessel through inlet nozzles in a plane just below the vessel flange and above the core. The coolant flows downward through the annular space between the vessel wall and the core barrel into a plenum at the bottom of the vessel where it reverses direction. Approximately ninety-five percent of the total coolant flow is effective for heat removal from the core. The remainder of the flow includes the flow through the rod control cluster guide thimbles, the leakage across the fuel assembly outlet nozzles, and the flow deflected into the head of the vessel for cooling the upper flange. All the coolant is united and mixed in the upper plenum, and the mixed coolant stream then flows out of the vessel through exit nozzles located on the same plane as the inlet nozzles.

The Reactor Coolant System is of primary importance with respect to its safety function in protecting the health and safety of the public.

2.2.5 Reactor Control

The reactor is provided with two independent reactivity control systems, one involving neutron absorbing control rods, and the other a soluble chemical neutron absorber (boric acid) in the reactor coolant. The control rods are grouped into clusters, approximately half of which are fully withdrawn during power operation, serving as shutdown rods to shut the reactor down immediately if necessary. The remaining rods comprise the controlling group which are used to control reactor coolant temperature. The concentration of boric acid in the coolant is varied as necessary during the life of the core to compensate for the more slowly occurring changes in reactivity throughout core life, such as those due to fuel depletion and fission product buildup.

Automatic protection systems are tied to the control systems and involve positioning of control rods and chemical absorber concentration. Procedural controls are also used to assure that established limits are not exceeded in reactor operation. The liquid control system is an independent system from the control rod system.

The reactor's protection system overrides all operational controls and automatically initiates appropriate action. Such action includes shutting down the reactor whenever specific conditions monitored by the system approach established safe limits. All sensor wiring and other equipment associated with the safety system is maintained physically and electrically separate from the control system in accordance with industry standards.

2.2.6 Turbine-Generator

The turbine is a three-element, tandem-compound, four flow exhaust, 1800 RPM unit with 44-inch last row blades, and has moisture separation and live steam reheat between the high pressure (HP) and low pressure (LP) elements. The turbine consists of one double-flow, HP element in tandem with two double-flow, LP elements. Four combination moisture-separator, live-steam reheater assemblies are located alongside the LP turbines.

All of the equipment in the turbine generator systems are designed to produce a maximum calculated gross output of 769,548 KW. The hydrogen inner-cooled generator is rated at 854,090 KVA at 75 psig of hydrogen gas pressure.

The turbine oil system is of a conventional design and consists of three parts: (1) High pressure oil system, (2) lubrication system, (3) electro-hydraulic governing control system. Lube oil is used to seal the generator glands to prevent hydrogen leakage from the machine.

2.2.7 Radwaste System

The H. B. Robinson Unit No. 2 is equipped with a Waste Processing System capable of collecting, storing, and processing radioactive or potentially radioactive wastes (gases, liquids, and solids) for offsite shipment or disposal. The Waste Processing System enables the plant to comply with all regulations for the release of radioactivity to the environment.

Radioactive fluids entering the Waste Processing System are collected in sumps and tanks until determination of subsequent treatment can be made. They are sampled and analyzed to determine the quantity of radioactivity, with a periodic isotopic identification, and then processed.

The system is capable of handling liquid, gas, or solid wastes. Most radioactive liquids are processed and retained inside the plant by the Chemical & Volume Control System recycle train. Processed water from waste disposal is discharged through a monitored line into the circulating water discharge. Gases are held up in decay tanks to allow sufficient decay and then vented under strict control or returned to the Volume Control System. Solid wastes are packaged into 55-gallon drums by a hydraulically operated baler. Most of the components of the Radwaste System are made of stainless or carbon steel. Major components include the waste holdup tank, sump tanks and pumps, spent resin storage tank, gas decay tanks, waste evaporator package, compressors, gas analyzer, waste condensate tanks, chemical and reactor coolant drain tanks, and associated piping and valves.

The system is controlled from a central panel in the auxiliary building, and appropriate alarms and indicators are located in the control room. All system equipment is located in or near the auxiliary building, except for the reactor coolant drain tank and pumps in the reactor containment.

2.2.8 Condensers And Condenser Cooling Water System

The circulating water is supplied from an intake structure located east of the plant on the bank of Lake Robinson. With Unit No. 2 at full load, the cooling water requirement is approximately 482,100 gpm. Approximately 4.3×10^9 Btu/hr. of waste heat is removed from the condenser during normal full load operation and this results in a temperature increase across the condenser of approximately 18°F. After passing through the tube side of the condensers, the cooling water is discharged through a canal on the west side of the plant to a point in the lake about 4.2 miles upstream of the plant.

The intake structure is designed for three vertical one-third capacity circulating water pumps each mounted in a separate pumping bay. Each bay is equipped with trash racks and 3/8-inch mesh traveling screens to remove debris and prevent the passage of fish through the plant condensers. At conditions of maximum flow, the velocity through the intake screens is about 2.1 feet per second.

A chlorination system is provided to control slime and algae growth in the cooling water system and to reduce fouling of the condenser tubes. The cooling water system is normally chlorinated twice daily for periods of about thirty minutes during each cycle. This chlorination is controlled so that free chlorine residuals of about 0.5 ppm are achieved at the condenser outlet.

The surface area at Lake Robinson is approximately 2,250 acres, of which 80% is used for the dissipation of heat absorbed by the water that passes through the plant. The lake is approximately 40 feet deep at the dam and provides storage for about 31,000 acre-ft. of water. The Lake Robinson dam and spillway structure are designed to pass a flow of 40,000 cfs at a lake flood level of 221.67 feet. The dam has a top elevation at 230 feet above mean sea level. The normal water elevation is 220 feet above mean sea level. Tainter gates having a top elevation at 220 feet and Howell Bunger valves at elevations of 178 ft. and 185.5 ft. are provided at the dam for multi-level releases and re-aeration of the releases before they enter the stream below the lake.

2.2.9 Operation of Nuclear Unit

The Robinson Unit No. 2 is a steam generating unit in which a nuclear reactor takes the place of an ordinary steam boiler. The electrical portion of the plant, the turbine-generator, is essentially the same as that employed with a fossil unit, and the product, electricity, is identical.

The heart of the nuclear unit is the Nuclear Steam Supply System, which consists of the reactor, the Reactor Coolant System, and various associated auxiliary systems. The reactor core is contained in the reactor pressure vessel and it is this core that produces the heat necessary for the generation of electricity. In the Robinson No. 2 unit, the core fuel is uranium, enriched in the uranium-235 isotope. Fissioning of the uranium-235 fuel in the reactor core generates heat which is transferred to the reactor coolant. The amount of heat generated is controlled by a coordinated combination of soluble neutron absorbers in the form of borated water and silver-indium-cadmium control rods.

Under full power operating conditions, approximately 2200 MW of heat is produced by fission in the Robinson No. 2 core. This heat is removed from the reactor core by the primary coolant water which circulates through the core under pressure with a sufficient margin to keep the coolant from boiling. From the reactor, the primary coolant water passes through the primary side of the steam generators where the heat is transferred to a secondary water system to produce steam. It is this steam which turns the turbine-generator to produce electricity. After the primary coolant water from the reactor passes through the steam generators, it is returned to the reactor where the process continues. Steam in the secondary loop is converted to water in the condenser as it leaves the turbine. The condensate is collected and is returned as feedwater to the steam generators to go through its cycle again.

The electricity produced by the turbine-generator is stepped up in voltage to 230 KV by transformers in the plant switchyard. From the switchyard, the electricity flows over the CP&L grid to its point of use by the consumer. Various auxiliary plant systems provide the means to supply make-up water for use in both the primary and secondary systems; to adjust the concentrations of chemicals used for corrosion inhibition and reactor control; to purify the reactor coolant water; to remove the residual heat when the reactor is shut down; to sample the primary and secondary coolant water; to process the wastes produced in the plant; and to carry out other functions essential to the operation of the nuclear unit.

Direct operational control of the nuclear unit is exercised by operators who are formally licensed by the USAEC. A minimum of one year's training and the successful completion of written, oral, and physical examinations are required before an operator's license is issued. Reexamination is required at two-year intervals to keep the operator's license current. Supervisory personnel are also required to be licensed as operators.

2.3 PERMITS AND ENVIRONMENTAL APPROVAL

From the inception of the Robinson Unit No. 2, CP&L has worked diligently with numerous federal, state, and local governmental organizations in an effort to assure compatibility of the plant with its environs and to assure that the plant would be capable of operating safely. In addition to the AEC's review of plant design which preceded the issuance of both a construction permit and an operating license, there have been a number of other permit proceedings and reviews concerned with the environmental impact of the plant.

Throughout all of these proceedings, there was an absence of expressed opposition to the then proposed construction and operation of Robinson Unit No. 2. At the public hearing held in Darlington, South Carolina, prior to the issuance of the nuclear facility construction permit by the AEC, there were no requests to intervene, and there were no limited appearances made in opposition to the construction of the facility. Likewise, there were no requests for public hearing in connection with the issuance of the operating license for the facility.

The initial construction and proposed use of Lake Robinson as a cooling facility were authorized and approved by the South Carolina Board of Health and the South Carolina Pollution Control Authority. Two permits were obtained from the South Carolina Board of Health. The first, issued on May 12, 1958, was for construction of Lake Robinson. The second, dated January 26, 1960, was for the impoundment of water in the lake.

Several permits have been issued by the South Carolina Pollution Control Authority in connection with the Robinson Plant. Permit #179, issued May 12, 1958, covered construction of the lake. Permit #217 was issued on May 15, 1961, granting permission to discharge cooling water from the plant into the lake. Since that date, the permit has been revised to modify the release requirements from the lake. This modification is contained in Permit #307 issued June 24, 1964.

In addition to these permits covering the lake and the discharge of heated water into the lake, the South Carolina Pollution Control Authority has issued permits numbered 216 and 1732, dated May 15, 1961, and November 25, 1970, respectively. Permit #216 granted permission to discharge effluent from the plant's sewage treating facility and permit #1732 covers the operation of the liquid waste disposal facilities serving Unit No. 2.

Application has also been made with the U.S. Army Corps of Engineers for a discharge permit for the H. B. Robinson Steam Electric Plant as required under the Corps recent program for implementing the 1899 Refuse Act. The application was filed with the Charleston District Engineer on June 29, 1971. Two copies of this application were also filed with the South Carolina Pollution Control Authority on the same date, along with a request for certification as required under the Water Quality Improvement Act of 1970. Both transmittals have been acknowledged, and instructions on filing Part B of the discharge permit application have been received by the Company. Response on Part B was made by CP&L in a letter dated September 28, 1971. CP&L knows of no other actions that have been taken on these applications at this time.

In the following sections, 2.3.1 to 2.3.5, a brief description is given of each major permit required in connection with the Robinson Plant and of the procedures that were followed in obtaining these permits.

2.3.1 AEC Construction Permit

On July 12, 1966, CP&L, in connection with its proposed construction of the Robinson Unit No. 2, submitted to the AEC a document titled "Preliminary Safety Analysis Report" (PSAR) as required by Title 10, Code of Federal Regulations, Part 50. The PSAR described all areas of the proposed plant design including its design criteria, quality assurance program and site description with regard to meteorology, climatology, geology, seismology, hydrology, topography, and population. Sections of the report described the reactor core, its cooling system, auxiliary system, power conversion system, and electrical transmission system. Other sections of the report were devoted to a description of the plant organization, the plant equipment testing program and a complete analysis of the consequences of numerous postulated abnormal occurrences. Seventy-two copies of the PSAR and all amendments were submitted to the AEC. Copies of the complete filing were also sent to the Mayor of Hartsville and to the Chairman of the Darlington County Commissioners. The AEC distributed copies of the PSAR to various state and federal agencies including the S. C. Pollution Control Authority and the S. C. Board of Health. A notice of the application was published in the Federal Register and the AEC established Document No. 50-261 for Robinson Unit No. 2. Copies of the PSAR and all subsequent documents related to the Robinson Unit No. 2 were made available to the public for inspection and reproduction in the AEC's Public Document Room, 1717 H Street, N.W., Washington, D. C., filed under the appropriate document numbers.

The Division of Reactor Licensing (DRL) conducted an extensive review and served as coordinator for the AEC review of the application. The project was assigned to a branch of DRL and a project reviewer was designated for the project. A portion of the review was conducted by specialists in the Division of Reactor Standards (DRS), a parallel division to DRL. In its review of the application, DRL called on selected outside consultants to assist them in evaluating the plant design features. These outside consultants included:

1. Environmental Science Services Administration, Air Resources Environmental Laboratory. This agency reviewed the climate and meteorological sections of the application.
2. U.S. Army Corps of Engineers, Coastal Engineering Research Center. This agency reviewed the potential storm flooding of the proposed site.
3. U. S. Geological Survey. This agency reviewed the hydrologic and geologic aspects of the proposed plant location.

4. U. S. Coast and Geodetic Survey. This agency reviewed the seismicity of the proposed site.

5. U. S. Fish and Wildlife Service. This agency reviewed the potential ecological effects on the environment of the plant site.

6. U. S. Public Health Service. This agency reviewed the radiological health aspects of the proposed plant.

In addition, various other firms and consultants not associated with the applicant were called upon by DRL to review the application. These consultants reviewed the structural adequacy and various design criteria for the plant.

Following this extensive review, the AEC reported its findings to the Advisory Committee on Reactor Safeguards (ACRS). The ACRS was composed of non-AEC personnel with recognized expertise in various disciplines who examined the entire technical aspects of the application and the AEC's review of the application. A subcommittee was formed and an on-site inspection of the site was made December 13, 1966.

On February 17, 1967, based upon this on-site investigation, and its thorough review of the proposed plant, the ACRS advised the Chairman of the AEC that they believed the plant could be built and operated "without undue risk to the health and safety of the public." The ACRS findings were published, a date was set for a public hearing, and an Atomic Safety and Licensing Board Panel was appointed to conduct the hearing. A waiting period was allowed so that interested parties having objections to the proposed plant could intervene in the proceedings. On March 10, 1967, prior to the scheduled public hearing, a pre-hearing conference was held at Darlington, S. C. The purpose of the pre-hearing conference was to establish the agenda and order of the proceedings and to instruct all potential participants in the hearing. This pre-hearing conference was a public meeting at which all interested parties were invited to participate.

On March 28, 1967, the Atomic Safety and Licensing Board Panel conducted a public hearing at which it examined the adequacy of the AEC review of the proposed project. During the course of the hearing, the public was invited to offer its comments with respect to the construction of the proposed generating unit. All public comments were in support of the project. Following the hearing, construction permit No. CPPR-26 was granted to CP&L on April 13, 1967. Figure 2.3-1 is a flow diagram of the normal processing of an application for an AEC construction permit.

2.3.2 AEC Operating License

The first step in obtaining an operating license for any nuclear facility is the preparation of a Final Safety Analysis Report (FSAR) by the proposed operator of the facility. The Robinson Unit No. 2 FSAR was submitted by CP&L to the AEC on November 26, 1968. The report reflected the final design of Robinson Unit No. 2, the anticipated testing programs, the planned plant organization and the proposed criteria to be followed in operating the unit. Distribution of the FSAR and its review by the AEC and its consultants were handled in substantially the same manner as that followed with respect to the PSAR. Copies of the FSAR were transmitted to the S. C. Board of Health; the Darlington, South Carolina County Commissioners; the Mayor of Hartsville, South Carolina; the AEC Public Documents Room; and those various state and federal agencies with an interest in Robinson Unit No. 2.

Again, DRL served as coordinator of the review, soliciting assistance from such consultants as the Environmental Science Services Administration, the U.S. Army Corps of Engineers, the U. S. Geological Survey, the U. S. Coast and Geodetic Survey and the U. S. Fish & Wildlife Service. Aside from the numerous technical reviews which took place with the AEC Division of Reactor Licensing, Division of Compliance and ACRS during the 20 months after submission of the FSAR, CP&L met with AEC Compliance to discuss the pre-operational and operational environmental surveys, submitted various quarterly reports on the pre-operational environmental surveillance program, received and responded to the comments from the U. S. Fish & Wildlife Service, and met with the S. C. Pollution Control Authority to discuss matters of interest to the state.

On April 10, 1970, the ACRS held its full committee meeting on Robinson Unit No. 2 and on April 16, 1970, transmitted a letter to DRL recommending the issuance of an operating license for the facility. On June 5, 1970, the AEC issued an "Environmental Statement" for Robinson Unit No. 2. The statement covered various environmental effects of the unit including resource commitments, thermal discharges, long-term productivity and other areas of environmental concern. The areas discussed in the AEC's "Environmental Statement" have received further investigation and are included in this report.

A public hearing is not mandatory for an AEC operating license. Upon completion of the AEC and ACRS review, the AEC publishes a notice of intent to license in the Federal Register. Any party desiring a public hearing is allowed 30 days in which to intervene in the proceedings. In the absence of a request for public hearing or permission to intervene, the AEC may issue the operating license upon a finding by its Compliance Division that "the plant is built in accordance with the application."

In the case of Robinson Unit No. 2, notice of DRL's intent to license was published in the Federal Register on May 16, 1970. There were no requests for public hearing or permission to intervene filed, and on July 13, 1970, DRL issued to CP&L a 5 MWt operating license numbered DPR-23. The low power restriction was removed on September 23, 1970, and Robinson Unit No. 2 was authorized by the AEC to operate at power levels not to exceed 2200 MWt. A chronology of the H. B. Robinson Unit No. 2 FSAR review is given in Table 2.3-1. Figure 2.3-2 is a flow diagram of the normal processing of an application for an AEC operating license.

2.3.3 State Waste Water Discharge Permits

The authority to abate, control, and prevent pollution in the State of South Carolina is vested in the Pollution Control Authority. The Authority was originally established within the State Board of Health. On July 1, 1971, it became a separate state agency. The Authority Membership consists of: Director of the South Carolina Water Resources Commission; State Health Officer; Executive Director of S. C. Wildlife Resources Department; Director of the Department of Parks, Recreation, and Tourism; Director of the State Development Board; Executive Director of the State Soil and Water Conservation Commission; one member from each of the congressional districts, and one member appointed by the Governor. The organization powers, and general procedures were established in Code of Law of S. C. 1962, Section 63-195 through 63-195.36.

The Authority is responsible for maintaining reasonable standards of purity of the air and water resources of the state consistent with the public health, safety and welfare of its citizens, maximum employment, the industrial development of the state, the propagation and protection of terrestrial and marine flora and fauna, and the protection of physical property and other resources.

Under South Carolina law, any person desiring to make any new outlet or source, or to increase the quantity of discharge from existing outlets or sources, for the discharge of sewage, industrial wastes or other wastes, or the effluent therefrom, or air contaminants, into the waters or ambient air of the state, shall first make an application to the Authority for a permit to construct and a permit to discharge from such outlet or source. If, after a hearing, the Authority finds that the discharge from such proposed outlet or source will not contravene the standards adopted by the Authority, such permit to construct and such permit to discharge shall be issued to the applicant. The Authority may, if sufficient hydrologic and environmental information is not available to make a determination of the effect of such a discharge, require the person proposing to make such discharge to conduct studies that will enable the Authority to determine that its quality standards will not be violated.

On February 14, 1958, Carolina Power & Light Company requested permission to appear before the March meeting of the South Carolina Pollution Control Authority to present a request to design and construct a dam in South Carolina. An engineering report was submitted along with application for a construction permit to construct a cooling lake. A temporary permit #179 was issued to CP&L for discharges during preliminary operations.

On March 10, 1959, a permit application was submitted for discharging heated water into the cooling lake. This permit #217 was issued on May 15, 1961. This permit was later updated on June 24, 1964, to modify the discharge requirements from the lake.

In October of 1959 an application was made for a permit to discharge effluent from the plant sewage treating system. This permit #216 was granted May 15, 1961.

On November 25, 1970, permit #1732 was issued for the discharge of chemical wastes that are made through the radwaste system serving Robinson Unit No. 2.

Figure 2.3-3 is a flow diagram of the typical procedures in obtaining a permit from the Pollution Control Authority.

2.3.4 S. C. State Permit For The Impoundment of Water

Pursuant to the Code of Law of South Carolina of 1962, Section 32-8, the S. C. State Board of Health in an effort to protect public health and prevent the incidence of insect-born diseases has adopted procedures which require a permit to construct a reservoir and impound water within the reservoir. Application for a lake construction permit is submitted to the Board of Health along with detailed plans and specifications for clearing the area to be impounded.

Particular attention is given to the public health as it may be affected by the impoundment. Considerations include the removal of grass, trees, brush, and other vegetation which could create a nuisance or threat to the public welfare. Consideration also is given to mosquito control measures and protection afforded workmen engaged in constructing the dam and reservoir.

In connection with the proposed construction of Lake Robinson, an application for a lake construction permit was filed with the S. C. State Board of Health in May of 1958. Satisfied that the proposed construction would not create a hazard to public health, the Board issued a construction permit on May 12, 1958.

Throughout construction, the Department of Health periodically inspected the progress of work. These inspections were made in an effort to verify compliance with the permit and determine the adequacy of control measures. On February 24, 1959, a representative of the S. C. Board of Health inspected the construction of the lake to verify compliance with the construction permit. On September 8, 1959, the Board of Health gave permission to CP&L to begin the impoundment of water to an elevation approved by the Board.

On January 26, 1960, after a representative from the State Board of Health had determined that CP&L had complied with the construction provisions of the regulations for impoundment of water, an operating and maintenance permit was issued defining the conditions by which water could be impounded. Since the issuance of that permit, the Board has periodically inspected the impoundment and adjacent area to guarantee that public health is being protected.

Figure 2.3-4 is a flow diagram of the normal procedures for obtaining permits to impound water in South Carolina.

2.3.5 Corps of Engineers' Water Discharge Permit

In accordance with Section 13 of the Rivers and Harbors Appropriation Act of March 3, 1899, and the Refuse Act, an application for a permit to discharge into navigable waters must be submitted to the U. S. Army Corps of Engineers in the district where the discharge is located. As required by the Water Quality Improvement Act of 1970, a copy of the plans and application must be sent to the state agency responsible for water quality in those waters affected by the discharge and to the Environmental Protection Agency (EPA). EPA makes a determination on the application and submits their findings to the District Engineer. The South Carolina Pollution Control Authority coordinates the review between the Corps of Engineers and those state agencies who also forward their comments. In reviewing this application, these agencies consider: conformance with the National Environmental Policy Act, fish and wildlife, water quality, aesthetics and various other factors.

In compliance with the U. S. Army Corps of Engineers' Refuse Act Permit Program, an application for a discharge permit for the H. B. Robinson Steam Electric Plant was filed with the Charleston District of the Corps of Engineers on June 29, 1971. Two copies of this application were filed with the South Carolina Pollution Control Authority on the same date along with a request for certification as required under the Water Quality Improvement Act of 1970. Both transmittals have been acknowledged, and instructions on filing Part B of the discharge permit application have been received by the Company. Response on Part B was made by CP&L in a letter dated September 28, 1971. CP&L knows of no other actions that have been taken on these applications at this time.

Figure 2.3-5 shows the normal processing of an application for the Corps of Engineers' Water Discharge Permit.

TABLE 2.3-1

CHRONOLOGY OF H. B. ROBINSON
UNIT NO. 2 FSAR REVIEW

11/26/68	FSAR Submitted
2/17/69	AEC-DRL Letter requesting information on our medical plans
3/11/69	First Technical Review Meeting with DRL
3/24/69	AEC-DRL Letter Requesting Additional Information
5/15 & 16/69	Second Technical Review Meeting with AEC-DRL
6/20/69	Third Technical Review Meeting with AEC-DRL - Meteorological
6/23,24,25/69	Meeting with AEC Compliance, (AEC-CO) at Site on Pre-operational and Operational Environmental Survey
6/27/69	Submitted 1st Quarterly Report of Pre-operational Environmental Surveillance Program
7/9/69	AEC-DRL Letter - Request Electrical Drawings
7/28/69	AEC-DRL Letter transmitting U. S. Fish & Wildlife Service comments
9/4/69	FSAR Amendment #1 - Responses to 2/17/69 and 3/24/69 Letters
9/10/69	Fourth Technical Review Meeting with AEC-DRL - Electrical Design
9/17/69	AEC-DRL Letter Requesting Additional Information
10/3/69	Meeting with AEC-DRL and AEC-CO at Site on Instrumentation & Control
10/10/69	AEC-DRL Letter requesting information on our Reactor Vessel
10/15/69	Submitted 2nd Quarterly Report on Pre-operational Environmental Surveillance Program
10/16/69	Meeting with AEC-DRL, Blume & Associates at Site on Seismic Design
10/23 & 24/69	Fifth Technical Review Meeting with AEC-DRL - Instrument & Electrical Design
10/27/69	FSAR Amendment #2 - Technical Specifications, Emergency Plan
11/4/69	AEC-DRL Letter - 4 outstanding concerns
11/5/69	AEC-DRL Letter - 2nd set of questions

12/2/69	FSAR Amendment #3 - Answered Questions in 9/17/69 Letter
12/8/69	Submitted Report WCAP-7372-L, December 1969, concerning H_2 Control for H. B. Robinson 2
12/8/69	Submitted "Containment Design Report," August 1969
12/10/69	FSAR Supplement #5 - Responses to 9/17, 11/4, and 11/5/69 letters
12/11/69	AEC-DRL Letter requesting financial information
12/15/69	FSAR Supplement #4 - Responses to 9/12 and 11/4/69 letters
12/17 & 18/69	Sixth Technical Meeting with AEC-DRL - Misc. Items and Organization
12/31/69	AEC-DRL Letter requesting information on Robinson thermal parameters
1/15/70	Meeting with AEC-DRL at site - crew size and organization
1/20/70	Letter to AEC-DRL answering thermal parameters
1/21/70	ACRS Subcommittee Site Inspection
1/23/70	FSAR Amendment #6 - Page Changes and Answers to 11/5/69 letter
1/23/70	First Technical Specifications Review Meeting with AEC-DRL
1/29/70	Seventh Technical Meeting with AEC-DRL - Structural
2/3/70	AEC-DRL Letter - Organization
2/3 & 4/70	Second Technical Specifications Review Meeting with AEC-DRL
2/6/70	FSAR Amendment #7
2/12/70	Meeting with S. C. Pollution Control Authority at Site
2/12 & 13/70	Third Technical Specifications Review Meeting with AEC-DRL
2/17/70	AEC-DRL Site Visit - Electrical
2/18/70	Letter in response to U. S. Fish & Wildlife comments
2/19/70	Fourth Technical Specifications Meeting with AEC-DRL
2/24/70	FSAR Amendment No. 8 - Organization
2/27/70	FSAR Amendment No. 9 - Blow Down #2
2/27/70	Meeting with AEC-DRL - Miscellaneous Items
3/13/70	Meeting with AEC-DRL - Outstanding Issues
3/18/70	FSAR Amendment No. 10 - Miscellaneous Items
3/18/70	Meeting with AEC-DRL on Seismic Analysis
3/24/70	FSAR Amendment No. 11 - Westinghouse Personnel

3/26/70	Second ACRS Subcommittee Meeting
4/3/70	AEC Compliance Letter - Separation of Redundant Cables, Welding Procedures, Records at Plant
4/3/70	Letter to AEC-DRL transmitting CP&L Annual Report
4/6/70	Letter to AEC-DRL Regarding Seismic Analysis
4/10/70	ACRS Full Committee Meeting
4/13/70	AEC-DRL Letter Denying Request to keep Amendment #11 proprietary
4/16/70	ACRS Letter to AEC-DRL
4/17/70	Letter to AEC-DRL confirming containment design report and control of H_2 reports are applicable
4/17/70	Letter to AEC-DRL informing them of Company management changes
4/24/70	AEC-DRL Letter Transmitting ACRS Letter
4/28/70	Letter to AEC-DRL requesting that WCAP Reports remain proprietary
4/28/70	Response to AEC Compliance on their 4/3/70 Letter
5/1/70	Meeting with AEC-DRL on Tendons & Pipe Rupture
5/7/70	AEC Compliance Letter Acknowledging our 4/28/70 letter
5/8/70	FSAR Amendment #12 - Resubmittal of Amendment 11 with names deleted
5/12/70	AEC-DRL Letter acknowledging CP&L request in Amendment #12
5/14/70	AEC-DRL Letter requesting information on tendons
5/14/70	AEC-DRL Letter transmitting notice and draft license
5/16/70	Notice of license in Federal Register
5/20/70	AEC-DRL letter transmitting their public safety evaluation
5/26/70	Submitted 3rd quarterly report on environmental monitoring program
6/5/70	Letter to AEC-DRL transmitting three reports: (1) Tendon, (2) Turbine Overspeed, and (3) Seismic Analysis of Class I Pipe and Equipment
6/5/70	AEC-DRL Letter transmitting environmental statement
7/1/70	Letter to AEC-DRL transmitting supplement to Turbine Overspeed Report
7/1/70	Meeting with AEC-DRL - Turbine Missile
7/3/70	Letter to AEC-DRL transmitting "Steam Pipe Break" report
7/15/70	Meeting with AEC-DRL/CO regarding outstanding items
7/16/70	Letter to AEC-DRL on outstanding items & cable tray

7/20/70	Meeting with AEC Compliance at Site on Containment Air Test
7/23/70	Letter to AEC-DRL submitting containment Integrated Leakage Rate Test Report
7/23/70	Meeting with AEC Compliance at Site on Outstanding Items
7/24/70	Meeting with AEC-DRL/DRS/CO on Containment Test & Outstanding Items
7/28/70	Letter to AEC-DRL transmitting Addendum A to Containment Leakage Rate Test
7/30/70	Telegram to AEC-DRL Regarding Safety Injection Pump Performance
7/31/70	AEC-DRL Letter transmitting 5 MWt Operating License
8/12/70	Letter to AEC-DRL transmitting re-analysis of Safety Injection Pump Performance
8/18/70	Letter to AEC-DRL transmitting Addendum to Seismic Design of Class I Piping and Equipment Report
9/23/70	AEC-DRL Letter transmitting approval to operate at a power level not to exceed 2200 MWt

3.0 ENVIRONMENTAL IMPACT OF THE NUCLEAR FACILITY

3.1 LAND USE COMPATIBILITY

Robinson Unit No. 2 was constructed on a site already dedicated to the generation of electrical power and as such minimized the conflicts with other land uses. Construction at the Robinson site began in 1957 with installation of a 185 MWe fossil unit which was placed in commercial operation in 1960. Development of the site in the late 1950's included construction of the 2250-acre Lake Robinson which provides cooling water for both the No. 1 and No. 2 Units.

In the initial development of the Robinson site, a total plant capacity of 1200 MWe was considered and anticipated. The plant area was cleared and graded for future units and the cooling lake was sized accordingly.

The decision to expand an existing generating site rather than develop a new plant site minimized the effect of this required generating capacity on the environment. Except for the physical erection and resulting visual effect of additional structures in the plant area, the only alteration of the landscape with the construction of Robinson Unit No. 2 was the extension of the cooling water discharge canal from a point approximately 1.2 miles upstream from the plant to a point 4.2 miles upstream. Extension of the canal was along the lake shore and involved land already owned by CP&L. Land clearing affected less than 100 acres of land, most of which was second growth pines. In many of those areas affected by clearing and construction, pine seedlings and various types of grasses have been replanted to control erosion, provide new ground cover for wildlife, and present an aesthetically pleasing landscape.

The construction of Robinson Unit No. 2 did not require the relocation of any people, the construction of any additional cooling facilities, or the relocation of any highways or railroads. Land use characteristics in the vicinity and region of the site with regard to industry, farming, and forestry were not affected.

Figure 1.1-1 shows the Robinson plant. This indicates the compatibility of the nuclear unit with its environs and the absence of significant impact from Unit No. 2 on surrounding land uses.

3.2 WATER USE COMPATIBILITY

The source of cooling water for Robinson Unit No. 2 is Lake Robinson. The lake was constructed in the late 1950's as a cooling facility for a 185 MWe fossil fueled unit placed in operation in May of 1960 and for those future steam generating units anticipated for the plant.

Construction and operation of Robinson Unit No. 2 had little effect on the water use compatibility of Lake Robinson. Lake Robinson has been and will continue to be used for fishing, boating, sailing, and other aquatic sports. There will be an increase in consumptive losses of water as a result of the increased evaporation accompanying the added heat load on the lake. These losses are tabulated in Table 3.2-1. Water is stored in the lake during periods of high inflow, and flow downstream of Lake Robinson is augmented during dry periods by releases of stored water. The result is a more dependable water supply in Black Creek downstream of Lake Robinson.

The biological effects of Unit No. 2 on the aquatic life in Lake Robinson are discussed in Section 3.6. Biological impacts from the operation of Unit No. 2 are not expected to extend beyond the lake.

All the municipal and industrial sources of potable water within a 20-mile radius of the Robinson site are obtained from groundwater sources. Within the vicinity of the plant all domestic water is artesian in origin. With the construction of Unit No. 1, two water wells of approximately 200 gpm each were provided at the Robinson site. These wells furnish water for boiler makeup, and for potable and sanitary uses. The construction of Robinson Unit No. 2 required three new water wells for make-up purposes and for backup in the event safety injection should be required and the service water system not be available for such use. A total of approximately 10,000 gallons per day is taken from three new water wells. This usage coupled with that of the Unit No. 1 has had no effect on the surrounding ground water as evidenced by the continued artesian pressure in the area. A further description of the ground water hydrology at the Robinson site is given in Section 2.1.8.

TABLE 3.2-1

AVERAGE EVAPORATIVE WATER LOSSES FROM LAKE ROBINSON WITH UNITS 1 & 2 IN OPERATION

Month	Natural Evaporation (cfs)	Forced Evaporation (cfs)	Total Evaporation (cfs)
January	3.16	12.04	15.20
February	5.26	13.95	19.21
March	8.51	14.08	22.59
April	12.44	15.99	28.43
May	14.79	16.60	31.39
June	16.41	18.00	34.41
July	16.04	17.63	33.67
August	14.83	17.45	32.28
September	12.03	17.21	29.24
October	7.88	15.12	23.00
November	4.97	13.84	18.81
December	3.06	11.91	14.97
Year Average	9.97	15.32	25.29

3.3 HEAT DISSIPATION

All steam electric generating plants must release heat to the environment as an inevitable consequence of producing useful electricity. Heat from the fission of nuclear fuel in the Robinson No. 2 reactor is used to produce high temperature and pressure steam. This steam is expanded through a turbine where the thermal energy of steam is converted to mechanical energy. This mechanical energy is used to drive the generator which in turn converts the mechanical energy of rotation to electrical energy. The process has a limited efficiency, however, and the steam, after having expanded through the turbine, must be condensed back into water. This is done by extracting the latent heat of condensation from the steam and transferring it to some other fluid. The fluid in this case is the circulating water and the heat transfer is made in the condenser.

For the Robinson Unit No. 2, the circulating water is obtained from Lake Robinson. A total of 1070 cfs is taken from Lake Robinson at the intake structure and passed directly to the condenser. The condenser consists of a large rectangular vessel containing thousands of small tubes through which the circulating water passes. Exhaust steam leaving the turbine flows over and around the outside of these tubes and, in so doing, condenses to water and drops to the bottom of the condenser where it is collected for reuse in the cycle. In the process, the latent heat of condensation of the steam is transferred to the circulating water. Under conditions of full load on the Robinson Unit No. 2, approximately 4.3×10^9 Btu/hr. of heat is transferred to the water, resulting in an approximately $18^{\circ}F$ increase in the water as it passes through the condenser. There is no physical contact between the condensing steam and the circulating water. Furthermore, since the steam side of the condenser operates at a vacuum under normal conditions, the possibility of steam side materials leaking into the circulating water is remote. After passing through the condensers, the heated water is then discharged to a canal which returns the warmed water to the lake at a point 4.2 miles upstream from the plant.

As the water flows through the lake either to be used again in plant condensers or to be released from the lake into the stream below, it cools by losing heat to the atmosphere. The major mechanisms of heat loss are back radiation, evaporation, and conduction. The magnitude of all three mechanisms is dependent upon the temperature of the water surface. Back radiation is proportional to the fourth power of the absolute temperature of the surface. Conduction from the surface is proportional to the difference in water temperature and air temperature. Evaporative heat losses are proportional to the difference in saturation vapor pressure at the water surface temperature and the water vapor pressure in the air.

There are two primary effects of the plant discharge on the lake. One is a general warming over most of the lake surface, and the other is the evaporation of water from the lake. The warming is confined essentially to the upper 10 or 15 feet of water. Below these depths, the water temperature remains near the natural temperature which might be expected in any impounded reservoir. Figures 3.3-1 through 3.3-6 show isotherms for various sectors of the lake.

The evaporative losses which vary from season to season are shown in Table 3.2-1. However, in a broad sense water is never lost. The supply of water circles endlessly from sky to land to ocean and then back to sky again. Water rising from the oceans, lakes, streams, and land accumulates in the atmosphere partly as invisible vapor and partly as tiny condensed droplets. Some of this moisture in the air falls to earth as rain, snow, sleet, or hail. There is a small amount that quickly returns to the ocean as runoff via streams; some feeds vegetation, some seeps into the ground; but most of the water on the earth's surface returns to the atmosphere by evaporation. Within this mechanism the amount of water remains essentially constant.

3.4 CHEMICAL DISCHARGES

In the operation of Robinson Unit No. 2, some chemical wastes are produced in the processing of high quality feedwater and in the operation of certain auxiliary systems. These chemicals include corrosion products such as iron and copper; corrosion inhibitors such as potassium dichromate, hydrazine and sodium phosphate; acids and bases such as boric acid, sulfuric acid and sodium hydroxide; and small quantities of various chemicals used in the plant laboratory. Those chemical wastes that are subject to possible radioactive contamination or toxic concentrations are processed through the radioactive waste treatment system where they are collected, monitored, neutralized or otherwise treated prior to release into the environment. A detailed description of the Radioactive Waste Processing System and its operation is given in Section 3.7.1 and 3.7.2. Those other chemical wastes or chemical uses not subject to radioactive contamination or toxic concentrations are discussed in the following paragraphs.

Sodium hydroxide (NaOH) and sulfuric acid (H_2SO_4) solutions are used to regenerate the make-up water demineralizers. After use, these solutions are collected in a tank where they are neutralized and subsequently discharged into the service water system which conveys them to the lake.

A chlorinating system is utilized to inhibit the growth of slime and algae in the Robinson No. 2 condenser and the circulating water tunnels. This system uses sodium hypochlorite and is normally operated for only two 30-minute cycles per day. Chlorine residuals in the water leaving the condenser are controlled so that concentration does not exceed more than 0.5 ppm. This residual is further dissipated in the discharge canal so that no more than a trace of chlorine is experienced in the lake.

Phosphate is used in the steam generator to control hardness scaling and to prevent corrosion. Blowdown water from the steam generators is either processed through the liquid Radioactive Waste Processing system or discharged from a flash tank to the circulating water system in the absence of radioactive contamination. Because of the extremely small quantities of phosphate that are discharged and because of the natural low levels of phosphate in the lake water supply, this disposal of blowdown water is not expected to have any effect on the environment. To date water samples from Lake Robinson have failed to reveal detectable quantities of phosphate.

In the turbine building and other areas where oil spills and leaks might be reasonably expected, the floor drains discharge to an oil trap and catch basin. There the oil and water are separated. The oil is accumulated and the water is discharged to the environment. Periodically the oil is removed from the trap and used in the fossil-fired Unit No. 1.

The only releases of chemical combustion products to the atmosphere are those associated with two auxiliary boilers which are provided for intermittent duty during startup, shutdown, and during liquid radwaste concentration operations, and from the two diesel generators provided for emergency power. Both the auxiliary boilers and the emergency diesels are fired with No. 2 fuel oil which has a maximum sulfur content of less than 0.1%. To control ground level concentrations of the resulting combustion gases, these gases are vented from stacks set at approximately 56 feet above plant grade in the case of the auxiliary boilers and 33 feet above plant grade in the case of the diesels.

3.5 SANITARY WASTES

The Robinson sewage and sanitary waste treatment system consists of a 3000-gallon per day septic tank, sand filter, and chlorine contact chamber. The wastes are collected and pumped to the septic tank where the solids are allowed to settle and undergo aerobic digestion. The septic tank produces an odorless liquid effluent and a granular sludge which is accumulated in the tank. The sludge is periodically removed for off-site disposal in accordance with state and local regulations. The liquid effluent from the septic tank drains away from the tank through a sand filter, and is collected and chlorinated before being discharged into the condenser cooling water system canal. The removal of solids and reduction in biochemical oxygen demand (BOD) as a result of this treatment is in excess of 90%. Permit No. 216 issued by the South Carolina Pollution Control Authority on May 15, 1961, covers the operation of the sewage and sanitary waste treatment system and the discharge of its effluent into the condenser cooling water system.

3.6 BIOLOGICAL IMPACT

3.6.1 Environmental Effects

3.6.1.1 Biological Effects

Lake Robinson was impounded with the construction of Unit No. 1, a 185 MWe coal-fired unit which went into operation in 1960. Creation of Lake Robinson converted about 2300 acres of second-growth pines, bottomland hardwoods, swamp forest, and peripheral lands into a 31,000 acre-ft. cooling reservoir. As a result of the impoundment and prior to the introduction of the plant heat load, waters in Black Creek from the point of entrance to the lake to the point of discharge to Black Creek downstream of the lake have been increased in temperature and dissolved oxygen (DO). From the stream entering the lake to the stream leaving the lake, the temperature has been increased by about $5^{\circ}F$ and DO has been increased by about one ppm. This temperature increase is due to heat absorbed from solar radiation and the increase in DO is due to aeration of the lake discharge. The black-water stream sport fishery in that stretch of the creek prior to construction of the lake was changed into a bass-bluegill-crappie impoundment fishery. While limited information is available on the fishery resources of Black Creek prior to the lake construction, it is generally known that black-water stream sport fisheries are mediocre. Open waters of the lake provide boating and sailing opportunities, and have enhanced the recreational-residential value of surrounding land.

Impact on Terrestrial Ecosystem

Construction and operation of H. B. Robinson Unit No. 2 has had and will continue to have little effect on the terrestrial ecosystem. The unit was constructed on land already cleared with the installation of Unit No. 1. Extension of the discharge canal toward the upper end of Lake Robinson required approximately 100 additional acres of second-growth pine woodlands which generally are recognized to provide poor habitat for wildlife. Banks of the canal and of the maintenance road, which is located between the discharge canal and the lake have been seeded with several types of grasses and pine seedlings. In all, 187,000 pine seedlings have been planted along the canal and other areas disturbed during the construction of Unit No. 2. While erosion along the maintenance road is moderate to severe in some areas, efforts to stabilize these areas are continuing. Eventually, these areas will be vegetated which will prevent erosion and provide cover for wildlife.

Impact on Aquatic Ecosystem

A Federal Aid anadromous fish stocking project was initiated in 1967 by the S. C. Wildlife Resources Department. The Department stocked Lake Robinson with striped bass-white bass hybrid fry in the following numbers:

Spring 1967	130,000
Spring 1968	200,000
Spring 1969	520,000

Fish populations in Lake Robinson have always been at a relatively low level. Prior to the startup of Unit No. 2, the S. C. Wildlife Resources Department reported that "age and growth studies of the major game species in Lake Robinson indicated relatively poor growth rates" when compared to other impoundments in South Carolina. The low population and growth rate figures are likely due to low natural productivity in the impoundment and not to heat rejected to the water from the generating facilities. These slow growth rates are believed to be due to the low nutrient levels and associated low productivity characteristic of many sandy-bottomed black-water streams and lakes.

Impact of Thermal Discharges

There are several factors which must be considered in a discussion of the effects of thermal discharges on aquatic organisms. These include behavior, growth, development and reproduction of the organisms. Each of these factors is affected by chemicals present in the water, acclimation to the temperature encountered, and many other factors such as the availability of food, pH of the water and dissolved oxygen in the water.

When subjected to uncomfortable temperatures, organisms may respond in one of the following four ways: (1) mobile organisms may leave the area of elevated temperatures; (2) physiological changes in the organism may adjust to the elevated temperature; (3) a protective position or behavior may be assumed such as the development of a dormant state; or (4) the organism may succumb.

The effect of elevated temperatures on a given species of fish is dependent on many factors including the temperature to which the fish has become adjusted prior to being subjected to the elevated temperature. Fish do have some ability to adjust to the physiological changes which occur with increasing water temperatures and, therefore, fish can withstand warmer temperatures if the rate of temperature increase allows the fish sufficient time to acclimate. Should the rate of temperature increase be too rapid to allow sufficient time for acclimation, or if the final temperature is too high, fish have the ability to leave the area of elevated temperature.

Persistent elevated temperatures are suspected of causing behavioral changes by (1) causing stratification of the water column, discouraging vertical movement of organisms; (2) creating thermal barriers to spawning and nursery grounds; (3) producing seasonal change in spawning and development; and (4) altering migration patterns.

Thermal tolerance of an organism depends on its most sensitive and exposed part, which appears to be its soluble protein complexes. The most vulnerable soluble protein complex of the adult is its neuro-endocrine transmitter substances which function outside of cellular membranes and involve its highest level of organization. As shown by Figure 3.6-1, thermal tolerance varies considerably from one life stage to another (Jensen, 1969). Young of a species are less complex than adults and can survive temperatures at which adults succumb. As organisms become more complex, resistance is exchanged for ability to adapt and thermal resistivity decreases. Adults seem to tolerate the greatest rate of temperature change because of their ability to acclimate or compensate behaviorally. In response to maximum temperature, the breeding adult is the most sensitive life stage. Table 3.6-1 indicates "provisional maximum temperatures recommended as compatible with the well being of various species of fish and their associated biota". This is a partial listing only, but it illustrates the limitations of temperatures on various activities of several fish species.

Temperature tolerance limits provide valuable information on the ability of fish to withstand elevated temperatures. There are, however, precautions which must be exercised in interpreting such data. These temperature tolerance limits were obtained, by necessity, through laboratory experiments and the results could be biased by additional stresses associated with capture and handling of the fish from stresses associated with the artificial environment in which the fish are kept for the experiments, and from examining specimens in isolation from interactions with other species.

The difficulties involved in keeping fish in aquaria water are well known to workers in the field (Jensen, 1969). Thermal tolerance tests conducted at the North Carolina State University Pamlico Marine Laboratory on estuarine organisms were complicated by the tremendous expenditure of time and effort in keeping estuarine organisms in artificial environments (Copeland, 1970). Parasites are a problem because of overcrowding and because of other stresses which are not present in the natural environment. Nitrogenous wastes produced during captivity may prove lethal to some or all of the captive organisms, and water that is too pure may create problems.

Temperature tolerance limits (LD-50) for several species of fish and conditions of acclimation are included in Table 3.6-2 and Table 3.6-3. When acclimated to 86°F, the LD-50 of bluegill under laboratory conditions was reported to be 93.2°F when held at the elevated temperature for 60 hours, and 96.9°F when held at the elevated temperature for 24 hours. The LD-50 for large-mouth bass was reported to be 93.2°F if the bass were held at the elevated temperature for 72 hours. Other work (Trembley, 1960) found the LD-50 of bluegill to be 103°F when acclimated to 79°F, and the LD-50 of large-mouth bass to be 100°F to 102°F when acclimated to 80°F and kept at the elevated temperature for 18 hours. Since fish can move freely in Lake Robinson and possess the ability to seek out favorable temperatures, it is not anticipated that they will remain in an area of elevated temperature for a sufficient period of time that water temperature could pose a threat to their survival.

As shown in Table 3.6-4, bluegill prefer temperatures as high as 90.1°F and large-mouth bass prefer temperatures as high as 89.6°F; however, acclimation temperatures were not given. Based on this and other data, it is apparent that a moderate elevation of temperature in Lake Robinson, which is typical of cooling lakes, should not inhibit a viable population of fish in the lake. Of course, factors other than the increase in temperature may inhibit the growth and reproduction of fish in Lake Robinson or any other lake.

There is little information that has been published on the ecology of cooling lakes. Many studies are presently underway and meaningful data should be available for prediction of effects within the next few years.

Experience in Lake Julian, a 365 acre cooling lake near Asheville North Carolina, suggests that a warm water fishery such as that of Lake Robinson can flourish at elevated temperatures. Lake Julian was impounded in 1964 and served a 200 MWe fossil unit until May of 1971 when a second fossil unit of 200 MWe was installed. Prior to the installation of Unit No. 2, water temperature near the discharge reached as high as 104°F during the summer months. With the operation of Unit No. 2, summer water temperature reached 109°F during 1971. Records maintained by the Lake Authority on catches by sports fishermen in the lake indicate that there is a healthy population of fish present in the lake, and only a portion of the fish caught in Lake Julian are recorded by the Lake Authority.

As shown in Figure 3.6-2, operation of both generating units at the Robinson Plant produced surface water temperatures of 90°F or above, over the upstream one-third to one-half of the lake. As shown by Figures 3.6-3 through 3.6-9, this warmer water is present only in the surface layer except in the immediate vicinity of the discharge to the lake. September 1971 thermal cross sections show the 90°F+ water to extend to the lake bottom in the immediate vicinity of the discharge and to extend downstream as a sheet overlying cooler water. In contrast to this condition, thermal cross sections during September 1962 when only Unit No. 1 was in operation (Figures 3.6-10 through 3.6-13) contained no areas of 90°F+. Comparison of lake temperatures from a survey in September 1962 prior to the operation of Unit No. 2 and from a survey in September 1971 with Unit No. 2 in operation shows that Unit No. 2 has had little effect on the temperatures of those waters below the lake surface. Summer conditions may produce slightly warmer water temperatures than those depicted and a larger area of the lake surface may have water temperatures of 90°F or greater; however, the effects on below surface water temperatures should remain small.

The availability of adequate amounts of dissolved oxygen (DO) is necessary to the survival and reproduction of fish. The amount of oxygen that can be dissolved in water decreases as temperature of the water increases. The maximum amount of oxygen that can be dissolved in fresh water at standard atmospheric pressure is given in Figure 3.6-14.

It should be noted that natural waters often do not carry the amount of DO that is theoretically possible. In those cases, an increase in temperature would not decrease the amount of DO present in the water but would only decrease the amount of DO that the water is capable of carrying. In black-water creeks, DO is normally less than saturation.

Another effect of increased temperature on dissolved oxygen levels in water is to increase the biochemical oxygen demand (BOD). Biodegradable organic material in water exerts a demand for oxygen during assimilation of the material. An increase in temperature intensifies the action of micro-organisms responsible for the assimilation. The material is assimilated over a shorter period of time and the amount of oxygen utilized during that time period is greater than the amount that would have been used during the same period at a lower temperature. The net result is a drop in the oxygen content as shown in Figure 3.6-15.

In consideration of the possible effects of temperatures on DO, surveys of the amount of DO present in the waters of Lake Robinson have been undertaken. A survey completed in October, 1971 shows that DO concentrations range from 4.9 to 7.0 milligrams per liter. Based on recent field surveys in other reservoirs (Doudoroff & Shumway, 1970), which have shown that warm water fish can thrive in waters which contain less than 4.0 milligrams per liter, it is concluded that adequate DO is available for a thriving fish population in Lake Robinson.

As stated earlier, Lake Robinson supports a limited bass-bluegill-crappie impoundment fishery with somewhat reduced growth of most species when compared to growth in other South Carolina reservoirs constructed on streams other than black-water creeks. Reduced growth which is typical of sandy bottomed black-water impoundments such as Lake Robinson is believed to be the result of poor nutrient availability. Water chemistry recently performed on samples collected in Lake Robinson support this position. Of course, other factors may be involved in the reduced growth.

During operation of Unit No. 2, the fishery may continue to be mediocre; however, Lake Robinson was designed as a cooling facility to dissipate waste heat to the atmosphere with a minimal impact on the environment and was not designed to maximize the fishery resource. While it is believed that the additional heat load from Unit No. 2 will not significantly affect the existing mediocre impoundment fishery, results from the ecological study must be awaited before the effect of Unit No. 2 will be known.

Impact of Passage Through The Plant Condensers

The effect on organisms being passed through the plant condensers has received increasing attention from biologists during recent years. In part, this increased interest is due to the rapid expansion of installed steam electric generating capacity and to the greater demand for cooling water in nuclear plants than is required in fossil plants of similar size. Factors which influence the effect on entrained organisms upon passage through the condenser include temperature rise through the condenser, maximum temperature attained, length of time the organisms are held at the elevated temperature, mechanical mortalities, and effects of biocides such as chlorine.

In the case of significant mortalities of entrained organisms, a source for repopulating the discharge water is necessary for a continued viable population. The overriding consideration in determining the effect of passage through the condensers is the effect on populations in the vicinity of the power plant and not the effect on populations in the discharge canal. Some locations may show no significant change if all organisms passing through the condensers succumb while other locations may be sensitive to a small percentage of mortalities.

Studies in the vicinity of the Dickerson Power Plant on the Potomac River (Patrick, et al, 1954) did not find a significant difference in the number of diatom species or the total number of individuals between upstream and downstream stations. These results are supported by other studies at the same plant which indicate that there were no significant effects on algae by passage through the condensers in August. Additional work (Patrick, 1968) indicates that there will be little effect on algae being passed through the condensers if temperatures do not exceed 100°F - 101°F.

In England, nanoplankton populations were not significantly affected by passage through the condensers of the Bradwell Nuclear Power Plant (Wood, 1963). However, at the Chalk Point Power Plant located on the Patuxent River in Maryland, significant effects on plankton being passed through the plant condensers were found (Mihursky, 1969). Samples taken at the intake and discharge locations showed reduction in photosynthetic capacity of up to 94% during the warmest part of the summer. However, it was noted that factors such as chlorine could have been partially responsible for the effect. Chlorine at this power station has been reported to be as high as 5 ppm in the discharge canal (Carter, 1968). At the same power plant, Morgan and Stross (1969) found that there was a decrease in primary production over the period of a year. Loss of production during the summer months was calculated to be as high as 424 tons. Increased production during the winter months did not equal this loss and there was a net loss in production over a year. However, the effects of heat and chlorination were not separated and much of the loss may be attributable to abnormally high levels of chlorine.

A report completed for the Edison Electric Institute by researchers at Johns Hopkins University (Jensen, 1970) found that photosynthesis was increased by increased temperatures from a power plant on the James River. Photosynthesis was reduced during the summer months; however, the reduction in photosynthesis was not nearly as great as reported by Morgan and Stross. In addition, increased photosynthesis during the cooler months was greater than the loss during warmer months and there was a net gain in photosynthesis over the year.

Trembley (1960) (1965) found fewer species in the warm water discharge of Martin's Creek Plant on the Delaware River but each species was represented by a greater number of individuals than were present in unaffected waters. Chlorination reduced the total numbers of individuals but did not appear to reduce the number of species.

Heinle (1969) reported that estuarine copepods were killed during passage through the condensers of the Chalk Point Plant even though temperatures encountered were generally below the upper limits of thermal tolerance of the copepods. Chlorine was suspected by Heinle as being the major factor in the kill. Population densities of copepods in the Patuxent River were found to be relatively constant in spite of significant mortalities in the plant condensers. This indicates that copepod populations have considerable resilience to changes in predation and to increased predation and environmental temperatures.

Studies in England of the effect of the Bradwell Nuclear Power Plant on zooplankton populations in the Blackwater River were conducted both before and after the plant started operation (Whitehouse, 1965). No changes were detected that could be attributed to the effects of the power plant.

Other work has demonstrated rapid recovery of fresh water protozoans after extreme temperature shocks (Cairns, 1969). When the temperature was increased from 74°F to 122°F, the number of species dropped from 26 to 7. Within 24 hours, the number of species had increased to 18 and complete recovery was demonstrated within 144 hours (Figure 3.6-16). Of course, a 48°F shock is much more severe than that produced in a power plant condenser. In the case of Robinson Unit No. 2, the temperature increase of the cooling water as it is passed through the condensers is about 18°F.

Research on epifaunal organisms at the Chalk Point Power Plant (Nauman & Cory, 1969) found that a higher production occurred in the discharge than in the intake during all months studied. This higher production occurred even though there was a decrease in the number of species in the discharge canal during July and August. Production in the effluent canal averaged three times as great as production in the intake during the period of a year.

Studies in Lake Julian, a cooling lake serving the Asheville Plant which carries a heavier heat load than Lake Robinson, during the Summer of 1971 demonstrated that a viable population of plankton can exist when discharge temperatures reach as high as 109°F. Species composition of algae in the discharge canal shifted from diatoms toward blue-green; however, populations in the main lake body are dominated by diatoms and green algae. Populations in the lake can be described as "healthy" and no large "blooms" have been observed.

From data which is cited above, one can predict that there may be some loss of phytoplankton and zooplankton during the summer months in the water being passed through the condensers of the H. B. Robinson Plant. It is not possible to predict the extent of these losses or what the effect of these losses will be on populations in Lake Robinson. The majority of the lake volume will have temperatures compatible with abundant plankton populations. Inflow from Black Creek and other creeks which discharge to Lake Robinson are a constant source of zooplankton and phytoplankton populations. However, low nutrient levels or other factors may limit these populations. Therefore, ecological studies of Lake Robinson provide the only means of assessing the effect of passage through the condenser on plankton populations in the lake. These studies are discussed in Section 3.6-2.

Unique or Endangered Species

There are no known unique or endangered species present in Lake Robinson. The white bass-striped bass hybrid stocked in Lake Robinson by the South Carolina Wildlife Resources Department is unique only in that it is not native to the lake. The primary reason the hybrid was stocked in Lake Robinson was to determine if it could survive in a reservoir lacking the preferred forage species of the fish parental to the hybrid. Predominant forage species available to the hybrid in Lake Robinson are sunfish and golden shiner. Studies in 1969 found that hybrid bass had survived since the original stocking in 1967.

Other Biological Impacts

On occasion, fish will enter the intake structure and be impinged upon the screens. These fish will be removed and disposed of onsite.

Eutrophication of Lake Robinson will likely occur at a very low rate and, as such, should not be a serious problem. The eutrophication rate will largely be dependent upon nutrient inflow in the watershed upstream of and at the lake. At the present time, the nutrient level in the lake is naturally low, and considering the rate of development in the Lake Robinson watershed, the nutrient input should not increase rapidly in the near future. With the present levels of nutrients in Lake Robinson and expected low nutrient levels in future years, it is unlikely that algal blooms will occur in the lake.

Waterfowl can be expected to use the lake as transient populations migrate in the Atlantic flyway. Ducks, geese, and coots, may be occasional visitors. They will not contribute significantly to the nutrient load, nor can they be expected to be much affected by the warmed cooling water discharge. The warmed waters of Lake Robinson will be an important haven for local and migrating waterfowl during times of severe winter weather - especially when the small streams and ponds in the area freeze over.

3.6.1.2 Radiological Effects

The radiological effects analysis is a systematic examination of the normal steady state, abnormal transient, or postulated accident occurrences of all modes of the H. B. Robinson Unit No. 2 operation. This analysis includes both reactor facility operation and reactor material transportation, with events in the operational mode placed into AEC-classification category. Radiological effects from normal radioactive effluents are discussed in detail in Section 3.7, transportation effects are discussed in Section 3.9, and the radiological significance of abnormal transient and postulated accident occurrences are discussed in detail in Section 3.11. Radiological effects are determined for the appropriate events in each category. The radiological effects determination was conducted utilizing reasonable assumptions, justifiable calculational models and techniques, and realistic assessments of environmental effects. The radiological impact is a measure of the relative radiological influence the Robinson Plant has with respect to residence background characteristics already present, as calculated in man-rem exposure to the population within a 50-mile radius of the site. Residence background characteristics are assumed to be a combination of the radiation received by the population from natural radiation background and man-made exposure sources, such as medical X-rays. The man-rem concept is the only meaningful way of evaluating the radiological impact on the environment. A summary of the man-rem for each of the categories discussed above is given in the individual sections.

Man-Rem Concept

The integration of radiation exposure to a group of people, as exemplified by the unit man-rem, as contrasted with dose to an individual in rem, is for genetic considerations. It is apparent that summation of exposures to individuals at these low levels has no population group effect from the somatic viewpoint. Therefore, the use of the unit man-rem is somewhat limited as it must be associated with a group of genetically significant size.

As has been shown in Section 3.7, the most significant mode of general population exposure from the Robinson Plant is from direct external radiation from the elevated plume of noble gases. The contribution from the consumption of fish from Lake Robinson is insignificant. These levels of exposure are shown to be only a small fraction of permissible dose as estimated for the nearest neighbors. Calculations indicate that actual dose beyond the nearest neighbors reduces rapidly so that average doses to all inhabitants of the 50-mile radius are lower than the nearest neighbor estimates by about two orders of magnitude. This is so because of the extensive diffusion capacity of the atmosphere and the fact that the number of occupants in the immediate environs is low.

Any man-rem integration requires consideration of whether this population group is of genetically significant size. Also, for an exposure to groups in a nearby town (Hartsville) or a small city (Florence), consideration must be given, considering population mobility, to whether the group remains intact for a time period of genetic significance, such as the human generation time of thirty years.

Some insight on genetically significant population groups is available in the publications of the internationally recognized expert group, the International Commission on Radiological Protection. A review of publications of this group through Publication #16 shows general and repeated use of phrases such as: "whole populations", "population at large", "large populations", "practices in some countries", and "circumstances which vary from country to country". One might conclude that basic thinking is oriented to the population of a small country or to the population of a significant section of a large country, which in either case would be in the range of 10^6 to 10^7 people or more. At the Robinson Plant a 50-mile radius from the site encompasses a population (1986 projected) of less than 800,000 people. The low probability of statistical detection of a genetic effect is applicable in considering a population of this size. For example, ICRP Publication No. 8 considers the probability of a dominant genetic effect being experienced by the children of a generation of exposed parents. The estimate (acknowledged as may well be high for a number of reasons) was that "the effects of a few rads would not be detected in the annual statistical returns of a population of 50 million". From this, perspective may be gained on the probable effects of a few rads per year to a few thousand people near the Robinson Plant. Due to the small genetic significant population around the plant and the small population dose, the only meaningful assessment of the radiological impact of the Robinson Plant is a comparison between the dose received from operation of the plant to that received from residence background.

The whole body dose is the only dose of importance that contributes to a genetically significant exposure in man-rem. Critical organ doses have been calculated but are not considered in the evaluation of the radiological impact from plant operations as the effect on the critical organ is not of genetic significance. Since the critical organ can tolerate a much greater dose than the whole body, the effect on the critical organ is less than the effect on the whole body.

Natural Radiation Background

Radiation of various forms is a normal part of man's natural environment, as it has been throughout his development, and man has demonstrated the ability to develop in the presence of this natural radiation. Every day we receive radiation from the sky, the ground, the air around us, and the food we eat. The magnitude of this radiation level is strongly influenced by where we live, what we do, and even in what kind of house we live. For most locations around the United States, this natural radiation level averages about 140 mrem per year. The various component contributions of this typical value are discussed below.

Cosmic rays provide one of the most significant natural radiation sources. Cosmic radiation is to some extent dependent on latitude and to a large extent dependent on altitude. In the mid-latitudes, the cosmic radiation varies from about 40 mrem per year at sea level to about 3800 mrem per year at altitudes that jet aircraft fly (35,000 feet). This does not mean that all commercial jet airliner crews receive 3800 mrem per year, since this would say they were continuously airborne. Assume, for instance, that these crews stay aloft a tenth of the year; thus, their occupational radiation exposure due to cosmic radiation alone would be in the range of 300 to 400 mrem per year. Even one transcontinental roundtrip per year would give the business man or vacationer about 4 mrem. The average cosmic radiation of 40 mrem per year will increase to about 150 mrem per year at some mile-high locations such as Denver and Salt Lake City. It is assumed that 50 mrem per year is a good average for people within a 50-mile radius of the H. B. Robinson Plant.

Another source of radiation in nature is the ground itself because it contains many radioactive minerals, particularly isotopes of the uranium and thorium series, together with the important uranium decay product, radium. Another significant radioisotope in the ground is potassium-40, the naturally radioactive isotope of the element potassium. This incidence of radioactive material in the ground causes the earth to act, with respect to an individual, as a large plane radiation source. This produces an average radiation exposure in the continental United States of about 60 mrem per year. Assuming that the average person spends about one-fourth of this time outside of buildings, this 6C mrem per year would reduce to 15 mrem per year. There are a number of locations in the world where the radiation exposure from the ground is actually much higher. In various locations in Brazil, India, and in the French mountains, the exposure may range from 180 to as high as 1600 mrem per year. This is largely due to the presence of deposits of thorium near the surface of the ground in such locations. There also have been reports of exposures higher than these.

The fact that these radioisotopes exist in the ground gives rise to a secondary source of radiation, since the natural decay of the uranium and thorium series each contains a natural radiogas. These radiogases evolve from the ground at a fairly constant rate and thus, cause concentrations of natural radiogases in the air. The principal constituent of this source of exposure of radiation in nature is the radiogas radon, which has a 3.8-day radioactive half-life. This element, together with its daughter decay products, causes a world average whole body external exposure of about 5 mrem per year. Actually the inhalation of these radiogases and the deposition of their radioactive daughters in the lung may cause a lung dose of as high as 200 mrem per year.

Since man takes materials from the ground to build homes and offices, natural radioisotopes from the ground are transferred to these structures. A significant variation will result from the use of different building materials. A wooden structure may give a radiation dose rate of about 50 mrem per year, while concrete may give 70, and brick as high as 100. Even these may vary within a particular material based on where the material originated. For example, there are some types of stone (such as some granite and marble) that will produce an exposure of 350 to 500 mrem/year.

All liquids in the world are now and have always been radioactive due to the presence of many naturally radioactive materials such as uranium, thorium, radium and carbon-14, all of which have very slow decay rates ranging from thousands to billions of years. Ocean water is a good example of such natural radioactivity. The measure of radioactivity contents in liquids is usually stated in units of picocuries per liter. In the case of ocean water the natural radioactivity content is about 350 picocuries per liter. Most of this is due to the naturally radioactive potassium - 40 which has a decay rate (half life) of 1.3 billion years. River water radioactivity usually averages between 10 and 100 picocuries per liter.

Due to these activities in liquids used for human consumption, the average concentration in the liquids of the human body is about 300 picocuries per liter. The general average radiation exposure from food and water is about 25 mrem per year, due to the deposition and retention of these radioactive materials within the body. In a typical case, about 20 mrem per year of this exposure comes from the natural radioisotope potassium - 40, which is found particularly in protein type foods.

Total Radiation from Nature

The following table summarizes the various contributions in arriving at an average natural radiation background of 140 mrem per year for people living in a 50-mile radius of the H. B. Robinson Steam Electric Plant.

Cosmic Rays	50
Ground (1/4 time)	15
Buildings (3/4 time)	45
Air	5
Food and Water	25
	140 mrem per year

Man-Rem From Natural Radiation Background

Calculations of the total exposure to the population as a result of natural radiation background have been made. Certainly it is obvious that if it is assumed that every person in the United States receives an average of 140 mrem/year then the total population exposure would be about 30 million man-rem per year. However, it is not appropriate to compare the radiological effects of the operation of any one nuclear power plant, as negligible as they are, with the total man-rem/year to the entire U. S. population. Therefore, the man-rem comparisons are made for the population within a 50-mile radius. Assuming the projected population within a 50-mile radius of the Robinson Plant is 783,831, the natural background radiation will result in about 156,762 man-rem/year.

Man-Made Radiation Background

Total population exposure from man-made sources is more difficult to evaluate since there can be an individual choice made as to whether such radiation is received. However, reasonable assumptions can be made in order to make estimates of man-rem per year since it is not feasible to monitor the population dose to individuals.

The population dose as a result of viewing television to a sample million people can be estimated. Typically an individual would receive about 1-10 mrem/year from watching TV. Say the average dose received is 5 mrem/year, then this results in 5000 man-rem/year. Looking at this same population, one can determine the man-rem as a result of exposure from luminous-dial watches. If only 10 percent of this example is exposed to 2 mrem/year, then the resultant population dose is 200 man-rem/year.

The use of medical X-rays is by far the largest contributor to population exposure from a man-made source. Again considering the example million-person population, diagnostic X-rays would result in about 100,000 man-rem/year assuming that each person received an average of 100 mrem/year. However, if only 10 percent of this population received an annual chest X-ray of 100 mrem per examination, the result would be 10,000 man-rem/year.

In summary, medical exposure results in the largest man-rem per year contribution from man-made sources. However, the examples of television viewing and wearing luminous dial watches do contribute to population exposure and should be included when comparing the impact on man from these and other man-made sources. For the purposes of comparison a value of 60 mrem/year due to all man-made sources has been used for determining man-rem exposures to the population within a 50-mile radius of the H. B. Robinson Steam Electric Plant.

Total Average Radiation Background

The total background radiation exposure received by the average citizen within a 50-mile radius of the Robinson Plant is the sum of the contributions received from natural background and man-made sources. The resultant total is the 140 mrem/year from natural sources and the 60 mrem/year from man-made sources giving an estimated total of 200 mrem/year to the average resident of this area.

Variations in Radiation Background

So far, only average radiation background has been discussed, however, it is well established that variations do occur from place to place and from year to year. The following information substantiates this.

Airborne radioactivity surveys conducted by the U. S. Geological Survey on behalf of the Division of Biology and Medicine of the USAEC have shown the variations of radioactivity level from place to place. These surveys are a part of the Aerial Radiological Measurement Surveys (ARMS) program, a program of airborne radioacitivity surveys of nuclear installations.

Measurements consist of whole body gamma dose from the ground, air and cosmic-ray sources. From the standpoint of airborne activity, only three naturally occurring radioactive elements are important: uranium, potassium-40, and thorium. The relative amounts vary with the type of geological formation. In fact, measurements have shown variations of natural background of up to four to six times within a 10-mile distance. This means that values between 50 to 200 mrem/year have been measured. Some areas that have certain types of granite and marble will produce exposures of 350 to 500 mrem/year. As stated earlier, this material has been used as building material for some of our most stately public structures. Variations can also occur from year to year even at the same location. For example, an annual variation of up to 10 mrem is not unexpected for some locations. The point is that spatial and temporal changes do exist in nature, though it is not obvious unless one is trying to measure such differences. Such variations are much greater than the total radiological effect from nuclear power plant operation.

Considerations in Minimizing One's Radiation Background

Since there are variations in our natural radiation background, this leads one to a conclusion that if radiation is of concern to an individual, then an evaluation as to what could be done to minimize the radiation received from nature is in order. For example, the cosmic radiation contribution to an individual's background exposure can be minimized by living closer to sea level elevations. People living about a mile above sea level could reduce this cosmic radiation background by about 50 to 100 mrem/year by moving towards a sea level location.

Whole body exposures can also be reduced by living in a home built of materials low in radioactivity content. For example, living in a wooden house instead of a concrete or stone one can result in a 50 mrem/year background reduction. Even buildings that we may work in are radioactive such that radiation exposure may be many times higher in some of the aesthetically designed granite and marble structures than other less radioactive buildings. No one is suggesting that people who work in buildings made of certain types of stone quit their jobs and seek employment where their background radiation levels would be minimized. If, however, one is concerned about the amount of natural radiation background he receives, one of his main considerations should be his choice of habitat.

Another example where one could minimize background exposure is by carefully selecting the types of food to be eaten, using those low in radioactivity content. This could reduce, not eliminate, the natural exposure by a few to about 10 mrem/year.

One could also minimize his natural background by not flying in airplanes since a transcontinental round-trip will result in about 4 mrem due to cosmic radiation. Reducing the number of cigarettes smoked a day from two packs to one could lower the lung dose by several tens of mrem/year. Reducing the consumption of coffee and alcoholic beverages will also minimize an individual's exposure. Working on the 2nd floor of a building instead of the 30th floor will also minimize background exposure. A long list of other examples could be made where each individual could minimize his exposure from natural radiation background.

Man-made radiation sources such as medical X-rays, television, luminous features on watches and appliances, and micro-wave ovens add to an individual's background exposure depending on the frequency of usage.

The largest man-made radiation source is from medical exposure, as stated earlier. Certainly, if no diagnostic medical or dental X-rays are received, there would be no exposure. However, many of us have received much benefit from diagnostic X-rays to aid in medical treatment. Certainly, therapeutic X-ray treatments have also resulted in many lives being saved or prolonged even though massive doses of radiation have been received. Not receiving such X-ray treatments would minimize one's exposure but the risk to the patient could be quite detrimental.

The radiation exposure from viewing television can be minimized by sitting farther away from the set or reducing the number of viewing hours per year. This could lower one's exposure by a few mrem/year. An additional few mrem/year reduction could be realized by wearing a wrist-watch without a luminous dial.

To summarize the many choices that each person has in order to minimize his background radiation exposure, let us postulate two individuals.

One lives near sea level, in a wooden house; does not receive medical X-ray examinations; does not smoke or drink alcoholic beverages; works on the first floor of a wooden building; and does not watch television. The second person lives in a stone house, in a mile-high city; receives his yearly chest X-ray and dental X-ray examinations; smokes cigarettes and drinks alcoholic beverages; works on the 20th floor of a granite building; and watches television regularly. The difference in the background radiation exposure between these two people could easily be several hundred mrem/year. They represent the range of possible exposures experienced by typical individuals. Most people would fall between these two extremes depending on the choices made, knowingly or unknowingly, to determine the background exposure received.

With the numerous ways that man could reduce his background radiation, it would appear that if radiation were of concern to man he would regulate his behavior to take advantage of the lowest possible level of natural radiation. Nowhere does he appear to have seen fit to regulate his behavior to this extent. Thus, it could be concluded that this particular low level of natural radiation has not been and is not currently a significant criterion to man when it is a matter of voluntary selection, even though these levels of exposure are several orders of magnitude greater than that received from the operation of the H. B. Robinson Steam Electric Plant.

Man-Rem From Nuclear Power Plants

The radiological impact of nuclear power plants is compared with the already radioactive environment in which we live. There is a basic difference between the man-rem received from natural and man-made radiation background and that from the nuclear power plants. That is, everyone within a 50-mile radius is assumed to receive the average background exposure, whereas everyone does not receive the same dose contribution from the power plant. The reason is that the natural atmospheric dispersion effects reduce the radiation concentration with increasing distance from the plant. Over the year, the wind directions, wind speeds and atmospheric stability change to disperse an airborne source so that out to 50 miles from the release location, the radiological effect is not measurable but only estimated by means of a calculation.

The total man-rem to the population out to 50 miles from the plant for the various conditions evaluated in the nuclear environmental effects determination are summarized in Sections 3.7 and 3.11. This list includes the man-rem results for normal plant operation considerations, various abnormal conditions and postulated design basis accident conditions. One should not add the man-rem from each condition since the probability of occurrence was not applied to all conditions. The reason is that it is not correct to add man-rem/year with man-rem/event without first considering the frequency of occurrence (such as one-millionth of an occurrence per year).

Radiological Impact

The general conclusion that is drawn from the total population exposure for each condition is that there is a negligible contribution from the nuclear power plant when compared to the natural and other man-made exposures received by the population. The highest contribution to the population exposure from the plant is due to normal plant operation. Even so, the highest dose to an individual near the plant is less than a few percent of natural background. This dose would approach negligible proportions at a distance of 50 miles (two to three orders of magnitude less).

As observed earlier, the many spatial and temporal changes in natural background and certain man-made sources more than mask out the contribution from normal operation of a nuclear power plant.

Transportation and abnormal occurrence considerations also result in a negligible addition to the population exposure.

From a radiological viewpoint, the nuclear power plant is indeed a good neighbor, one that has a negligible impact on the environment.

3.6.2 Environmental Studies

3.6.2.1 Biological Studies

Biological studies of Lake Robinson are to be conducted during a two-year period to assess the impact of Robinson Unit No. 2 on the aquatic environment. Primary emphasis of the study is to be on the lake fishery, including the primary producers. Nekton samples will be collected in an effort to indicate any shift of populations in the lake as a result of the increased heat input from Unit No. 2. The fish will be examined and classified according to species, age, and condition. The identification and assessment of phytoplankton will document the distribution of major groups throughout the lake and determine the dominant species in Lake Robinson. Samples of zooplankton will be collected, counted and identified. Biomass will be calculated and productivity will be estimated. Water chemistry to determine those constituents relevant to the biology of the lake or likely to be affected by the operation of the plant will supplement the biological parameters being investigated.

3.6.2.2 Radiological Studies

A pre-operational environmental monitoring program was conducted in the Robinson site environs to determine the magnitude and nature of radioactivity in the environment surrounding the site, to test the equipment, sampling and analytical procedures, the suitability of selected sampling points, and investigate the overall statistical variability of the system results. The information obtained is used as a baseline in evaluating any changes in environmental radioactivity levels that may result from plant operation.

The pre-operational radiological monitoring program was conducted from December 1968 to September 1970 to determine background radiation levels and concentrations of radioactive materials in the aquatic and terrestrial environment surrounding the plant. The expected spatial distribution of plant effluents, meteorology conditions, lake diffusion, population distribution, and critical pathways were all considered in the selection of approximately 25 sampling and monitoring locations for the pre-operational monitoring program. The results of the pre-operational program were summarized in two reports: (1) " Pre-operational Environmental Monitoring at the H. B. Robinson Unit 2 Site - 1969 Annual Report" and (2) "Pre-operational Environmental Monitoring Report - January 1, 1970 - September 30, 1970". These reports have been transmitted to the AEC.

The operational environmental radiological monitoring program was similar to the pre-operational program with only minor changes in locations, sampling frequency and analyses through March, 1971. Subsequently, the program has been revised to place more emphasis on isotopic identification in the aquatic environment. The program shown in Table 3.6-5 represents the current monitoring program. Additional adjustments may be made in this program as necessary to place appropriate emphasis on specific radionuclides or groups of radionuclides and critical pathways for exposure to man after additional operational experience has been obtained.

The only variance in the current program from that shown in Table 3.6-5 is in regard to benthic organisms. Several attempts have been made to segregate benthic organisms from bottom sediments; however, due to the near absence of benthic organisms, there has never been a sample of sufficient size for separate analysis, and the benthic organisms have been included in the analysis of the bottom sediments. By including the benthic organisms with the bottom sediments, any buildup of radioactivity would be detected in the benthic organisms.

In addition to the radiological monitoring program being conducted by Carolina Power & Light Company, an extensive monitoring program is being conducted by the Eastern Environmental Radiation Laboratory of the Environmental Protection Agency in cooperation with the AEC Division of Compliance and the South Carolina Department of Radiological Health.

Each participating organization is performing independent analyses of selected samples. The South Carolina Department of Radiological Health is also conducting their own independent radiological monitoring program in the environs surrounding the plant.

Environmental Monitoring Results

A comparison of environmental monitoring data for the last nine months prior to reactor startup (January 1, 1970 to September 30, 1970) and for the first six months of operation (October 1, 1970 to March 31, 1971) shows no significant difference in pre-operational and operational levels. Since April 1, 1971, highly sensitive isotopic analyses of water, sediment, and fish have indicated trace amounts of ^{58}Co, and lesser amounts of other activation products, that can be attributed to operation of the nuclear plant. Levels of ^{58}Co that have been measured in Lake Robinson water are more than four orders of magnitude below the $(MPC)_w$ for ^{58}Co. The principal radionuclides detected in Lake Robinson fish during the Spring of 1971 were ^{40}K, ^{137}Cs, and ^{58}Co. The ^{40}K is naturally occurring and is the most abundant radionuclide. The ^{137}Cs, from worldwide fall-out deposition as evidenced by the pre-operational environmental monitoring results, was the second most abundant radionuclide. The principal radionuclide present which is attributable to operation of the nuclear plant is ^{58}Co; however, a large portion of this activity was found in fish entrails with lesser amounts in the edible portion (less than 1 pCi/gm wet weight).

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TABLE 3.6-1

PROVISIONAL MAXIMUM TEMPERATURES RECOMMENDED AS COMPATIBLE WITH THE WELL-BEING OF VARIOUS SPECIES OF FISH AND THEIR ASSOCIATED BIOTA*

93 F: Growth of catfish, gar, white or yellow bass, spotted bass, buffalo, carpsucker, threadfin shad, and gizzard shad.

90 F: Growth of largemouth bass, bluegill, and crappie.

84 F: Growth of pike, perch, walleye, smallmouth bass, and sauger.

80 F: Spawning and egg development of catfish, buffalo, threadfin shad and gizzard shad.

75 F: Spawning and egg development of largemouth bass, white, yellow, and spotted bass.

68 F: Growth or migration routes of salmonids and for egg development of perch and smallmouth bass.

55 F: Spawning and egg development of salmon and trout (other than lake trout).

48 F: Spawning and egg development of lake trout, walleye northern pike, sauger, and Atlantic salmon.

*From Industrial Waste Guide on Thermal Pollution published by U. S. Department of Interior, 1968.

TABLE 3.6-2

TOLERANCE LIMITS FOR CERTAIN FISHES

Values are LD_{50} temperature tolerance limits, i.e., water temperatures survived by 50 percent of the test animals. Counts were made by observing or estimating the number killed during exposure, or within a reasonable time thereafter in which it could be safely assumed that all deaths were attributable to the temperature effects.

(This Table Taken in Part From Anon., 1962)

Fish	Acclimated to °C	(°F)	Lower Limit °C	(°F)	Hr	Upper limit °C	(°F)	Hr
Bass, largemouth	20.0°C	(68.0°F)	5.0°C	(41.0°F)	24	32.0°C	(89.6°F)	72
(Micropterus salmoides	30.0°C	(86.0°F)	11.0°C	(51.8°F)	24	24.0°C	(93.2°F)	72
floridanus)								
Bluegill (Lepomis	10.0°C	(50.0°F)				29.0°C	(82.4°F)	24
macrochirus macrochirus)	30.0°C	(86.0°F)				36.0°C	(96.9°F)	24
Bluegill (L. macrochirus	15.0°C	(59.0°F)	3.0°C	(37.4°F)	24	31.0°C	(87.8°F)	60
purpurescens)	30.0°C	(86.0°F)	11.0°C	(51.8°F)	24	34.0°C	(93.2°F)	60
Bullhead (Ameiurus n.	20.0°C	(68.0°F)	1.0°C	(33.8°F)	24	32.0°C	(89.6°F)	96
nebulosus, A. n.	30.0°C	(86.0°F)	7.0°C	(44.6°F)	24	35.0°C	(95.0°F)	96
narmoratus)								
Catfish, channel	15.0°C	(59.0°F)	0.0°C	(32.0°F)	24	30.0°C	(86.0°F)	24
(Ictalurus lacustris	25.0°C	(77.0°F)	6.0°C	(42.8°F)	24	34.0°C	(93.2°F)	24
lacustris, I.l punctatus)								
Chub, creek (Semotilus	5.0°C	(41.0°F)				25.0°C	(77.0°F)	96
a. atromaculatus)	25.0°C	(77.0°F)				32.0°C	(89.6°F)	96
Dace, blacknose (Rhinichthys	5.0°C	(41.0°F)				30.0°C	(80.6°F)	340
a. atratulus, R.a.	25.0°C	(77.0°F)	5.0°C	(41.0°F)	24	29.0°C	(84.2°F)	340
meleagris)								
Goldfish (Carassius	2.0°C	(35.6°F)				28.0°C	(82.4°F)	14
auratus)	17.0°C	(62.6°F)	0.0°C	(32.0°F)	14	34.0°C	(93.2°F)	14
	24.0°C	(75.2°F)	5.0°C	(41.0°F)	14	36.0°C	(96.8°F)	14
Greenfish (Girella	37.0°C	(98.6°F)	15.0°C	(59.0°F)	14	42.0°C	(107.6°F)	14
nigricans)	12.0°C	(53.6°F)	5.0°C	(41.0°F)	120	30.0°C	(86.0°F)	120
	18.0°C	(64.4°F)	13.0°C	(55.4°F)	72	31.0°C	(87.8°F)	120
Killifish (Fundulus	14.0°C	(57.2°F)	1.0°C	(33.8°F)	48	32.0°C	(89.6°F)	
heteroclitus)	20.0°C	(68.0°F)	2.0°C	(35.6°F)	48	34.0°C	(93.2°F)	
Minnow, fathead	20.0°C	(68.0°F)	2.0°C	(35.6°F)	24	32.0°C	(89.6°F)	133
(Pimephales promelas)	30.0°C	(96.0°F)	11.0°C	(51.8°F)	24	33.0°C	(91.4°F)	133
Minnow, blunt-nose	15.0°C	(59.0°F)	1.0°C	(33.8°F)	24	31.0°C	(87.8°F)	133
(Hyborhynchus notatus)	25.0°C	(77.0°F)	8.0°C	(46.4°F)	24	33.0°C	(91.4°F)	133

Fish	Acclimated to °C	(°F)	Lower Limit °C	(°F)	Hr	Upper Limit °C	(°F)	Hr
Mosquito fish	15.0°C	(59.0°F)	2.0°C	(35.6°F)	24	35.0°C	(95.0°F)	66
(Grambusia affinis affinis, G.a. holbroki)	35.0°C	(95.0°F)	15.0°C	(59.0°F)	24	37.0°C	(98.6°F)	66
Perch (Perca flavescens)	5.0°C	(41.0°F)				21.0°C	(69.8°F)	96
Winter	25.0°C	(77.0°F)	4.0°C	(39.2°F)	24	30.0°C	(86.0°F)	96
Summer	25.0°C	(77.0°F)	9.0°C	(48.2°F)	24	32.0°C	(89.6°F)	96
Shad, gizzard	25.0°C	(77.0°F)	11.0°C	(51.8°F)	24	34.0°C	(93.2°F)	48
(Dorosoma cepedianum)	35.0°C	(95.0°F)	20.0°C	(68.0°F)	24	37.0°C	(98.6°F)	48
Shiner, common	5.0°C	(41.0°F)				27.0°C	(80.6°F)	133
(Notropis cornutus	25.0°C	(77.0°F)	4.0°C	(39.2°F)	24	31.0°C	(87.8°F)	133
frontalis)	30.0°C	(86.0°F)	8.0°C	(46.4°F)	24	31.0°C	(87.8°F)	133
Shiner, common	25.0°C	(77.0°F)				32.0°C	(89.6°F)	133
(Notropic cornutus chrysocephalus)	30.0°C	(86.0°F)				34.0°C	(93.2°F)	133
Shiner, lake	5.0°C	(41.0°F)				23.0°C	(73.4°F)	133
(N. atherinoides)	15.0°C	(59.0°F)	2.0°C	(35.6°F)	24	29.0°C	(84.2°F)	133
	25.0°C	(77.0°F)	8.0°C	(46.4°F)	24	31.0°C	(87.8°F)	133
Shiner, golden	20.0°C	(68.0°F)	8.0°C	(46.4°F)	24	32.0°C	(89.6°F)	66
(Notemigonus c. crysoleucas, N.c. auratus)	30.0°C	(86.0°F)	11.0°C	(51.8°F)	24	35.0°C	(95.0°F)	66
Sucker, common	15.0°C	(59.0°F)						
(Catostomus commersoni)	25.0°C	(77.0°F)	5.0°C	(41.0°F)	24	29.0°C	(84.2°F)	133
Sunfish	10.0°C	(50.0°F)				28.0°C	(82.4°F)	24
(Lepomis gibbosus)	30.0°C	(86.0°F)				24.0°C	(75.2°F)	24
Trout, brook	3.0°C	(37.4°F)				23.0°C	(73.4°F)	133
(Salvelinus fontinalis)	20.0°C	(68.0°F)				25.0°C	(77.0°F)	133
	25.0°C	(77.0°F)				25.0°C	(77.0°F)	133

TABLE 3.6-3

MAXIMUM THERMAL TOLERANCE (LD-50) FOR SEVERAL SPECIES OF FISH (Trembley, 1960)

Fish Species	No. of Fish in Test	Acclimation Temp. - °F	Duration of Test	Exposure Time at Each Temp. Increment	Temperature - °F LD 50	LD 100
Largemouth Bass (Micropterus salmoides)	10	80	18 hours	2 hours	100-102	103
	22	81	15 hours	1 hour	98-99	100
"	16	77	21 hours	1 hour	99	100
Smallmouth Bass (Micropterus dolomieui)	20	55	10 hours	1 hour	85-90	
Bluegills (Lepomis macrochirus)	10	79	18 hours	2 hours	103	
	22	81	15 hours	1 hour	*Above 99	
"	12	77	21 hours	1 hour	101-102	
"	12	73	8 hours	1 hour	99-100	100
Brown Bullhead (Ictalurus nebulosus)	10	73	8 hours	1 hour	99	102-103
Redbelly Sunfish (Lepomis auritus)	6	81	15 hours	1 hour	*Above 99	
Rock Bass (Amboloplites rupestris)	6	81	15 hours	1 hour	95	98-99
Striped Bass (Roccus saxatilis)	8	40	8 hours	1 hour	75	82
White Perch (Roccus americana)	16	40	8 hours	1 hour	82	83
Walleye (Stizostedion vitreum)	10	81	8 days	1 day	99	100
	10	63	6 days	1 day	94	97
"	10	70	24 hours	1 hour	90	92

*None killed. Test stopped due to pump trouble.

TABLE 3.6-4

THE FINAL TEMPERATURE PREFERENDA FOR VARIOUS SPECIES OF FISH AS DETERMINED BY LABORATORY EXPERIMENTS

Young of the Year or Yearling Fish Were Used, Except as Noted. (This Table Taken in Part From Ferguson, 1958)

Species	Final Preferendum	Authority
Bluegill (*Lepomis macrochirus*)	32.3°C (90.1°F)	Fry & Pearson (MS, 1952)
Bass, Largemouth (*Micropterus salmoides*)	30.0-32.0C (86-89.6°F)	Fry (MS, 1950)
Carp (*Cyprinus carpio*)	32.0°C (89.6°F)	Pitt, Garside & Hepburn (1956)
Pumpkinseed (*Lepomis gibbosus*)	31.5°C (88.7°F)	Anderson (MS, 1951)
Goldfish (*Carassius auratus*)	28.1°C (82.6°F)	Fry 1947
Bass, Smallmouth (*Micropterus dolomieu*)	28.0°C (82.4°F)	Fry (MS, 1950)
Grass Pickeral (*Esox vermiculatus*)	26.6°C (78.8°F)	Berst & Lapworth (MS, 1950)
Yellow Perch (*Perca flavescens*)	24.2°C (75.6°F)	Ferguson (1958)
Yellow Perch (*Perca flavescens*)	21.0°C (69.8°F)	McCracken & Stark (MS, 1948)

TABLE 3.6-5

ENVIRONMENTAL SURVEILLANCE PROGRAM FOR THE H. B. ROBINSON NUCLEAR - ELECTRIC PLANT

Sampling Description						
Type	Sampling Point	Sampling Points Description	Sampling Frequency	Sample Size	Analysis	Remarks
Air Samples	(22) (2)	Hartsville Visitors' Center W of Reactor	Weekly	1/3 cycle 1.5 hrs. on 3.0 hrs. off at 1 cfm	Gross Beta after at least 72 hrs. decay. Gross Alpha on one set/month	Gamma Spectra if > 10 pCi/m^3
Ground Water	(23)	Well near Site Entrance	Quarterly	One Ga[illegible]	Gross Beta Tritium	Gamma Spectra and Sr-90 if Beta >30 pCi/l
Surface Water	(11)	Dam Spillway	Weekly	One Gallon*	Gross Beta Tritium	*
	(5)	Plant Intake	Weekly	One Gallon	Gross Beta Tritium	
	(8)	Downstream from Discharge Canal Outfall	Weekly	One Gallon	Gross Beta Tritium	
	(21)	Bridge at north end of Lake	Quarterly	One Gallon	Gross Beta Tritium	
	(32)	Prestwood Lake	Weekly	One Gallon*	Gross Beta Tritium	*
Bottom Sediments	(21)	Bridge at north end of Lake	Quarterly	One Pound	^{60}Co, ^{58}Co, ^{137}Cs, ^{134}Cs, ^{90}Sr	
	(24)	In Discharge Canal	Quarterly	One Pound	(Ditto above)	
	(5)	Plant Intake	Quarterly	One Pound	(Ditto above)	
	(8)	Downstream from Discharge Canal Outfall	Quarterly	One Pound	(Ditto above)	

*A 200 l sample will also be collected on cation exchange resin column for ^{58}Co and ^{60}Co, and will be saved for quarterly composite analysis for $^{134,137}Cs$, $^{89,90}Sr$, and ^{140}Ba-La. Gross alpha will be run on one set of water samples per quarter.

TABLE 3.6-5 (Continued)

Sampling Description: Type	Sampling Description: Sampling Point	Sampling Description: Sampling Points Description	Sampling Frequency	Sample Size	Analysis	Remarks
Soil	(25)	West of Lake	Semi-Annual	One Pound	^{90}Sr, ^{137}Cs	Stored for future analysis
	(26)	East of Lake	Semi-Annual	One Pound	Gamma Spectra	
Fish* (bass, bream crappie, catfish, carp)	(8)	Near Discharge Canal Outfall	Quarterly	Two pounds flesh each of bottom feeders and free swimmers	**	
Air Radiation Dosimeters	(22)	Hartsville	Monthly		Gamma	TLD
	(10)	Picnic Area	Monthly		Gamma	TLD
	(17,18, 19,20)	4 on east shore of Lake	Monthly		Gamma	TLD
	(1,3,4, 12)	4 on south Property Line	Monthly		Gamma	TLD
	(13,15, 16)	3 on west Property Line	Monthly		Gamma	TLD
	(11)	Dam Site	Monthly		Gamma	TLD
	(5)	Microwave Tower	Monthly		Gamma	TLD
	(14)	Four Corner Area	Monthly		Gamma	TLD
	(6,7)	Unit 1	Monthly		Gamma	TLD
	(28,29, 30,31)	4 south of Unit 2 in prevailing wind direction	Monthly		Gamma	TLD

*Location will vary to obtain necessary specimens and representative samples.

**Isotopic analysis by radiochemistry and gamma spectrometry for $^{58,60}Co$, $^{89,90}Sr$, $^{134,137}Cs$, and ^{140}Ba-La.

TABLE 3.6-5 (Continued)

Type	Sampling Point	Sampling Points Description	Sampling Frequency	Sample Size	Analysis	Remarks
Benthic Organisms	(8)	Downstream from Discharge Canal Outfall	Semi-Annual	*	Gross Beta ^{58}Co, ^{60}Co, ^{134}Cs, ^{137}Cs, ^{90}Sr	
	(21)	Bridge at north end of lake	Semi-Annual	*	(Ditto above)	

*Benthic Organisms will be segregated from the bottom sediments collected at these sampling points and analyzed as indicated.

3.7 RADIOACTIVE DISCHARGES

The operation of the H. B. Robinson Unit No. 2 results in the production of radioactive materials that for the most part are contained within the fuel elements in the reactor vessel. The radioactive materials are produced as a direct result of the fission process or are radioactive materials in the reactor core resulting from nuclear reactions. Any radioactive materials which escape from the fuel or are activated within the reactor are contained in the primary coolant which is a completely enclosed system housed within the Containment Building. Small quantities of gaseous and liquid radioactive materials are removed from the primary coolant under controlled conditions during purification processes or during deboration. Also, small quantities of radioactive materials may escape from the primary coolant due to leakage. The Chemical and Volume Control System and the Waste Processing System are designed to contain and process these radioactive materials.

3.7.1 Radioactive Waste Processing System

The Radioactive Waste Processing System is designed to collect, store, process and prepare for off-site shipment or disposal plant wastes which contain or could contain radioactive material, both gases and liquids. The system design is such that radioactive effluents from the plant during normal operations are in accordance with revised and expanded regulations, 10 CFR 20 and 10 CFR 50, issued in the Federal Register Volume 35, No. 234, December 3, 1970, effective January 3, 1971, which require that radioactive effluents be restricted to "as low as practicable". Since that time, a revised Appendix I to 10 CFR 50 has been issued which gives numerical guidance in regard to the "as low as practicable" concept. The Waste Processing System has been evaluated using this numerical guidance and the system meets the design objectives as set forth in Appendix I to 10 CFR 50 (maximum off-site dose to a single individual due to normal releases will not exceed 10 mrem/year, integrated liquid effluent activity will not exceed 5 curies per year while maintaining a discharge canal activity of less than 0.2 pCi/l due to these releases, and the maximum integrated dose to an individual will not exceed 5 mrem due to these liquid releases). Accidental release of radioactivity will be safeguarded against so that the likelihood of occurrence is very remote, and if such releases did occur, the radiological consequences would be within applicable AEC guidelines. Accidents and the environmental consequences of accidents are discussed in Section 3.11.

The Waste Processing System is divided into three sections:

1. Liquid Radioactive Waste Processing System
2. Gaseous Radioactive Waste Processing System
3. Solid Radioactive Waste Processing System

3.7.1.1 Liquid Radioactive Waste Processing System

The liquid radwaste system collects, stores, and processes for reuse or disposal all normally and potentially radioactive aqueous liquid wastes from the H. B. Robinson Unit No. 2. Radioactive liquids entering the Waste Processing System are collected in sumps and tanks until determination of subsequent treatment is made. During normal plant operation, the Waste Processing System processes liquids from equipment drains and leak-offs, radioactive chemical laboratory drains, radioactive laundry and shower drains, decontamination area drains and demineralizer regeneration. The system collects and transfers to the Chemical and Volume Control System liquids from the reactor coolant loop drains, pressurizer relief tank, reactor coolant pump secondary seals, excess letdown during startup, accumulators, and valve and reactor vessel flange leak-offs. These liquids transferred to the Chemical and Volume Control System are processed and returned for reuse within the plant.

Liquid wastes are collected in the waste hold-up tank, the laundry and hot shower tanks, and the chemical drain tank. At these points the liquids are sampled to determine what processing is required.

Wastes collected in the waste hold-up tank will normally be processed through the waste concentrator. The condensate is collected in one of two waste condensate tanks where it is sampled to determine further action. If activity levels are high, these liquids are returned to the waste hold-up tank for further processing. If, after sampling, these liquids are determined to meet the requirements of 10 CFR 20 and 10 CFR 50 they are discharged to the circulating water system where they are diluted by the circulating water.

During the first year of operation, there have been numerous problems with the operation of the waste concentrator and its performance has not met design standards. Although the concentrator has not met design performance, releases have been only a fraction of 10 CFR 20, Appendix I to 10 CFR 50, and Technical Specification limits. Modifications are now planned which, when completed, should bring the performance of the waste concentrator up to design standards. In addition to improvements in the waste concentrator, CP&L has on site two demineralizers which will be installed downstream from the waste concentrator. The condensate from the concentrator will then be routed through these demineralizers and will be of suitable quality for reuse within the plant. When these demineralizers are installed, these liquids will be discharged to the environment only when water inventories within the plant demand it and only then if the radioactive content meets all applicable AEC regulations.

Other improvements are being made in the Liquid Processing System to further minimize releases to the environment. Sources of excessive liquid input to the system are being identified and corrected. For example, modifications are in progress which will collect charging pump leakage and return it to the Chemical and Volume Control System where it will be processed for reuse in the plant. This will exclude from the Waste Processing System one of the largest sources of liquid both in activity and volume.

Laundry and decontamination shower drains are collected in the laundry and hot shower tanks. These wastes are of low radioactive content (normally 1×10^{-5} μCi/ml). Because of the tendency of these liquids to foul ion exchange resins and the other process equipment, they are normally discharged, after sampling for compliance with discharge standards, through the laundry drain filter to one of the condensate tanks. The liquid is then resampled for radioactive content and released to the discharge canal where it is diluted by circulating water if the radioactive content does not exceed applicable regulations. If radioactive content does not permit the release of these liquids, they are transferred to the waste hold-up tank for processing through the waste concentrator.

All radioactive liquid releases from the plant are pumped through a flow meter to obtain the actual volume released and through a radiation monitor which will terminate the discharge if unexpected radiation levels are detected. Although the sample analysis for radioactive content prior to release provides the basis for recording activity releases, the radiation monitor provides surveillance over the operation by closing the discharge valve should the liquid activity level exceed a preset value.

As stated previously, although some portions of the liquid waste system have not operated up to design specifications, releases have been only a fraction of the Technical Specification and 10 CFR 20 limits and have been in compliance with the design objectives of Appendix I of 10 CFR 50.

3.7.1.2 Gaseous Waste Processing System

The Gaseous Waste Processing System is designed to collect radioactive and potentially radioactive gases and to hold these gases for decay or for reuse within the plant. The system is designed to give a minimum of 45 days decay prior to release to the atmosphere which results in only the isotopes Kr-85 and Xe-133 being released to the environment.

A secondary function of the Waste Gas System is to supply nitrogen and hydrogen to primary plant components. Most of the gas received by this sytem during normal operation is cover gas displaced from the Chemical and Volume Control System hold-up tanks as they fill with liquid. Since this cover gas must be replaced when the tanks are emptied during processing, facilities are provided to return gas from the gas decay tanks to the hold-up tanks, thus eliminating the need to discharge these gases to the atmosphere.

Gases collected in the system flow to one of two compressors, and from there to one of four decay tanks. Normal operation of these tanks is to have one tank for collecting gas, one tank isolated for decay, one tank for reuse as cover gas, and the fourth tank empty as a standby. Normally, the last tank to be filled will be the first tank to be reused for cover gas in order to permit the maximum decay time before releasing to the environment.

From time to time, as gas inventories in the system demand, a gas decay tank will be released to the environment. Before a tank is released to the environment, it is sampled and analyzed to determine and record activity levels and then discharged to the plant vent at a controlled rate through a radiation monitor only if it meets prescribed standards for release. The radiation monitor will close the gas discharge valve if activity levels exceed a preset limit. As with liquid releases, the radiation monitor is for surveillance of the releases and the sample analysis provides the permanent record.

With no fuel failure there will be essentially no release of radioactivity to the atmosphere. However, assuming continuous operation with 1% fuel failure, the releases to the atmosphere will comply with all regulations including the numerical guides of Appendix I to 10 CFR 50.

3.7.1.3 Solid Radioactive Waste Processing System

The Solid Waste Processing System is designed to package all solid wastes in DOT approved 55-gallon or 30-gallon drums for removal from the site to a licensed burial facility. Concentrates from the waste evaporator are pumped into a battery of six 55-gallon drums previously filled with a mixture of vermiculite and cement. After filling, the drums are moved to a shielded storage area and held until a sufficient number are accumulated for shipment.

Spent resins are packaged in a similar manner. After the resin has been agitated in the resin storage tank, water is pumped through the tank at a controlled rate to sluice the slurry to the drumming room. There the resin is received in a battery of six drums. The slurry enters the drum and is dewatered by the absorption of the liquid in a mixture of vermiculite and cement. Again the drums are held in a shielded area for shipment.

Dry solid wastes such as air filters, paper, rags, and other radioactively contaminated items are collected throughout the plant. Those items which are compressible are compacted into DOT approved 55-gallon drums in a hydraulic press-baili[illegible] ine. Noncompressible wastes are packaged in 55-gallon drums or other DOT "specification" containers.

3.7.2 Radioactive Releases

During normal operation of the H. B. Robinson Unit No. 2 nuclear plant, small amounts of radioactive materials are discharged into the environment on a controlled basis. Although the resulting doses from these radioactive discharges, even under the most severe operating conditions, are considered insignificant when compared to residence background doses, they are assumed to impose a theoretically calculable radiation dose to the local population. A discussion of the maximum expected releases as well as the actual releases experienced to date is included in the following sections along with the calculated resulting doses from these releases.

3.7.2.1 Radioactive Liquid Releases

The maximum estimated quantity of radioactivity in liquid releases from the H. B. Robinson Plant on an annual basis is shown in Table 3.7-1. These values were obtained using the following assumptions as a basis:

1. A decontamination factor of 10^4 for the Waste Processing System (waste concentrator) was used. Previous calculations to estimate maximum releases in the FSAR assumed a decontamination factor of 10^6 for the waste concentrator; however, operating experience to date has shown this to be unobtainable in the present system and a system decontamination factor of 10^4 is used as a more realistic value. There will, however, be an improvement in the performance of this system when modifications to the concentractor and installation of the demineralizers, as discussed in Section 3.7.1.1, are completed.
2. The value for tritium was obtained by using leakage of ternary fission tritium from the Zircaloy fuel of 1 percent. Original calculations in the FSAR assumed a 30% leakage of tritium from the fuel based on experience with stainless steel cladding. A detailed study performed by Westinghouse at the Robert E. Ginna Station and other operating stations using Zircaloy clad fuel has shown the leakage of fission tritium from the fuel to be less than 1 percent. Semi-quantitative measurements at the H. B. Robinson Plant indicate the 1 percent leakage to be justified.
3. The values shown in Table 3.7-1 were based on continuous operation with 1 percent failed fuel.

The total estimated annual releases shown in Table 3.7-1 represent a maximum release rate as shown by the very conservative assumptions used and it is expected that these levels would never be reached in actual operation. Although these releases represent a maximum, they are used to calculate the radiological effects on the environment.

Also shown in Table 3.7-1 is the equilibrium concentrations in Lake Robinson and the resulting fraction of the MPC for that isotope. Because the cooling water discharge flow is greater than the flow through the lake, the dilution capability of Lake Robinson, rather than the circulating water flow, is used to determine the fraction of MPC. The equation used to obtain the equilibrium concentrations in the Lake is:

$$C = \frac{A}{V\left(\lambda + \frac{Q}{V}\right)}$$

where: C = equilibrium concentration in the lake (μCi/ml)

A = annual release rate to the lake (μCi/year)

V = volume of the lake (3.8×10^{13} ml)

Q = flow of water out of the lake (2.24×10^{14} ml/year)

λ = decay constant ($year^{-1}$)

Based on the equilibrium concentrations in the lake and MPC values from Table II, Appendix B, 10 CFR 20, continuous release at the levels shown in Table 3.7-1 would result in a total release of about 0.3 percent of MPC limits for an identified mixture and would meet all the design objectives of 10 CFR 50, Appendix I. It should further be noted that actual releases are expected to be a small portion of those shown in Table 3.7-1 as evidenced by actual releases experienced during the first year of operation. The actual releases of radioactive materials to the lake during the period September 1970 through August 1971 are shown in Table 3.7-2. A total of 0.583 curies of activation products and 38.274 curies of tritium were discharged to the lake during this period resulting in a concentration in the lake of only 0.013 percent of the MPC for an identified mixture.

Although releases of radionuclides from the H. B. Robinson Plant are small, it is important to know the ultimate radiological consequences to man. Of the possible pathways to man for isotopes in liquid waste, only the internal exposure from the water-fish-man pathway is considered significant.

There is no amount of drinking water taken from Lake Robinson or from Black Creek downstream from the lake. Approximately five miles downstream from Lake Robinson is Prestwood Lake. This impoundment was made exclusively for the industrial use of Sonoco Products Company, although recreational uses such as boating, swimming, and fishing are permitted.

Radioactivity from the lake would not be expected to enter the ground water supply and, subsequently, local wells. Normally, ground water movement is toward a creek such as Black Creek resulting in a ground water discharge in the area. The artesian conditions in the Lake Robinson area prior to construction of the lake tend to verify this fact. If, however, for some unknown reason, radioactivity did get into the ground water aquifer, it would show up in wells at the plant site before reaching other wells in the area. Wells at the plant site are routinely monitored for radioactivity as part of the environmental monitoring program. Based on the preceding information, drinking water is not considered to be a significant pathway.

Although swimming and boating are permitted on Lake Robinson, direct external exposure from these activities is expected to have a negligible effect on people using the lake. Some magnitude of this pathway of exposure can be made by calculating the dose to a water skier from the surface exposure due to cesium-137, the anticipated predominant isotope with a strong gamma emission (Table 3.7-1). The lake surface dose rate is calculated as follows:

$$\frac{\text{rem}}{\text{year}} = 2.1 \times 10^{-9} \frac{\mu\text{Ci}}{\text{ml}} \times 3.7 \times 10^{4} \frac{\text{dps}}{\mu\text{Ci}} \times 3.16 \times 10^{7} \frac{\text{sec}}{\text{year}} \times 1 \frac{\text{ml}}{\text{gm}} \times 0.662 \frac{\text{Mev}}{\text{dis.}}$$

$$\times 0.82 \times 1.6 \times 10^{6} \frac{\text{erg}}{\text{Mev}} \times 0.5 \times \frac{1}{10^{2}} \frac{\text{gm-rad}}{\text{erg}} \times 1 \frac{\text{rem}}{\text{rad}} = 1.06 \times 10^{-5}$$

where 0.5 = 2π geometry factor

0.82 = fraction of gammas actually emitted by Cs-137 which escape the atom

If we assume an individual skis for 2 hours a day, fifty days per year, his actual dose from this source would be 1.21×10^{-7} rem/year. This additional annual exposure is considered to be insignificant.

There is no commercial fishing in Lake Robinson; however, sport fishing is permitted in the lake. Predominant fish in the lake are shown in Table 3.7-3. Although the information in this table was obtained at one time, samples were taken from several locations in the lake and the data is expected to be representative of the fish population.

Fish living in water that contains very low concentrations of radionuclides may concentrate some of these radionuclides through the microorganism - small invertebrate - fish food chain. The collective effect of these concentration mechanisms may be estimated from stable element concentrations in water and fish. An extensive review of stable element data available in the literature has been made[1]. Concentration factors, Cf, for fish in Lake Robinson are based on data provided by this review. Where concentration factors are unknown, the suggested conservative concentration factor of 10^5, as stated in the report, is used. Specifically, this pertains to tellurium.

The projected maximum equilibrium concentrations in fish are listed in Table 3.7-4 for key radionuclides that may be released in liquid effluents. Average per capita consumption of fish in the Middle Atlantic Region is 14.3 pounds/year[2] but more than 1/3 of this is canned or frozen fish from commercial sources. Consumption of fish from Lake Robinson by even the most avid sport fisherman is not likely to exceed the 50 grams/day which has been estimated for a commercial fisherman[3]. An intake of 50 grams/day of fish and 2200 milliliters/day of water[4] has been assumed to estimate internal exposure via the aquatic pathway. Whole body doses are based on the limits for water released to unrestricted areas. These limits were obtained from Reference 4 by dividing the recommended 168 hour levels by 10 so as to obtain 168 hour maximum concentration levels allowed for an average annual whole body dose of 0.5 rem. The following equation was used to obtain the resulting whole body doses:

$$\text{Whole body dose (mrem/year)} = \frac{50}{2200} \times \frac{Cw \times Cf}{MPCw\text{-}wb} \times 500$$

Where: 50 = grams of fish consumed daily[3]

2200 = ml of water consumed daily[4]

Cw = calculated equilibrium concentration in the lake in μCi/ml (Table 3.7-1)

Cf = isotopic concentration factor from water to fish[1]

MPCw-wb = maximum permissible concentration in water to deliver 50 mrem/year whole body dose[5]

500 = maximum permissible mrem/year whole body dose[5]

The total whole body dose as shown in Table 3.7-4 is 3.03 mrem/year. It should be noted that 0.59 mrem/year of this total is based on a Cf of 1×10^5 for Te-132, which is probably high by at least a factor of 100. In addition 0.79 mrem/year of the total is based on tritium. Unless the fish is consumed raw, the water content of the fish (and with it the tritium) will be greatly reduced by the cooking process. Also the primary contributors are all fission products (cesium, tellurium), which presupposes the 1 percent failed fuel. In the expected event that fuel failure is less than the 1 percent, then the whole body dose will be correspondingly less as evidenced by calculating doses a person might receive as the result of releases during the first year of operation. As shown in Table 3.7-5, this calculation shows a resulting dose of 0.065 mrem/year due to the consumption of 50 grams/day of fish from Lake Robinson.

Since there is no commercial fishing from Lake Robinson and sport fishing is primarily by individuals in the local area, there will be essentially no increase in the total population dose within the 50-mile radius.

3.7.2.2 Gaseous Effluents

The estimated maximum quantity of gaseous radioactivity released from the H. B. Robinson Plant on an annual basis is shown in Table 3.7-6. These values are based on the assumptions of (1) continuous operation at 2300 MWt with cladding defects in fuel rods generating one percent of the rated core thermal power, and (2) a minimum of 45 days hold-up time in the gas decay tanks. The continuous operation for one year with one percent fuel defects is considered unrealistic and is presented for conservative calculation purposes.

The estimated maximum expected quantity of gaseous radioactivity released from the H. B. Robinson Plant on an annual basis is also shown in Table 3.7-6. These values are based on the more realistic assumptions of (1) continuous operation at 2300 MWt with cladding defects in fuel rods generating 0.2 percent of the rated core thermal power, and (2) a minimum of 45 days hold-up time in the gas decay tanks. These assumptions are considered to be conservative and would be the maximum that could ever be expected on an annual basis. The conservatism of these assumptions can be illustrated by the fact that the annual release of 1476 curies per year estimated on this basis is significantly higher than estimates extrapolated from experience to date in operating pressurized water reactors and far exceeds the 0.022 curies released from the H. B. Robinson Plant during the period September 1970-August 1971, as shown in Table 3.7-7.

Radiation doses from these gaseous effluents as a function of distance and direction were calculated for each of the release modes shown above. A summary of resulting population doses is shown in Table 3.7-8. These doses were calculated using the annual average atmospheric dispersion for the site. The 1986 population projections as shown in Figures 2.1-5 and 2.1-6 were used to obtain the population distribution. Doses were calculated using the ICRP "infinite semispherical cloud" model.[4]

The average annual radiation dose, in rems, was calculated for each sector of the individual population rings using the annual average meteorological conditions for that sector and distance from the plant. The population dose in each sector, in man-rem/year, was calculated by multiplying the average dose for that sector by the projected population in that sector for the year 1986. The total population dose in each ring was obtained by summing the population doses within the 16 individual sectors within that ring. The total population dose is the sum of the doses in each of the rings out to 50 miles. The average per capita dose was calculated by dividing the total population dose by the total projected population within the 50-mile radius.

Also included, for comparison purposes, in Table 3.7-8 are the population doses estimated to result from residence background radiation in the absence of the plant. Sources of background radiation are discussed in Section 3.6.1.2. It can be concluded from this data that the population dose due to gaseous effluents will, under the most severe operating conditions, be only a small fraction of the background and that the plant can be operated safely within the limits of 10 CFR 20 and the design objectives of Appendix I, 10 CFR 50.

Although the only significant mode of general public exposure from effluents from the Robinson Plant is from direct external radiation from the elevated plume of noble gases as described above, other modes of exposure were evaluated and judged to be by comparison of little or no significance. Radioiodine and particulate effluents from the plant will be controlled within the design objectives contained in Appendix I, 10 CFR 50 and within the technical specifications from the plant. Since there are no commercially grown and locally marketed food crops in the local area, and since the nearest dairy herd is at least seven miles from the site, the resulting population dose from discharge of iodines and particulates is expected to approach zero.

3.7.3 Maximum Exposed Individual

The maximum exposed individual is considered to be a person standing at the nearest site boundary 356 days per year and consuming 50 grams/day of fish from Lake Robinson. This also assumed that maximum discharges to Lake Robinson have continued for a sufficient length of time to reach equilibrium concentrations in the lake and an additional length of time for fish to concentrate these nuclides (since Cs-137 is the critical nuclide, this period of time would be several years). If gaseous releases continued for one year at the design release rates, the exposure to an individual at the site boundary would be 7.85 mrem/year. Adding to this the 3.03 mrem/year due to fish consumption would result in an annual exposure of 10.88 mrem. However, using the maximum expected annual release of 1476 curies of gaseous activity, the same person's annual dose would be 1.56 mrem from this source and an additional 3.03 mrem from fish consumption for a total of 4.59 mrem/year. This dose is considered to represent a maximum dose to an individual and would in practice never be achieved. Calculated dose to this individual resulting from releases through August 1971 is only a small fraction of this 4.59 mrem as shown in Tables 3.7-5 and 3.7-8.

3.7.4 Population Dose

As shown in Table 3.7-7, the total dose to the population within a 50-mile radius of the plant is 26.25 man-rem/year from gaseous releases assuming a maximum design basis annual release and 5.25 man-rem/year assuming a maximum expected annual release. It should be noted that the computed man-rem dose did not take credit for the shielding provided by occupying of homes, offices, cars, etc. which would in fact, reduce the man-rem doses by about a factor of 2. There is essentially no increase in the population dose due to fish consumption by a few local sport fishermen.

As shown in Table 3.7-8 and discussed in Section 3.6.1.2, this same population receives 156,762 man-rem/year exposure from natural and other man-made radiation. Even considering the unrealistic assumption of gaseous releases at the maximum design value, the total population dose due to plant operations is only 0.02 percent of that estimated to be received from natural background and other man-made sources of radiation in the absence of the plant. In actual practice the dose to the population would be expected to be much less than that shown. It can be concluded that the additional exposure received by the population from plant operations is of only very minor significance when compared to that received from background sources.

SECTION 3.7 REFERENCES

1. Chapman, W. H., H. L. Fisher, and M. W. Pratt, "Concentration Factors of Chemical Elements in Edible Aquatic Organisms" Lawrence Radiation Laboratory, University of California, Livermore, California, Report No. UCRL 50564, December 1968.

2. Nash, Darrel A., "A Survey of Fish Purchases by Socio-Economic Characteristics" Annual Report, February 1969 - January 1970, Bureau of Commercial Fisheries, Working Paper No. 50.

3. Cowser, K. E. and W. S. Snyder "Safety Analysis of Radioactive Release to the Clinch River" ORNL 3721, Supplement 3, 1966.

4. ICRP Publication 2: "Report of Committee II on Permissible Dose for Internal Radiation, 1959". International Commission of Radiological Protection. Pergamon Press New York, 1959.

5. U. S. Atomic Energy Commission, Title 10 - Atomic Energy, Part 20 - Standards for Protection Against Radiation, Appendix B, Table II, Column 2, Revised December 10, 1969.

TABLE 3.7-1

ESTIMATED MAXIMUM ANNUAL LIQUID ISOTOPIC RELEASES*
H. B. ROBINSON UNIT NO. 2

Isotope	Annual Release μCi/year	$T_{1/2}$	MPCw μCi/ml	Decay Constant $Year^{-1}$	Equilibrium Concentration in Lake μCi/ml	Fraction** of MPCw
Cr-51	2.40×10^{1}	27.8d	2×10^{-3}	9.1×10^{0}	4.22×10^{-14}	2.1×10^{-11}
Mn-54	1.08×10^{2}	303d	1×10^{-4}	8.4×10^{-1}	4.2×10^{-13}	4.2×10^{-9}
Mn-56	2.94×10^{3}	2.6h	1×10^{-4}	2.35×10^{3}	3.27×10^{-14}	3.3×10^{-10}
Co-58	3.29×10^{3}	71.3d	9×10^{-5}	3.56×10^{0}	9.1×10^{-12}	1.0×10^{-7}
Fe-59	1.27×10^{2}	45.6d	5×10^{-5}	5.54×10^{0}	2.9×10^{-13}	5.8×10^{-9}
Co-60	3.88×10^{2}	5.26y	3×10^{-5}	1.33×10^{-1}	1.7×10^{-12}	5.7×10^{-8}
Sr-89	1.33×10^{3}	52.7d	3×10^{-6}	5.03×10^{0}	3.22×10^{-13}	1.1×10^{-7}
Sr-90	4.02×10^{1}	27.7y	3×10^{-7}	2.5×10^{-2}	1.78×10^{-13}	6.9×10^{-7}
Y-90	4.62×10^{1}	64h	2×10^{-5}	9.42×10^{1}	1.22×10^{-14}	6.1×10^{-10}
Sr-91	3.43×10^{2}	9.67h	5×10^{-5}	6.28×10^{2}	1.42×10^{-14}	2.8×10^{-10}
Y-91	2.36×10^{3}	58.8d	3×10^{-5}	4.34×10^{0}	6.1×10^{-12}	2.0×10^{-7}
Y-92	5.43×10^{1}	3.58h	6×10^{-5}	1.73×10^{3}	8.2×10^{-16}	1.4×10^{-11}
Zr-95	1.02×10^{2}	65.5d	6×10^{-5}	3.76×10^{0}	2.77×10^{-13}	4.6×10^{-9}
Nb-95	1.01×10^{2}	35d	1×10^{-4}	7.23×10^{0}	2.03×10^{-13}	2.0×10^{-9}
Zr-97	6.60×10^{1}	17h	2×10^{-5}	3.58×10^{2}	4.7×10^{-15}	2.4×10^{-10}
Mo-99	9.79×10^{5}	66.7h	4×10^{-5}	9.05×10^{1}	2.67×10^{-10}	6.7×10^{-6}
Ru-105	1.00×10^{1}	4.44h	1×10^{-4}	1.37×10^{3}	1.9×10^{-16}	1.9×10^{-12}
I-131	7.87×10^{5}	8.05d	3×10^{-7}	3.14×10^{1}	5.55×10^{-10}	1.8×10^{-3}
Te-132	8.28×10^{4}	77.7h	2×10^{-5}	7.77×10^{1}	2.6×10^{-11}	1.3×10^{-6}
I-132	2.43×10^{4}	2.26h	8×10^{-6}	2.64×10^{3}	2.42×10^{-13}	3.0×10^{-8}
I-133	9.94×10^{5}	20.3h	1×10^{-6}	3.03×10^{2}	8.5×10^{-11}	8.5×10^{-5}
I-134	3.76×10^{0}	52m	2×10^{-5}	6.86×10^{3}	1.44×10^{-7}	7.2×10^{-13}
I-135	2.90×10^{5}	6.68h	4×10^{-6}	9.05×10^{2}	8.2×10^{-12}	2.1×10^{-6}
Cs-134	8.65×10^{4}	2.05y	9×10^{-6}	3.01×10^{-1}	3.67×10^{-10}	4.1×10^{-5}
Cs-136	1.25×10^{4}	13.7d	6×10^{-5}	1.95×10^{1}	1.3×10^{-11}	2.2×10^{-7}
Cs-137	4.70×10^{5}	30.0y	2×10^{-5}	2.3×10^{-2}	2.1×10^{-9}	1.0×10^{-4}
Ba-140	3.17×10^{2}	12.8d	2×10^{-5}	1.97×10^{1}	3.25×10^{-13}	1.6×10^{-8}
La-140	2.91×10^{2}	40.2h	2×10^{-5}	1.51×10^{2}	3.7×10^{-14}	1.9×10^{-9}
Ce-144	1.13×10^{3}	284d	1×10^{-5}	8.90×10^{-1}	4.7×10^{-12}	4.7×10^{-8}
Total	3.74×10^{6}					2.04×10^{-3}
H-3	8.49×10^{8}	12.26y	3×10^{-3}	5.6×10^{2}	3.17×10^{-6}	1.06×10^{-3}

*Based on continuous operation with cladding defects in fuel rods generating one percent of the rated core thermal power.

**Based on equilibrium concentrations in the lake and MPC's from Table II, Appendix B, 10CFR20.

TABLE 3.7-2

RADIOACTIVE RELEASES IN LIQUIDS
FROM H. B. ROBINSON UNIT 2
(SEPT. 1970 - AUG. 1971)

Isotope*	Total Release mCi	Concentration *** in Lake (μCi/ml)	MPC_f**
Cr-51	13.2	2.3×10^{-11}	1.15×10^{-8}
Mn-54	63.5	2.5×10^{-10}	2.5×10^{-6}
Fe-59	2.6	7.2×10^{-12}	1.44×10^{-7}
Co-58	450.0	1.25×10^{-9}	1.4×10^{-5}
Co-60	29.0	1.27×10^{-10}	4.2×10^{-6}
I-131	23.0	1.6×10^{-11}	5.3×10^{-5}
Cs-137	1.9	8.4×10^{-12}	4.2×10^{-7}
Total	583.2		7.43×10^{-5}
H-3	38,274	1.7×10^{-7}	5.7×10^{-5}

* The isotopic distribution of releases shown here is based on representative isotopic identification of individual releases and on composite identification of other releases and is representative of the actual distribution of the total annual release.

**Based on MPC's from Table II, Appendix B, 10 CFR Part 20. The MPC_f is the fraction of the MPC in the lake and is obtained by dividing the concentration in the lake by the MPC for that isotope.

***Concentration in the lake is calculated as follows:

$$X = \frac{C}{V\left(\lambda + \frac{R}{V}\right)} \left[1 - \exp -\left(\lambda + \frac{R}{V} \right) t \right]$$

Where

X = concentration in the lake (μCi/ml)
C = addition rate to the lake (μCi/year)
V = volume of lake (ml)
R = flow rate from the lake (ml/year)
λ = decay constant ($year^{-1}$)
t = time (years)

TABLE 3.7-3

LAKE ROBINSON FISH DISTRIBUTION[1]

		Total No.	Total Wt.	% Total No.	% Total Wt.
Redfin pickerel	Esox americanus	1	0.2	0.03	0.04
Chain pickerel	Esox niger	42	15.2	1.2	3.4
Golden shiner	Notemigonus crysoleucas	1,113	113.1	30.9	25.3
Lake chubsucker	Erimyzon sucetta	134	52.5	3.7	11.8
Spotted sucker	Minytrema melanops	65	128.1	1.8	28.7
White catfish	Ictalurus catus	1	Trace	0.03	Trace
Bullhead	Ictalurus spp.	38	4.7	1.1	1.1
Madtom	Noturus spp.	3	Trace	0.1	Trace
Starhead topminnow	Fundulus notti	30	Trace	0.8	Trace
Pirate perch	Aphredoderus sayanus	68	3.0	1.9	0.7
Mud sunfish	Acantharchus pomotis	1	Trace	0.03	Trace
Warmouth	Chaenobryttus gulosus	227	25.7	6.3	5.8
Blackbanded sunfish	Enneacanthus chaetodon	55	2.4	1.5	0.5
Bluespotted sunfish	Enneacanthus gloriosus	169	5.4	4.7	1.2
Redbreast sunfish	Lepomis auritus	99	14.8	2.7	3.3
Pumpkinseed	Lepomis gibbosus	25	3.4	0.7	0.8
Bluegill	Lepomis macrochirus	1,273	37.4	35.3	8.4
Largemouth bass	Micropterus salmoides	222	33.3	6.2	7.5
Black crappie	Pomoxis nigromaculatus	39	7.3	1.1	1.6

(1)"Fisheries Investigations in Lakes and Streams, District IV", Annual Progress Report for period of July 1, 1968 through June 30, 1969, South Carolina Wildlife Resources Dept., 1969

TABLE 3.7-4
WHOLE BODY EXPOSURE FROM ESTIMATED
MAXIMUM ANNUAL LIQUID ISOTOPIC RELEASES
H. B. ROBINSON UNIT NO. 2

Isotope	C Annual Release µCi/yr.	Cw Concentration In Lake µCi/ml	Concentration Factor C_f	MPCw Whole Body µCi/ml	Whole Body Dose= $\frac{50}{2200} \times \frac{Cw \times Cf}{MPCw} \times 500$ (m em/yr.)
Cr-51	$2.4x10^{1}$	$4.22x10^{-14}$	$2x10^{2}$	$2x10^{-2}$	$47.96x10^{-10}$
Mn-54	$1.08x10^{2}$	$4.20x10^{-13}$	$2.5x10^{1}$	$8x10^{-4}$	$14.91x10^{-8}$
Mn-56	$2.94x10^{3}$	$3.27x10^{-14}$	$2.5x10^{1}$	$3x10^{-2}$	$30.97x10^{-11}$
Co-58	$3.29x10^{3}$	$9.10x10^{-12}$	$5x10^{2}$	$4x10^{-4}$	$12.93x10^{-5}$
Fe-59	$1.27x10^{2}$	$2.90x10^{-13}$	$3x10^{2}$	$2x10^{-4}$	$49.44x10^{-7}$
Co-60	$3.88x10^{2}$	$1.70x10^{-12}$	$5x10^{2}$	$1x10^{-4}$	$96.60x10^{-6}$
Sr-89	$1.33x10^{3}$	$3.22x10^{-13}$	$4x10^{1}$	$7x10^{-5}$	$20.91x10^{-7}$
Sr-90	$4.02x10^{1}$	$1.78x10^{-13}$	$4x10^{1}$	$4x10^{-7}$	$20.23x10^{-5}$
Y-90	$4.62x10^{1}$	$1.22x10^{-14}$	$1x10^{2}$	$4x10^{-1}$	$34.66x10^{-12}$
Sr-91	$3.43x10^{2}$	$1.42x10^{-14}$	$4x10^{1}$	$7x10^{-4}$	$92.22x10^{-10}$
Y-91	$2.36x10^{3}$	$6.10x10^{-12}$	$1x10^{2}$	$2x10^{-1}$	$34.66x10^{-9}$
Y-92	$5.43x10^{1}$	$8.20x10^{-16}$	$1x10^{2}$	$3x10^{1}$	$31.06x10^{-13}$
Zr-95	$1.02x10^{2}$	$2.77x10^{-13}$	$1x10^{2}$	$1x10^{-1}$	$31.48x10^{-10}$
Nb-95	$1.01x10^{2}$	$2.03x10^{-13}$	$3x10^{4}$	$4x10^{-1}$	$17.30x10^{-8}$
Zr-97	$6.60x10^{1}$	$4.70x10^{-15}$	$1x10^{2}$	$4x10^{0}$	$13.35x10^{-13}$
Mo-99	$9.79x10^{5}$	$2.67x10^{-10}$	$1x10^{2}$	$8x10^{-4}$	$37.93x10^{-5}$
Ro-105	$1.00x10^{1}$	$1.90x10^{-16}$	$1x10^{2}$	$9x10^{-2}$	$23.99x10^{-13}$
I-131	$7.87x10^{5}$	$5.55x10^{-10}$	$1x10^{0}$	$2x10^{-4}$	$31.54x10^{-6}$
Te-132	$8.28x10^{4}$	$2.60x10^{-11}$	$1x10^{5}$	$5x10^{-4}$	$59.10x10^{-2}$
I-132	$2.43x10^{4}$	$2.42x10^{-13}$	$1x10^{0}$	$4x10^{-3}$	$68.76x10^{-11}$
I-133	$9.94x10^{5}$	$8.50x10^{-11}$	$1x10^{0}$	$9x10^{-4}$	$10.73x10^{-7}$
I-134	$3.76x10^{0}$	$1.44x10^{-7}$	$1x10^{0}$	$1x10^{-2}$	$16.37x10^{-5}$
I-135	$2.90x10^{5}$	$8.20x10^{-12}$	$1x10^{0}$	$2x10^{-3}$	$40.60x10^{-9}$
Cs-134	$8.65x10^{4}$	$3.67x10^{-10}$	$1x10^{3}$	$9x10^{-6}$	$46.34x10^{-2}$
Cs-136	$1.25x10^{4}$	$1.30x10^{-11}$	$1x10^{3}$	$9x10^{-5}$	$16.42x10^{-4}$
Cs-137	$4.70x10^{5}$	$2.10x10^{-9}$	$1x10^{3}$	$2x10^{-5}$	$11.93x10^{-1}$
Ba-140	$3.17x10^{2}$	$3.25x10^{-13}$	$1x10^{1}$	$5x10^{-4}$	$73.87x10^{-9}$
La-140	$2.91x10^{2}$	$3.70x10^{-14}$	$1x10^{2}$	$2x10^{1}$	$21.03x10^{-11}$
Ce-144	$1.13x10^{3}$	$4.70x10^{-12}$	$1x10^{2}$	$3x10^{-2}$	$17.81x10^{-8}$
H-3	$8.49x10^{8}$	$3.77x10^{-6}$	$9.26x10^{-1}$	$5x10^{-3}$	$78.90x10^{-2}$
			Total		3.03

TABLE 3.7-5
WHOLE BODY DOSES FROM RELEASES TO
LAKE ROBINSON
(SEPT. 1970 - AUG. 1971)

Isotope	Total Release To Sept.'71 (mCi)	Cw Concentration In Lake (μCi)/ml	Concentration Factor Cf	MPCw For Whole Body	Whole Body Dose = $\frac{50}{2200} \times \frac{Cw \times Cf}{MPCw} \times 500 \frac{mrem}{year}$
Cr-51	13.2	2.3×10^{-11}	2×10^{2}	2×10^{-2}	2.61×10^{-6}
Mn-54	63.5	2.5×10^{-10}	2.5×10^{1}	8×10^{-4}	8.88×10^{-5}
Fe-59	2.6	7.2×10^{-12}	3×10^{2}	2×10^{-4}	1.23×10^{-4}
Co-58	450	1.25×10^{-9}	5×10^{2}	4×10^{-4}	1.77×10^{-2}
Co-60	29	1.27×10^{-10}	5×10^{2}	1×10^{-4}	7.21×10^{-3}
I-131	23	1.60×10^{-11}	1×10^{0}	2×10^{-4}	9.08×10^{-7}
Cs-137	1.9	8.4×10^{-12}	1×10^{3}	2×10^{-5}	4.80×10^{-3}
H-3	38,274	1.7×10^{-7}	9.26×10^{-1}	5×10^{-3}	3.5×10^{-2}
		Total			6.5×10^{-2} $\frac{mRem}{Year}$

TABLE 3.7-6

ESTIMATED ANNUAL GASEOUS RELEASE BY ISOTOPE FROM H. B. ROBINSON UNIT NO. 2

Isotope		Maximum Design Activity Curies/yr.(1)	Maximum Expected Activity Curies/yr.(3)
Kr 85		3857	772
Kr 85m, 87, 88		Negligible	Negligible
Xe 133		3522(2)	704(2)
Xe 133m, 135, 135m, 138		Negligible	Negligible
	Total	7379	1476

(1) Based on 1% defective fuel and 2300 MWt load follow operation

(2) 45-day holdup

(3) Based on 2% defective fuel and 2300 MWt load follow operation

TABLE 3.7-7

GASEOUS RELEASES FROM
H. B. ROBINSON UNIT NO. 2

Isotope	Activity Released Sept. 1970-Aug. 1971 Curies
Mixture Xe-133, Kr-85	0.022

TABLE 3.7-8

POPULATION EXPOSURE FROM GASEOUS RELEASES AT THE
H. B. ROBINSON STEAM ELECTRIC PLANT

Distance From The Site in Miles	Population (1986 Projection)	Maximum Man-Rem Dose From Design Basis	Maximum Expected Dose In Man-Rem	Actual Man-Rem Dose From Sept. 1970-Aug. 1971	Natural Background Man-Rem Sept. 1970-Aug. 1971
0-1	534	2.91	0.58	8.7×10^{-6}	107
1-2	994	1.20	0.24	3.6×10^{-6}	199
2-3	1534	0.93	0.19	2.8×10^{-6}	307
3-4	2875	1.12	0.22	3.4×10^{-6}	576
4-5	8003	2.18	0.43	6.5×10^{-6}	1600
5-10	19624	2.67	0.53	8.0×10^{-6}	3924
10-20	55905	2.94	0.59	8.8×10^{-6}	11182
20-30	184893	4.97	1.00	1.5×10^{-5}	36978
30-40	223153	3.75	0.75	1.1×10^{-5}	44630
40-50	286298	3.58	0.72	1.1×10^{-5}	57260
TOTAL (0-50)	783813	26.25	5.25	8.0×10^{-5}	156762
	Average Rem / Person	3.35×10^{-5}	6.7×10^{-6}	1.02×10^{-10}	2.0×10^{-1}

3.8 AESTHETICS

The site is located in a rolling wooded rural area in the northeastern section of South Carolina. The terrain surrounding Lake Robinson has been preserved in its natural state except in the plant area and those areas where residential and recreational facilities have been developed by others on adjoining lands. Prior to construction of the nuclear unit, the site had been dedicated to the generation of electrical energy. The addition of the nuclear unit did not significantly alter the aesthetic value of the site area. The nuclear unit renders a minimum disturbance to the rural background and was designed with clean, architecturally pleasant lines.

During the construction of H. B. Robinson Unit No. 2, some temporary upsetting of the environment was unavoidable. Every effort has been made to eliminate all temporary construction effects. A temporary access road was built on CP&L property from the main hardtop road serving the plant area for the purpose of bringing in materials and equipment for construction and for access by workmen. After completion of the unit, the land used for the temporary road was returned to its original state by reseeding and planting pine seedlings.

To provide additional protection to the lake, the discharge canal was lengthened by 3 miles. After completion of the canal modification, the slopes and embankment were seeded and planted with pine seedlings to control erosion and to enhance the aesthetic qualities of the canal and make it harmonious with the surrounding environs.

After completion of construction, the plant area within the fenced enclosure was seeded and the area surrounding the plant was seeded and planted with a large number of pine seedlings for erosion control and enhancement of the aesthetic qualities of the area.

Figure 1.1-1 is an aerial photograph of the H. B. Robinson plant site and local environs. This photograph illustrates the compatibility of the nuclear unit #2 with the environs and the progress made to date in elimination of temporary construction effects.

A visitor's center and picnic area are located at the site. The center is architecturally pleasing and the area, which is well landscaped, provides an excellent vantage point to view the plant.

3.9 TRANSPORTATION EFFECTS

The generation of electrical energy in a nuclear power plant requires the periodic shipment of new fuel assemblies to the plant, spent fuel assemblies to a fuel reprocessing facility, and packaged low-level radioactive materials to licensed waste burial grounds. The shipment made in compliance with Federal and State requirements pertaining to th per packaging and transportation of the materials.

New pressurized water reactor fuel (UO_2 pellets clad in Zircaloy) for the Robinson Plant will be shipped by either rail or truck from the fabrica plant in packages designed to protect them from physical damage due to the normal handling and vibration of transportation and will be in accordance with U. S. Department of Transportation (DOT) regulations for the transportation of fissile materials. Because new fuel contains no fission products or radioactive gases, an accident involving a new fuel shipment in which the package and fuel assemblies were damaged wo result in no release of radioactivity and would, therefore, have environmental effect. The only effect would be an economic loss for replacement of the damaged new fuel assemblies.

Inherent in the generation of power with a nuclear reactor is the fact that fissionable isotopes in the nuclear fuel are depleted to the extent that they need to be replaced with new fuel. However, the spent fuel still contains residual fissionable uranium and plutonium. This recovery operation can most safely and economically be carried out at a separate fuel reprocessing facility serving many individual reactors. Therefore, the spent fuel must be transported to a recovery facility where valuable uranium and plutonium can be recovered and residual wastes packaged for safe disposal.

The Robinson nuclear unit will discharge approximately 52 spent fuel assemblies each year. The spent fuel will be cooled in the plant fuel storage pools for at least three months prior to shipment during which time many of the isotopes present will decay away. When cooled, the spent fuel will be packaged in containers designed and constructed to meet the rigorous requirements of the USAEC and U. S. Department of Transportation. These requirements provide for protection of the public in case of abnormal and accident conditions as well as normal conditions of transport. The normal shipping conditions require that the package be able to withstand temperatures ranging from -40°F to 130°F and to withstand the normal vibrations, shocks, and wetting that would be incident to normal transport. The accident conditions for which the package must be designed include, in sequence, a 30-foot free fall onto a completely unyielding surface, a 40-inch drop onto a 6-inch diameter pin, 30 minutes in a 1475°F fire, followed by 8 hours immersion in 3 feet of water. The permissible radiation levels and releases for these shipping conditions are given in Table 3.9-1. The radiation levels shown in Table 3.9-1 represent limits established by the regulations. The containers will exhibit radiation levels and releases under accident conditions less than those permitted by the regulations.

Prior to their use, container designs and the transport system will be reviewed and approved by USAEC and USDOT, and transportation will be authorized by a license issued by the USAEC. License provisions will include adequate Quality Assurance and Testing Programs to assure equipment is constructed and used in accordance with approved designs and procedures. When loaded, containers will be decontaminated, if necessary, and carefully surveyed and inspected to assure that they have been properly prepared for shipment and are in full compliance with license provisions governing transportation. Shipments will also be placarded in accordance with Federal regulations.

CP&L has a long-term contract by which Allied Gulf Company will reprocess spent fuel. Spent fuel will be transported by both rail and exclusive-use truck. By rail 7 to 12 fuel assemblies can be handled in one shipment; by truck, the capacity is limited to one fuel assembly per shipment. Since rail service is available at the Robinson Plant, most spent fuel will be shipped by rail. Truck shipment will be used only for odd numbers of assemblies left over from full rail shipments.

Based on this plan, approximately 5 rail shipments and approximately 2 truck shipments will be made each year. Destination for these shipments will be Allied Gulf Nuclear Services in Barnwell, South Carolina. Rail routing will be via Florence, S. C. and Orangeburg, S. C., a distance of 130 miles which will require approximately 48 hours, via direct movement over the Seaboard Coastline Railroad. Truck routing will be via highways, SC 151, I-20, US 321, and SC 64, a distance of 132 miles, which will require 4½ hours.

The total yearly spent fuel shipping program will be carried out in approximately one month. In all cases, truck shipments will be routed to avoid heavily populated and congested areas as well as tunnels, bridges or roads which prohibit such shipments. Progress of truck shipments will be frequently reported to the reprocessor while enroute and each truck will have two specially trained drivers. Instruments for detection of abnormal conditions and instructions for immediate action will accompany all truck shipments and will be available at rail connection and interchange points. Progress of rail shipments will be monitored and reported at all connections and interchange points.

A formal Accident Control and Recovery Plan will be developed prior to the first shipment which will provide for rapid and orderly utilization of CP&L, carrier, Allied-Gulf, USAEC, State and Local Radiological Assistance Personnel as required in the event any abnormal condition or accident is encountered. The plan will include salvage and recovery as well as control of bodily injury and property damage.

It is believed that there will be no significant adverse environmental effects associated with the transportation of spent fuel from the Robinson Plant. This conclusion is based on the following:

(1) The volume of rail and truck traffic added in the region of interest is an insignificant part of existing traffic.

(2) The packaging and vehicle will be designed to withstand both normal and accident conditions without release of radioactive spent fuel or harmful radiation exposure to the public.

(3) The hazards associated with possible accidents are largely those associated with conventional heavy object shipments, not radiological hazards.

(4) The probability of accidents is lower than comparable heavy object shipments because of the additional equipment design and operational safety requirements because of thorough driver screening and training.

Shipment of solid waste containers of low level radioactive material between the plant and a disposal location will be done periodically. Regulations pertaining to such packaging and shipments prescribed by the AEC and U. S. Department of Transportation will be met. Approximately 1000 drums of solid waste will be shipped from the plant each year. Each shipment will consist of from 15 to 100 drums.

The only exposure to people from routine shipments is for the brief period such a shipment is in direct view. A person standing along the roadway while a solid waste shipment passes would receive an insignificant direct dose.

The radiation exposure to the public in transporting new fuel, spent fuel, and low level radioactive wastes from the plant will constitute no hazard to the general public, nor result in any significant environmental effect.

The principal environmental effect from these shipments would be the direct radiation dose from the shipments as they move from the plant to the reprocessing plant. In this regard, it has been assumed that the shipments will be made at the maximum permitted level of 10 mrem per hour at six feet from the nearest accessible surface. Based on this, and with the nearest person assumed to be 100 feet from the centerline of the tracks (because of railroad right of way) it is estimated that the dose rate at that point would be 0.2 mrem per hour. This would fall off to 0.01 mrem per hour at approximately 300 feet beyond which the reduction exposure received by the population is considered to be negligible.

TABLE 3.9-1

CONTAINER DESIGN RESTRICTIONS

	NORMAL CONDITIONS	ACCIDENT CONDITIONS
EXTERNAL RADIATION LEVELS		
SURFACE	200 MR/hr	
3 FT. FROM SURFACE		1000 MR/hr
6 FT. FROM SURFACE	10 MR/hr	
PERMITTED RELEASES		
NOBLE GASES	NONE	1000 Ci
CONTAMINATED COOLANT	NONE	0.01 Ci alpha, 0.5 Ci mixed fission products 10 Ci Iodine
OTHER	NONE	NONE
CONTAMINATION LEVELS		
BETA AND GAMMA	2200 dpm/100 cm^2	
ALPHA	220 dpm/100 cm^2	

3.10 TRANSMISSION LINES

The transmission lines were planned, designed, routed and constructed to minimize the environmental impact.

3.10.1 Description of Transmission Lines

The power generated at the Robinson Nuclear Unit is transmitted over four 230 KV transmission lines extending to the transmission grid.

The transmission lines which were constructed in 1970 with the Robinson Nuclear Unit are as follows:

Robinson - Sumter 230 KV	38.6 miles
Robinson - Florence South 230 KV	27.1 miles
Robinson - Florence North 230 KV	17.6 miles
Robinson - Rockingham 230 KV	17.6 miles

The line to Rockingham and the north line to Florence consist of two short sections of new 230 KV line constructed from the plant to connect to an existing 230 KV line, near Society Hill, S. C. The line to Rockingham consists of 17.6 miles of new 230 KV line and a 31.9 mile section of the existing 230 KV line between Florence and Rockingham. The Robinson-Florence North 230 KV Line consists of 17.6 miles of new 230 KV line and 20.6 miles of the same 230 KV line from Florence to Rockingham. The line to Sumter and the southern line to Florence was constructed on completely new right of way from Robinson to the respective substations. See Figure 3.10-1 for the transmission system in South Carolina.

The location of the 230 KV lines superimposed on a portion of the South Carolina state highway road map is shown on Figure 3.10-2.

Each of the transmission lines is operated at 230 KV, and consists of wood two pole H-frame structures, except for structures immediately adjacent to the Robinson Plant. The wood structures are shown on Figure 3.10-3. The basic structure consists of two 70-foot wood poles extending 61 feet out of the ground. Span lengths average 650 feet. The conductor is 1,272,000 45/7 ACSR (diameter = 1.345 inches) per phase. The overhead ground wires are either 2 - 7 #10 alumoweld (diameter = .306 inches) or 2 - 3/8" high strength steel (diameter = .360 inches).

In the immediate vicinity of the Robinson Plant, galvanized steel lattice towers in place of H-frame structures were used to provide sufficient height to cross existing lines leaving the switchyard.

3.10.2 Environmental Effects of Transmission Lines

The construction and the operation of the lines have a minimum effect on the environment.

The lines have caused no change in population patterns and will have minimum change on land use in future years. No residences were removed or affected. The only lands committed to the lines are the areas they traverse. Ownership of the land is retained by the property owners who continue to use it for agricultural, recreational or other purposes not inconsistent with the operation of the lines.

The Company continues to cooperate with State and Local agencies, property owners and other individuals in creating recreational and wildlife opportunities along portions of the right of way. The Company continues to prepare the land, in cooperation with the property owners, for other uses such as pasture land and for agricultural purposes.

The right of way affords excellent potential for game food plots and game cover, recreation areas, parks, golf courses, orchards, picnic areas, storage areas, parking areas, Christmas tree and other types of nurseries, wildlife sanctuaries, refuges and management areas, and access roads either private or public.

Forest fires are a constant threat and can cause extensive damage to the forests and wildlife. Where the right of way crosses wooded areas, it provides an excellent fire break to help limit and confine forest fires to the immediate area. The right of way also provides a ready means of access for fire fighting equipment in inaccessible areas.

To reduce the visual impact of the lines, wood pole H-frame structures using wood poles of minimum height were used. The poles blend in with the forested area and because they are of low height are generally not visible above the tree tops at a distance.

At locations where the lines cross areas of public access such as roads, rivers, and streams, the existing growth in the right of way is left in its natural state during reclearing operations to provide a screen for the structures. The reclearing is limited to that material which poses a hazard to the line. Where necessary to remove large trees and other growth, special clearing techniques are used to reduce any possible damage to the remaining growth. Native types of plants, low growing trees, etc. are planted in areas where needed for effective screening. The wood pole structures are located behind the screening to blend in with trees, and this together with their low profile provides a very effective means of reducing the visibility of the structures. Access to the right of way behind the screening is by access roads located at an angle to the screening. It is the intent of the Company to preserve and enhance the natural growth in these areas.

The wood pole structures were transported to each site and constructed with a minimum disturbance to the environment. Their foundations, 2 per structure, required an absolute minimum of excavation, since the pole butt is directly buried in the ground. Excess soil removed from the pole hole was evenly distributed over the surrounding area. Pole holes were 36 inches in diameter and 9 feet deep. Each tangent structure only occupies an area of approximately 4 square feet after erection.

Because of the very small area actually occupied by the structures, normal agricultural practices are maintained on the lands where the lines cross agricultural areas.

Normal operation and maintenance of the lines require infrequent traversing of the right of way. Airplane patrol of the lines is conducted on a regular basis. Maintenance personnel are directed to the precise area requiring attention as a result of the airplane patrol. Once a year either 2 or 3 men in a suitable vehicle travel the entire line length closely inspecting the condition of structures and right of way. This infrequent traveling of the right of way has a minimum effect on the land and growth. Right-of-way maintenance is scheduled on a 4 to 5 year cycle to control vegetation growth. Areas such as major road and stream crossings are being maintained and improved so as to preserve the effects obtained by special reclearing. The screening at these crossings will improve each year as selective pruning will enhance the growth and thickness of the vegetation. Right-of-way maintenance also takes into account any uses of the land for recreation and wildlife purposes.

The lines do not cross any designated historical sites, recreation areas, or wildlife management areas. Public lands were avoided in the route selection. The regulatory agencies involved in the review of the transmission lines were:

I. Federal Aviation Administration - Issued permit to obstruct navigable airspace.

II. South Carolina Highway Commission - Issued permits to cross certain highways.

3.10.3 Environmental Effects of Transmission Lines that Could Not Be Avoided

The visibility of the lines in some areas and the curtailed use of the land for timber production in the right of way are the only environmental effects which could not be avoided in the construction and operation of the transmission lines.

The visibility is reduced to a minimum through the use of low structures which do not generally project above the tree tops of mature timber and through selective reclearing and planting at points of high visibility such as road and river crossings.

Although timber production capacity of those lands in the cleared portion has been curtailed, other uses are made of the right of way such as providing food and better habitat for many species of wildlife.

3.11 POSTULATED ACCIDENTS

3.11.1 Introduction

This section evaluates the environmental impact of postulated accidents and occurrences which may occur, however remote, during the operating life of the H. B. Robinson Unit No. 2 Nuclear Plant. 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 3.11-1. 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 would occur. The radiological consequences of an accident are evaluated on the basis that average meteorological conditions, as calculated from the actual site meteorology data and the population distribution projected for the year 1986, exist at the time of an accident. This is considered realistic for random events.

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 on the basis that it conservatively represents a potential accident situation. Consideration of the nine classes reveals that these classes can be conveniently grouped on the basis of their likelihood of occurrence as follows:

3.11.1.1 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 nor necessary. 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. Any possible cumulative effects or trends leading to unacceptable environmental effects will be identified. 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 Class 2 through 5 are considered in the following pages. Class 1 events, because of their trivial consequences, are not considered in this report, as indicated in the AEC guidelines.

3.11.1.2 Classes 6 and 7

This group deals with refueling and fuel handling accidents inside the containment. Detailed procedures are provided to handle irradiated fuel. However, considering the large amount 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, are of no significant adverse impact on the environment.

3.11.1.3 Class 8

This class includes those accidents that are not expected to occur during the life of this plant and whose initiation events are considered in the Final Safety Analysis Report (FSAR), available in the Public Document Room. 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 FSAR. The basic difference between the FSAR evaluations and those presented in this section is represented by the values of the parameters used as input in the analytical models. The FSAR 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:

i) hypothetical FSAR 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,

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

If any of the accidents covered in this category were to occur, assessment of the actual impact on the environment will be performed and a comprehensive plant inspection conducted before a return to power.

3.11.1.4 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 Final 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 FSAR, are within the allowable limits for remote probability accidents (10 CFR 100 limits).

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

3.11.1.5 Meteorology Data

The meteorological data used in this section is obtained from the site atmospheric stability analysis contained in the Final Safety Analysis Report (FSAR). Average values are used for establishing the X/Q for each sector which is a conservative estimate of the exponential type X/Q versus distance function.

The annual average dilution factor at the site boundary used in this analysis is the annual average dilution factor at the nearest site boundary of 2×10^{-5} sec/m^3 contained in the Technical Specifications for the H. B. Robinson Unit No. 2 Plant.

3.11.1.6 Population Distribution

The population distribution used in this analysis is taken from the FSAR and described in Section 2.1.3 of this report. Since the expected plant life is 40 years, the average environmental effect on the population is estimated by using the projected population for the year 1986 to represent the mid-point of the plant life. Using this population distribution, the average environmental effect of the plant over its expected lifetime is estimated by the methods shown in Section 3.11.1.7.

3.11.1.7 Calculation of Doses

For each of the accident classes considered in this report an average site boundary thyroid and whole body dose was computed. The average total body dose includes the beta skin dose contribution. In addition, the total dose to the population within a 50-mile radius of the site was analyzed for each accident class using the meteorological and population data described in sections 3.11.1.5 and 3.11.1.6.

The models used to compute the thyroid, whole body, and population doses are presented below.

3.11.1.7.1 Thyroid Dose

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

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

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

DCF_i = Dose conversion factor of isotope i

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

$\overline{(X/Q)}_{S.B.}$ = average annual X/Q at the site boundary as given in Section 3.11.1.5

3.11.1.7.2 Whole Body Dose

The average 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:

$$\text{Whole Body Dose} = 0.246 \times \overline{(X/Q)}_{S.B.} \times \sum_i A_i \times (\overline{E}_{\beta i} + \overline{E}_{\gamma i})$$

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

$\overline{(X/Q)}_{S.B.}$ = Average annual X/Q at the site boundary as given in Section 3.11.1.5

(The assumption of a semi-infinite spherical cloud is conservative.)

3.11.1.7.3 Population Dose

The total population dose was computed using the equation:

$$\text{Population Dose} = 0.246 \sum_i A_i \times (\overline{E}_{\beta i} + \overline{E}_{\gamma i}) \sum_r \sum_\phi \frac{X}{Q}_{r,\phi} P_{r,\phi}$$

where:

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

$X/Q_{r,\phi}$ = the X/Q for a given sector (ϕ) and distance (r) as given in Section 3.11.1.5.

$P_{r,\phi}$ = the population estimate for a given sector (ϕ) and distance (r) as given in Section 3.11.1.6

3.11.2 Evaluation of Class 2 Events

3.11.2.1 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 in-plant monitoring and appropriately repaired to minimize any potential off-site effect.

3.11.2.2 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 conservative 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 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.

3.11.2.3 Discussion of Remoteness of Possibility of Volume Control Tank Release

The volume control tank is designed for 75 psig 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. In summary the release of 10 percent of the noble gas inventory is considered to conservatively represent the accident or occurrences falling in this class.

Since the volume control tank is not subject to high pressure or stress and is of 75 psig design, an accidental release from the tank is considered very remote.

3.11.2.4 Assumptions Used in The Analysis and Evaluation of Volume Control Tank Release

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

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

2) 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.

3) 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.

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

3.11.2.5 Justification for Assumptions

a) The 0.2 percent defect level is based on reactor operating experience with W PWR 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.

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

3.11.2.6 Doses at the Site Boundary and Total Population Dose (Man-Rem)

With the above assumptions the whole body dose at the nearest site boundary resulting from the volume tank release as calculated by the method shown in Section 3.11.1.7, is 0.322 mrem from the released noble gas activity, while the total population dose is 0.073 man-rem.

3.11.3 Evaluation of Class 3 Events

3.11.3.1 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 inadvertent 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.

3.11.3.2 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 conservative example of a Class 3 event would be a malfunction or error which would allow initiation of activity release from the waste gas decay tank. This activity would leak into the fuel handling building atmosphere and pass through the vent to the outside atmosphere. The fuel handling building 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 the waste gas decay tank to the outside atmosphere.

3.11.3.3 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. Sufficient volume is provided in these tanks to store the gases evolved during a reactor shutdown.

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 150 psig design, any 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 conservatively represent accidents and occurrences falling in this class.

3.11.3.4 Assumptions Used In The Analysis and Evaluation of Gas Decay Tank Release

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

1) 0.2 percent fuel defects.

2) Within 2 hours after initiation of a release from the gas decay tank, 10 percent of the noble gas is released.

3) Immediately after the noble gas activity escapes from the waste gas decay tank it is released at ground level from the fuel handling building to the outside atmosphere.

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

3.11.3.5 Justification for Assumptions

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

b) The fuel handling building vent monitor will detect the noble gas activity being released to the outside atmosphere 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 the waste decay tank.

3.11.3.6 Doses at Site Boundary and Total Population Dose (Man-Rem)

With the above assumptions the whole body dose at the nearest site boundary resulting from the gas decay tank release is 1.204 mrem and the total population dose is 0.274 man-rem.

3.11.4 Evaluation of Class 4 Events

3.11.4.1 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 the 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 normal operation and in other accident classes all of 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. No additional events are identified in this class.

3.11.5 Evaluation of Class 5 Events

3.11.5.1 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 simultaneous 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 simultaneously, 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.

3.11.5.2 Description of Class 5 Events - Fuel Defects With Steam Generator Tube Leakage

In the unlikely 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. The blowdown would be terminated automatically upon receipt of a high radiation signal from the steam generator liquid sample monitor which 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.

3.11.5.3 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 is 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 one day.

3.11.5.4 Assumptions Used in the Analysis and Evaluation of Off-Normal Operational Release

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:

1) 0.2 percent defective fuel

2) The primary-to-secondary leak rate is 1 gpm

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

4) The period of off-normal operation is one day at full power.

5) The atmospheric dispersion factor at site boundary used in the dose calculation is the annual average.

6) Secondary system decontamination factors:

   Steam generator water to steam

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

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

   Steam to condenser off-gas

   $$DF = 10^4 \frac{\mu Ci/gm \text{ steam}}{\mu Ci/cc \text{ air}} \quad \text{(all halogens)}$$

   $$DF = 1 \frac{\mu Ci/gm \text{ steam}}{\mu Ci/cc \text{ air}} \quad \text{(all noble gases)}$$

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

8) Air flow rate through the condenser off-gas system is 60 scfm.

3.11.5.5 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 automatically by the steam generator liquid monitor within a few minutes of initiation of the off-normal operation. The one day off-normal operation therefore will not result in blowdown release. The one day off-normal operation at full power of the fourth assumption is based on the expected off-normal operational time. The operator can shut the plant down sooner if the releases are excessive. Assumption 5 is based on the site meteorological data. Assumption 6 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.

The condenser off-gas flow rate of 60 scfm is a system parameter.

3.11.5.6 Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the thyroid dose and the whole body dose at the nearest site boundary resulting from the condenser off-gas release are 1.28 mrem and 0.285 mrem, respectively. The total population whole body dose is 0.065 man-rem and 0.290 man-rem thyroid.

3.11.6 Evaluation of Class 6 Events

3.11.6.1 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.

3.11.6.2 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.

3.11.6.3 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 pool 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 of 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 pool 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 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 occur 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.

3.11.6.4 Assumptions Used in the Analysis and Evaluation of Fuel Handling Accident Inside Containment

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

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

2) The accident results in the rupture of the cladding of the equivalent of one row of fuel rods.

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

4) 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.

5) The fuel pellet-cladding gap inventory of fission products in these rods will be released to the refueling canal water at the time of the accident.

6) The refueling canal 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.

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

8) 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 leaking from the containment after isolation is assumed negligible compared to that escaping from the purge line during the first five minutes prior to isolation.

3.11.6.5 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 radioacitivity in the fuel pellet-cladding gap is dependent on the power level and temperature distribution of the assembly.

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 automatically 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 will occur due to the accident, the leak rate from the containment is expected to be near zero.

3.11.6.6 <u>Doses at Site Boundary and Total Population Dose (man-rem)</u>

The doses at the nearest site boundary from a refueling accident inside the containment are 0.644 mrem thyroid and 0.129 mrem whole body. The total population dose from this accident is 0.029 man-rem whole body and 0.146 man-rem thyroid.

3.11.7 <u>Evaluation of Class 7 Events</u>

3.11.7.1 <u>Discussion of Class 7 Events</u>

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 and 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 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; thus, most of the major contributing isotopes to the thyroid and whole body dose have decayed to a negligible level.

3.11.7.2 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 fuel handling building vent.

3.11.7.3 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 pool. In addition, the design of storage racks and manipulation facilities in the spent fuel pool 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) No configuration of one fuel assembly in racks will result in criticality.

In summary, those factors which are discussed under Section 3.11.6 regarding remoteness of possibility of fuel handling accidents within the containment also apply here.

3.11.7.4 Assumptions Used in the Analysis and Evaluation of Refueling Accident Outside Containment

The identical assumptions a) through g) of Section 3.11.6 are also postulated for calculation of the fuel handling accident outside the containment.

3.11.7.5 Justification for Assumptions

The justification for the assumptions are the same as given in Section 3.11.6.

3.11.7.6 Doses at Site Boundary and Total Population Dose (man-rem)

The doses at the nearest site boundary from a refueling accident outside the containment are 3.789 mrem thyroid and 0.763 mrem whole body. The total population dose from this accident is 0.164 man-rem whole body and 0.866 man-rem thyroid.

3.11.8 Evaluation of Class 8 Events

3.11.8.1 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 with the realistic basis that these engineered safeguards will be available and will either prevent the progression of the accident or mitigate the consequences.

3.11.8.2 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 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:

a. 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.

b. 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 ECCS 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.

3.11.8.2.1 <u>Discussion of the 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 instituted 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 to shutdown and to maintain the nuclear unit 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. Also, essential equipment has been placed in a structure which is capable of withstanding extraordinary natural phenomena, such as tornadoes, flooding conditions, high winds, or other natural phenomena.

The materials and components of the Reactor Coolant System are subjected to thorough nondestructive inspection prior to operation and a pre-operational hydro test was performed at 1.25 times the design pressure.

The unit is also operated under very closely controlled conditions to ensure that the operating parameters are kept within the limits assumed in the design. The reactor pressure vessel is paid particular attention because of the shift in nil ductility transition temperature (NDTT) with irradiation. 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. The materials of construction were selected for the expected environment and service conditions and are 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 unit is provided with various means of detecting leakage from the Reactor Coolant System. The sensitivity of these leak detection systems give reasonable assurance that a small crack 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 particle examinations. This in-service inspection program 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 FSAR.

Those credible transients which could cause pressure surges have been considered in the design and will be limited by the following features:

1) Reactor Protection System trips -

2) Incorporation of relief and safety valves in the pressurizer and appropriate sizing of the steam side safety and relief valves.

These features insure 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.

3.11.8.2.2 Assumptions Used in the Analysis and Evaluation of Loss-of-Coolant Accident

The analysis for this accident is based on:

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

2) 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 90 percent of the core power, so that less than 90 percent of the total gap inventory would be released.

3) Of the fission product activity, which is released from the gap, 25 percent of the halogens and 100 percent of the noble gases are available for leakage from the containment.

4) The spray efficiency is $5.2 \times 10^{-3} sec^{-1}$ for elemental iodine.

5) The containment leak rate is 0.1 percent for the first 24 hours and 0.045 percent/day for the next 29 days.

3.11.8.2.3 Justification for Assumptions

a) Fission product diffusion through the fuel pellet is a temperature dependent process. Since the reactor has been made subcritical, fissioning essentially ceases and the pellet temperature begins to drop from the operating value almost immediately. The gap activity represents 1.5 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 FSAR, supplemented by Emergency Core Cooling Performance, September 29, 1971.

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

d) Data presented in the FSAR indicate that little organic iodine is released from the fuel.

e) The calculation of the spray effectiveness for iodine removal is based on the drop diffusion model developed by L. F. Parsly.[1] The spray drop-size data used in this model are based on drop-size measurements performed by Westinghouse. 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 realistic estimates of the expected performance of the spray system.

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

3.11.8.2.4 Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the thyroid dose and the whole body dose at the nearest site boundary are 0.399 mrem and 4.280 mrem, respectively. The total population whole body dose is 1.026 man-rem and 10.005 man-rem thyroid.

3.11.8.3 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.

2) The overpower reactor trips (nuclear flux and ΔT) and the reactor trip occurring 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 and a check valve. These six 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 valves in one line, closure of either the check valve or the isolation 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.

3.11.8.3.1 Discussion of Remoteness of Possibility of a Steam Line Break Accident

A steam line break is considered highly unlikely. The steam system valves, fittings and piping are conservatively designed according to USAS B31.1. The piping is a ductile material completely inspected prior to installation. After installation, the entire system was hot functionally tested prior to fuel loading. This test is designed to uncover any flaws that may exist in the piping, fittings, or valves.

In addition to pre-operational tests to insure 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. 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.

3.11.8.3.2 Assumptions Used in the Analysis and Evaluation of Steam Line Break

The analysis for this accident is based on:

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

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

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

4) The break occurs outside the containment.

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

3.11.8.3.3 Justification for Assumptions

a) The fuel defect level and steam generator leak rate are derived from the 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 are required for an orderly cooldown and depressurization of the primary system. Primary-secondary coolant transfer occurs for this time period.

3.11.8.3.4 Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the thyroid dose and the whole body dose at the nearest site boundary are 0.015 mrem and 0.002 mrem respectively. The total population whole body dose is 10.005 man-rem and 0.005 man-rem thyroid.

3.11.8.4 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) to 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.

3.11.8.4.1 Discussion of Remoteness of Possibility of Steam Generator Tube Rupture

The potential for failure of a steam generator tube is considered minimal. The steam generator tube is constructed out of a highly ductile material (SB-163). Further, based on ultimate strength at design temperature, the calculated bursting pressure of a steam generator tube is in excess of 11,100 psi compared to the maximum operating differential pressure the tube wall sees of about 1530 psi. This margin applies to the longitudinal failure modes. An additional factor of two applies to ultimate pressure strength in the axial direction tending to resist double-ended failure.

It is expected that rupture would be preceeded by small perforations, which could be induced by fretting, corrosion, erosion or fatigue. The activity in the secondary system is continuously monitored via the condenser off-gas discharge monitors, the steam generator liquid monitor, 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.

3.11.8.4.2 Assumptions Used in the Analysis and Evaluation of Steam Generator Tube Rupture

The analysis of this accident is based on:

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

2) 126,000 pounds of primary coolant are carried over to the secondary side.

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

4) The faulty steam generator is isolated within 30 minutes.

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

3.11.8.4.3 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.

b) The steam generator leakage is based on plant operating experience with W PWR Inconel steam generators.

c) 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.

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., Dwbrovskii I. Ya., Smrinova I. N. "Transfer of Iodine form 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.

3.11.8.4.4 Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the thyroid dose and the whole body dose at the nearest site boundary are <0.001 mrem and 4.042 mrem respectively. The total population whole body dose is 0.908 man-rem and <0.005 man-rem thyroid.

3.11.8.5 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 normal boration at low level alarm and rapid 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 reduce the airborne fission product concentration. Fission products escaping to the external environment do so through minute leaks in the containment structure.

3.11.8.5.1 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 insure 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.

3.11.8.5.2 Assumptions Used in the Analysis and Evaluation of Rod Ejection Accident

The analysis for this accident is based on:

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

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

3) Iodine from 50 percent of the coolant is released to containment with a partition factor of $10 \frac{\mu Ci/gm\ water}{\mu Ci/gm\ steam}$.

4) The remaining assumptions are the same as for the LOCA.

3.11.8.5.3 Justification for Assumptions

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

b) 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; however, no rods fall below a DNBR expected to cause clad perforation. It is therefore concluded that no rods will suffer clad perforations during the transient.

c) 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.

d) The remaining assumptions are the same as for the LOCA.

3.11.8.5.4 Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the thyroid dose and the whole body dose at the nearest site boundary are <0.001 mrem and 0.012 mrem, respectively. The total population whole body dose is 0.003 man-rem and <0.001 man-rem thyroid.

3.11.8.6 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.

3.11.8.6.1 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 Saunders diaphragm valves, bellows seals, self-contained pressure regulators and soft-seated packless valves throughout the radioactive portions of the system.

During operation, gas samples are drawn automatically from the gas decay tanks and automatically analyzed to determine their hydrogen and oxygen content. There should be no significant oxygen content in any of the tanks. An alarm will warn the operator if any sample shows 2 percent or higher by volume of oxygen.

Since the components of the waste gas system are not subjected to any high pressures or stresses and they are of 150 psig 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.

3.11.8.6.2 Assumptions Used in the Analysis and Evaluation of Waste Gas Decay Tank Rupture

The analysis for this accident is based on:

1) Operation with 0.2 percent equivalent fuel defects.

2) Noble gas release only.

3.11.8.6.3 Justification for Assumptions

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

3.11.8.6.4 Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the whole body dose at the nearest site boundary is 12.074 mrem. The total population whole body dose is 2.736 man-rem.

3.11.8.7 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 sump pit are sufficient to hold the entire tank contents without overflowing to areas outside the building.

3.11.8.7.1 Discussion of Remoteness of Possibility of Volume Control Tank Rupture

The volume control tank is designed for an internal pressure of 75 psig. The normal internal operating pressure is approximately 15 psig. Level alarms, pressure relief valves, and automatic bank 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 75 psig, structural failure of the tank is considered very remote. No similar tanks have failed in W PWR operating experience.

3.11.8.7.2 Assumptions Used in the Analysis and Evaluation of Volume Control Tank Rupture

This accident analysis is based on:

1) Plant operation with 0.2 percent equivalent fuel defects

2) Noble gas release only

3) Tank inventory based on noble gas equilibrium values.

3.11.8.7.3 Justification for Assumptions

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

3.11.8.7.4 Doses at Site Boundary and Total Population Dose (man-rem)

With the above assumptions the whole body dose at the nearest site boundary is 3.22 mrem. The total population whole body dose is 0.728 man-rem.

3.11.9 Conclusions

Based on the evaluations of the various postulated accidents and occurrences in Sections 3.11.2 through 3.11.8 and the resultant radiological results as summarized in Table 3.11-2, 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 as discussed in Section 3.6.1.2.

TABLE 3.11-1

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 radioactivity	Fuel failures during normal operation. Transients outside expected range of variables.
5	Events that release radioactivity 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

TABLE 3.11-2

SUMMARY OF DOSES FROM POSTULATED ACCIDENTS AND OCCURRENCES

EVENT	NEAREST SITE BOUNDARY THYROID mrem	NEAREST SITE BOUNDARY WHOLE BODY mrem	POPULATION DOSE 50-MILE RADIUS THYROID man-rem	POPULATION DOSE 50-MILE RADIUS WHOLE BODY man-rem
Class 2	NA	0.322	NA	0.073
Class 3	NA	1.204	NA	0.274
Class 4	NA	NA	NA	NA
Class 5	1.280	0.285	0.290	0.065
Class 6	0.644	0.129	0.146	0.029
Class 7	3.789	0.763	0.866	0.164
Class 8-LOCA	0.399	4.280	<0.005	1.026
SLB	0.015	0.002	<0.005	<0.005
SGTR	<0.001	4.042	<0.005	0.908
REA	<0.001	0.012	<0.005	0.003
WGDTR	NA	12.074	NA	2.736

NA - not applicable

4.0 ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

Construction and operation of Robinson Unit No. 2 has and will continue to have some impact on aesthetics, land and water resources and on the quality of air and water. Efforts have been made to avoid and minimize these environmental effects. Those which cannot be avoided will be discussed in this section.

Any effort on the part of man to provide a service or product necessary to maintaining or improving human life standards involves some possibility of impact on the environment. CP&L has attempted to balance the benefits of providing electric power against the risks to the environment in such a way that the risks are minimized using technically and economically feasible systems. In order to implement this policy, CP&L located H. B. Robinson Unit No. 2 adjacent to Unit No. 1, on an existing CP&L plant site, thereby minimizing an unavoidable environmental effect of additional land use required by a new site. By locating on an existing site, the plant does not interfere with any existing use of the environment, nor prevent any reasonably foreseeable beneficial use or enjoyment of the environment. Since the unit uses nuclear fuel as a heat source and is on an existing CP&L site, there has been no significant diversion of resources from any existing source.

Wherever possible, areas affected by clearing and construction have been replanted with trees and grasses to control erosion, to provide new ground cover for wildlife, and to reduce the aesthetic impact.

As a result of the operation of any nuclear power plant, there are certain radioactive products which must be disposed of. To minimize any effects these materials might have on the environment, the unit is equipped with a waste processing system. This system collects radioactive fluids and these fluids are sampled, analyzed, and processed as required and then released only under controlled conditions in accordance with all appropriate regulations of 10 CFR 20 and 10 CFR 50, so that effluents will be held as low as practicable.

Solid wastes, which consist of waste liquid concentrates, spent resins, and miscellaneous materials such as paper and glassware, are packaged and shipped off-site for disposal at approved sites in accordance with AEC and U. S. Department of Transportation regulations.

The spent fuel from each fuel cycle will be stored for a time necessary to reduce its radioactivity, and then it will be shipped off-site for reprocessing in specially designed casks meeting all the AEC and U. S. Department of Transportation regulations. By strictly adhering to these regulations, the environmental impact of these shipments will be negligible.

In order to assure that all possible environmental effects are minimized, monitoring programs have been established and implemented to detect any environmental change which might be attributed to the operation of the unit, thereby assuring safe and healthful surroundings for the area.

Operation of Unit No. 2 will result in an additional heat discharge to Lake Robinson. However, this additional heat is not expected to result in significant changes to the aquatic or terrestrial environment.

H. B. Robinson Unit No. 2 was constructed and is being operated in compliance with all applicable federal and State of South Carolina regulations designed to protect the environment. All discharges to the air and water will conform to these regulations and will meet applicable quality standards.

By practicing environmental responsibility such as those measures described above, it is the desire of CP&L to attain the widest range of benefits for its customers through harmonious use of the environment without risk to health or safety, or other undesirable consequences. If environmental effects are detected by the environmental monitoring program or other surveillance methods which show that the regulatory requirements are exceeded, CP&L will take appropriate action to reduce environmental impact to acceptable levels.

5.0 ALTERNATIVES TO THE NUCLEAR UNIT

5.1 SPECIFIC POWER NEEDS

Carolina Power & Light Company provides electrical service to its customers in North and South Carolina. The electrical energy requirements of its customers are doubling every six years compared to the national average of doubling about every ten years. CP&L's commitment to provide electrical energy to its customers has required an accelerated pace of providing new electrical generation capability.

The operation of Robinson Unit No. 2 is essential to the ability of Carolina Power & Light Company to meet its current and predicted load requirements. As of November 1, 1971, CP&L owned and operated seven steam electric generating plants with a net winter capability of 3,622,000 KW; four hydroelectric plants with a net winter capability of 211,500 KW; and internal combustion generating units with a net winter capability of 560,000 KW; for a total net winter capability of 4,393,500 KW. The Robinson Unit No. 2 provides 700,000 KW of this total electric generating capability.

The Robinson Unit No. 2 is vitally important to the ability of CP&L and its neighboring power systems to meet the current energy demands of the Virginia-Carolinas territory. The reserve margins of systems serving this territory are smaller than desirable to assure reliable power supply for the territory. As CP&L and its neighboring utilities bring into operation additional electric generating units, the vital importance of Unit No. 2 to the territorial power supply will diminish somewhat; however, the unit will continue to be an essential resource for the CP&L system. Virginia Electric and Power Company (VEPCO) and Duke Power Company (Duke) each have a large nuclear unit scheduled to become operational in early 1972. The specific short-term power needs which the Robinson Unit No. 2 will fulfill are graphically illustrated by looking at CP&L's resources, loads, and reserves during the next ten months. Table 5.1-1 shows CP&L's resources, loads, and reserves by month for the period November 1971 through August 1972, assuming the availability of Robinson Unit No. 2 for the entire period, the availability of

VEPCO's Surry nuclear Unit No. 1 and Duke's Oconee nuclear Unit No. 1 at their rated capacities for the period February 1972 through August 1972 and the availability of VEPCO's Surry Unit No. 2 in August 1972. Even with such assumptions, the CP&L reserves will be only 8.7 percent in January 1972, considering maintenance schedules. The reserve margin during the critical summer months of July and August is 15.8 percent. CP&L considers that it needs approximately 18 percent reserve or the largest unit plus 100 MW to provide reliable service to its wholesale and retail customers. This reserve margin is necessary to accommodate the unscheduled outage of its largest generating unit, reduced capability of its other units due to equipment failure, variations in actual load from that forecasted and extreme weather conditions which experience has indicated could result in load increases of as much as 4 percent above that forecast for normal conditions. The importance to CP&L of the availability of the Robinson, Surry, and Oconee nuclear units is to maintain adequate or near adequate reserve except for January 1972 when its reserve margin will be only 8.7 percent.

Table 5.1-2 shows CP&L's resources, loads, and reserves for the same ten-month period as shown in Table 5.1-1, assuming that Robinson Unit No. 2 is available for the entire period and the Surry and Oconee units are not placed in service during the period. It will be observed that CP&L's reserves will be only 8.7 percent in January and 3.4 percent in August.

Table 5.1-3 shows CP&L's reserves for the same 10-month period as in Tables 5.1-1 and 5.1-2, assuming Robinson Unit No. 2 is not available and the Surry and Oconee nuclear units are not placed in service during the period. It will be noted that CP&L will not be able to carry its load in any month of the 10-month period if necessary maintenance of existing units (some of which is for the installation of additional pollution abatement equipment) is undertaken. If necessary maintenance is omitted, CP&L will not be able to carry the load in six of the ten months and will be critically short of reserve margin in the remaining four months.

Tables 5.1-1, 5.1-2, and 5.1-3 also assume the availability in June 1972 of a 420 MWe fossil unit addition to CP&L's Sutton Plant which is presently 62 percent complete.

Robinson Unit No. 2 is the largest generating unit on the CP&L system, constituting approximately 16 percent of CP&L's present generating capability. In terms of actual electrical energy production, it is even more significant than its relative size would indicate since it is a base load unit. During 1972, it is expected to supply 3,810,240 megawatt-hours of electric energy or 17.7 percent of the expected system requirements.

TABLE 5.1-1

CP&L POWER RESOURCES, LOAD, AND RESERVES BY MONTHS
WITH ROBINSON NO. 2 IN SERVICE

Limited Term Sales Based on Surry 1 and Oconee 1 in Service by Feb. 1, 1972
and Surry 2 by Aug. 1, 1972

	1971		1972							
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Installed Capacity										
Hydro	211.5	211.5	211.5	211.5	211.5	211.5	213.5	213.5	213.5	213.5
Fossil	2922.0	2922.0	2922.0	2922.0	2922.0	2922.0	2894.0	3314.0	3314.0	3314.0
Nuclear	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0
IC's	560.0	560.0	560.0	560.0	560.0	560.0	487.0	487.0	487.0	487.0
Total Owned Capacity	4393.5	4393.5	4393.5	4393.5	4393.5	4393.5	4294.5	4714.5	4714.5	4714.5
Long Term Purchases	213.2	213.2	213.2	213.2	213.2	213.2	212.7	212.7	212.7	212.7
Other Purchases & (Sales)										
Wateree #2	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0
SCPSA Reserve Exchange	32.0	32.0	32.0	32.0	32.0	32.0	20.0	20.0	20.0	20.0
Asheville #2	(155.0)	(155.0)	(155.0)	(155.0)	(155.0)	(155.0)	(115.0)	(115.0)	(115.0)	(115.0)
Sutton #3	-	-	-	-	-	-	-	(140.0)	(140.0)	(140.0)
AEP	60.0	-	-	-	-	-	-	-	-	-
Limited Term Purch. or (Sale)	(360.0)	(352.0)	(342.0)	6	6	6	104	29*	29*	203*
Total Power Resources	4244.7	4192.7	4202.7	4550.7	4550.7	4550.7	4577.2	4782.2	4782.2	4956.2
Forecast Peak Load	3289	3535	3818	3600	3480	3200	3400	4000	4130	4279
Reserve	955.7	657.7	384.7	950.7	1070.7	1350.7	1177.2	782.2	652.2	677.2
Percent Reserve	29.1	18.6	10.7	26.4	30.8	42.2	34.6	19.6	15.8	15.8
Sched. Maint.	(293)	(190)	(51)	(51)	(308)	(685)	(401)	0	0	0
Reserve	662.7	467.7	333.7	899.7	762.7	665.7	776.2	782.2	652.2	677.2
Percent Reserve	20.1	13.2	8.7	25.0	21.9	20.8	22.8	19.6	15.8	15.8

*100 MW APS Purchase from 5/1/72 to 9/1/72 included on VEPCO System in Limited Term Calculation

TABLE 5.1.2

CP&L POWER RESOURCES, LOAD, AND RESERVES BY MONTHS
WITH ROBINSON NO. 2 IN SERVICE

Limited Term Sales Based on Surry and Oconee Units Not in Service

	1971		1972							
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Installed Capacity										
Hydro	211.5	211.5	211.5	211.5	211.5	211.5	213.5	213.5	213.5	213.5
Fossil	2922.0	2922.0	2922.0	2922.0	2922.0	2922.0	2894.0	3314.0	3314.0	3314.0
Nuclear	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0	700.0
IC's	560.0	560.0	560.0	560.0	560.0	560.0	487.0	487.0	487.0	487.0
Total Owned Capacity	4393.5	4393.5	4393.5	4393.5	4393.5	4393.5	4294.5	4714.5	4714.5	4714.5
Long Term Purchases	213.2	213.2	213.2	213.2	213.2	213.2	212.7	212.7	212.7	212.7
Other Purchases & (Sales)										
Wateree #2	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0
SCPSA Reserve Exchange	32.0	32.0	32.0	32.0	32.0	32.0	20.0	20.0	20.0	20.0
Asheville #2	(155.0)	(155.0)	(155.0)	(155.0)	(155.0)	(155.0)	(115.0)	(115.0)	(115.0)	(115.0)
Sutton #3	-	-	-	-	-	-	-	(140.0)	(140.0)	(140.0)
AEP	60.0	-	-	-	-	-	-	-	-	-
Limited Term Purch. or (Sale)	(360.0)	(352.0)	(342.0)	(342.0)	(342.0)	(342.0)	(253.0)	(328.0)*	(328.0)*	(328.0)*
Total Power Resources	4244.7	4192.7	4202.7	4202.7	4202.7	4202.7	4220.2	4425.2	4425.2	4425.2
Forecast Peak Load	3289	3535	3818	3600	3480	3200	3400	4000	4130	4279
Reserve	955.7	657.7	384.7	602.7	722.7	1002.7	820.2	425.2	295.2	146.2
Percent Reserve	29.1	18.6	10.7	16.7	20.8	31.3	24.1	10.6	7.2	3.4
Sched. Maint.	(293)	(190)	(51)	(51)	(308)	(685)	(401)	0	0	0
Reserve	662.7	467.7	333.7	551.7	414.7	317.7	419.2	425.2	295.2	146.2
Percent Reserve	20.1	13.2	8.7	15.3	11.9	9.9	12.3	10.6	7.2	3.4

*100 MW APS Purchase from 5/1/72 to 9/1/72 included on VEPCO System in Limited Term Calculation

TABLE 5.1-3

CP&L POWER RESOURCES, LOAD, AND RESERVES BY MONTHS
WITH ROBINSON NO. 2 HALTED 11/71 - CAPACITY INCLUDED IN ALLOCATIONS

Limited Term Sales Based on Surry and Oconee Units Not in Service

	1971		1972							
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Installed Capacity										
Hydro	211.5	211.5	211.5	211.5	211.5	211.5	213.5	213.5	213.5	213.5
Fossil	2922.0	2922.0	2922.0	2922.0	2922.0	2922.0	2894.0	3314.0	3314.0	3314.0
Nuclear	-	-	-	-	-	-	-	-	-	-
IC's	560.0	560.0	560.0	560.0	560.0	560.0	487.0	487.0	487.0	487.0
Total Owned Capacity	3693.5	3693.5	3693.5	3693.5	3693.5	3693.5	3594.5	4014.5	4014.5	4014.5
Long Term Purchases	213.2	213.2	213.2	213.2	213.2	213.2	212.7	212.7	212.7	212.7
Other Purchases & (Sales)										
Wateree #2	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0	61.0
SCPSA Reserve Exchange	32.0	32.0	32.0	32.0	32.0	32.0	20.0	20.0	20.0	20.0
Asheville #2	(155.0)	(155.0)	(155.0)	(155.0)	(155.0)	(155.0)	(115.0)	(115.0)	(115.0)	(115.0)
Sutton #3	-	-	-	-	-	-	-	(140.0	(140.0)	(140.0)
AEP	60.0	-	-	-	-	-	-	-	-	-
Limited Term Purch. or (Sale)	(360.0)	(352.0)	(342.0)	(342.0)	(342.0)	(342.0)	(253.0)	(328.0)*	(328.0)*	(328.0)*
Total Power Resources	3544.7	3492.7	3502.7	3502.7	3502.7	3502.7	3520.2	3725.2	3725.2	3725.2
Forecast Peak Load	3289	3535	3818	3600	3480	3200	3400	4000	4130	4279
Reserve (Deficit)	255.7	(42.3)	(315.3)	(97.3)	22.7	302.7	120.2	(274.8)	(404.8)	(553.8)
Percent Reserve (Deficit)	7.8	(1.2)	(8.3)	(2.7)	0.7	9.5	3.5	(6.9)	(9.8)	(12.9)
Sched. Maint.	(293)	(190)	(51)	(51)	(308)	(685)	(401)	0	0	0
Reserve (Deficit)	(37.3)	(232.3)	(366.3)	(148.3)	(285.3)	(382.3)	(280.8)	(274.8)	(404.8)	(553.8)
Percent Reserve (Deficit)	(1.1)	(6.6)	(9.6)	(4.1)	(8.2)	(11.9)	(8.3)	(6.9)	(9.8)	(12.9)

*100 MW APS Purchase from 5/1/72 to 9/1/72 included on VEPCO System in Limited Term Calculation

5.2 IMPORTING POWER

Carolina Power & Light Company and the neighboring utilities with which CP&L is interconnected are in similar power supply situations. Each utility is confronted with long lead times for construction of generating facilities, high rates of load growth and a need to increase reserve capacity margins. The operation of Robinson Unit No. 2 was planned to provide export power to neighboring utilities in 1970 and 1971 while they were bringing into operation other large nuclear units. The importance of the Robinson Unit No. 2 to CP&L's neighboring utilities is demonstrated in Section 5.1 for the period November, 1971, through August, 1972, especially if the other large nuclear units are not available as scheduled.

The reliance of neighboring utilities upon the operation of Robinson Unit No. 2 and CP&L's ability to export power to them is illustrated by looking at the resources, loads, and reserves for CP&L and its neighboring utilities over the next year. Tables 5.2-1, 5.2-2, and 5.2-3 show the resources, loads and reserves for CP&L, VEPCO, Duke and South Carolina Electric & Gas systems for Winter 1971-1972 and Summer 1972 under the same set of assumptions as are shown in Tables 5.1-1, 5.1-2, and 5.1-3 for the CP&L system. With Robinson Unit No. 2 available for the entire period, Surry Nuclear Unit No. 1 and Oconee Nuclear Unit No. 1 available in February, 1972, and Surry Nuclear Unit No. 2 available in August, 1972, the territorial reserves will be 17.4 percent for Winter 1971-1972 and 17.2 percent for Summer 1972. With the Robinson Unit No. 2 available for the full period and the Surry and Oconee Units unavailable, the territorial reserves are 17.4 percent for Winter 1971-1972 and only 4.3 percent for Summer 1972. With none of the three nuclear units available, the territorial reserves are 13.2 percent for Winter 1971-1972 and less than 1 percent for Summer 1972.

With the critically low reserves in the Virginia-Carolinas territory, it is apparent that purchase power is not available to CP&L from neighboring utilities on a firm basis. In fact, the other companies in the territory are dependent upon energy sales from CP&L to support their system reliability through Winter 1971-1972 and, if the Oconee and Surry nuclear units are not placed in service as scheduled, for such period of time as it takes to place those units in service. The operation of Robinson Unit No. 2 is essential, therefore, not only to the CP&L system but also to the limited energy resources of the Virginia-Carolinas territory.

The neighboring utilities are not planning to install extra generating capacity in the quantities required to allow CP&L to import the necessary power in years after 1972. Interchanges of large blocks of power on a firm basis will not be possible between CP&L and its neighbors. The primary function of the interconnections established with the neighboring utilities aside from the purchase and sale of small blocks of power is to provide emergency assistance in the event of equipment failure.

TABLE 5.2-1

CP&L, DUKE, SCE&G, & VEPCO
POWER RESOURCES, TERRITORIAL LOADS, AND RESERVES

With Robinson No. 2 In Service
With Oconee No. 1 and Surry No. 1 & 2 In Service For Summer 1972

1971-72 Winter

Load - MW	16,873
Capacity - MW	19,802
Reserve - MW	2,929
Reserve - %	17.4

1972 Summer

Load - MW	19,951
Capacity - MW	23,380
Reserve - MW	3,429
Reserve - %	17.2

TABLE 5.2-2

CP&L, DUKE, SCE&G, & VEPCO
POWER RESOURCES, TERRITORIAL LOADS, AND RESERVES

With Robinson No. 2 In Service
With Oconee No. 1 and Surry No. 1 & 2 Not In Service For Summer 1972

1971-72 Winter

Load - MW	16,873
Capacity - MW	19,802
Reserve - MW	2,929
Reserve - %	17.4

1972 Summer

Load - MW	19,951
Capacity - MW	20,800
Reserve - MW	849
Reserve - %	4.3

TABLE 5.2-3

CP&L, DUKE, SCE&G, & VEPCO
POWER RESOURCES, TERRITORIAL LOADS, AND RESERVES

With Robinson No. 2 Halted 11/71 With Oconee No. 1 and Surry No. 1 & 2
Not In Service For Summer 1972

1971-72 Winter

Load - MW	16,873
Capacity - MW	19,102
Reserve - MW	2,229
Reserve - %	13.2

1972 Summer

Load - MW	19,951
Capacity - MW	20,100
Reserve - MW	149
Reserve - %	0.7

5.3 ALTERNATE MEANS OF POWER GENERATION

Carolina Power & Light Company is continuously conducting planning studies to determine the amount of additional generation required to meet projected load demands. Previous planning studies in 1965 indicated that a base load unit of approximately 700,000 KW would be required on the CP&L system to be operational in 1970.

Having identified the amount of power needed, CP&L evaluated various generating means for meeting this need. Four means of generation were considered; hydroelectric, internal combustion, fossil/steam, and nuclear/steam.

The first means, hydroelectric, was ruled out as there were no sites having sufficient flow for plants of the size required.

The second generation scheme, internal combustion turbines, was ruled out due to the size limit of this means of generation, the high cost per kilowatt-hour of generation, and they are not designed for base load operation.

The types of fuel available on the CP&L system for steam electric units are: coal, oil, and nuclear. Production costs and capital investment cost studies were performed to aid in the determination of the type of steam electric plant to be constructed at the site. The results of studies which projected the operation of the CP&L system for a number of years into the future indicated an economical advantage in favor of building nuclear units as compared to fossil units. Factors which strongly influenced these studies were the high cost and uncertainty of availability of fossil fuels. For these reasons, CP&L elected to construct a nuclear unit at the Robinson Plant.

5.4 ALTERNATE SITES

Site selection for a steam electric plant begins with load projections which show the amount of additional power required during the next decade, and which indicate where and when the additional power will be needed. Once the need for additional generation is established, selection of a site for the generating facility proceeds. Site selection involves an analysis and optimization of many factors such as availability of adequate condenser cooling water, population density, location of schools and churches, proximity of parks and recreation areas, wildlife refuges, impact on historical monuments and areas of historical interest, effect on airports, other industries, availability of adequate transportation facilities, cost of developing the site, local geology, effect of potential sources of pollution in the watershed, transmission requirements, and other environmental impact. Generally, when the alternative is available, the impact of a new facility can be minimized by the use of an existing site instead of a new site.

The decision by CP&L in 1965 to expand an existing generating site rather than develop a new plant site is an example of this minimization of environmental impact. The selection of the Robinson site permitted CP&L to utilize an approved cooling water system and land already dedicated to the generation of electric energy. The plant area had been cleared for future expansion during the construction of Robinson Unit No. 1 in the late 1950's. Except for the physical erection and resulting visual effect of additional structures in the plant area, the only alteration of the landscape with the construction of Robinson Unit No.2 was an extension of the cooling water discharge canal from a point approximately 1.2 miles above the plant to a point 4.2 miles above the plant. Extension of the canal was along the lake shore on land already owned by CP&L and required the clearing of only a small amount of additional land.

Choosing any other site would have necessitated the building of a new cooling facility, either a cooling lake or a cooling tower. Such a choice would have had a larger impact on the environment than the decision to utilize a site already dedicated to the generation of electrical energy. Load studies which provided the basis for CP&L's 1965 decision on a new generating facility showed a need for additional capacity in the central or south-central part of the system. Two existing CP&L plants satisfied this geographic requirement. The Robinson Plant, however, was the only one of the two existing plants which could accommodate a 700 MWe installation without extensive modifications to the then existing cooling water systems.

5.5 COOLING WATER ALTERNATIVES

Operation of Robinson Unit No. 2 requires approximately 1070 cfs of cooling water which is elevated in temperature by about 18°F as it passes through the plant condensers. Aside from the existing cooling lake, wet cooling towers provided the only workable alternative for the dissipation of this heat. Dry cooling towers were not feasible either technically or economically, and stream flows in Black Creek are not sufficient for once through cooling.

Wet cooling towers, like cooling lakes, dissipate heat through the process of evaporation. As the water evaporates, heat is removed at the rate of about 1,000 Btu/lb of water vaporized. Most of this heat is taken from the water that remains, thereby lowering its temperature.

Wet cooling towers, in addition to adding substantially to the costs of the unit, would have created environmental impacts which on balance would have been greater than those associated with the use of Lake Robinson as a cooling facility. Towers would have created a large visual structure which would have detracted from the aesthetic appearance of the plant, would have increased consumptive water losses, would have increased the incidents of fogging and would not have substantially reduced the land clearing requirements.

Either closed cycle towers or open cycle towers could have been installed to serve Robinson Unit No. 2; however, the added expenditures required for construction and operation of the towers were not considered appropriate in view of the already existing Lake Robinson which was designed, approved by the state regulatory agencies and constructed to serve as a heat dissipation facility and which, from experience, had shown the lake to be an efficient and economical method of dissipating heat. While towers and other methods of cooling are suitable at some locations, the use of Lake Robinson as a cooling facility for Unit No. 2 provided the most reasonable method of dissipating the waste heat.

6.0 SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY

The ability of man to harness the energy resources of the earth has been an essential component of man's ability to survive and develop socially. Electrical energy is a key factor in providing food products, sewage treatment, the manufacture of goods, numerous physical comforts and necessities, and it is vital to the health and welfare of the nation. With the development of our modern society, electricity has advanced from a novel luxury to an essential requirement for the innumerable necessary services and products demanded by our present civilization. Electricity has become essential to the health, welfare, safety and economy of the residents of the area served and the organization entrusted to provide the residents with electrical energy must assure an adequate supply of electricity.

Electric power requirements in this country have been doubling every ten years. CP&L customer requirements for power have doubled in the past six years, and further expansion is expected to continue in much the same pattern. In order to provide the residents of CP&L's service area with the electricity necessary to meet this growth, it was necessary to build a power plant the size of H. B. Robinson Unit No. 2. CP&L is aware of its responsibility to provide electricity to its customers in a manner consistent with responsible environmental practices. As described in various parts of this report, detailed consideration was given to the different environmental aspects of the plant in making decisions concerning design, construction and operation of the plant.

The short-term use of the environment to produce electricity for our immediate requirements must be evaluated with respect to the enhancement of long-term productivity and any adverse environmental effects which might be realized by future generations. Considered in this respect, the nuclear unit now in operation at the Robinson Plant is compatible with the environment. The resources which must be diverted from the earth's environment to operate the nuclear power plant are small. This consumption of natural resources is an important consideration when attempting to evaluate the quality of environment we are creating or leaving for future generations. In evaluating the short-term use of the environment, it is also important to consider the fact that the electricity being produced will be used to facilitate social progress and technological developments that will aid in protecting our environment.

At this stage in our technology, even with nuclear power and its very low radioactive release concepts, there does appear to be some possible slight but inevitable, short-term impacts on the environment. These impacts are associated with the basic principle of steam electric plants, the need to provide cooling water and the resultant heating of the air and water. These short-term effects have been minimized, as explained in other sections of this report. Any environmental impact associated with the short-term use of the land is expected to be the least amount practicable and then must be evaluated relative to the benefits derived from use of the electricity produced.

The short-term effects resulting from construction and operation of the plant will result in no cumulative adverse effects, and there is no reason why after the plant is decommissioned, the environment could not be returned to its original state of existence prior to the nuclear unit, with the possible exception of a very small part of the site.

Before the lake was created, the land the site is on was mostly idle scrub land. Less than 10 percent of the land was devoted to agricultural production, and possessed little or no recreational value. Construction of Lake Robinson created a large recreational attraction which, at the end of the plant's life, could be left intact for recreational purposes, or, if desired, the dam could be removed and the area could be returned to its original environmental condition, with no remaining adverse effects on its long-term productivity.

The operation of the H. B. Robinson Unit No. 2 will not curtail the range of beneficial short-term uses of the environment. The unit will result in increased productivity which will actually enhance long-term productivity for future generations. If future generations elect to convert the lake area back to terrestrial uses, this can be done over a period of time and the lake area restored to essentially its natural state.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF NATURAL RESOURCES

The construction and the present operation of the H. B. Robinson Unit No. 2 necessarily involves the commitment and use of a certain amount of natural resources. Only man has the unique ability to alter the environment on a large scale. With this ability, however, comes the responsibility of using the environment in a manner consistent with protecting and preserving the environment to the fullest extent practicable while advancing the standard of living of mankind. With respect to this responsibility, CP&L is fulfilling its responsibility to supply electricity to its customers by the methods which minimize the environmental impact. Considering the many benefits to society of electric power, and the small diversion or use of natural resources by the plant, the resulting cost-benefit ratio is very favorable. In terms of the necessary benefits provided by electric power, there is no other available alternative which has so little impact on the environment. In terms of resources which are consumed, converted, or diverted for temporary use, the following commitments are considered:

1) Land
2) Water (this is only a partial commitment, or diversion, since it is not consumed but only used briefly and returned in essentially its original condition)
3) Materials of Construction
4) Fuel (Uranium)
5) Human Resources

During the life of the plant, the immediate land area occupied by the plant and its structures cannot be used for other purposes, although the cooling lake has been and will continue to be used for recreational purposes. At the end of the useful life of the plant, there is no intrinsic reason why the land and water use could not be returned to the full range of uses prior to plant construction, since the land, air, and water quality will not be altered by the plant's operation. Upon decommissioning the unit, it may be necessary to restrict the use of a small portion of the plant site. It should be pointed out here that the plant is located on a site which was in existence before the nuclear plant was built and that construction and operation of the nuclear plant did not require acquisition of any new land resources. The water used for cooling the plant condensers is drawn from Lake Robinson which was created for the purpose of cooling a power facility some ten years before the nuclear plant was brought into operation. A number of recreational activities are now enjoyed on the lake and at the end of the plant's useful life, there should be no curtailment of the full range of water usage.

The materials used in the construction of the plant could, for the most part, be recycled or reused if necessary. However, these materials should probably be considered an irreversible commitment although if it became necessary for future use, some of the materials could be reclaimed.

The fuel consumed by the operation of the unit will be an irretrievable use of a resource. However, to simply state it is irretrievable does not give a full picture. The use of nuclear fuel (uranium) affords an opportunity to conserve our fossil reserves for future generations and also to utilize them for more preferred usage. This is made possible because using uranium as an energy source does not establish a competitive situation, since uranium is not used or required in significant amounts as a resource in other industry or operations necessary for maintaining our modern society. This is in contrast to the depletion of fossil type resources which are required in many other essential industries and operations. Thus, while the nuclear fuel cannot be recovered in its original form, its depletion will not deprive other activities of essential resources, as does depletion of fossil resources. In addition, as uranium is consumed, other valuable materials are produced, including additional fuel (plutonium) which will be used in the breeder reactors expected to be in operation in the not too distant future.

As far as uranium is concerned, there were 204,000 tons of U_3O_8 reserves available (at $8.00 per pound) on January 1, 1970, and 243,000 tons as of December 31, 1970.[1] For the reserves of the free world producible at $10.00 per pound, there was an estimated total of 700,000 short tons at the end of 1969, of which an estimated 250,000 tons are estimated to be in the U. S.[2] The cumulative requirements for U_3O_8 in reactors in the United States are expected to reach 212,000 short tons by 1980 and 450,000 short tons by 1985.[3] By the mid 1980's commercial breeder reactors are expected to come onto the scene.

In summary, there appears to be a more than abundant supply of nuclear fuel available for the unit during its useful life, without depleting resources necessary for other facets of our society.

In the consideration of human resources as an irreversible resource, the benefit from the human effort expended to design and construct the plant must be evaluated relative to the benefits to society derived from the electricity now being produced. Considered in terms of the necessity of availability of electricity for normal living conditions, and the instrumental part electricity plays in aiding social and technical progress, the effort to design and build the plant is a good investment in the future of the area being served by the plant.

By seeking to design for a compatible balance between the population and the resources committed to provide them with the energy supplies necessary to achieve and/or maintain high standards of living, CP&L has achieved the production of electricity for its customers in a manner which does not adversely affect the environment in terms of irreversible and/or irretrievable commitment of resources.

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(1) Annual Report to Congress of the USAEC, for 1971.

(2) Major Activities in the Atomic Energy Programs, Jan-Dec 1969. USAEC, Jan, 1970.

(3) Op. Cit. USAEC, Jan., 1970.

8.0 COST/BENEFIT ANALYSIS OF THE NUCLEAR FACILITY

Carolina Power & Light Company has been an important participant in the social and economic development of the area which it has served for more than 63 years. In more recent years the Company's increasing commitment to environmental concerns has been reflected in numerous decisions, many of which have reached fruition in the Robinson Unit No. 2 and in subsequent major decisions. In recognizing its obligations to society to supply not only the electrical power required for public health, safety, and comfort, but also a consideration of enhancing the overall quality of life of its customers through responsible environmental management, CP&L has examined ways and means whereby its major decisions on generation capacity could provide additional benefits other than economic. Two such decisions affecting the Robinson Plant were made almost 20 years ago:

1. The recognition that additional generation capacity would be needed in the future and that a cooling lake could serve a dual benefit to society - power plant cooling and a new recreational facility. This recognition resulted in the commitment to build Lake Robinson. The wide public acceptance and high degree of utilization by the public of Lake Robinson encouraged the Company to build similar lakes as a part of the generating facility at two other sites. The utilization and acceptance by the public of these facilities has also confirmed the wisdom of these decisions.

2. During the same decade the Company decided that nuclear power should play an important role in meeting the area's requirements for electrical power with minimum impact upon the natural environment. This decision was implemented through participation in the Carolinas-Virginia Nuclear Power Associates in the development, construction, and operation of one of the first privately financed nuclear power projects.

The commitment of the H. B. Robinson Nuclear Unit in early 1966 constituted a culmination of these two major long-range policies, and CP&L is pleased to have this opportunity to present the benefits and costs of this important project.

8.1 GENERAL CONSIDERATIONS

As a result of the recent U.S. Court of Appeals decision in the Calvert Cliffs case, emphasis has been placed on the evaluation of alternatives for power generation using the cost/benefit approach. This approach has been developed by economists as a tool for governmental decision making where proposed projects can be compared on the basis of the dollar benefit per dollar cost. It should be understood that (1) various philosophies and approaches have been applied in the cost/benefit problems encountered to date so that no real uniformity exists in the techniques applied by various individuals in specific cases, and (2) a formalized cost/benefit technique has not been applied extensively in the past to the decisions relative to power plants and their environmental impact. However, most of the more important factors were weighed in the decision-making process.

In view of the existence of some diversity in approach, the following discussion is provided to define the underlying philosophy and logic of the cost/benefit analysis presented in this report.

8.1.1 Multi-Dimensional Cost/Benefit Approach

In the past, "costs" and "benefits" have been placed in monetary terms whenever possible, and a ratio of benefit to cost (or cost to benefit) derived on a dimensionless basis of dollars cost to dollars benefit. Alternatives could then be ranked on the basis of the dimensionless ratio. Although this approach is the least cumbersome to use from the standpoint of comparative ranking, it cannot realistically be applied in cases where the input data is subjective and not readily quantified. For example, one would like to present aesthetic benefit or cost in quantitative or monetary terms but would find that any two observers would have quite diverse views on the aesthetic pleasantness or obtrusiveness of a given structure.

The approach used in this report is to quantify costs and benefits where possible but to present a range of values or value judgments where objective analysis is not practical. Moreover, these cost and benefit statements represent an aggregate in multi-dimensional form. That is, some quantities are in dollars while others are in quantities and qualitative descriptions more applicable to measurement in the environmental and social spheres.

Furthermore, the "costs" and "benefits" as defined herein are defined on a broad scope. The apparent philosophy of the Court of Appeals decision and later Atomic Energy Commission guidelines appears to be that costs in terms of environmental effects be compared against the benefits to society of a given project or alternative. In the context of this report it is assumed that costs and benefits can be realized in three distinct areas:

1. Environmental Effects
2. Social Effects
3. Economic Effects

It is the combined social, environmental and economic costs that are compared with the combined social, environmental, and economic benefits. For example, considering plant siting, typical costs might be displacement of wildlife or forest (environmental), displacing local agricultural pursuits (economic), or encroachment on historical sites (social); some benefits might include reduction in air pollutants (environmental), broadening of the tax base locally (economic), or enhancement of recreational areas (social).

8.1.2 Format and Scope

The cost/benefit analysis is a tool for decision making. It allows one to weigh factors comparatively between alternatives before the decision is reached. Ideally, the process occurs in matrix form for several decision points in the planning, design, siting, and construction of the project. The decision-making process occurs at numerous points in the chronology of the project with each decision affecting those that follow. In addition, some decisions previously made need to be reviewed in terms of the results of later decisions or inputs to those decisions. While these feedback loops cannot be ignored, they are usually economically costly and somewhat unwieldly mathematically.

Figure 8.1-1 illustrates the decision-making process in a generalized approach for a power generation project and presents the logic followed throughout the remainder of this discussion. Six elements are defined as the primary model or decision points in the analysis: Establishing energy requirements and energy source, selection of power plant type and size, selection of site, selection of cooling system, selection of waste systems, and selection of transmission method and route.

While, in general, a matrix of alternatives can be drawn so that each alternative in the six decision points can be simultaneously evaluated in a way that assesses interactions between and among alternatives using mathematical modeling techniques, the approach has been simplified for this report. The simplification is a linearization of cost/benefit analysis with one analysis being performed for each chronological decision point. This simplification is included for two reasons: (1) The limited time available for the preparation and analysis of this report, and (2) the fact that much of the decision making for the H. B. Robinson Unit No. 2 is history.

The weak point in the cost/benefit approach is not the logic but the availability of realistic input data on many of the parameters. Although energy requirements, hardware costs, and economic considerations are relatively easy to predict, biological data, social costs and benefits, and the more subjective data are less reliable.

The H. B. Robinson Unit No. 2 has been built and is operational. Most of the decisions have been made with regard to need, siting, cooling system and so on, and these are traced by heavy lines on Figure 8.1-1. The comments which follow attempt to summarize the reasons for past decisions and to point out wherever possible the costs and benefits.

8.2 SELECTION OF ENERGY SOURCE

Technological man, or post-industrial man as he is sometimes called, has increased his standard of living remarkably in the twentieth century. He has largely done this by effectively harnessing energy and making it perform useful work or provide useful heat through various machines or energy converters. The energy demand per capita has increased from an estimated 12,000 kilocalories per day in primitive agriculture societies to 70,000 kilocalories per day in the mid-nineteenth century and, finally, to 230,000 kilocalories per day in 1970 in the United States.

In the area served by Carolina Power & Light Company increasing quantities of energy are required to keep pace with rising production of farm and factory, improved housing for middle and low income families, increased population influx to this area, and increased mobility of society. Electrical energy use has been increasing at nearly twice the rate of increase for energy use as a whole. An examination of the cost/benefit relationships of the use of centrally generated electricity as opposed to numerous, individual, point energy sources reveals the reason for society's emphasis on electricity.

8.2.1 Environmental Costs and Benefits

Space heating, process heating, transportation, and electric power are the major uses of energy in this area. All of these uses except electric power require the conversion of raw energy to useful energy at the point of use. For example, coal, oil, natural gas and wood are burned in homes to provide space heating. Each of these pollute the air in an uncontrolled manner with regard to both quantity and geographical distribution since no air pollution control equipment is required on individual units. In addition, both primary and secondary waste heat is discharged to the environment. Transportation systems often pollute the air to an even greater extent because of their high index of pollution coupled with a low delivered efficiency which requires more fuel per unit of useful work.

Electric power is a more efficient means of converting raw energy to useful energy than most point source conversion systems with an overall efficiency advantage of 15 to 20 percent. Thus, the Robinson Unit No. 2 has provided a raw energy savings of 10^{12} Btu/yr. In addition, fuel, particularly liquid and gaseous hydrocarbons, are becoming more difficult to find. Because nuclear fuel is used for Robinson Unit No. 2, this plant reduces society's requirements for oil and gas resources by approximately 35 billion cubic feet of gas per year or by approximately 350 million gallons of oil per year.

The transmission systems for electric power have some environmental costs associated with clearing of right of ways, construction of transmission lines and substations, and visual impact of structures. It is important to realize, however, that no storage space or storage facilities are required at the point of use. Energy systems converting raw energy at the point of use generally involve the allocation of storage space and facilities each having adverse environmental impact and attendant safety problems.

Noise abatement in cities also supports the increasing rate of electrical power in the energy use pattern. The noise problem always accompanies the conversion of fossil energy to useful work. The nuclear-steam power plant presents a manageable problem in this regard; the other small conversion systems do not.

8.2.2 Social Costs and Benefits

Among the more important social benefits accruing to the citizens in the area served by the Robinson Plant are:

1. A more favorable environment in terms of public health, safety, and comfort.
2. The development of a modern, technologically oriented group of design, construction, operating, and management employees.

As an integral part of the Robinson Unit No. 2, CP&L commenced a program of staff upgrading through extensive training courses for existing personnel. In addition, the staff was expanded through the acquisition of acknowledged experts in various fields of scientific training. The new staff has been of great service to the community through participation in civic affairs and through their contribution in helping the people of local communities to develop scientific understanding by participating in local forums and other educational programs.

CP&L constructed one of the first nuclear plant information centers in the nation. More than 5,000 people, including students from primary and secondary schools, have visited the Robinson Information Center. The social benefit to be gained by stimulating the imagination and initiative at the formative stage of even one of these students cannot be overemphasized. In addition to the Information Center project, CP&L has worked with the local universities to develop research programs in science and engineering.

The introduction of the Robinson Unit No. 2 has had a social benefit in that plant construction provided employment for over 500 skilled workers and current plant operating personnel number over 50 highly skilled technicians and professional personnel. In addition, the power produced by the plant should be further leverage for the labor market by creating new jobs in other industries. Also, the continuing need to meet AEC regulatory requirements has provided full employment for at least 20 new professional employees on the CP&L staff.

8.2.3 Economic Costs and Benefits

The H. B. Robinson Unit No. 2 was one of the first large nuclear projects in the U. S. Since CP&L had been involved in the Carolinas-Virginia Nuclear Power Association for several years, they were familiar with the technical feasibility of nuclear power as a method of generating electrical energy in a large power plant and were aware of the future role which nuclear energy would play in the power industry. Based on this insight and the economic and environmental advantages offered by nuclear power, a nuclear unit was selected for the H. B. Robinson site. The economic advantage to the customer in the service area was apparent in 1965 from conditions prevailing at that time which included the availability of fossil fuel at 26 cents/million Btu. The energy crisis which occurred in the past two years has pushed the cost of fossil fuel far above the 1965 value and has resulted in even greater benefits accruing because of the nuclear project than were originally contemplated. While the capital cost of a new plant is higher than for a fossil plant, nuclear fuel costs are much lower and far less subject to inflationary trends.

On a local basis, electrical generating plants are, in general, an economic benefit too. Tax bases for local areas are expanded after a plant is in operation and often new industries are spawned by the influx of dollars, people, and other industries in the locale of the plant.

In general, the electrical energy source alternative has a clear advantage over other energy sources from the cost/benefit standpoint.

8.2.4 Establishing Energy Supply and Demand

Having accepted society's decision to demand an increasing amount of electrical energy, CP&L is confronted with the decision to define, by suitable forecasting methods, the energy needs of its customers and then to choose from among several alternatives how it should go about filling these needs. As indicated on Figure 8.1-1, these alternatives are:

1. To ignore the need and not provide the electrical power.
2. To import or purchase the power from other producers in or near the area where the need exists.
3. To expand the presently available operating units of the Company.
4. To construct new generating units.

Of course, the first alternative is unacceptable. Utilities are obligated morally, legally, and economically to respond to customer demands for power. One can hardly imagine the profound effects on our whole technological society's structure if adequate power were not available on demand to keep our public health and safety systems, our homes, our communications, our industrial processes, and our transportation systems functioning.

The second alternative is a somewhat more realistic alternative and is often employed by utilities on a temporary basis to fill power demands. To understand this one must review the electricity supply-demand situation in the Carolinas-Virginia area.

Carolina Power & Light Company serves customers in the North and South Carolina area and shares the territorial load network with Virginia Electric and Power Company (VEPCO), South Carolina Electric & Gas Company, and Duke Power Company. In 1965, when the Robinson Unit No. 2 nuclear steam generating plant was conceived, a projection of the 1970 energy use pattern for the Carolina Power & Light Company customers was predicted. The present experience with power demand bears out these longer term predictions. As shown in Section 5.1, the present power reserves even with the Robinson Unit No. 2 in operation are below the Company's established adequate reserves requirements. Furthermore, the supply of power from other utilities in the Carolinas-Virginia area is also limited as indicated by the low total power reserves for all the utilities in the area. As a consequence of this situation, the possibility for purchase of power by CP&L on a long-term basis was not a practical alternative to meet the needs of its customers.

The third alternative, expansion of presently operating units, was also evaluated as a technically, economically, and socially costly alternative. Most plants are designed as generating units with all the interrelated equipment such as steam generators and turbines of a compatible size. It would not be technically feasible to increase the capacity of these units by an additional piece of equipment unless the entire unit was replaced by one of a larger size. This alternative would, therefore, be expensive and would be unacceptable since extended power outages would be required during the replacement period.

The only practical alternative, and the one chosen for implementation, was the construction of a new unit. This alternative obviously had the highest overall benefit since it fulfilled the demand for power and environmentally resulted in a net benefit: new plants using the latest pollution abatement technologies tend to minimize adverse impact on the environment.

8.3 SELECTION OF POWER PLANT SIZE AND TYPE

Once the decision was made to build a new unit, the Company had to decide how large a unit to build and what type. The four types given consideration were:

1. Hydroelectric Generation
2. Gas Turbine Generation
3. Fossil Generation
4. Nuclear Generation

Since there were no suitable water resources in the area, the hydroelectric alternative was abandoned. Gas turbines are useful in providing peak load service but are not designed for continuous base-load service. Theoretically, one could operate sufficient gas turbines to provide the required base load but such a scheme would not be economically competitive with the fossil or nuclear alternatives. Both the fossil-steam and nuclear-steam generating alternatives were given careful scrutiny in 1965 when this decision point was reached. From the standpoint of environmental cost, the decision was made to minimize environmental impact for either type of plant as a basic Company philosophy. Therefore, the cost/benefit comparison was made essentially on economic grounds.

A total evaluated cost per year for a 700 MWe electrical unit was estimated for both a nuclear and a fossil unit. The analysis showed that a nuclear unit would involve a higher evaluated cost initially because of the higher capital cost and a slightly higher fuel investment initially. Within two years the escalation of fossil fuel cost would increase the evaluated yearly cost of the proposed fossil unit to a value greater than the nuclear unit. The nuclear unit would maintain this advantage in evaluated cost for the remainder of the unit life based on fuel cost projections. As a result, the decision was made in favor of the nuclear unit. The increase in cost of fossil fuel has proved the soundness of the analysis.

The size of the unit was established on the basis of two criteria: demand and availability of "standard" commercial nuclear units. A plant of approximately 700 MWe was indicated by load projections and this size was being offered by nuclear reactor suppliers at that time.

8.4 SELECTION OF SITE

Following the decision to build a new, 700 MWe nuclear unit, a site had to be selected. In a general sense, two alternatives were available: new sites or expansion at an existing site. The cost to benefit comparison was clearly in favor of utilizing the existing Lake Robinson site.

During the initial site development, the waters of Black Creek were impounded to form a 2250 acre cooling lake to provide condenser cooling water and service water for a total generating capacity of about 1200 MWe. The construction and operation of the lake were approved by the South Carolina Board of Health and by the South Carolina Pollution Control Authority. These permits authorized construction of the lake and set forth regulations for use of the lake including the amount of water flow from the dam, limits on water temperature, and use of water from the lake for ash sluicing.

The site was also attractive for the addition of a nuclear unit in that the area was sparsely populated near the site. Since the land had been cleared during the construction of Robinson Unit No. 1 to provide for a second unit, the addition would preclude the environmental impact of clearing a new site.

The benefits of the decision for locating Robinson Unit No. 2 at the Lake Robinson site were:

1. An existing, approved cooling water supply constructed expressly for steam electric generating plant cooling.
2. Company owned property already committed to electricity generation with plant personnel and services available.
3. Minimum impact on the environment from construction effects as compared with the clearing and grading of a new site elsewhere.

4. Minimum impact on the aquatic resources of the area since the existing lake was designed for the expanded heat load.

5. Location in a sparsely populated area.

The costs incurred from the Lake Robinson siting decision were:

1. Increased heat load for Lake Robinson.

2. Small radioactivity releases to Lake Robinson.

3. The visual presence of an additional structure in the plant area.

4. Construction of an extension to the cooling water canal from a point approximately 1.2 miles above the plant to a point 4.2 miles above the plant which was initially planned and for which land was provided.

The heat load to the lake, a problem which will be discussed as part of the cooling system cost/benefit analysis, was not considered a severe deterrent because of the Company's foresight in the 1950's when the lake was created. It was designed to dissipate the added load and was an impoundment dedicated to power plant cooling as a basic purpose. Radioactive liquids released to the lake were recognized as an environmental and public health impact which could be prevented by proper selection of treatment and handling procedures as will be discussed below. The aesthetic cost was minimum since a fossil unit already existed on the site. To minimize the environmental cost of additional construction for the new canal, land clearing was minimized and confined to the lake shore and areas used for borrowing and wasting construction materials were improved by planting pine seedlings and various grasses.

In view of the many benefits at a minimum cost, Carolina Power & Light Company elected in 1965 to proceed with the Robinson Unit No. 2 project at the Lake Robinson site.

8.5 SELECTION OF COOLING SYSTEM

With the site selected, the cooling system selection was the next decision confronted in the cost/benefit analysis. Three alternatives were included:

1. Once-through stream cooling.
2. Cooling Towers.
3. Cooling Lake.

The only water sources available at the chosen site are Black Creek and Lake Robinson, a 2250 acre impoundment of Black Creek. Since Lake Robinson existed at the time the siting decision was made for Robinson Unit No. 2, the once-through stream cooling method was not really available. Even if Lake Robinson did not exist, Black Creek with its average flow of 115 cfs would not have the capacity to supply the 1070 cfs flow required for Unit No. 2.

Wet mechanical draft cooling towers were an acceptable alternative technically to dissipate the waste heat load. Cooling towers would minimize impact on the aquatic biota in Black Creek and Lake Robinson because of their lower water appropriation and the elimination of a thermal plume in the lake. However, towers create other environmental costs: they are large, visually obtrusive structures that present aesthetic intrusion on the landscape; they contribute to fog, icing and high humidity in the local area; drift or water carryover from the towers can be a nuisance and can cause arcing in local power transmission equipment; and they increase water consumption to some degree from the lake. Economically, the cooling tower alternative was not justified for the Robinson site. Towers would cost approximately $15,000,000 as compared with approximately $1,000,000 for extending the discharge canal and using Lake Robinson which already existed as a cooling facility. Based on these high environmental, social, and economic costs as compared with a modicum of benefits, cooling towers were not chosen for Robinson Unit No. 2.

8.5.1 Costs and Benefits of Existing Cooling System

The final decision for Unit No. 2 was to select the existing Lake Robinson cooling system. This system takes water from the downstream end of Lake Robinson through a screen arrangement designed to keep fish and debris out of the plant. The water is pumped at 1070 cfs through cooling water pumps to the main steam condenser where its temperature is increased 18°F as it takes on the unit's waste heat load. From the condenser, the heated water flows to the upper end of the lake through a specially constructed discharge canal.

As the hot water flows into the lake, it rises to the surface because of its lower density and most of the waste heat is dissipated by evaporation. During the course of its flow from the upper end of the lake to the lower end, the "thermal plume" cools by the evaporation of from 4500 to 7500 gallons per minute and the temperature in the plume drops by 18°F. The heated water in the lake is confined to the top 10 to 15 feet of surface water; below these depths to the maximum lake depth of about 40 feet, temperature distributions are typical of the normal or natural temperatures for impounded waters in a warm water zone.

On a typical operating cycle with both Robinson Unit No. 1 and 2 operating, the temperature of Black Creek at the outlet of Lake Robinson averages about 10°F higher than at the inlet. Experience indicates that, on the average, natural solar radiation accounts for about 6°F of this increase and that the operation of both the nuclear and fossil units accounts for the remaining 4°F increase.

The current water quality standards, applicable to Black Creek, set forth by the South Carolina Pollution Control Authority allow a 5°F rise in stream temperature after complete mixing and a maximum of 90°F.

The existence of temperatures in the lake and in Black Creek downstream of the dam which are higher than those above the lake would not require close scrutiny per se were it not for two considerations: the effect of temperature on aquatic organisms and the effect of temperature on downstream users of Black Creek. The only user within four miles from the discharge is Sonoco Products Company, a manufacturer of specialty paper products that uses the water from their own impoundment of Black Creek for dilution of wastes and for cooling. The flow stability over a yearly cycle which the Lake Robinson impoundment provides has been noted as a beneficial effect to Sonoco.

Black Creek in the area above and below the lake is classified as an A-2 swamp area by the South Carolina Pollution Control Administration. As such, standards for discharges are: for pH from 5 to 8, dissolved oxygen 2.5 ppm minimum and phenolic content 1 microgram per liter. The operation of both Robinson units has not only been within these limits but has actually improved some characteristics of the water quality in the lake and in Black Creek downstream where dissolved oxygen has been increased by about 1 ppm by aeration due to special design features at the dam and where suspended solids and turbidity have been decreased due to the settling action in the lake.

The water in Black Creek and Lake Robinson does not naturally have characteristics suitable to maintain a large fish population. Nutrient content is low and the pH is relatively low at about 4.8 - 5.5. Predominant species as sampled by the South Carolina Wildlife and Resources Department in 1968 are shown in Table 3.7-3. The Wildlife and Resources Department achieved a modest success in stocking a hybrid striped-white bass in 1969; however, in spite of this stocking, Lake Robinson's future as a sports fishery is questionable even without the fossil and nuclear units because of the low quality of water upstream.

The primary impact of the unit on the existing fish population is the thermal stress caused by the plume and the predation of the plant intake screens. While some fish have been collected on the screens, there is no evidence to suggest that a significant alteration of the fish population has occurred. Fish can avoid high temperature waters in the heated plume, particularly since the plume is confined to the surface waters at the upper end of the lake.

Predation and heating the waters of the lake can, on the other hand, have beneficial effects on fish. If nutrients are available, growth rates of fish can be increased at higher temperatures which are below the lethal limits, and predation on the plant screens can help to maintain a stable fish population by culling rough fish and allowing others of interest to the sports fisherman to increase in number.

In addition to fish predation, the unit's operation can impact on the planktonic or free floating organisms in the water. These include many small phytoplankton (plants), zooplankton (animals), and fish eggs and larvae. Passage through the condenser and intake pumps can result in a plankton loss of from 20 to 100 percent based on experiments at other locations. In general, however, these losses in the plant should have a relatively minor impact on the population of plankton in the lake because these small organisms reproduce rapidly. A long-term effect of the heated water in the lake may be anticipated as species more able to survive the heated water increase in numbers at the expense of those less able to survive. This may represent an environmental cost or a benefit depending on the surviving species.

The important consideration from a biological point of view is that Lake Robinson does not contain a natural ecosystem. It was formed to provide cooling water for a generating plant; the fish and planktonic communities were secondary considerations. Fish populations in the lake were mediocre prior to the construction of Robinson Unit No. 2, primarily due to the water quality inherent in the black water impoundment.

In addition to the quite minimal environmental costs and the environmental and economic benefits noted above, Lake Robinson provides social benefits for the South Carolina area. Before Lake Robinson existed, the area was largely second growth pines and some stream fishing was available to local residents. Today, the lake affords greatly expanded recreational opportunities for the area including a sports fishery and 2250 acres of open water for swimming, sailing, boating, water skiing, and other water sports. In addition, picnicking and hiking around the lake are added recreational benefits.

8.6 SELECTION OF TRANSMISSION SYSTEM

Having made the above cost/benefits decisions on siting, cooling system and plant type, the next selection was the transmission system. The existing 115 KV transmission lines which had been installed to accommodate the existing 185 MW fossil-fired unit did not have the capacity to transmit the additional power from the new 700 MWe nuclear unit.

A transmission system having adequate capacity was required to deliver the additional power to the area load centers. The continued use of 115 KV transmission was not desirable because of the number of transmission lines that would have been required. Based on thermal capacity, one 230 KV line is equivalent to 2-115 KV lines. The social and environmental costs of right of way, lines and equipment prohibited serious consideration of 115 KV transmission.

A separate 230 KV transmission system was then planned to connect the 700MWe nuclear unit to the area load centers. The new 230 KV lines were planned, designed, routed and constructed to minimize environmental cost. The existing 230 KV line from Rockingham to Florence was routed into the Robinson Plant by constructing two short segments of 230 KV line from a point near Society Hill, S. C., to the plant. These two extensions together with the existing line provided two of the required 230 KV circuits with one circuit extending to Rockingham and the other extending to Florence. In addition to the above two circuits, only two other lines were required, one to Sumter and an additional line to Florence. The four circuits were the minimum transmission required for system reliability and to deliver the power to the load centers were it was required. The 230 KV system was also connected to the 115 KV system at the plant through a transformer bank.

Consideration was given to uprating the existing 115 KV transmission lines to 230 KV operation, but this would have required removing the existing 115 KV structures and conductors and replacing them with larger 230 KV structures, heavier insulation and larger conductors. In addition, 15-115 KV substations that were connected to these 115 KV lines would have required the replacement of 115 KV equipment with 230 KV equipment. During the reconstruction period large segments of the transmission network would have been removed from service, placing the reliability of the power supply to the areas in jeopardy. Lengthy service interruptions would have been required at the 115 KV substations during the replacement of the 115 KV equipment. The environmental cost of land use for line right of way was also greater, as more acres of new right of way were required for uprating the 115 KV lines than for the new 230 KV lines.

In view of the above social and environmental costs, the reconstruction of the 115 KV system to 230 KV operation was not found to be feasible.

As previously stated in Section 3.10, the new 230 KV lines were designed to minimize the environmental impact. Pole design was selected to be unobtrusive and blend with surroundings, land use changes were minimized, and screening was provided at highway and stream crossings.

The Company cooperated with state and local agencies and property owners in the development of beneficial uses of the right of way for agriculture, wildlife and recreation. The routing was selected to minimize environmental and social costs by avoidance of public lands, major construction, historical and archeological sites, airports and other sensitive areas.

8.7 SELECTION OF WASTE HANDLING SYSTEMS

In the selection of systems or methods of handling the radioactive and sanitary wastes for the Robinson Unit No. 2, three alternatives were available as shown in Figure 8.1-1:

1. Direct release to the environment.
2. Shipment off-site or to municipal treatment systems.
3. Pre-process on-site to a condition suitable for shipment or release.

Direct release of wastes would involve severe environmental costs in terms of water contamination, damage to aquatic biota, air pollution, and public health. This alternative was not considered acceptable. Shipment of radioactive wastes off-site was a feasible alternative but was too costly and inefficient because of the large volumes of liquids and gases involved. Off-site disposal of chemical and sanitary wastes was not possible because no local municipal facilities were available.

The final alternative was chosen as the only cost effective one. The Company decided for a commitment to minimize environmental costs by pre-treating all wastes on site until the radioactivity or biological activity reached low enough values for release.

A complete description of the present radwaste system is included in Section 3.7. As noted in that description, all radioactive liquids are either processed and retained by the Chemical and Volume Control System or by the Waste Processing System. The Waste Processing System collects low-activity fluids from drains, leak-offs, and demineralizer regeneration and concentrates them in the waste evaporator. Concentrated bottoms from the evaporator are stored in drums for off-site disposal at licensed burial grounds; condensates are held in storage tanks and analyzed for activity level prior to dilution and discharge in the condenser cooling water flow to the lake.

Gaseous wastes originating in the degassing operation for the reactor coolant, cover gases in holdup tanks, and miscellaneous vents, reliefs, and sample points, are held in storage tanks until the activity has decayed to a level low enough to allow safe discharge to the atmosphere. The gas in the tanks is analyzed for activity level prior to release at a controlled rate.

Solid radwastes such as paper, spent demineralizer resins, and waste concentrator bottoms are packaged in drums for shipment to off-site licensed burial facilities.

With the above operating procedures during the past eleven months, actual releases of radioactive liquids to Lake Robinson have been 0.583 curies of fission and corrosion products and 38.3 curies of tritium. Gaseous releases of noble gases krypton and xenon were 0.022 curies. These releases have resulted in equilibrium concentrations in Lake Robinson which are a factor of 10^{-5} to 10^{-8} less than the MPC limits for various isotopes. The resulting maximum dose to an individual exposed continuously at the site boundary and eating 50 grams daily of Lake Robinson fish is 0.065 mrem per year. This dose is insignificant when compared with a background dose of 200 mrem from natural and other man-made sources.

From a cost/benefit standpoint, the only alternative available at this time is to modify the existing radwaste processing system so as to achieve even lower releases of radioactivity to the environs. Carolina Power & Light Company has modifications in progress which should reduce releases to levels even lower than those previously experienced.

Sanitary wastes from the plant are filtered and chlorinated before being discharged to the lake. No contamination of the lake has resulted from this source. All operation of this system is in accordance with permits issued by the South Carolina Pollution Control Authority. No need for improvement of these systems exists and, therefore, no alternatives need to be evaluated from a cost/benefit standpoint.

8.8 OVERALL PROJECT SUMMARY

The overall benefits of the H. B. Robinson Unit No. 2 clearly overbalance the environmental and economic costs. These costs and benefits in the social, environmental, and economic areas are present in summary form in Table 8.8-1.

TABLE 8.8-1

H. B. ROBINSON UNIT NO. 2 COST/BENEFIT SUMMARY

DECISION	COSTS	BENEFITS
Selection of Energy Source (Electricity)	Terrestrial impact and diversion of land for transmission system	Overall energy savings due to increased efficiency 10^{12} Btu/yr.
		Reduction in noise level in urban areas
		Development of skilled work force
		Enhanced quality of life in locale including public health, safety, and personal comfort
		Enhanced local tax base
Selection of Power Plant Size and Type (700 MWe nuclear)	Higher initial capital cost	Lower yearly evaluated cost based on lower fuel costs
	Radioactive materials releases	Maximum utilization of available site and cooling water lake at minimum additional expense
		Availability of "standard" size nuclear unit at 700 MWe
		Compatible output and demand level
		Minimum environmental impact from standpoint of land use, fuel commitment, aquatic resources
		Fuel savings 35 billion cu. ft/yr. natural gas or 350 million gallons/yr. oil

TABLE 8.8-1 (Continued)

DECISION	COSTS	BENEFITS
Selection of Plant Site (Lake Robinson Site)	Increased heat load for lake Radioactivity releases to lake and air Visual presence of unit Extension of cooling water discharge canal 3 miles and environmental impact thereof	Available cooling water supply already dedicated to power plant cooling Available, cleared site already dedicated to power generation Available, trained employees for construction, design and operation Minimum impact from construction effects Minimum impact from waste heat load on South Carolina waterways Sparsely populated area
Selection of Cooling System (Lake Robinson)	Increased evaporative load and more water consumption Possible diversity and abundance changes in plankton community Possible heating of Black Creek downstream 3 to 5^{o} F.	Increase in water quality of Black Creek Maintaining stable flow for downstream users Enhancement of area sports fishery to a limited degree through impoundment, increase in quality, and stocking program Recreational asset for area for swimming, boating, and other water sports as well as picnicking and hiking Available cooling capacity at minimum capital and operating costs

TABLE 8.8-1 (Continued)

DECISION	COSTS	BENEFITS
Selection of Transmission System (New 230 KV Lines)	New rights of way	High safety and reliability No power outages during construction No substation replacement Minimum economic cost Aesthetically compatible support design Minimum visual intrusion Available for development of wildlife areas, recreation, and access for forest fire fighting Avoidance of sensitive areas - historical sites, parks, etc.
Selection of Waste Handling Systems (In-plant treatment and controlled releases off-site)	3×10^{-5} mrem/yr. dose to maximum exposed individual (200 mrem/yr. background) Operating costs of processing facilities	Nearly total containment of radwastes Minimum biological impact from sanitary wastes and chemical wastes Control of level and amounts of releases based on weather, activity level, etc.

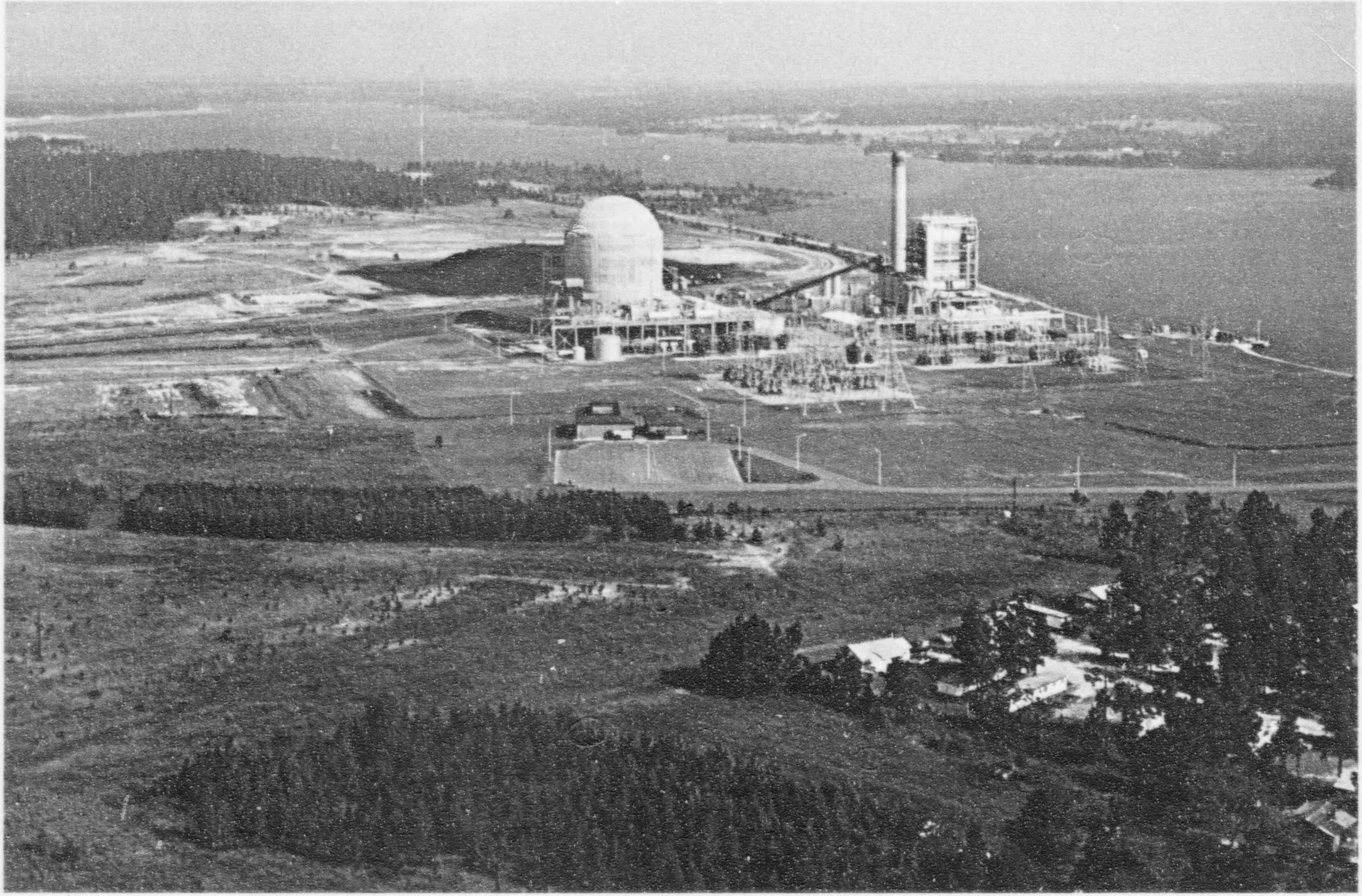
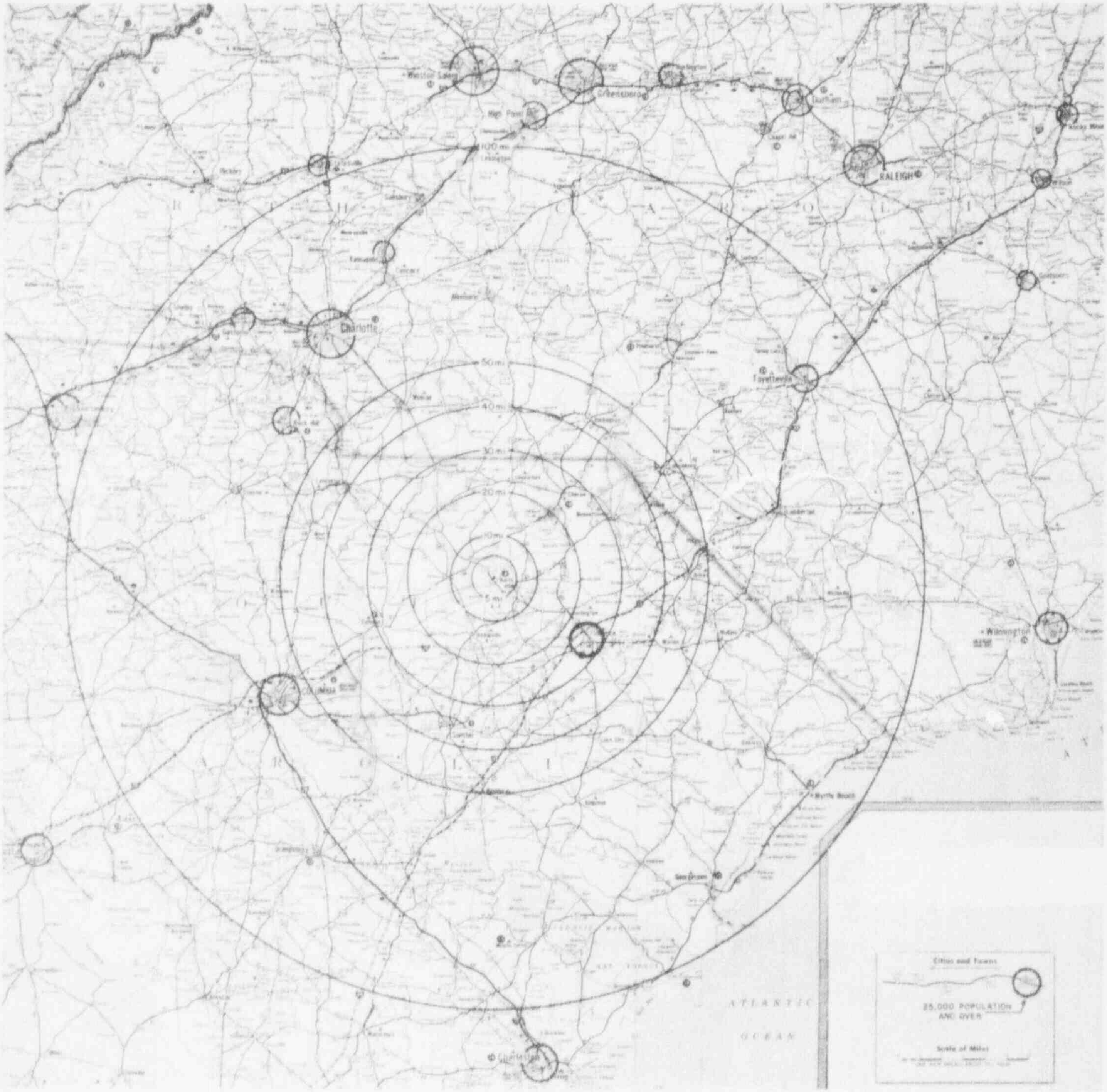


Figure 1.1-1 Aerial photograph of H. B. Robinson Plant taking in October, 1971, showing fossil Unit No. 1 and nuclear Unit No. 2.



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UNIT NO. 2
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GENERAL SITE
LOCATION MAP

FIG. NO. 2.1–1

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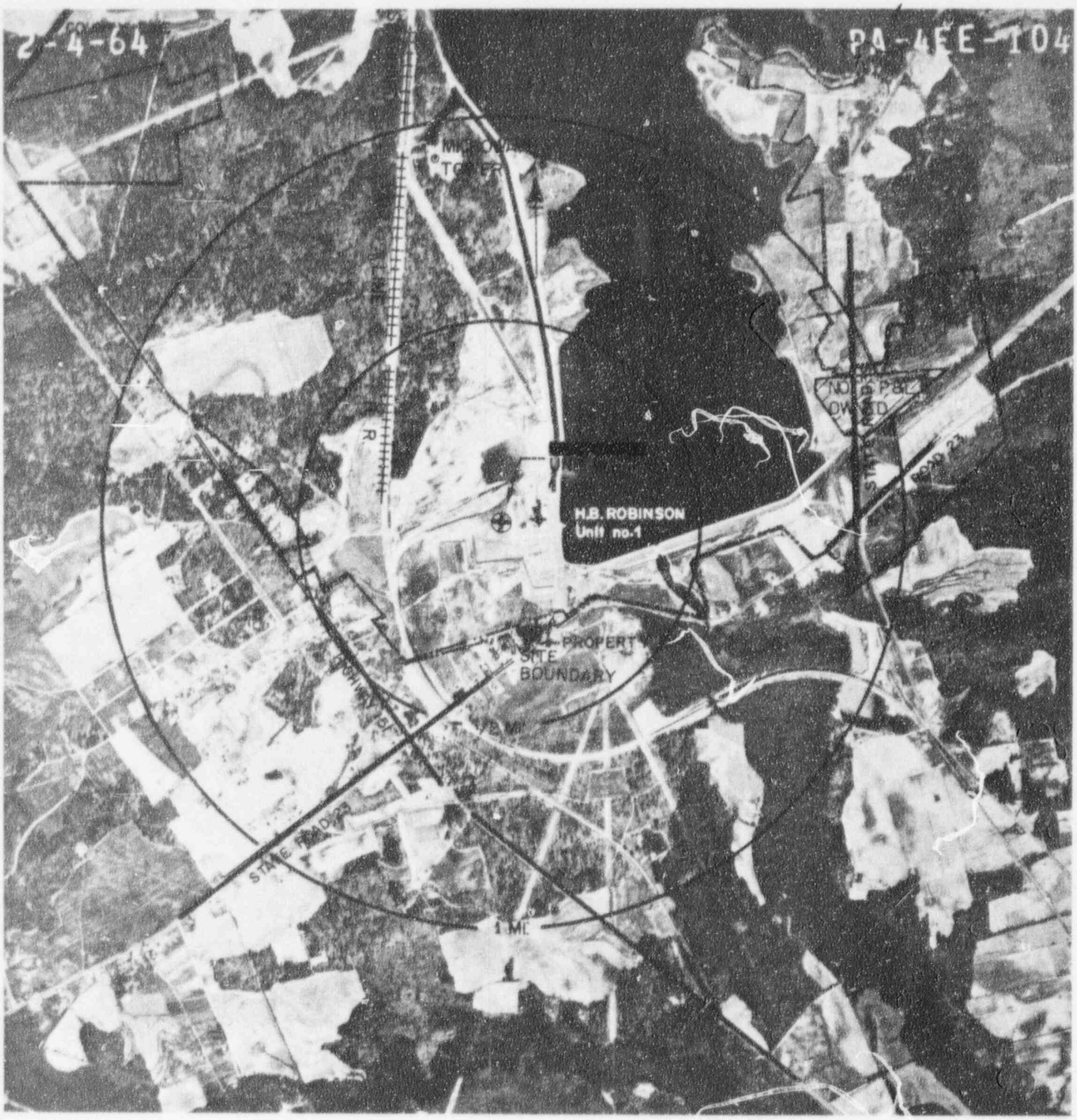

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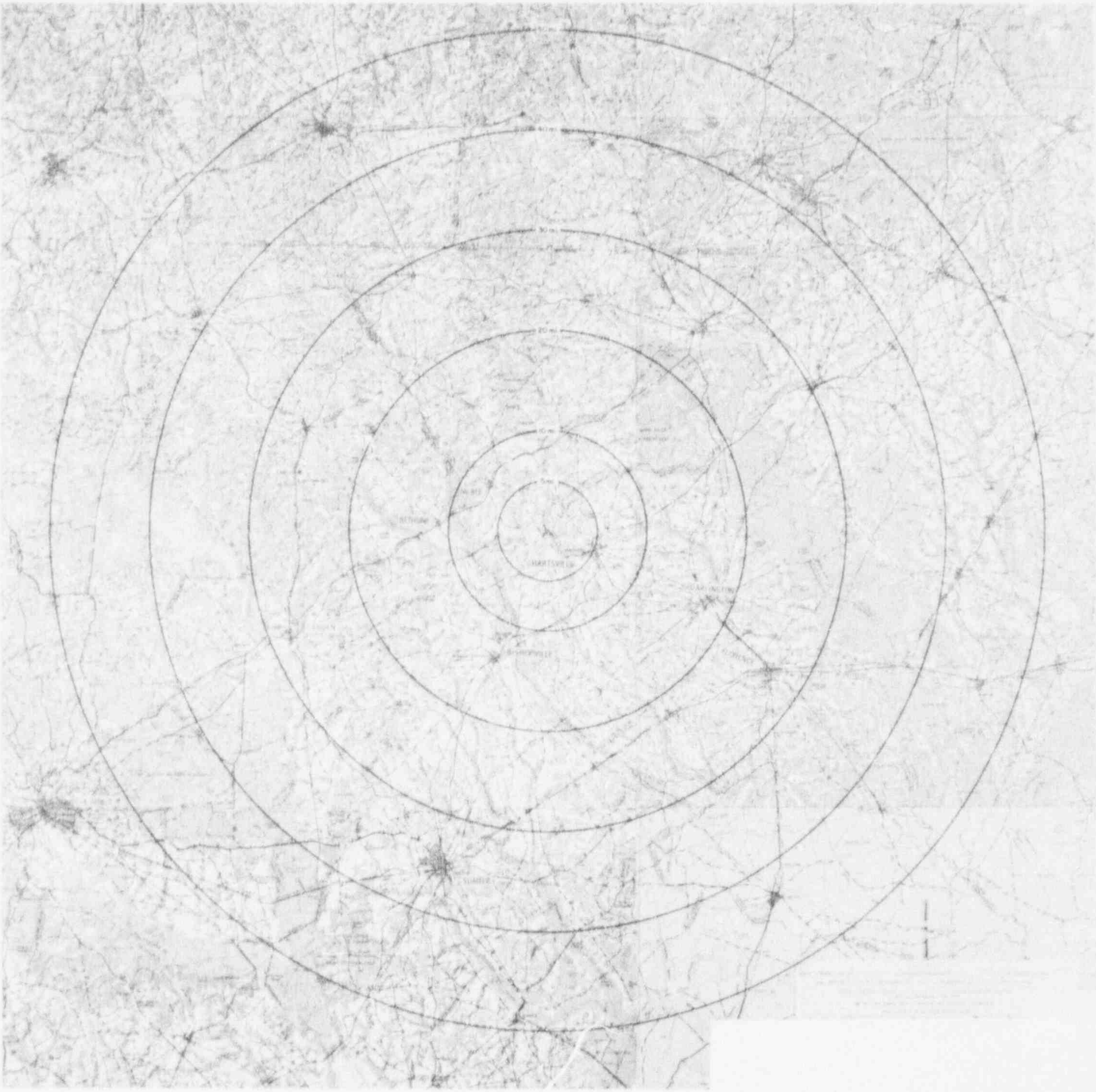
PLANT SITE BOUNDARY

FIG. NO. 2.1-2



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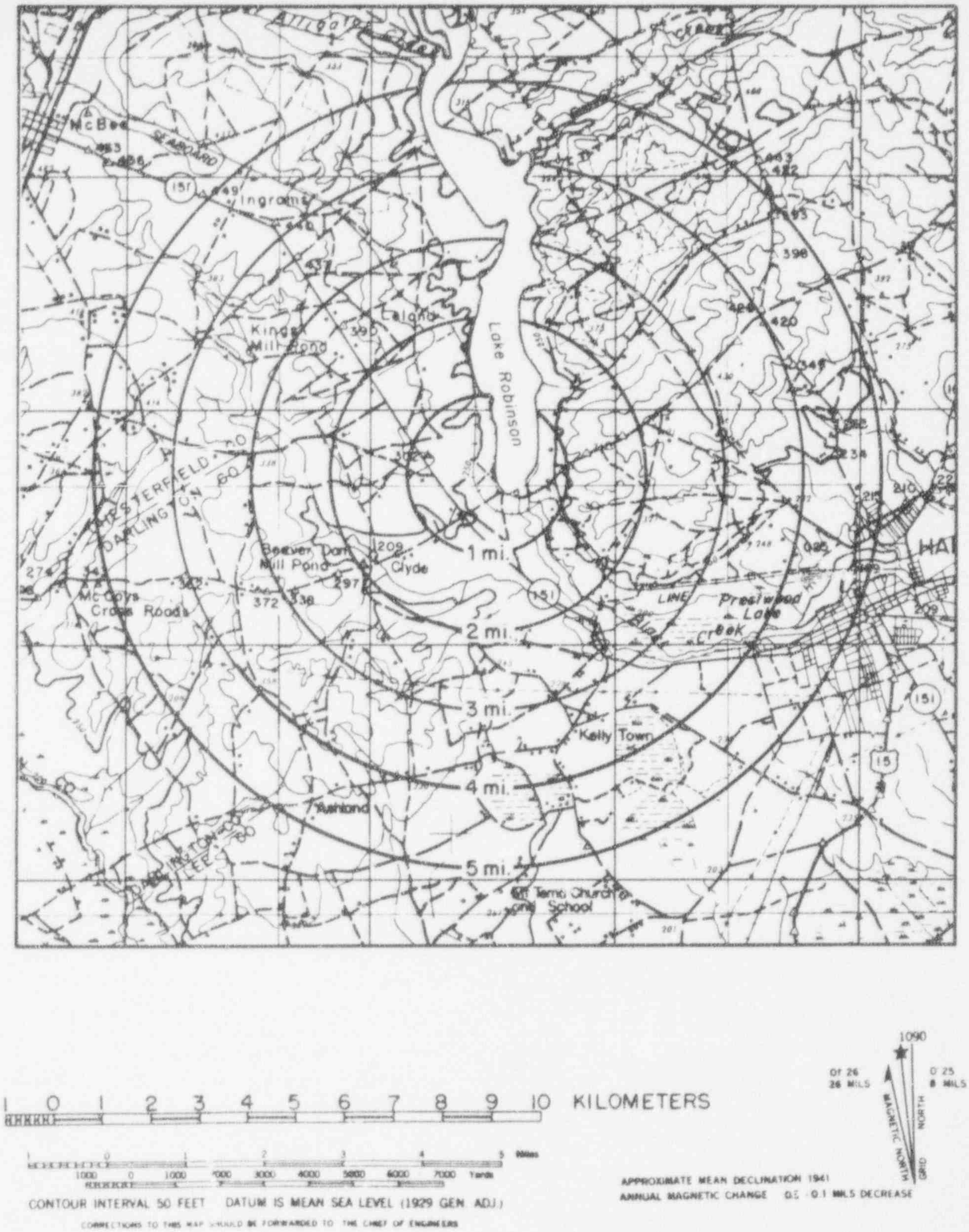
GENERAL SITE TOPOGRAPHY

FIG. NO. 2.1-3



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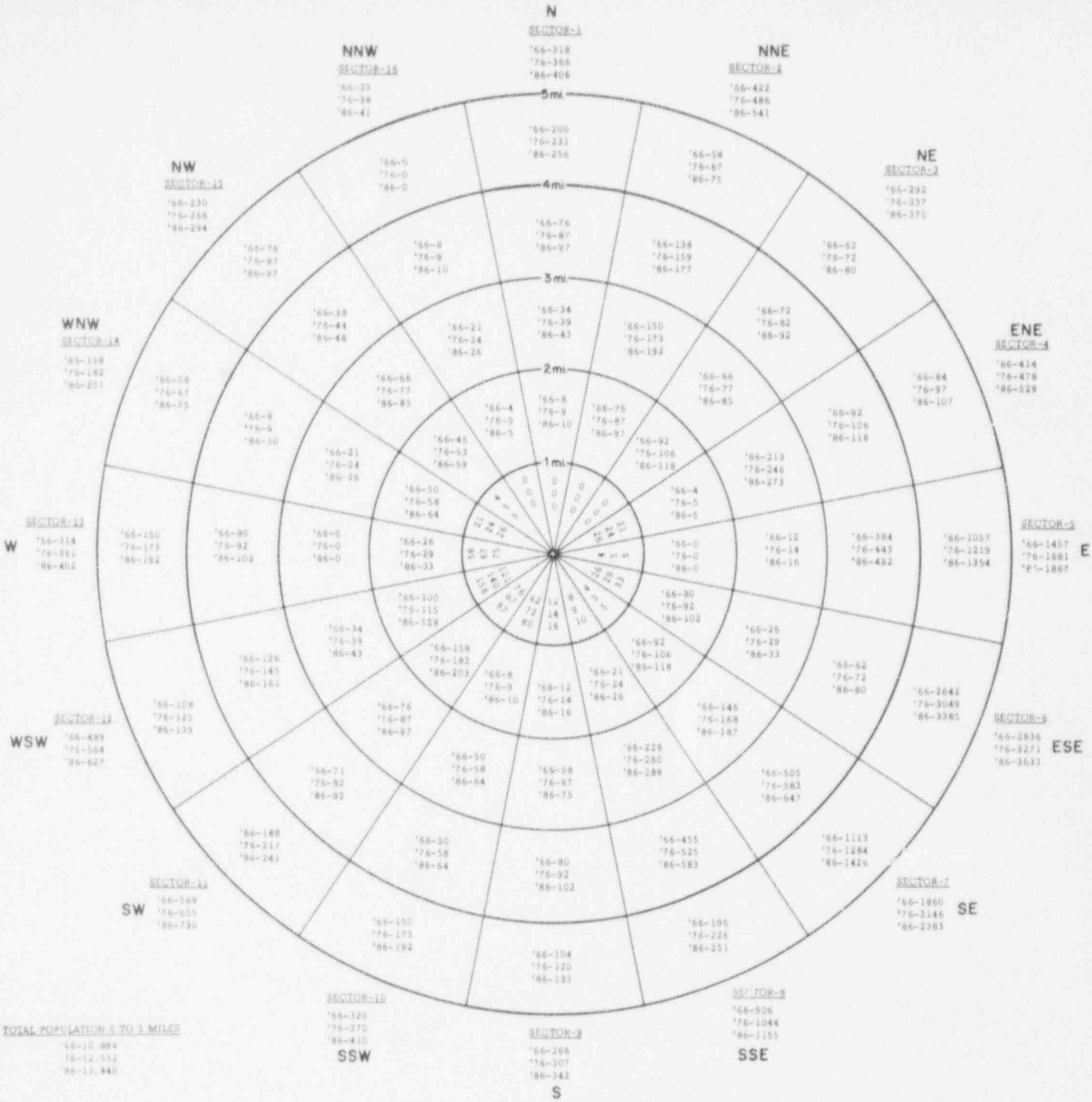
SITE ENVIRONS DETAILS

FIG. NO. 2.1-4



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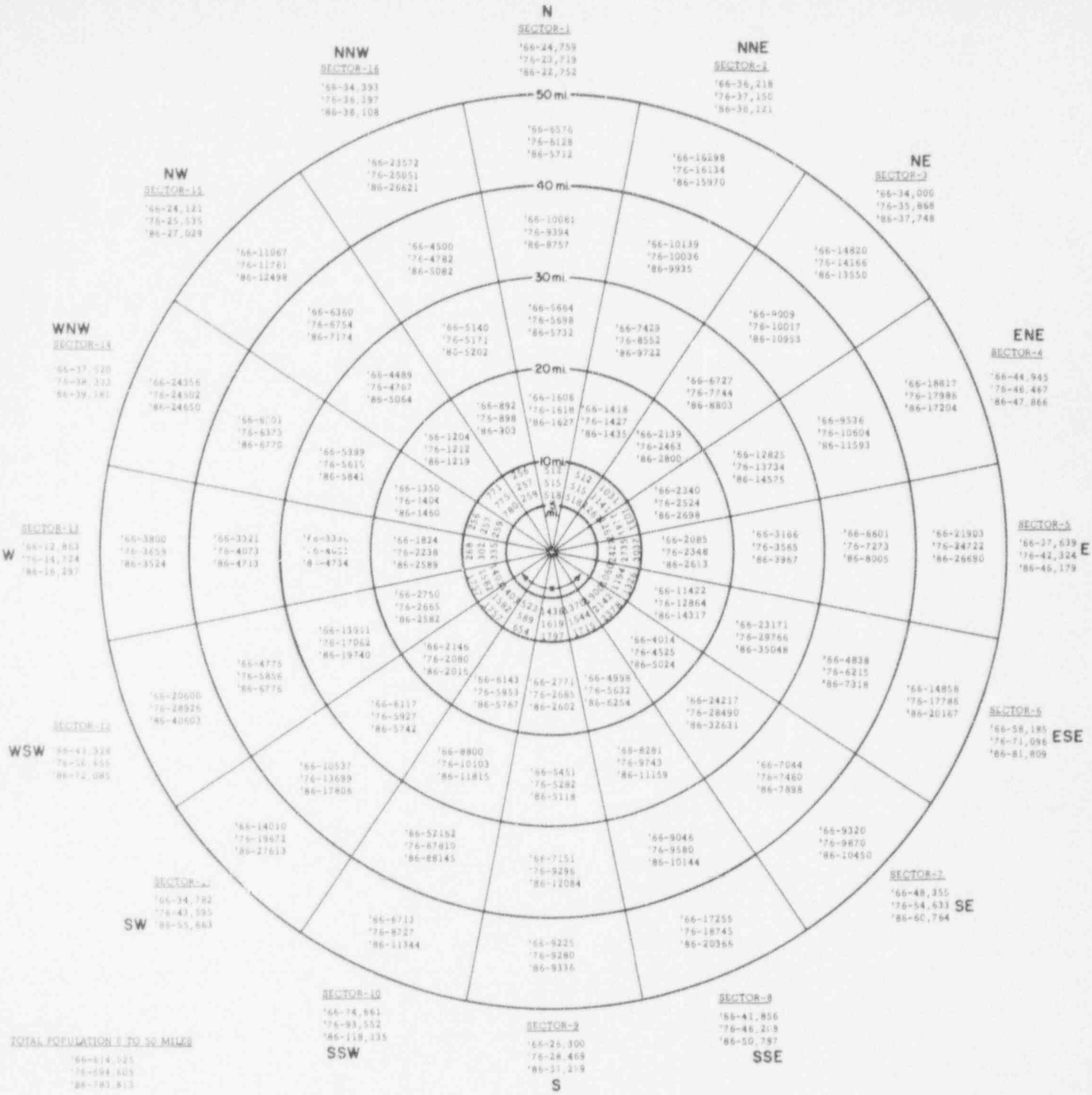
UNIT NO. 2
Environmental Report

POPULATION DISTRIBUTION
0–5 MILES

FIG. NO.	2.1–5



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UNIT NO. 2
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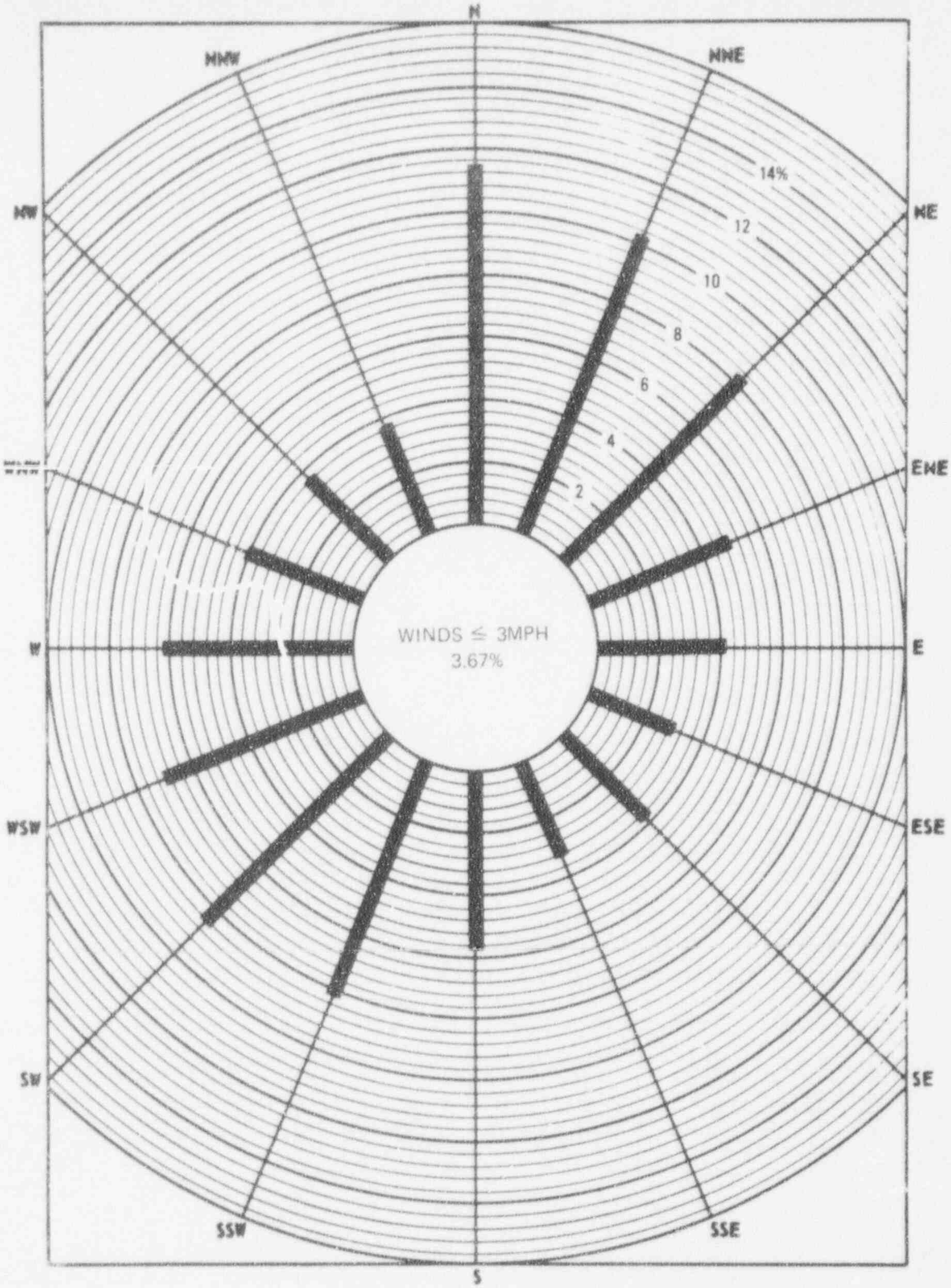
POPULATION DISTRIBUTION
0–50 MILES

FIG. NO. 2.1–6



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UNIT NO. 2
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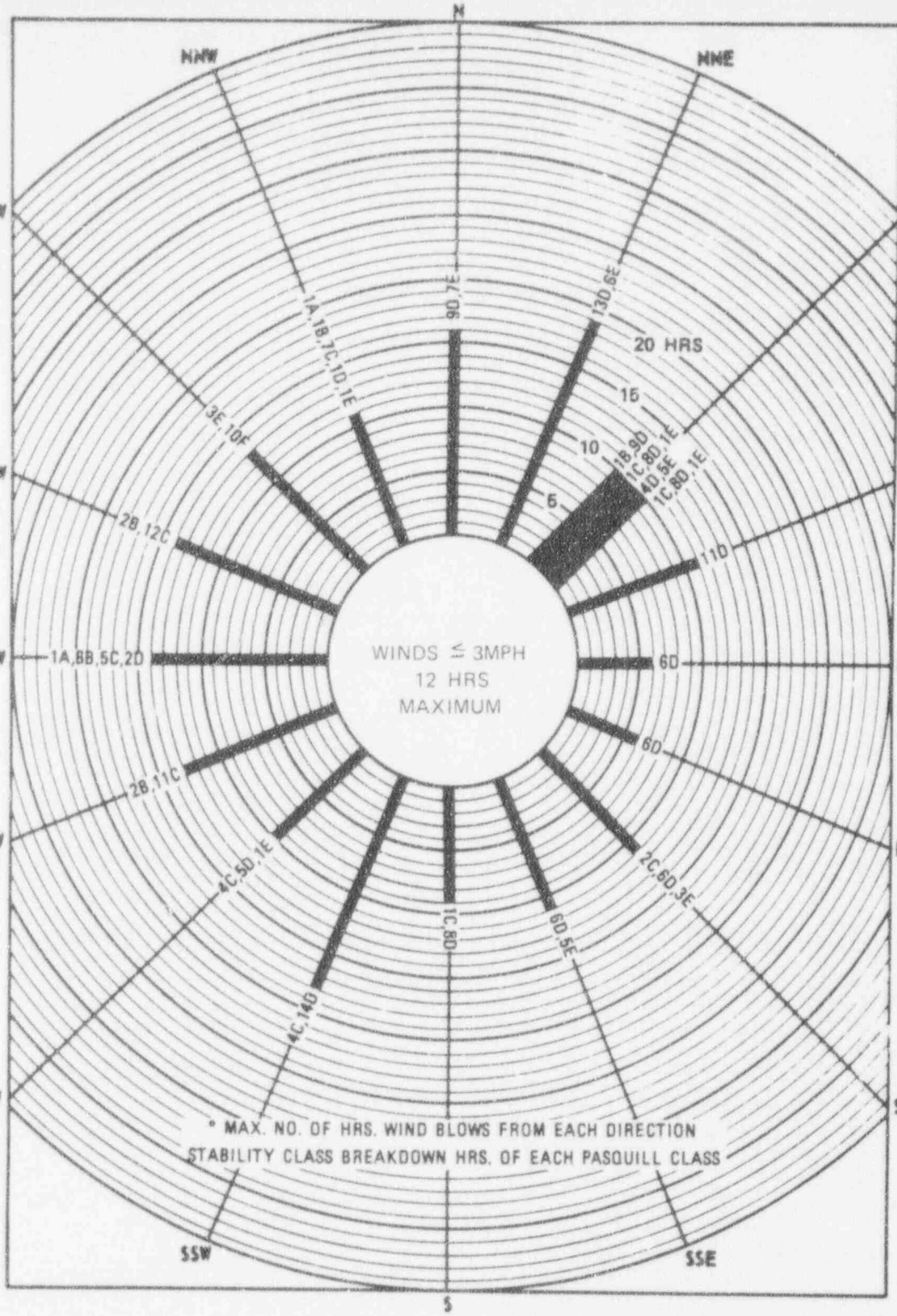
ANNUAL WIND ROSE
H. B. ROBINSON SITE DATA

FIG. NO. 2.1-7



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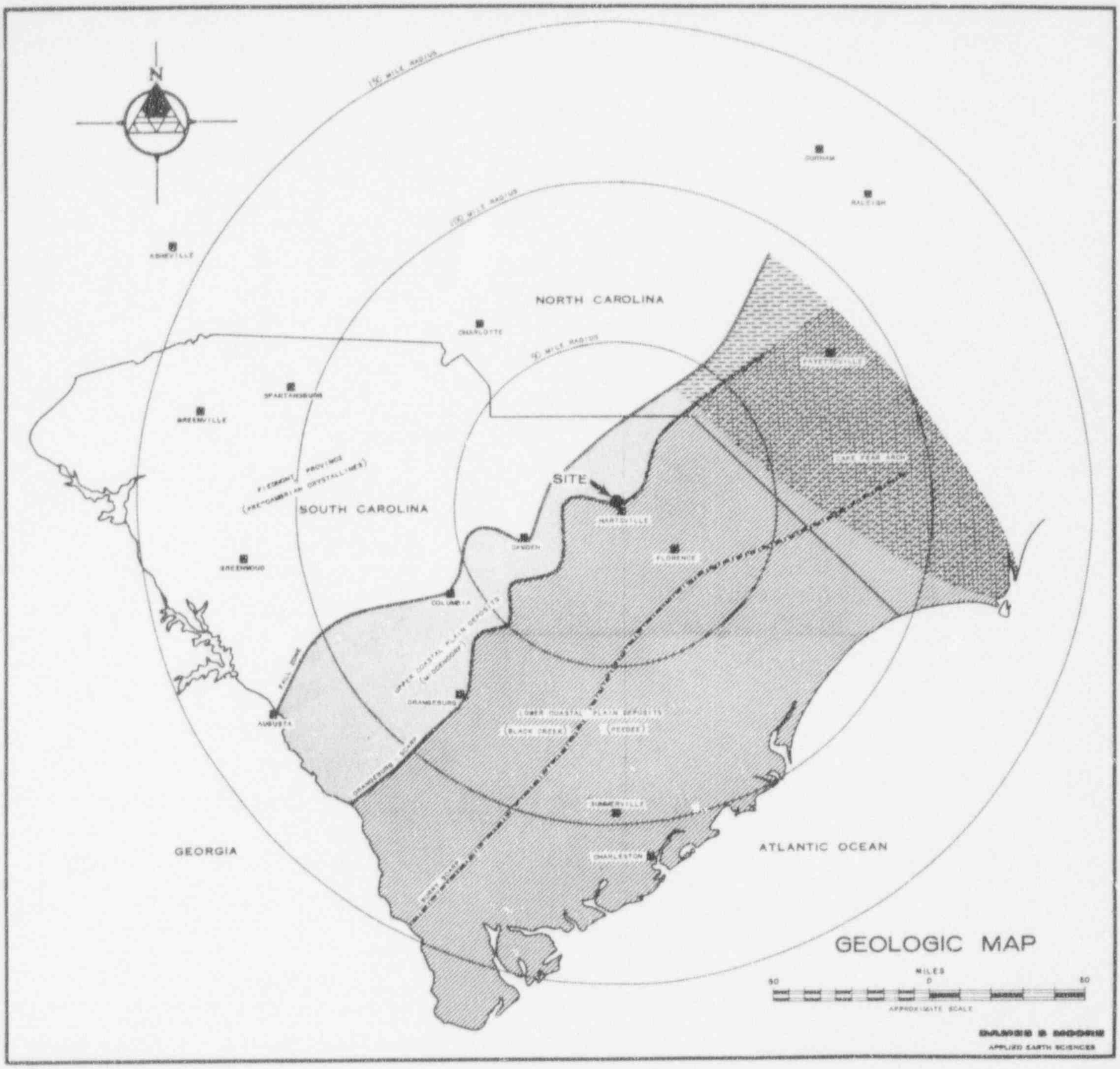
PERSISTENCE WIND ROSE
H. B. ROBINSON SITE DATA

FIG. NO. 2.1-8



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UNIT NO. 2
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PLANT SITE
GEOLOGIC MAP

FIG. NO. 2.1–9

LOG SYMBOLS	DESCRIPTION	COMPRESSIONAL WAVE VELOCITY (FT./SEC.)	ASSUMED POISSON'S RATIO	SHEAR WAVE VELOCITY (FT./SEC.)	UNIT WEIGHT (LBS/CU.FT.)
	ALLUVIUM, RECENT (SAND & GRAVELS)	1500	.33	755	125
	N.DDENDOTF, CRETACEOUS (SANDS, SILTY AND SANDY CLAY, SANDSTONE AND MUDSTONE)	7200	.33	3600	130
	CRYSTALLINE, PRECAMBRIAN (GRANITE, GNEISS, PHYLLITE SCHIST)	17500	.15	11200	170

GEOLOGIC COLUMN

DAMES & MOORE

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UNIT NO. 2
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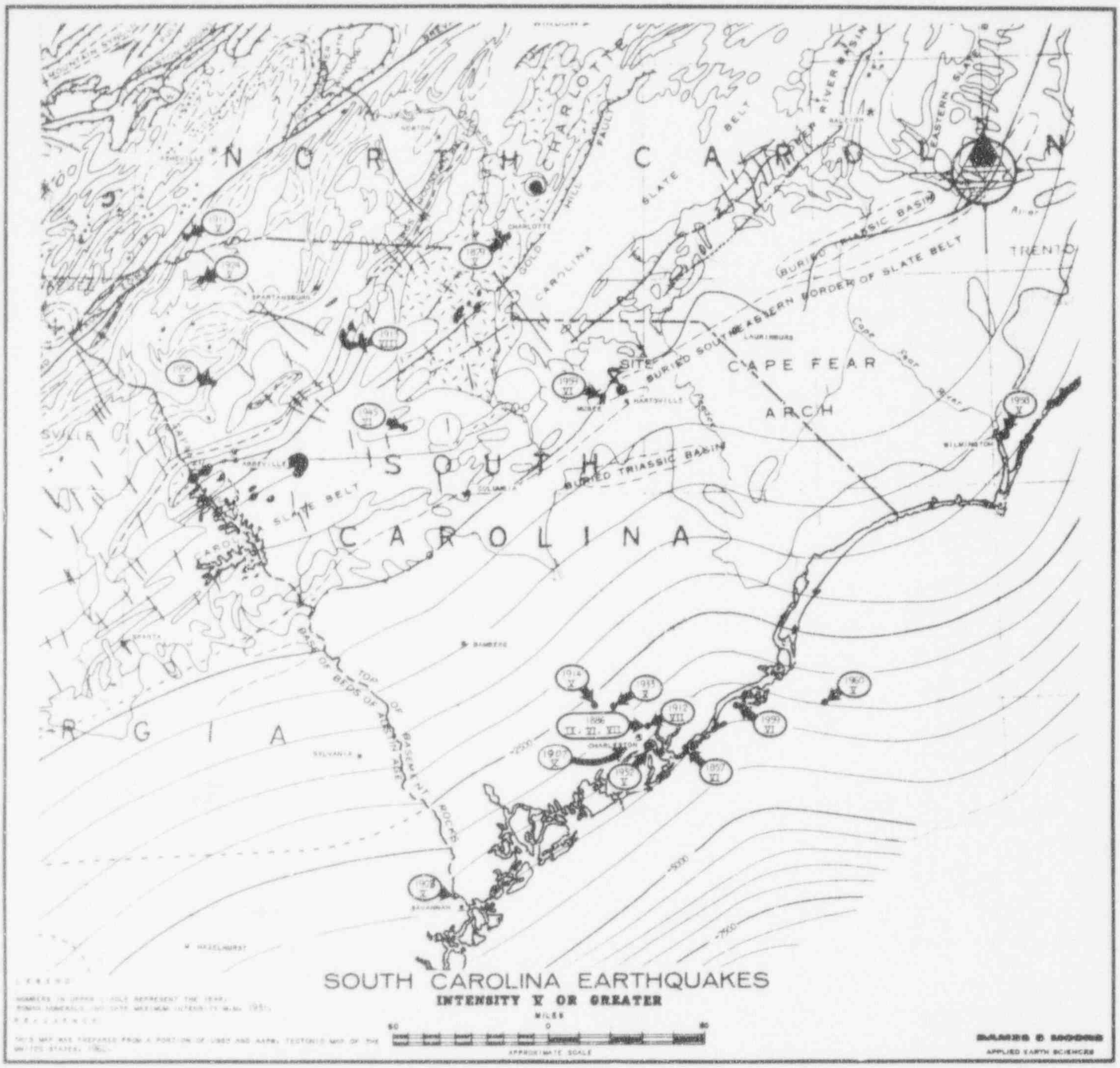
PLANT SITE
GEOLOGIC COLUMN

FIG. NO. 2.1–10



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UNIT NO. 2
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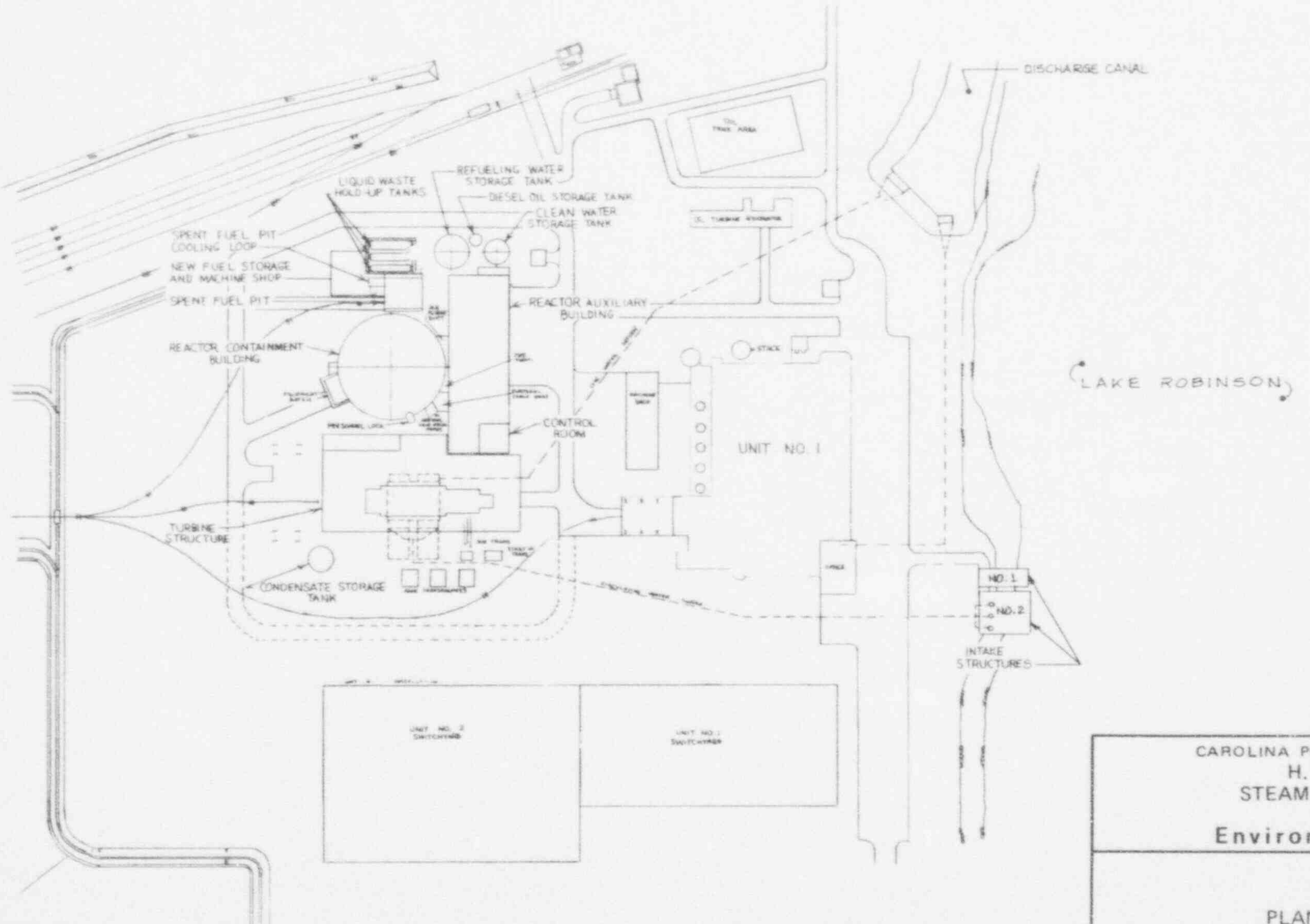
PLANT REGION EARTHQUAKES

FIG. NO. 2.1–11



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UNIT NO. 2
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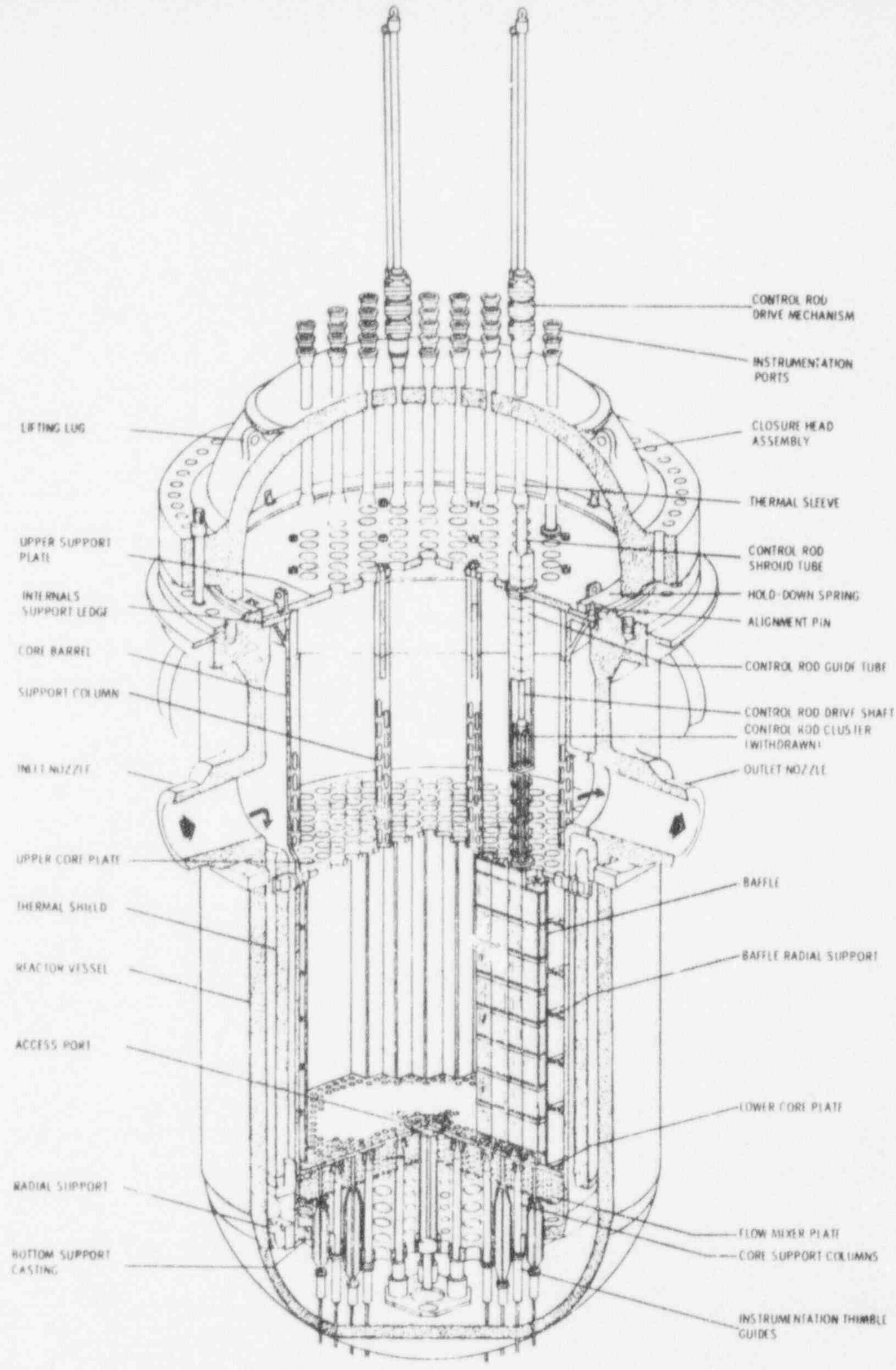
PLANT PLOT PLAN

FIG. NO. 2.2–1



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UNIT NO. 2
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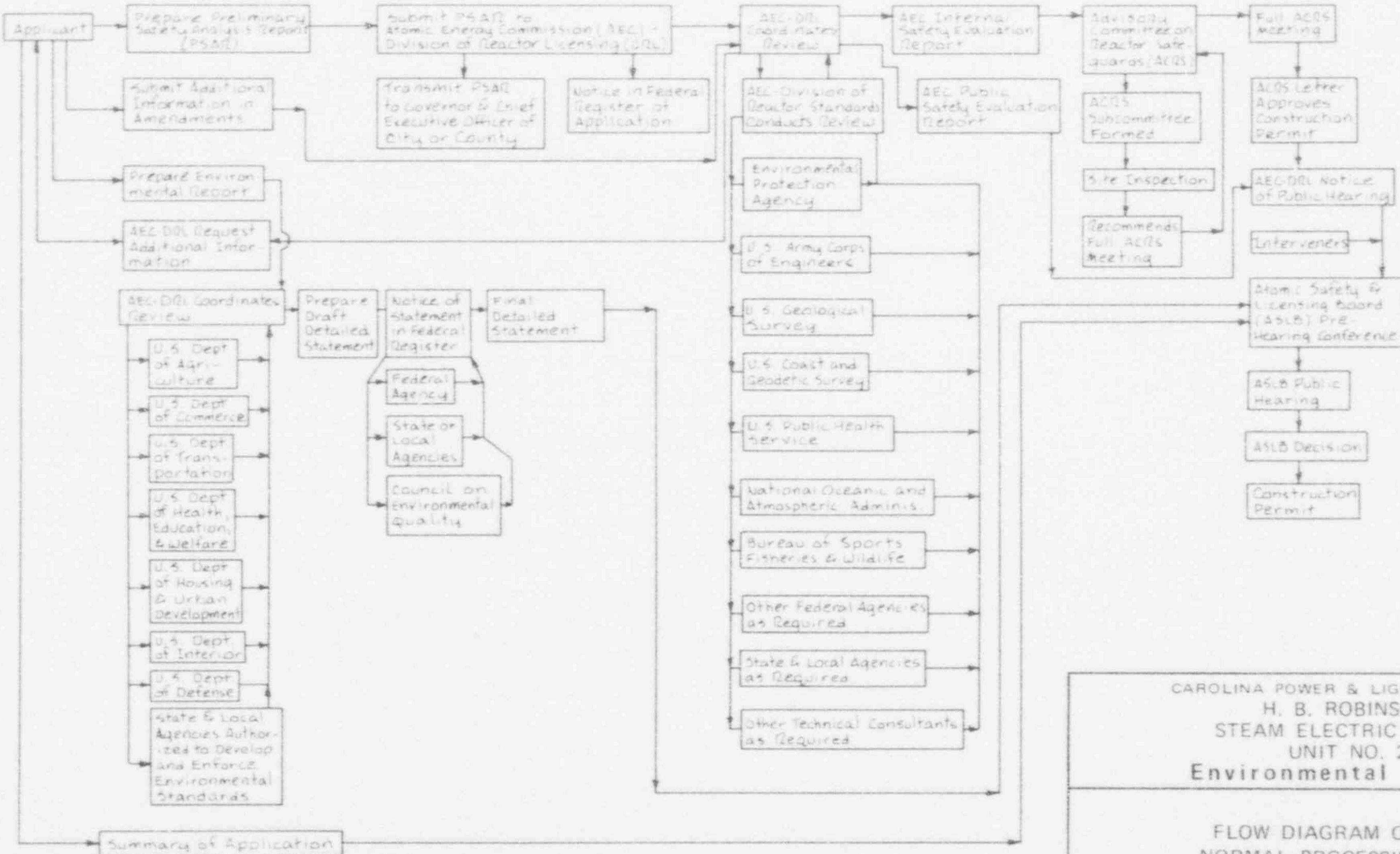
REACTOR VESSEL INTERNALS

FIG. NO. 2.2-2



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UNIT NO. 2
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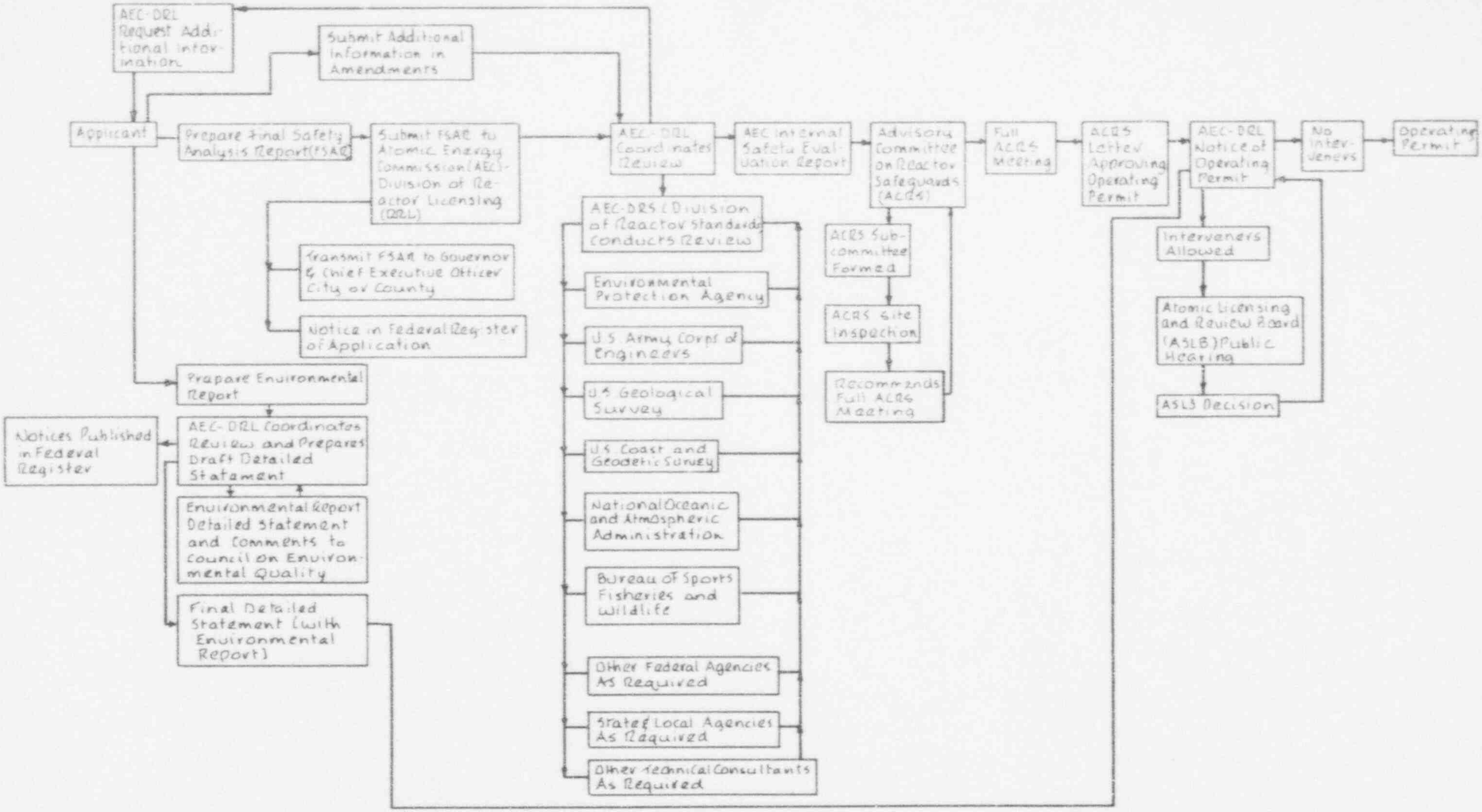
FLOW DIAGRAM OF THE NORMAL PROCESSING FOR AN APPLICATION FOR THE AEC CONSTRUCTION PERMIT

FIG. NO. 2.3-1



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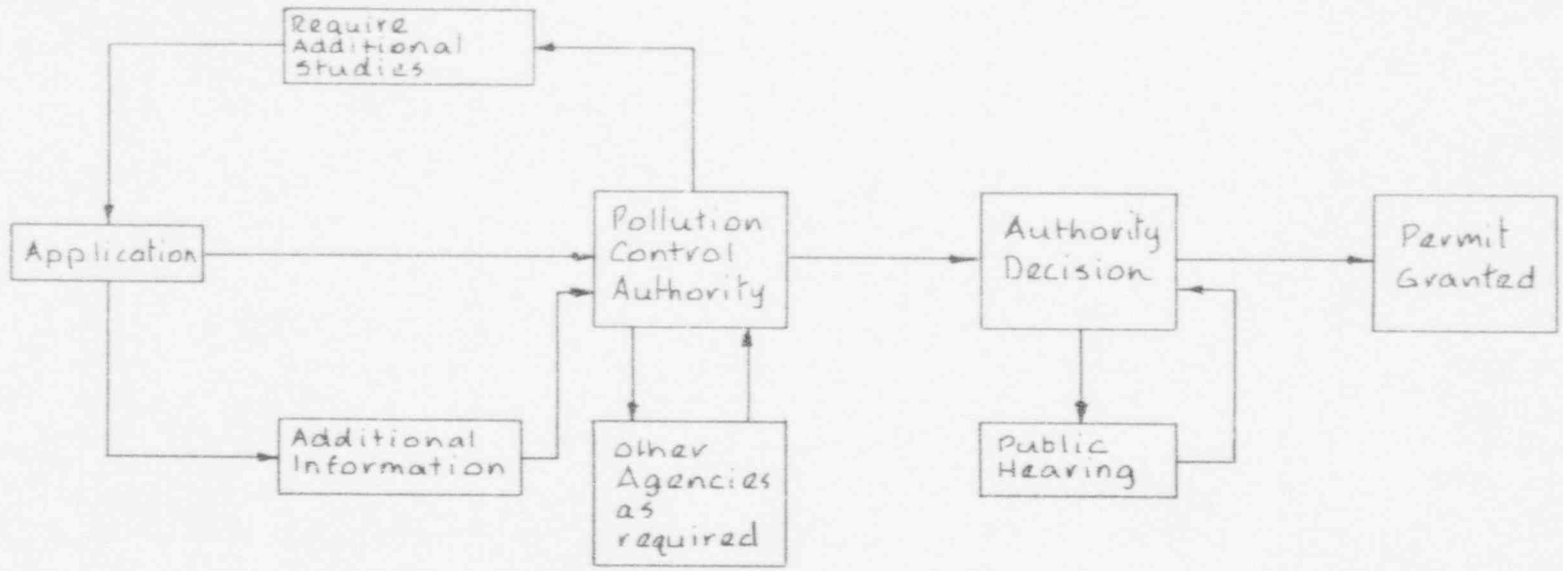
FLOW DIAGRAM OF THE NORMAL PROCESSING FOR AN APPLICATION FOR THE AEC NUCLEAR FACILITY OPERATING PERMIT

FIG. NO. 2.3-2



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UNIT NO. 2
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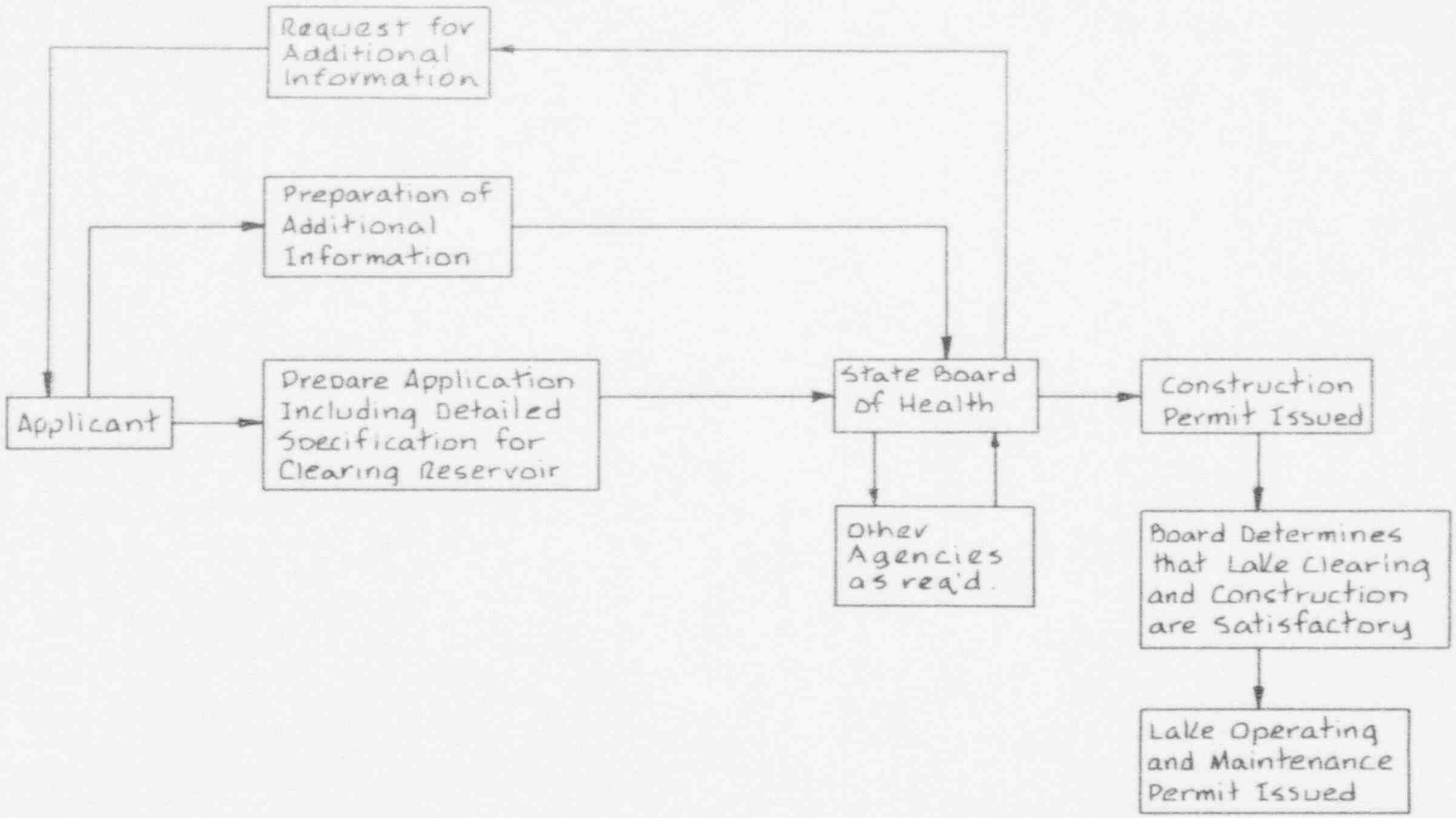
FLOW DIAGRAM OF THE NORMAL PROCESSING FOR AN APPLICATION FOR THE STATE WASTE WATER DISCHARGE PERMITS

FIG. NO. 2.3-3



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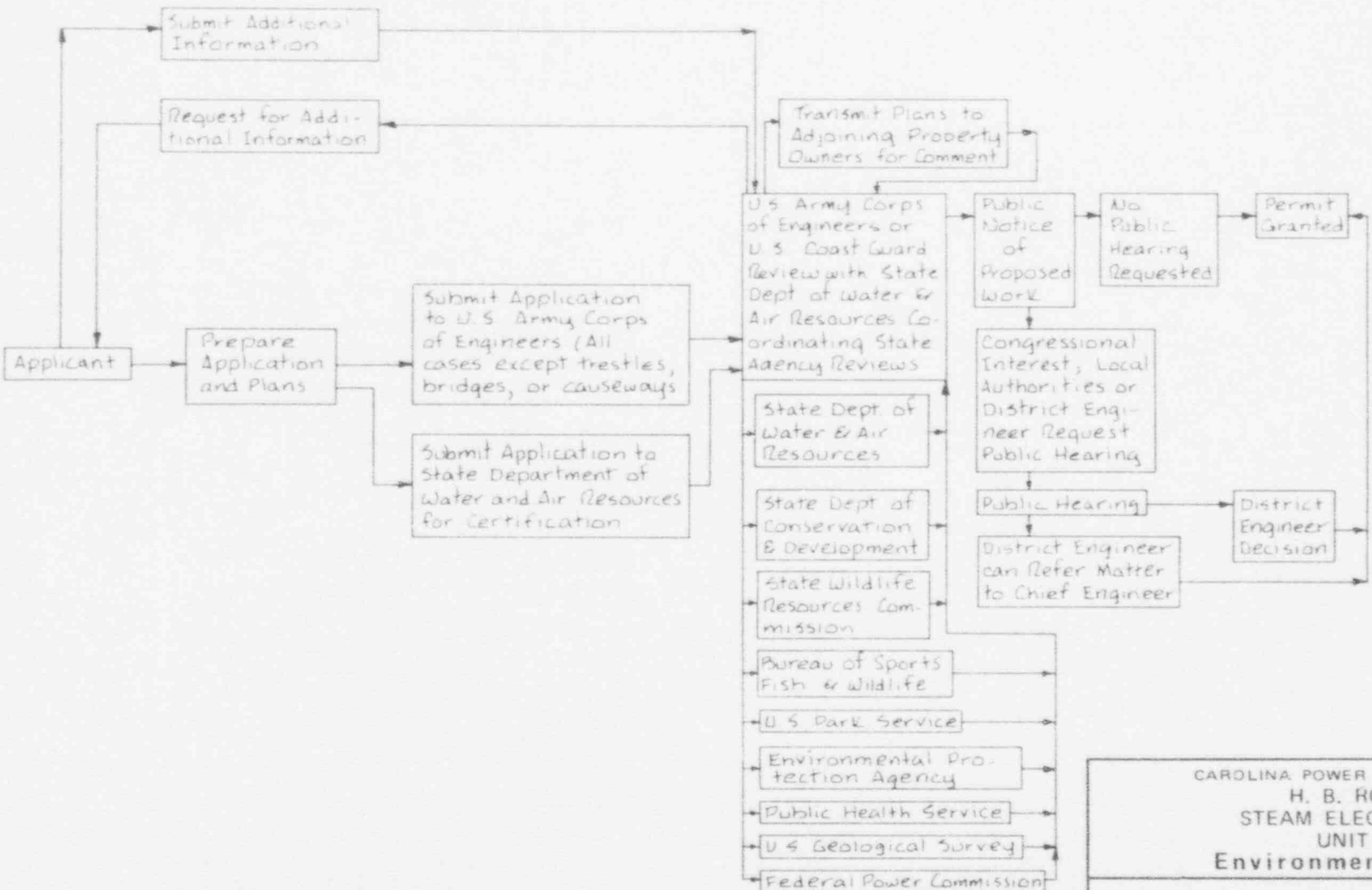
FLOW DIAGRAM OF THE NORMAL PROCESSING OF AN APPLICATION FOR SOUTH CAROLINA PERMITS FOR IMPOUNDMENT OF WATER

FIG. NO. 2.3–4



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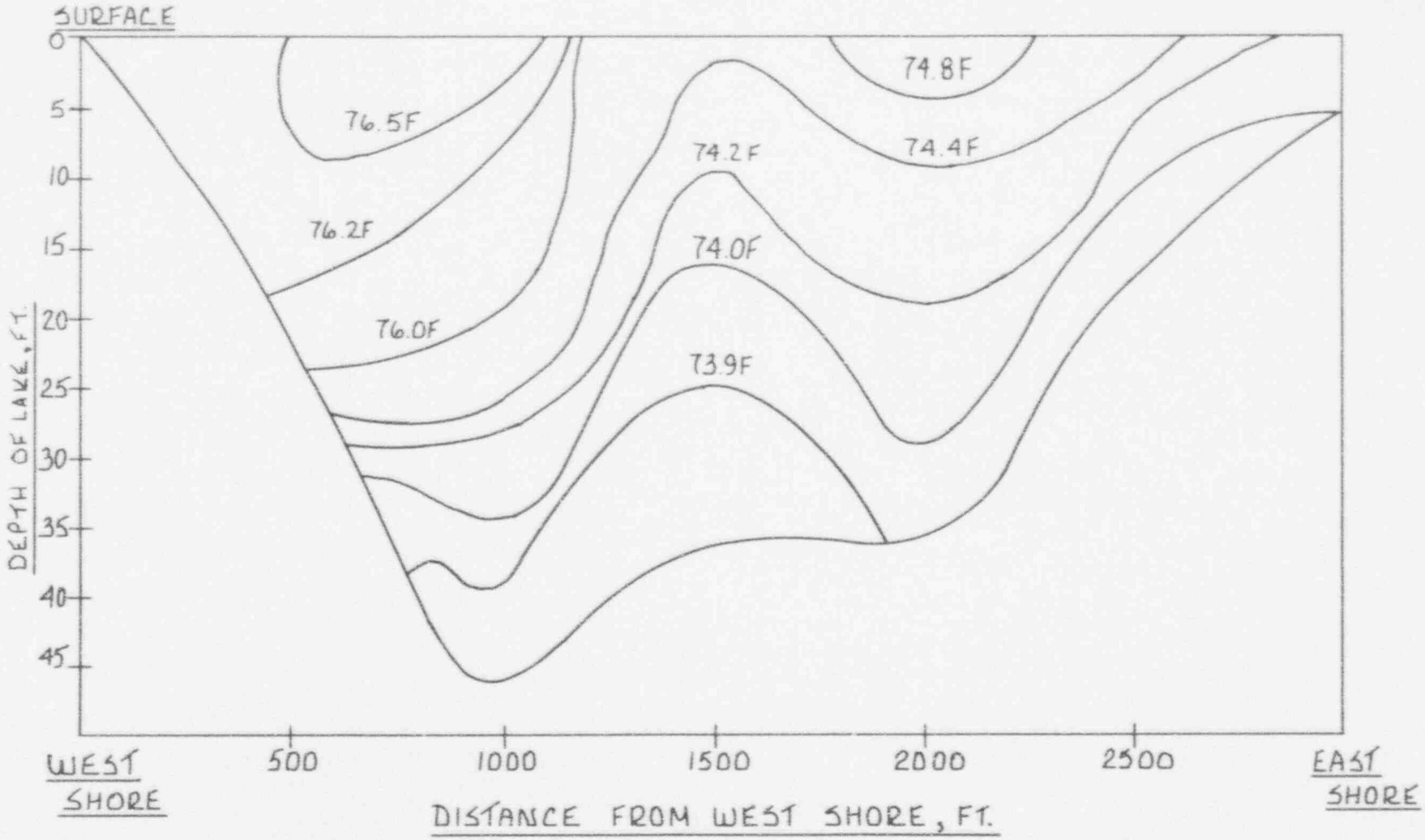
FLOW DIAGRAM OF THE NORMAL PROCESSING OF AN APPLICATION FOR THE DISCHARGE PERMIT IN NAVIGABLE WATERS

FIG. NO. 2.3-5



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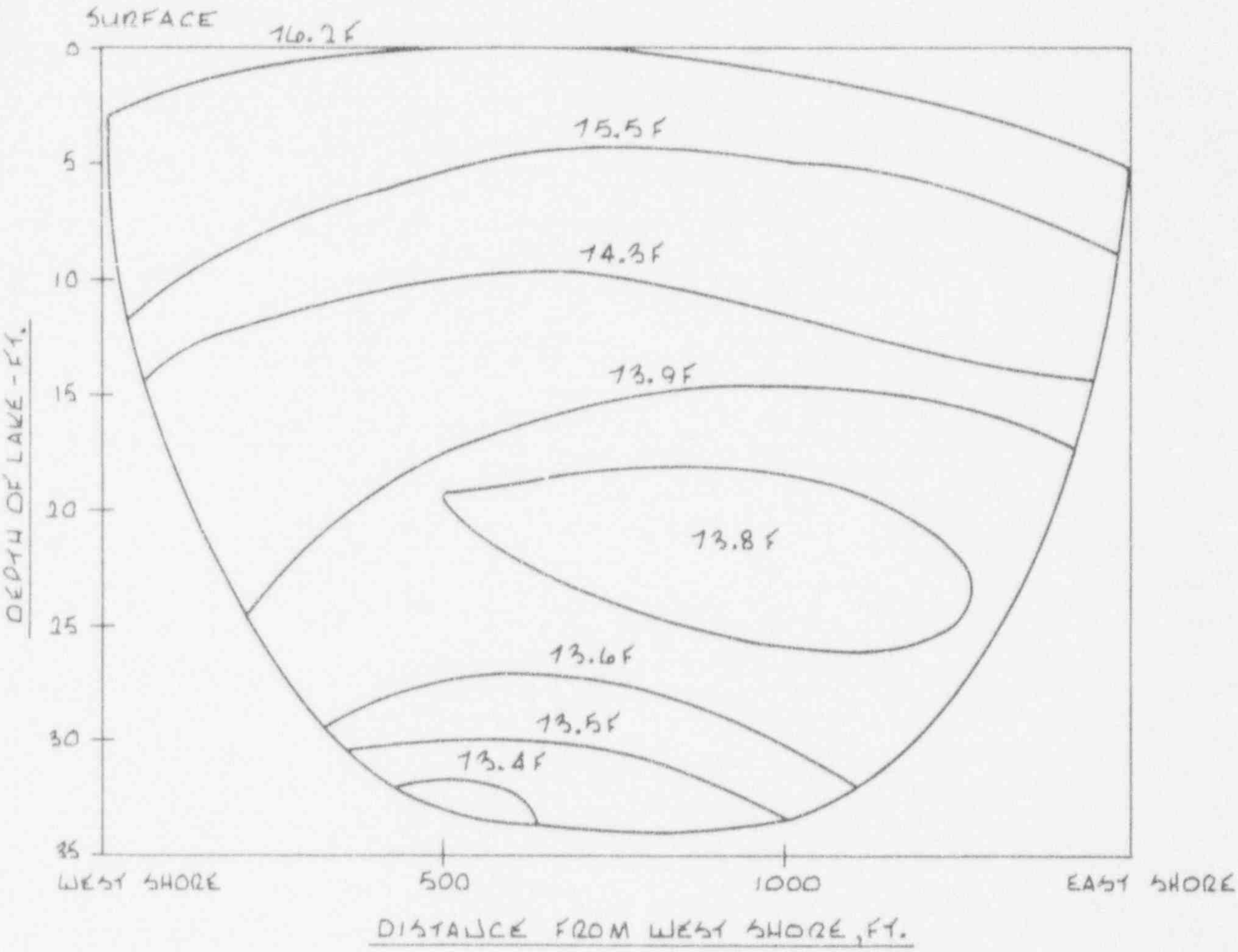
LAKE ROBINSON ISOTHERMS AT 1000FT
UPSTREAM OF DAM
(FROM SURVEY ON OCTOBER 14, 1971)

FIG. NO. 3.3–1



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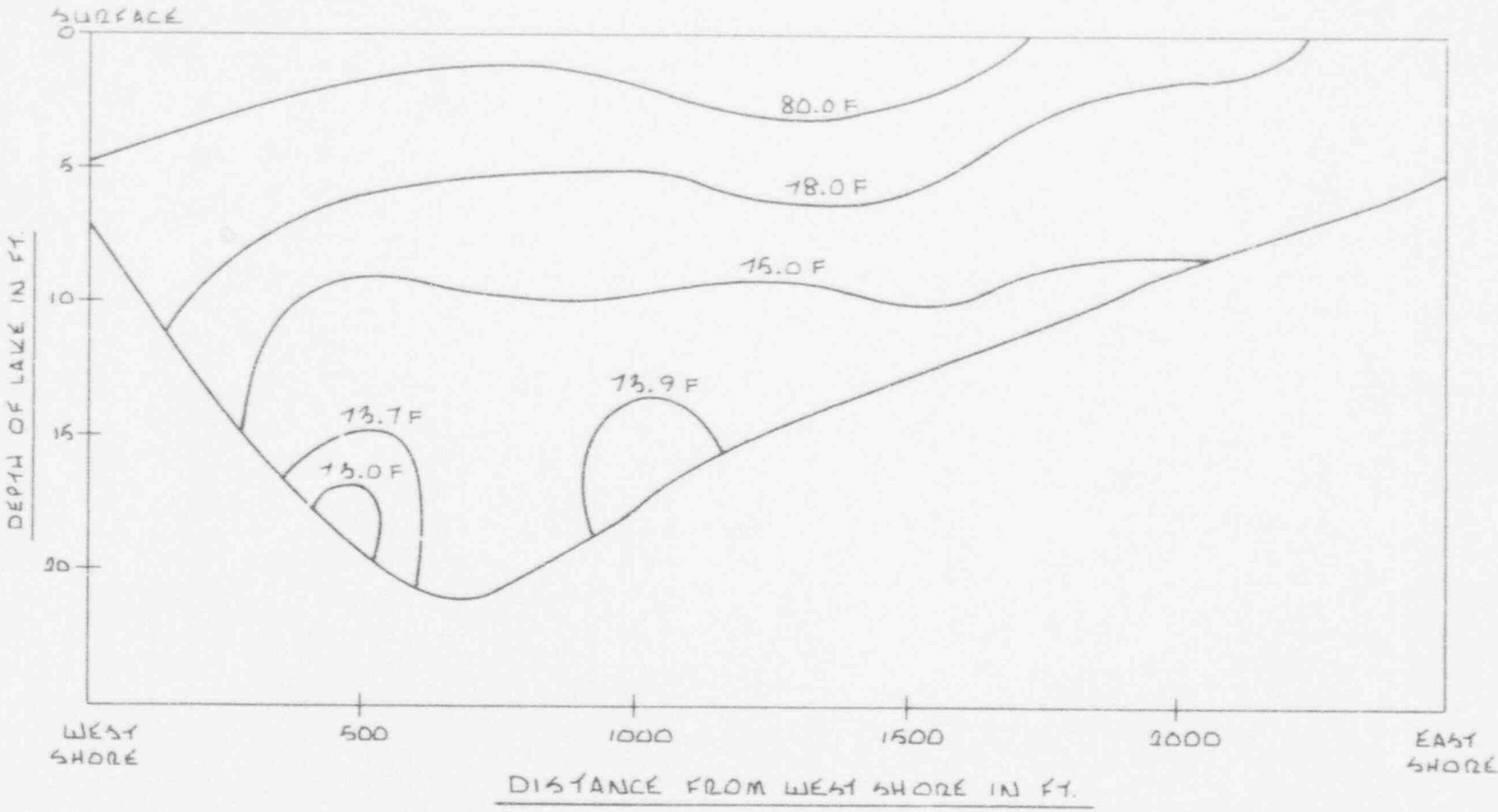
LAKE ROBINSON ISOTHERMS AT 0.8 MILES UPSTREAM OF DAM (FROM SURVEY ON OCTOBER 14, 1971)

FIG. NO. 33-2



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UNIT NO. 2
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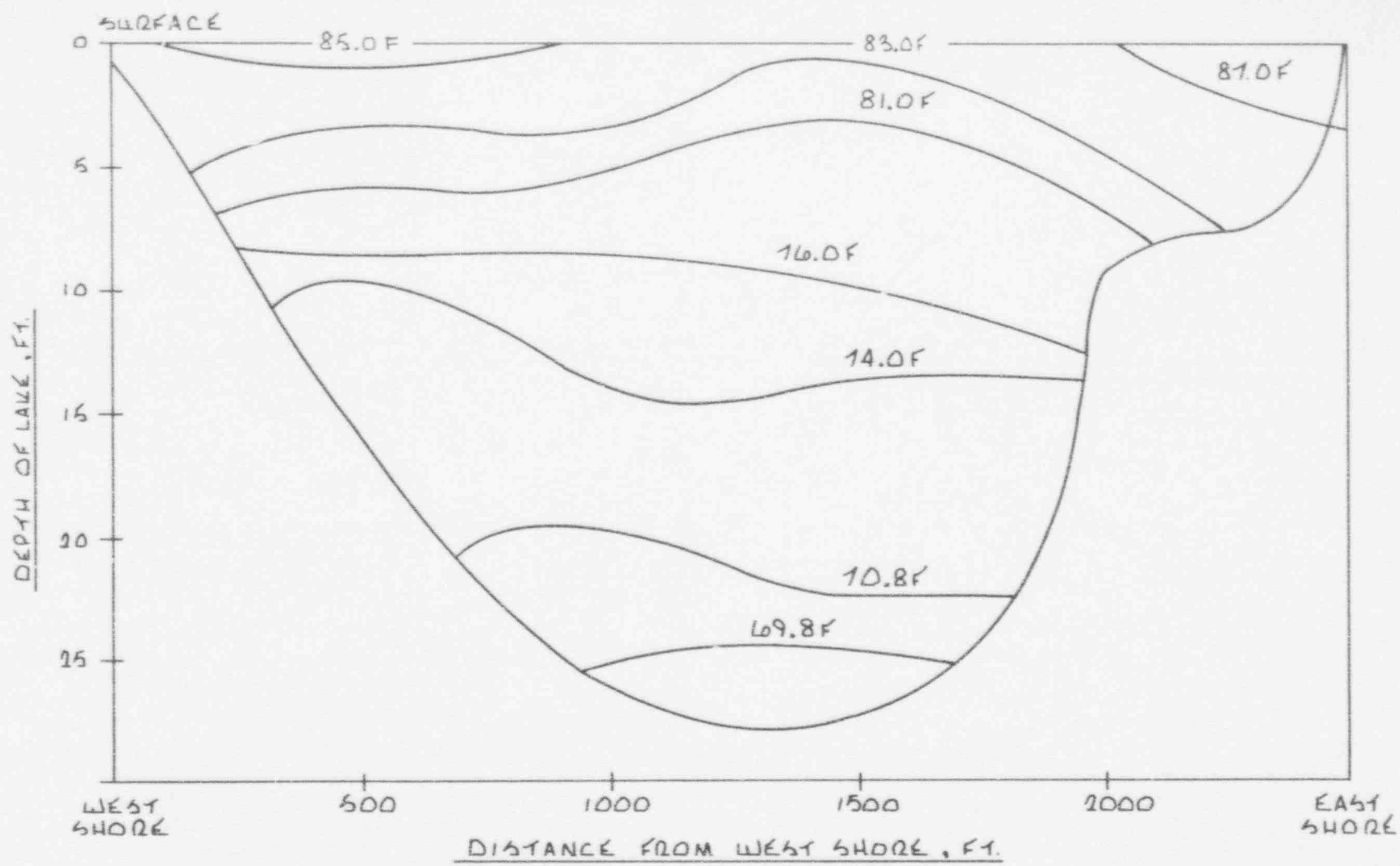
LAKE ROBINSON ISOTHERMS AT THE CENTRAL CO-OP LINE (FROM SURVEY ON OCTOBER 14, 1971)

FIG. NO. 3.3-3



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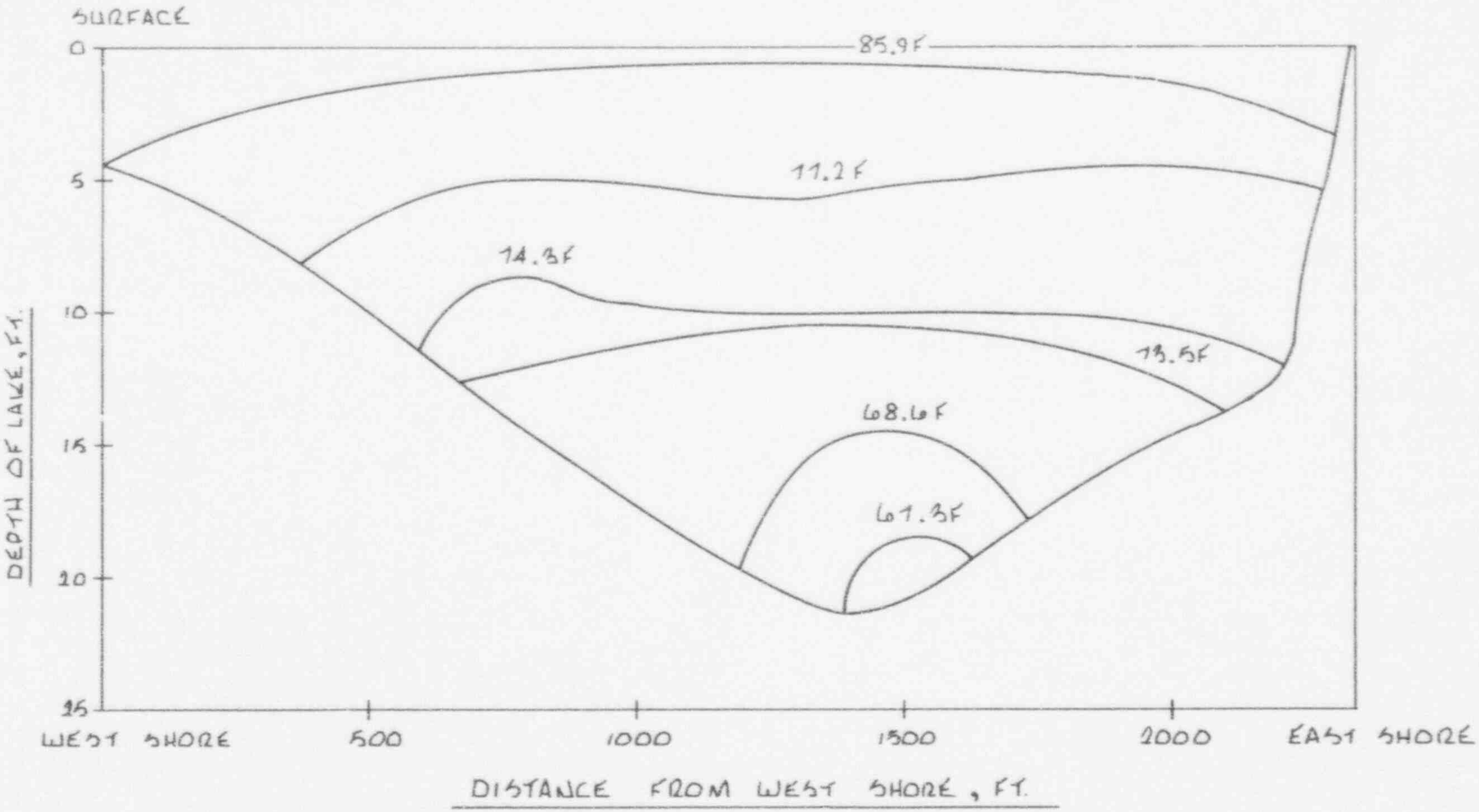
UNIT NO. 2
Environmental Report

LAKE ROBINSON ISOTHERMS FROM THE GAS LINES TO EASTERLINGS LANDING (FROM SURVEY ON OCTOBER 14, 1971)

FIG. NO. 3.3–4



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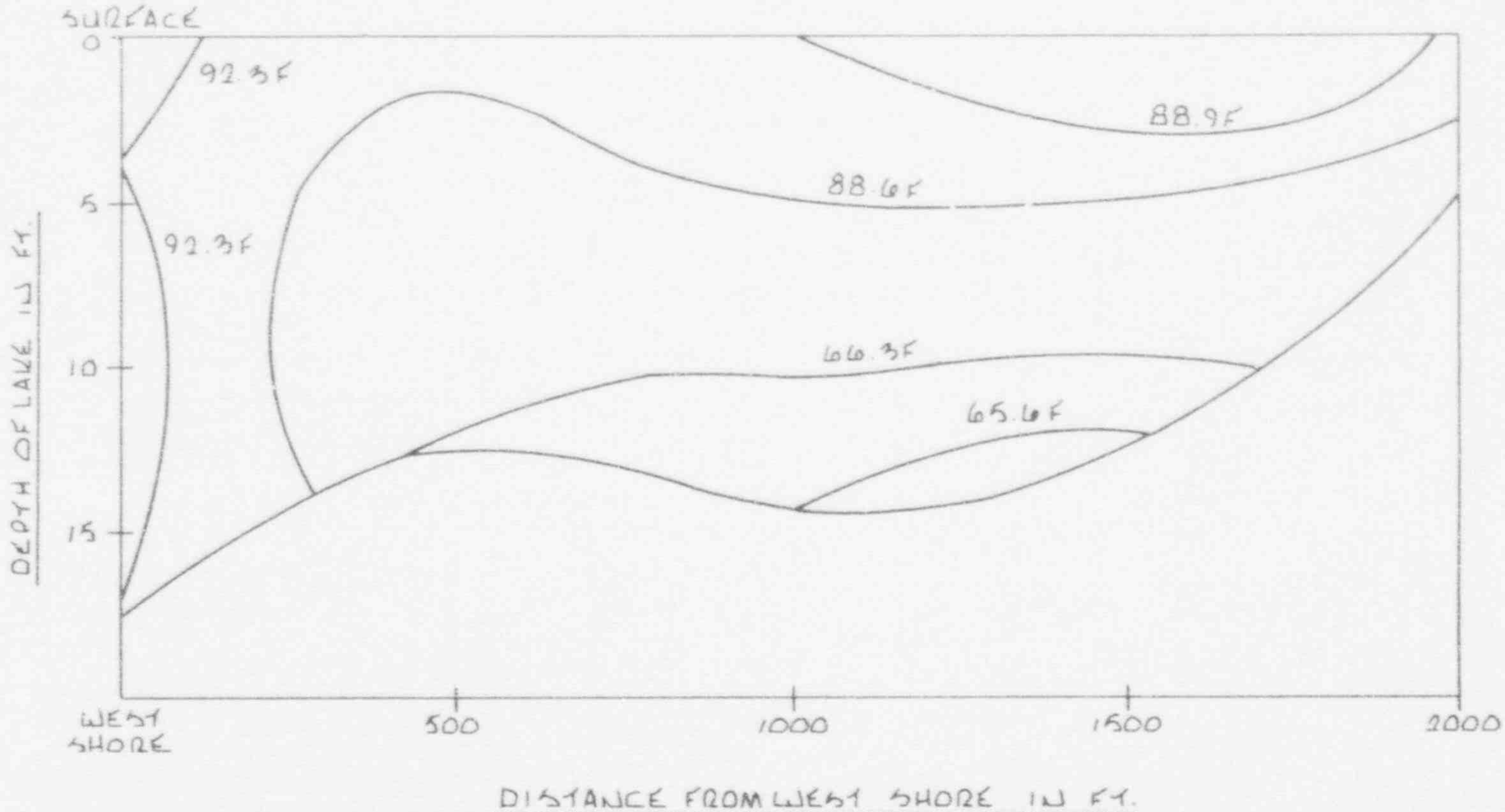
LAKE ROBINSON ISOTHERMS
AT THE LOWER ROAD
(FROM SURVEY ON OCTOBER 14, 1971)

FIG. NO. 3.3-5



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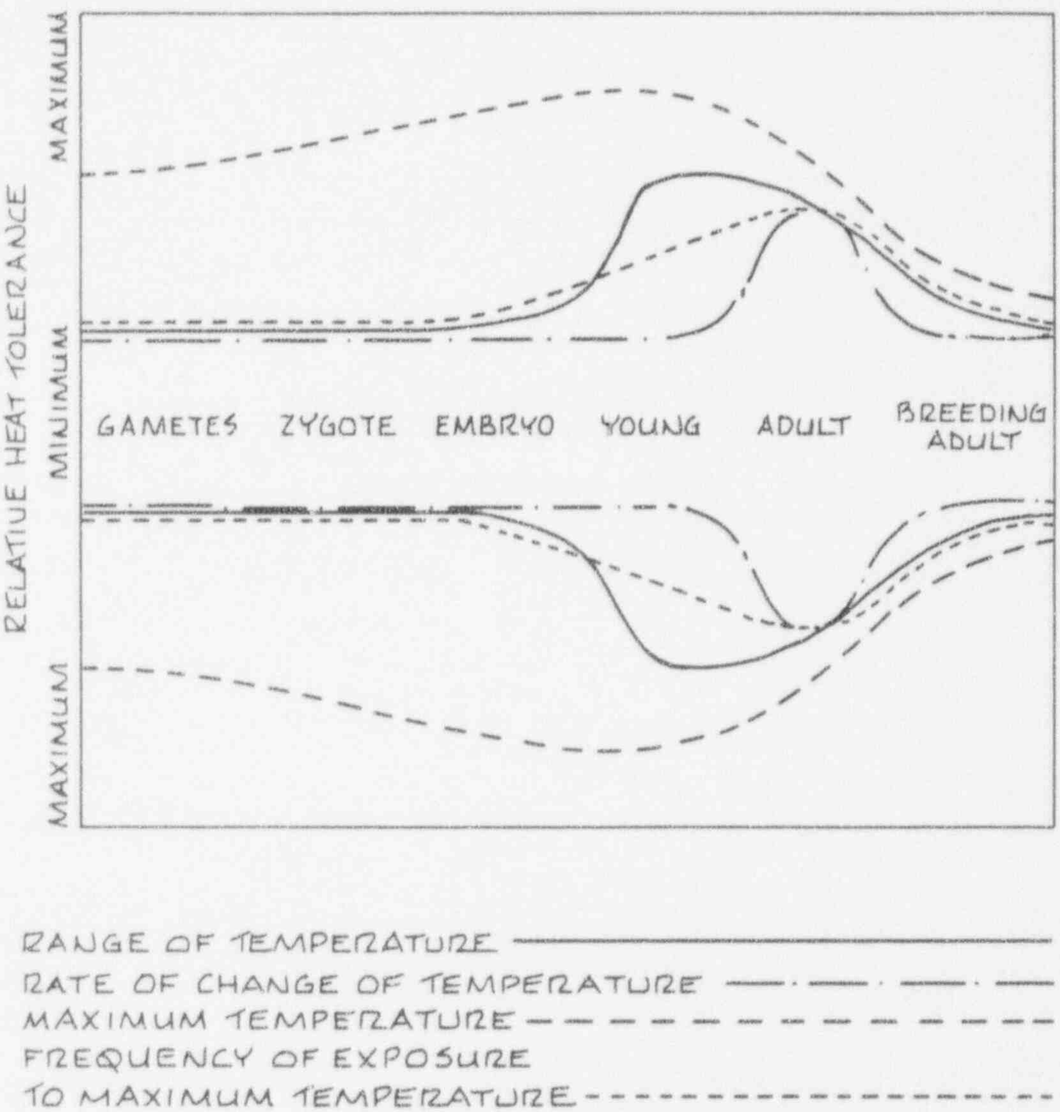
LAKE ROBINSON ISOTHERMS
AT THE DISCHARGE
(FROM SURVEY ON OCTOBER 14, 1971)

FIG. NO. 3.3-6



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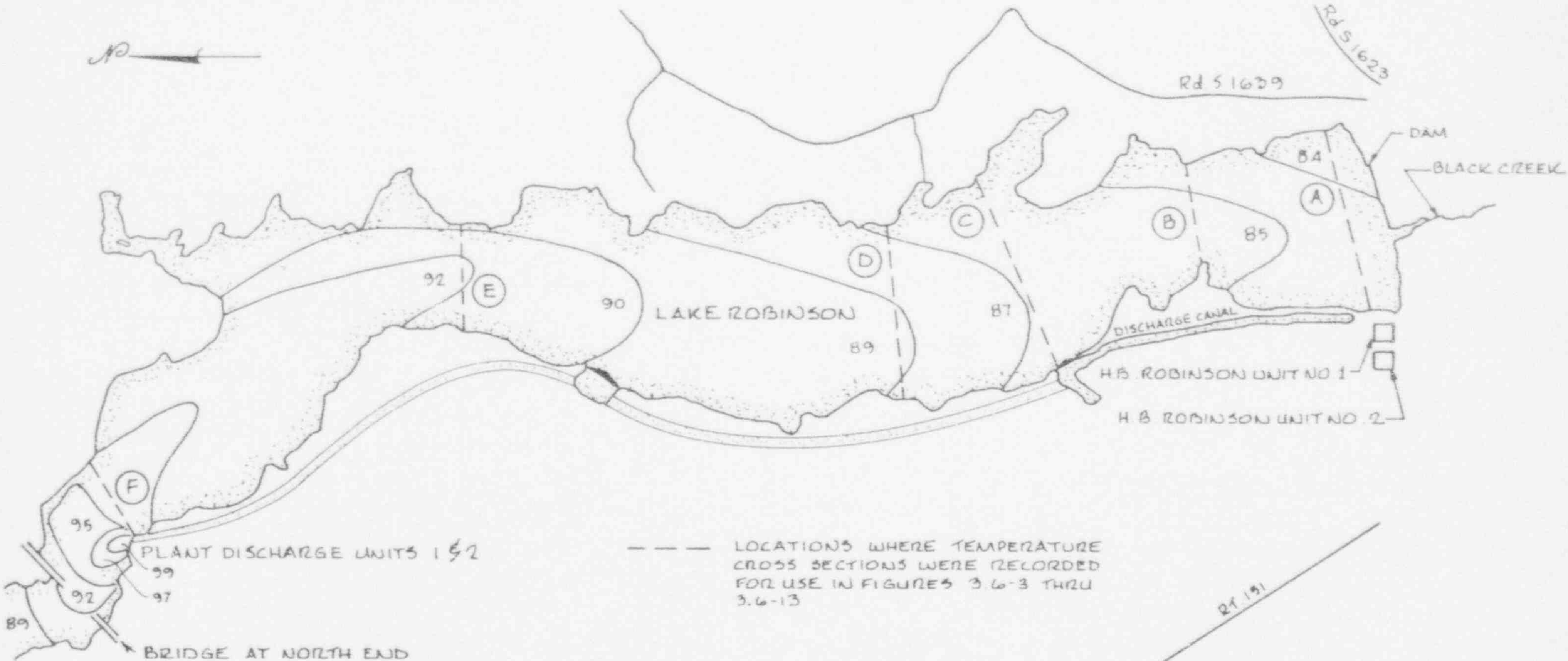
THERMAL TOLERANCE OF LIFE STAGES
(JENSEN, 1969)

FIG. NO. 3.6–1



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UNIT NO. 2
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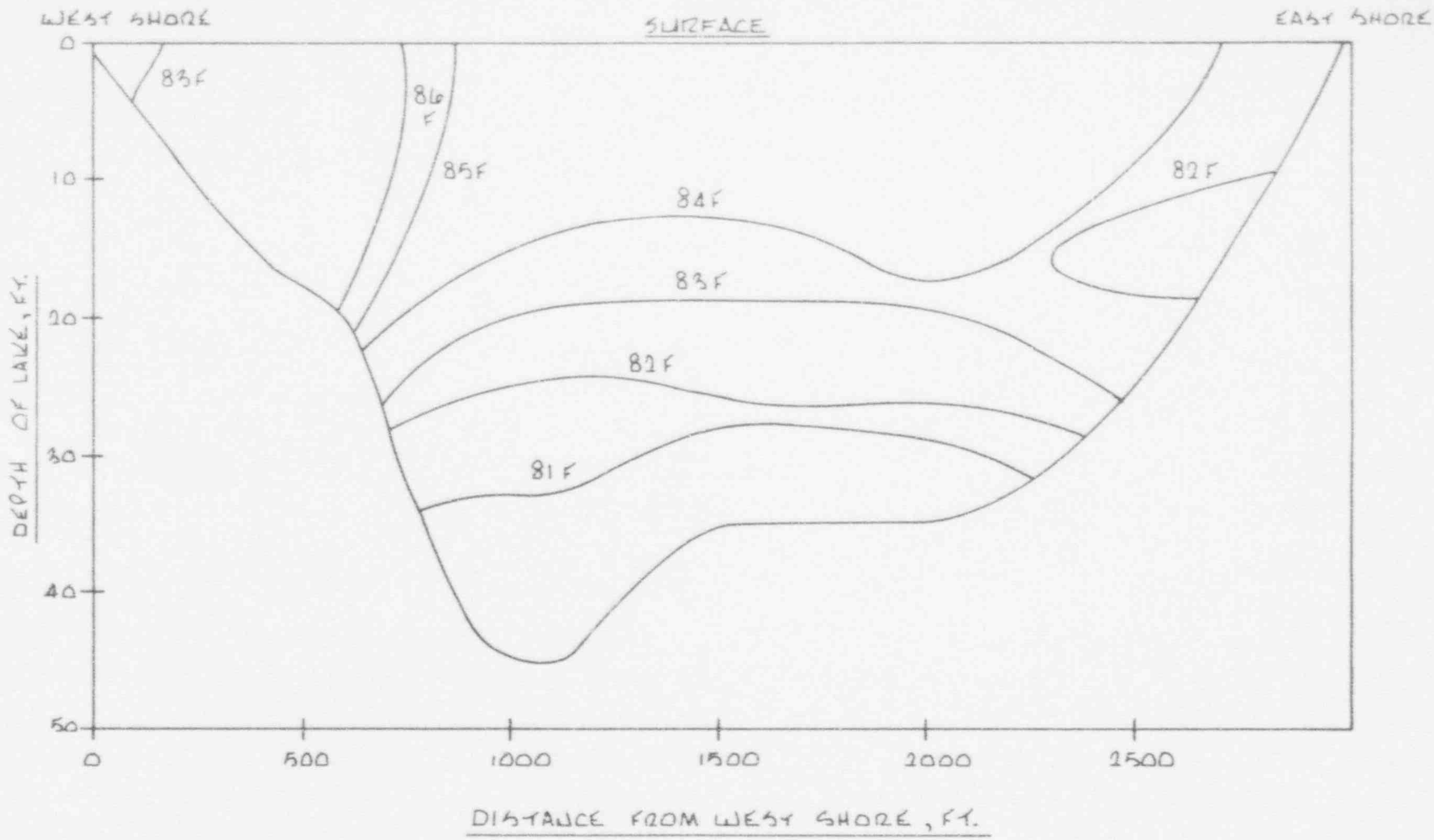
SURFACE WATER TEMPERATURE (°F)
ISOTHERMS IN LAKE ROBINSON
IN SEPTEMBER 1971

FIG. NO. 3.6–2



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UNIT NO. 2
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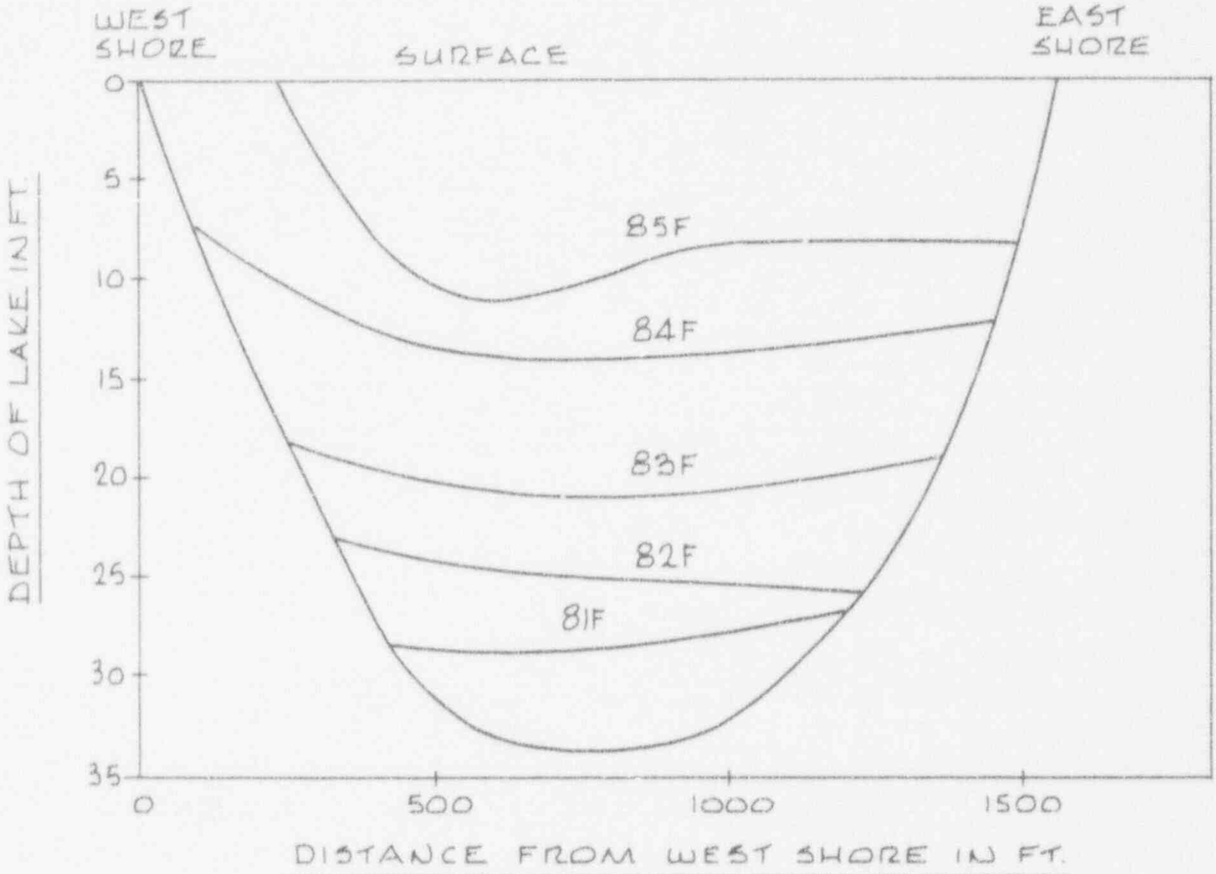
TEMPERATURE ISOTHERMS (^{o}F) IN
LAKE ROBINSON ALONG CROSS SECTION A
WITH UNIT NO. 2 OPERATING (9/17/71)

FIG. NO. 3.6–3



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UNIT NO. 2
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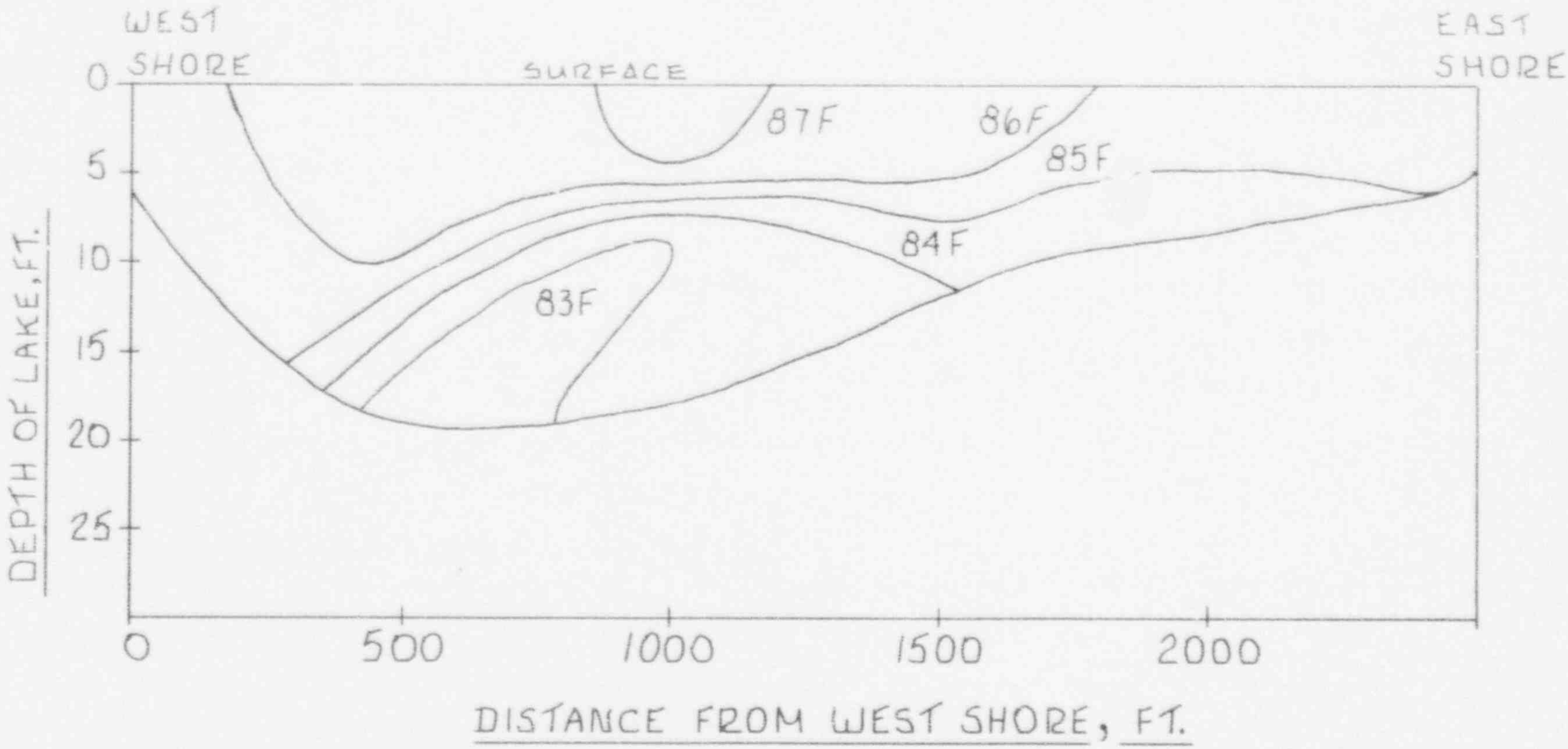
TEMPERATURE ISOTHERMS (°F) IN
LAKE ROBINSON ALONG CROSS SECTION B
WITH UNIT NO. 2 OPERATING (9/17/71)

FIG. NO. 3.6-4



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UNIT NO. 2
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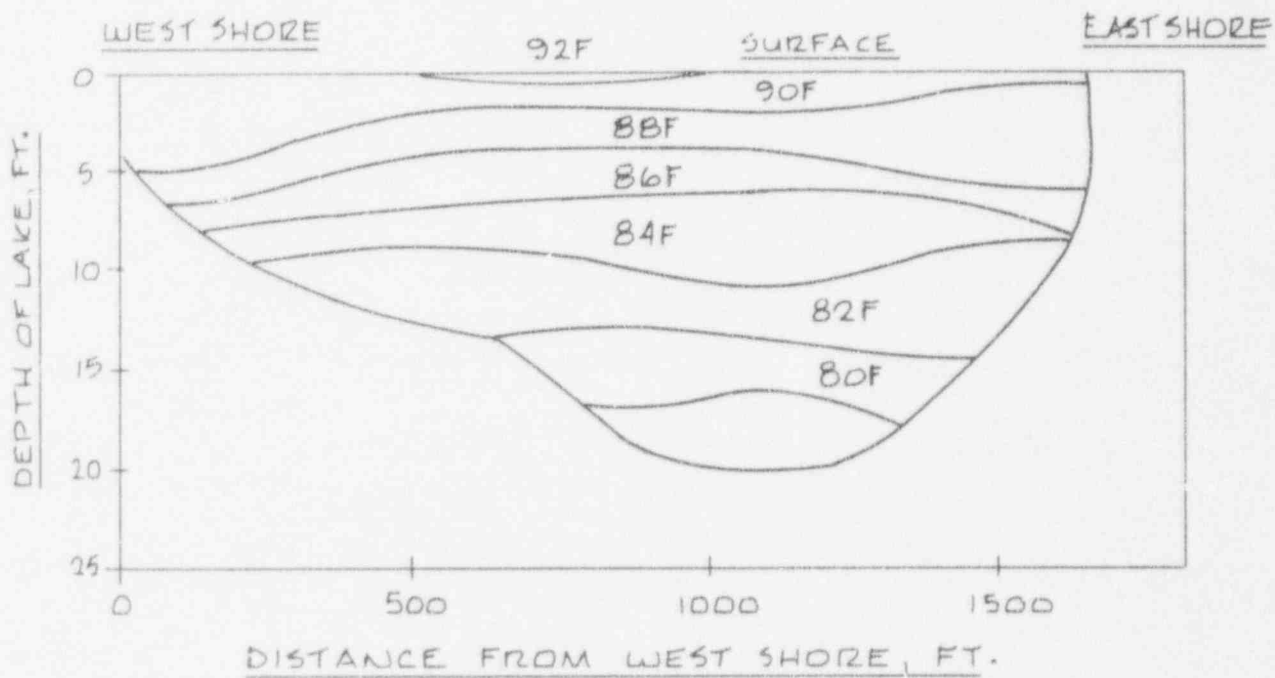
TEMPERATURE ISOTHERMS (°F) IN LAKE ROBINSON ALONG CROSS SECTION C WITH UNIT NO. 2 OPERATING (9/17/71)

FIG. NO. 3.6-5



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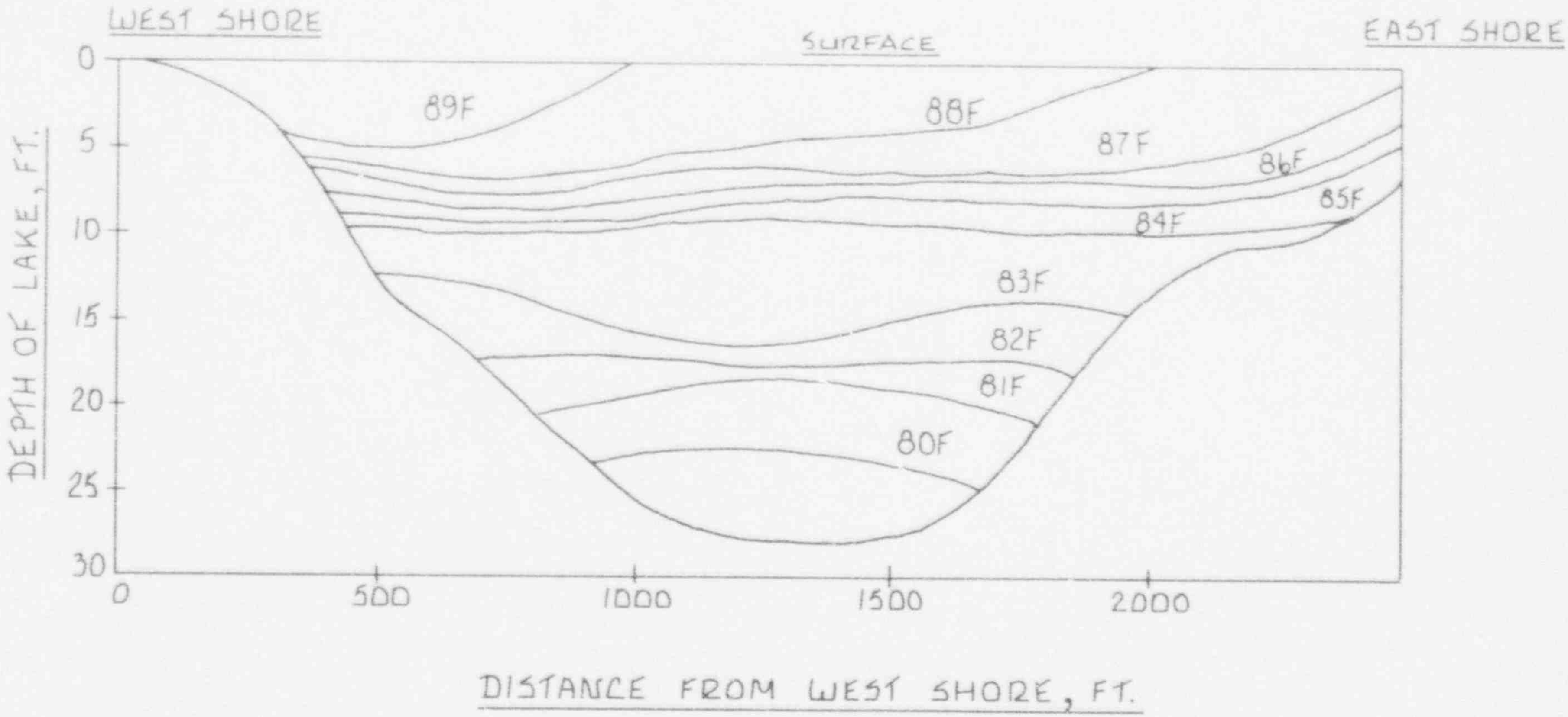
TEMPERATURE ISOTHERMS (°F) IN
LAKE ROBINSON ALONG CROSS SECTION D
WITH UNIT NO. 2 OPERATING (9/17/71)

FIG. NO. 3.6–6



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UNIT NO. 2
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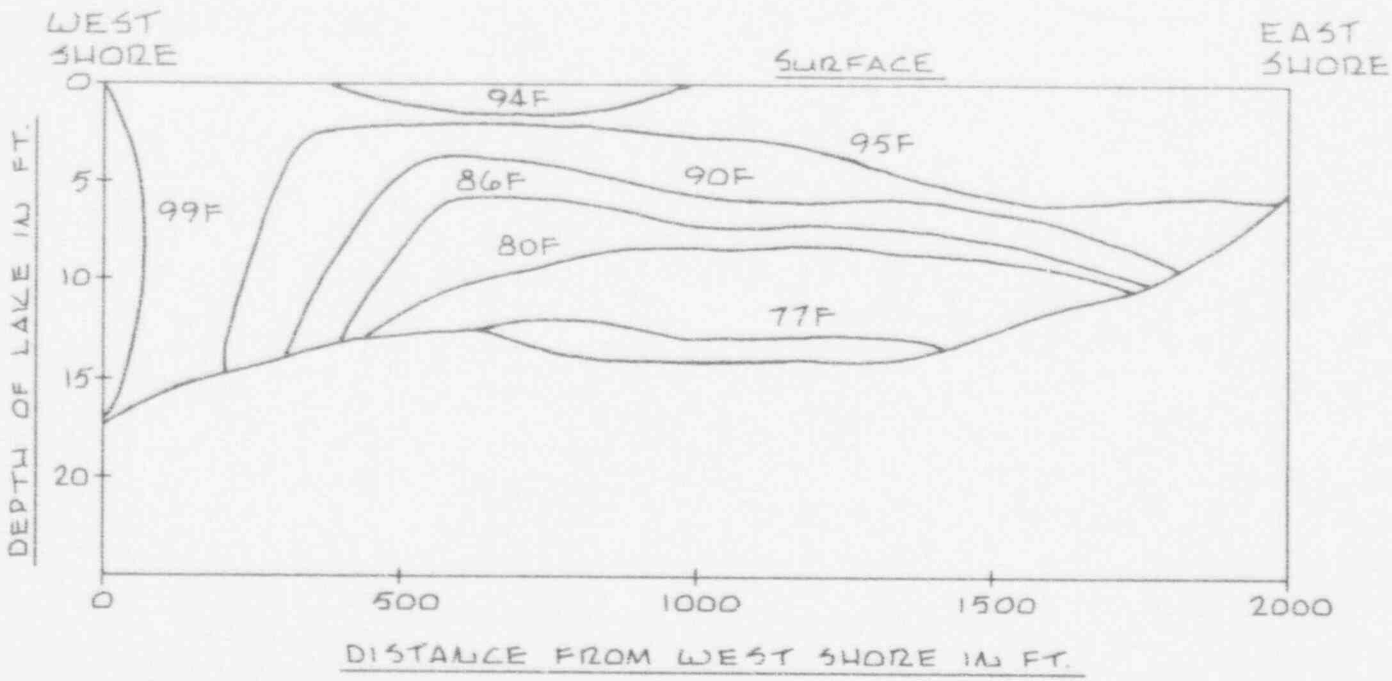
TEMPERATURE ISOTHERMS (°F) IN LAKE ROBINSON ALONG CROSS SECTION E WITH UNIT NO. 2 OPERATING (9/17/71)

FIG. NO. 3.6-7



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UNIT NO. 2
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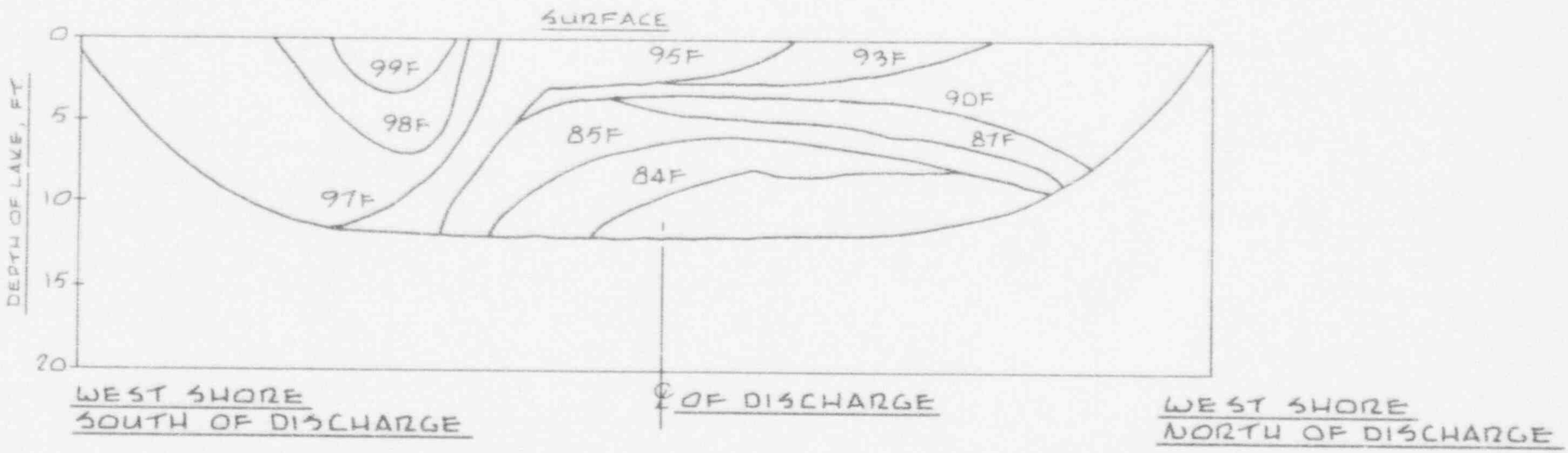
TEMPERATURE ISOTHERMS (°F) IN
LAKE ROBINSON ALONG CROSS SECTION F
WITH UNIT NO. 2 OPERATING (9/17/71)

FIG. NO. 3.6–8



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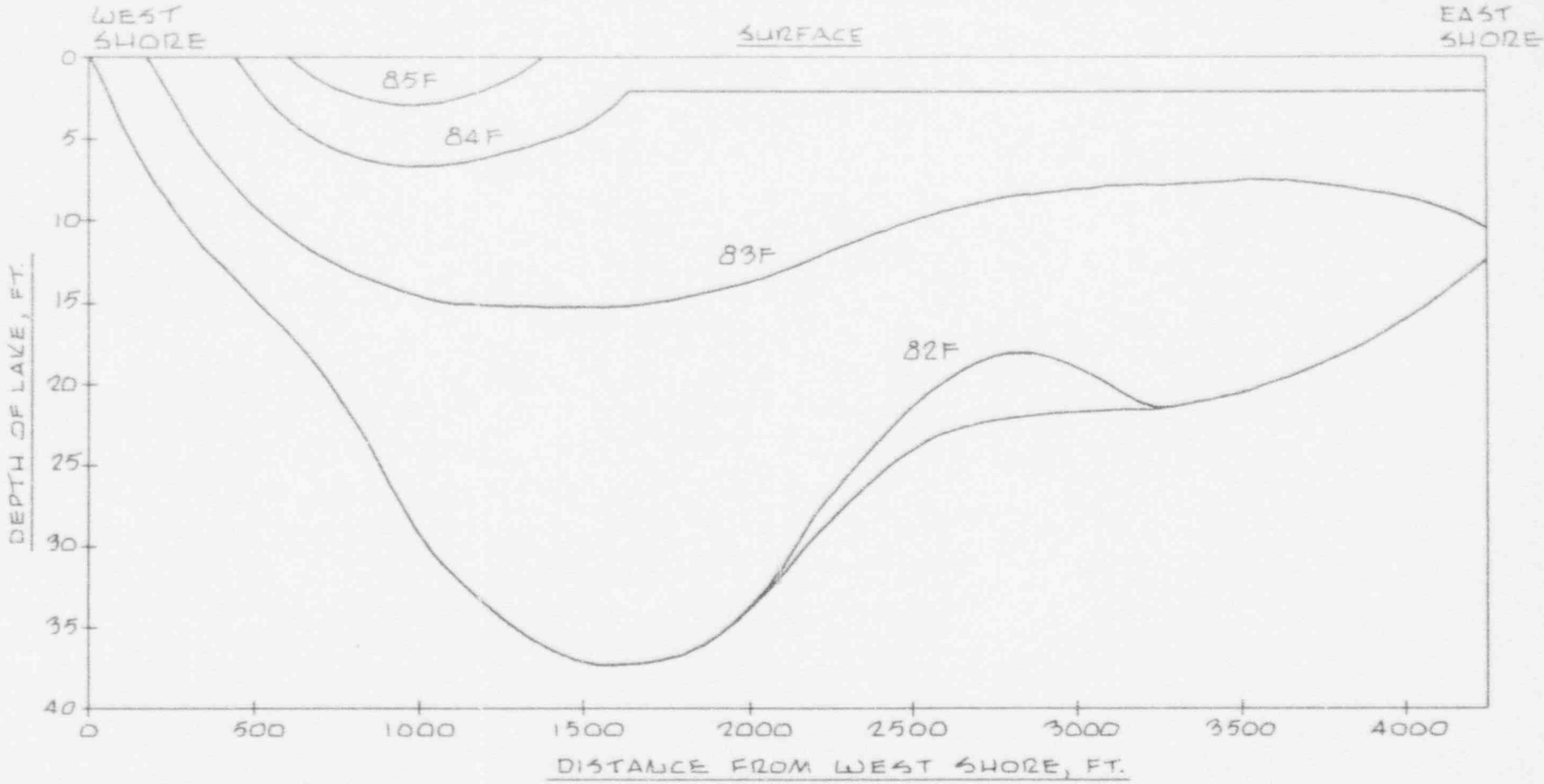
UNIT NO. 2
Environmental Report

TEMPERATURE ISOTHERMS (°F) ALONG 500 FOOT RADIUS AROUND DISCHARGE WITH UNIT NO. 2 OPERATING (9/17/71)

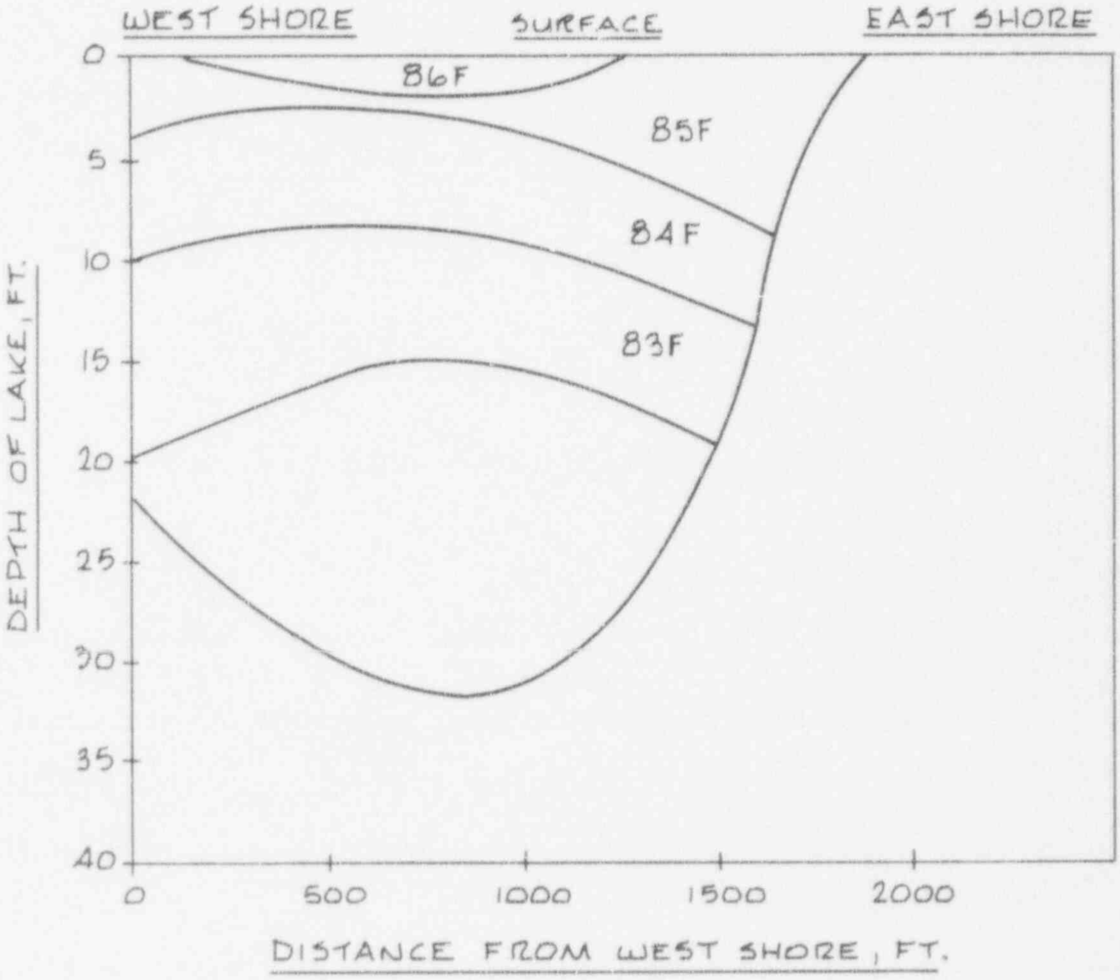
FIG. NO. 3.6–9



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

TEMPERATURE ISOTHERMS (°F) IN LAKE ROBINSON ALONG CROSS SECTION A PRIOR TO OPERATION OF UNIT NO. 2 (9/62)

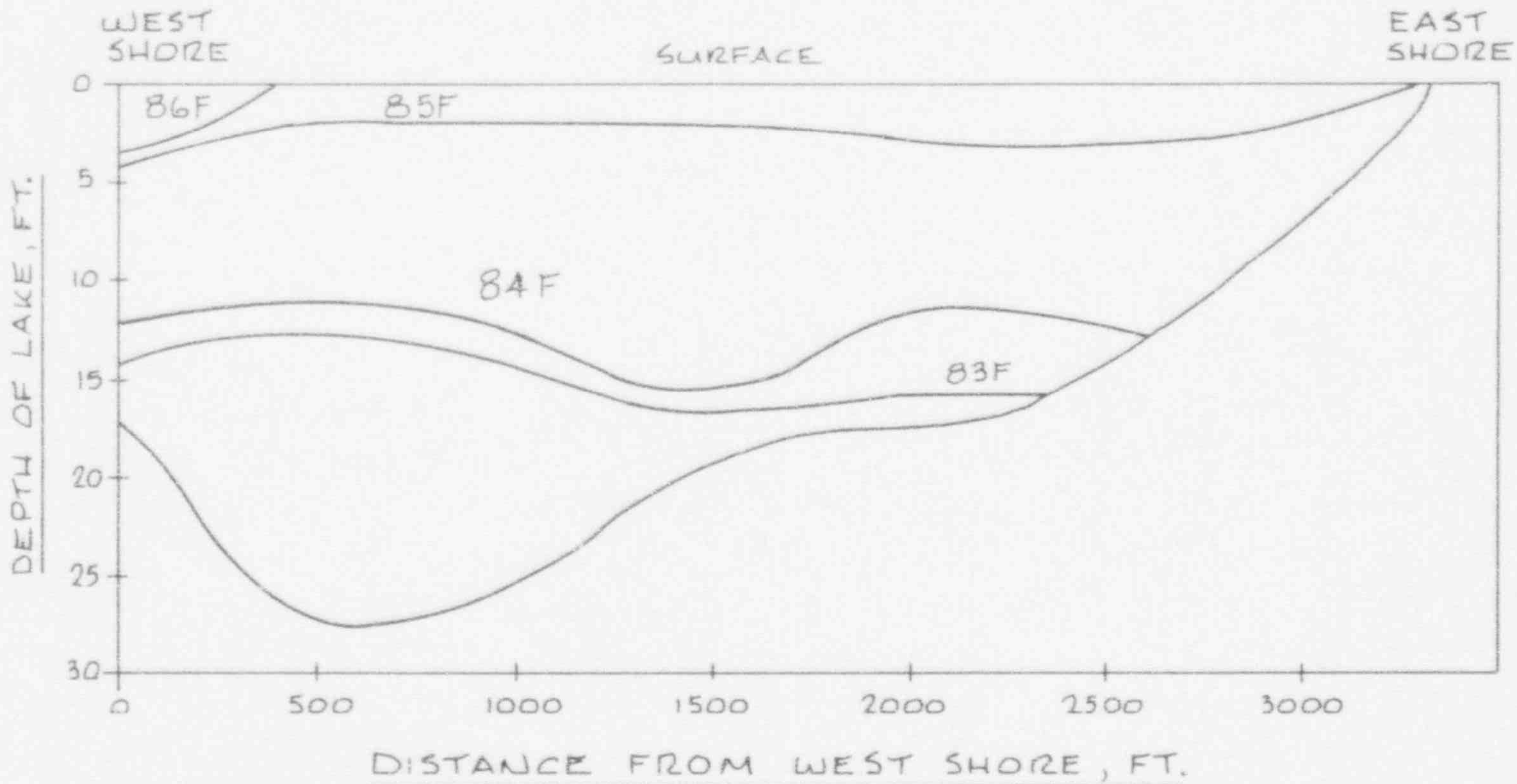
FIG. NO. 3.6-10



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

TEMPERATURE ISOTHERMS (°F) IN
LAKE ROBINSON ALONG CROSS SECTION B
PRIOR TO OPERATION OF UNIT NO. 2 (9/62)

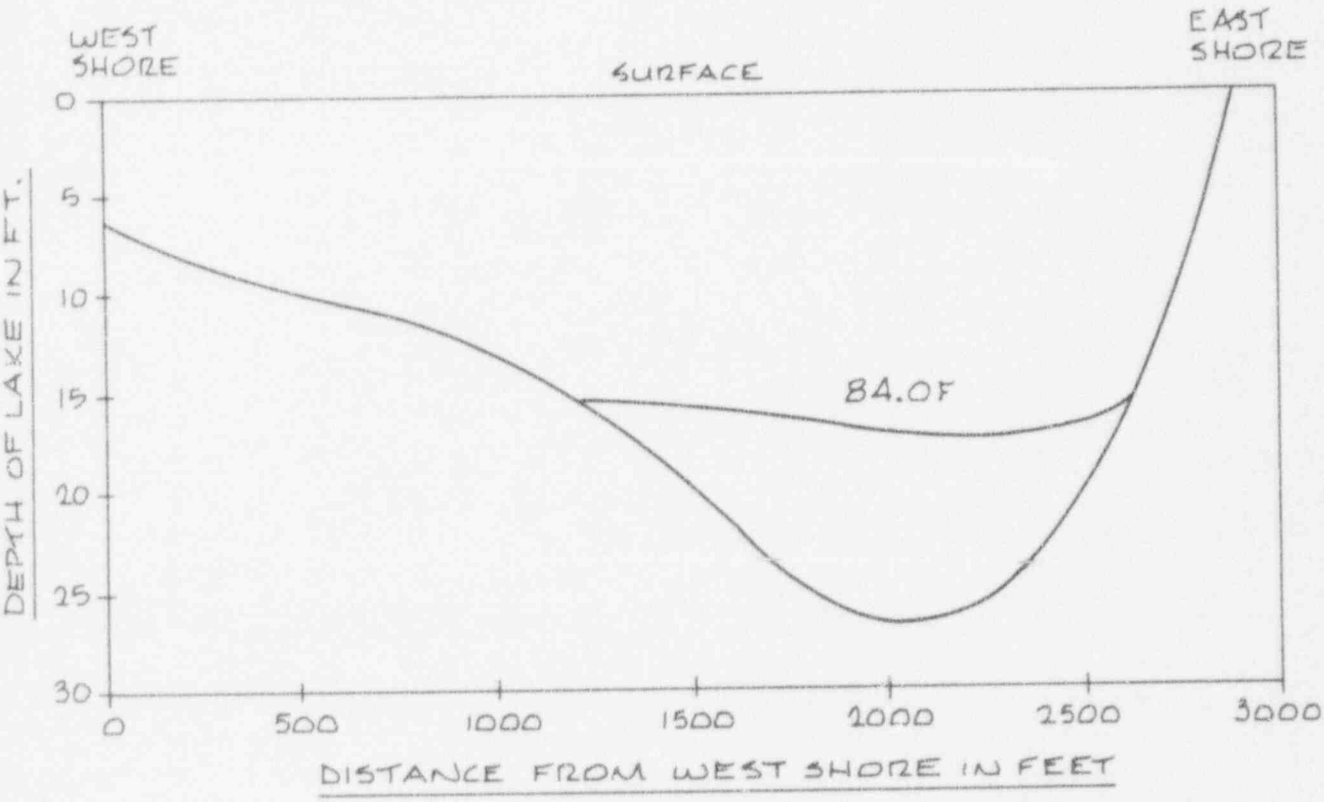
FIG. NO. 3.6–11



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

TEMPERATURE ISOTHERMS (°F) IN LAKE ROBINSON ALONG CROSS SECTION C PRIOR TO OPERATION OF UNIT NO. 2 (9/62)

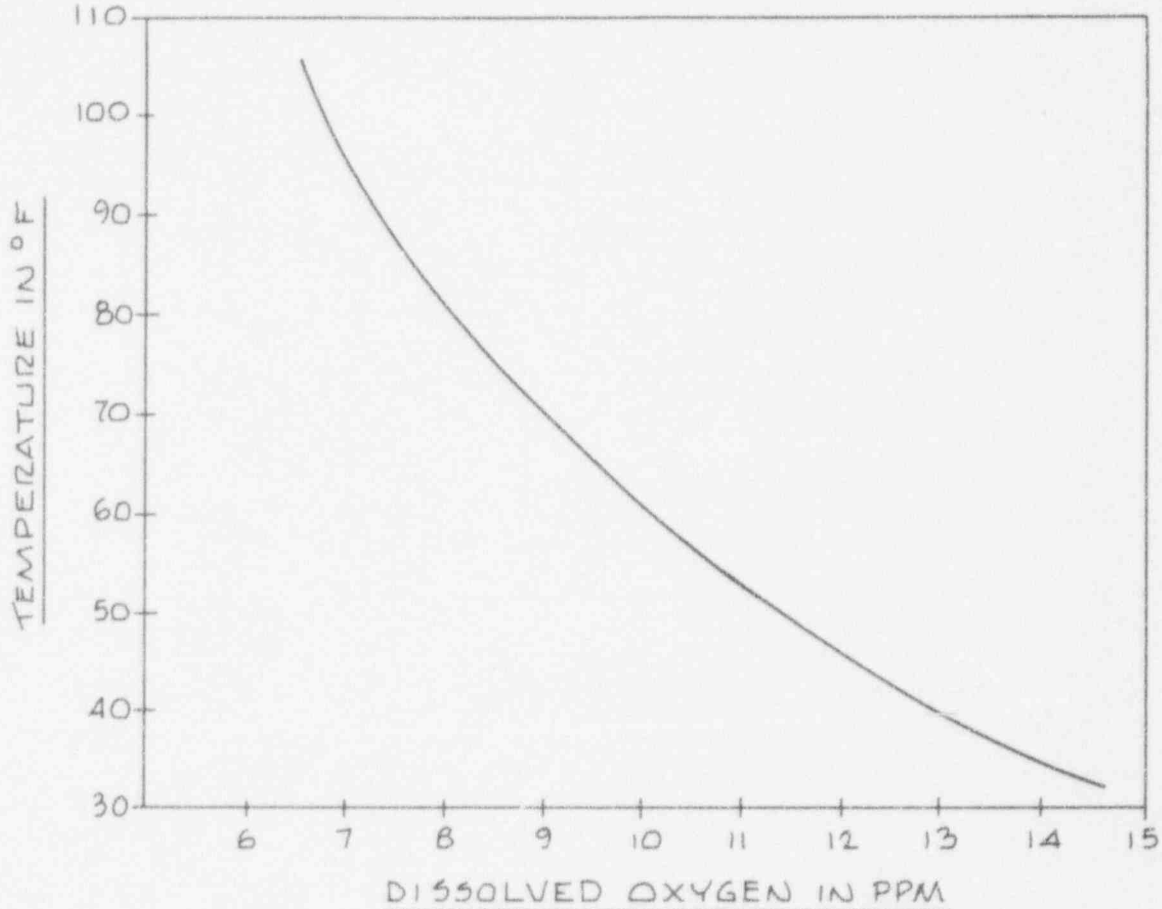
FIG. NO. 3.6–12



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

TEMPERATURE ISOTHERMS (°F) IN LAKE ROBINSON ALONG CROSS SECTION D PRIOR TO OPERATION OF UNIT NO. 2 (9/62)

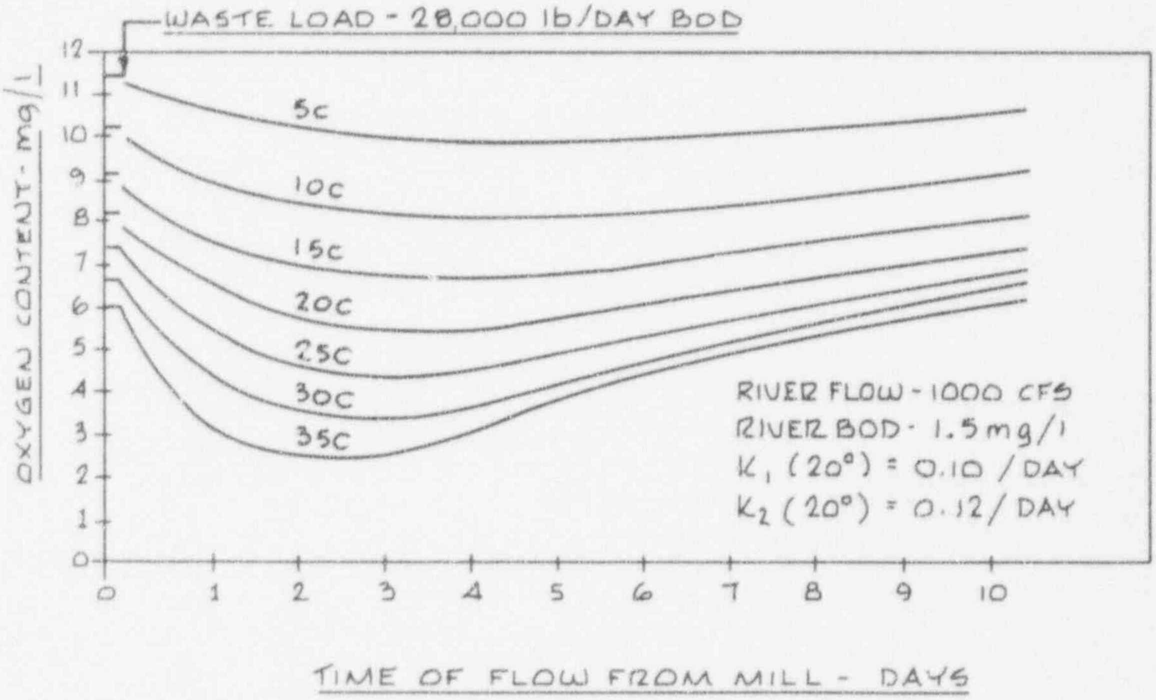
FIG. NO. 3.6–13



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

THEORETICAL LIMIT OF OXYGEN THAT CAN BE DISSOLVED IN WATER AT VARIOUS TEMPERATURES

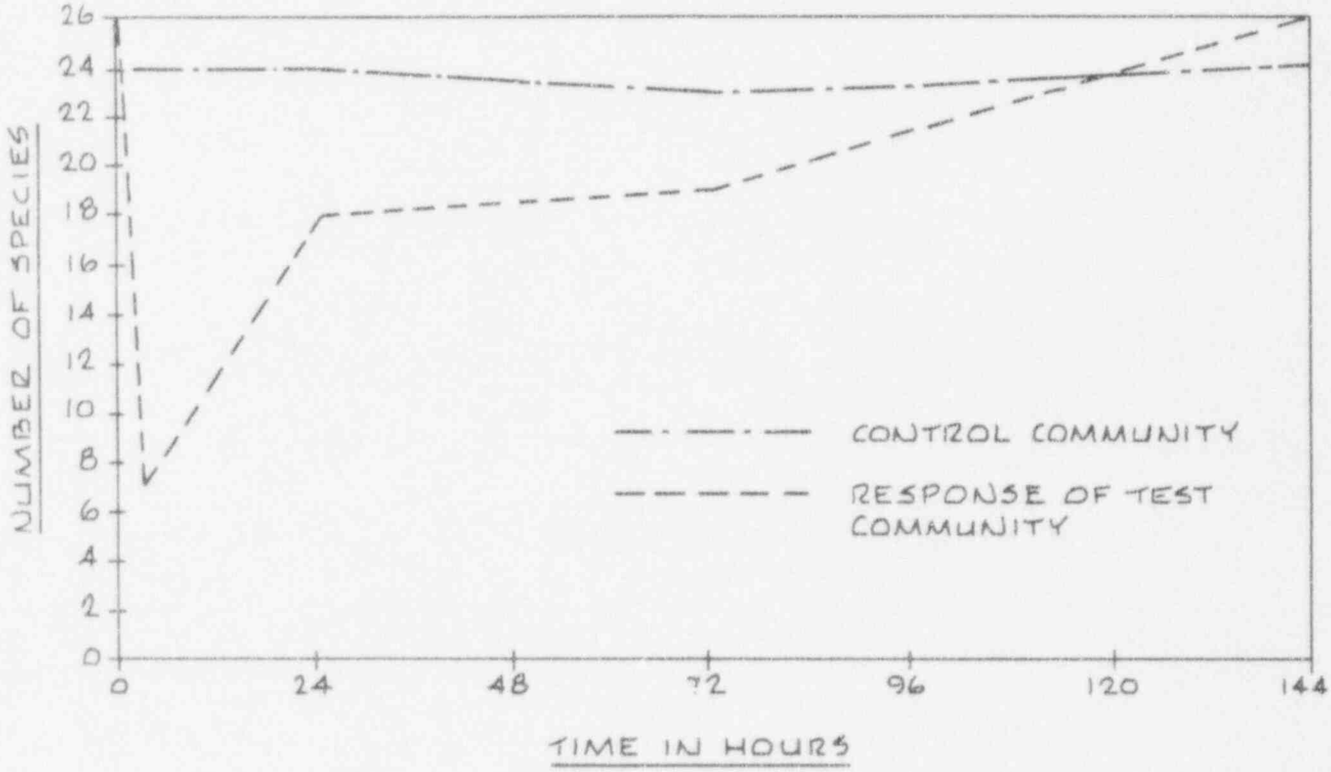
FIG. NO. 3.6-14



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

LAG IN DISSOLVED OXYGEN CONTENT OF A STREAM DUE TO THE DISCHARGE OF BIODEGRADABLE MATERIAL (KRENKEL & PARKER, 1968)

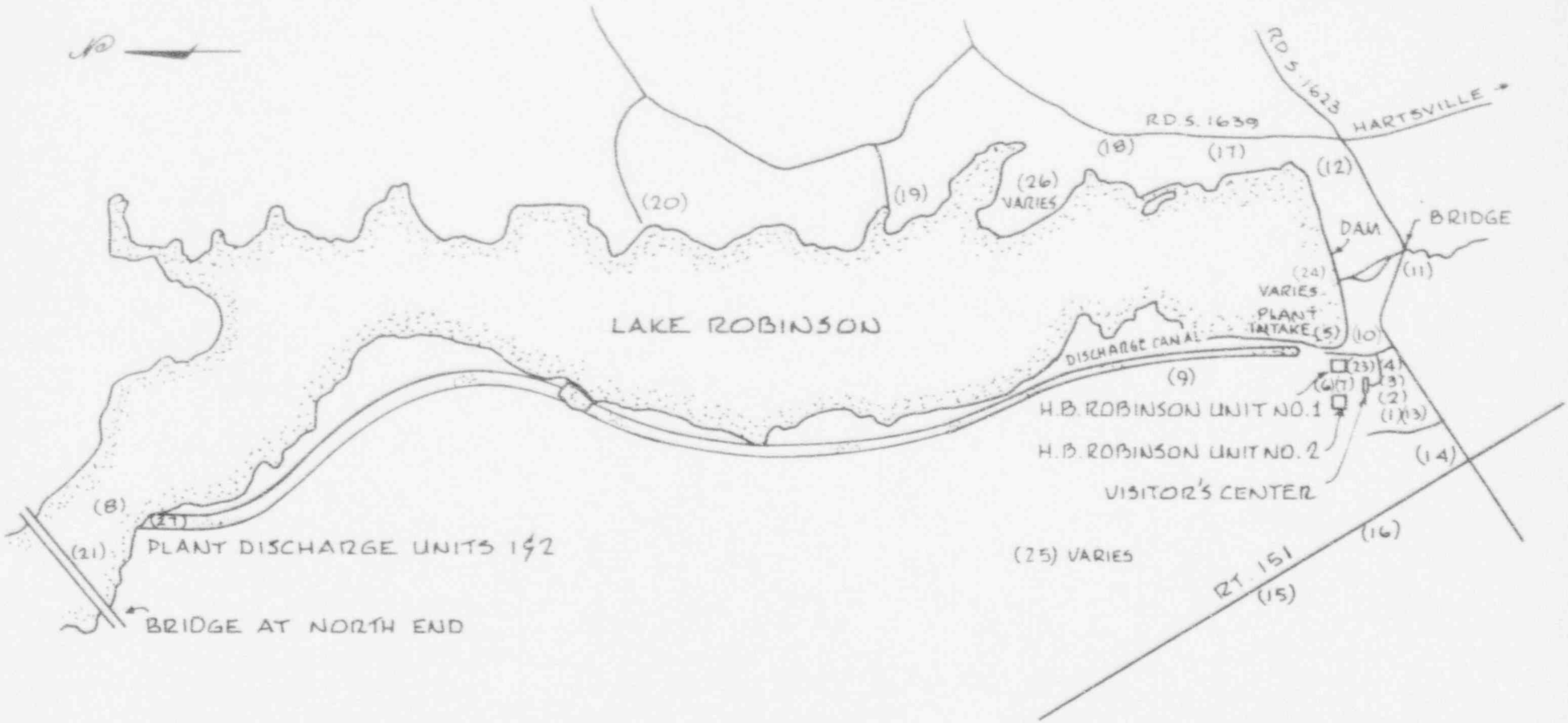
FIG. NO. 3.5–15



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

RESPONSE OF THE PROTOZOAN COMMUNITY TO A BRIEF TEMPERATURE SHOCK OF 48 F (CAIRNS, 1969)

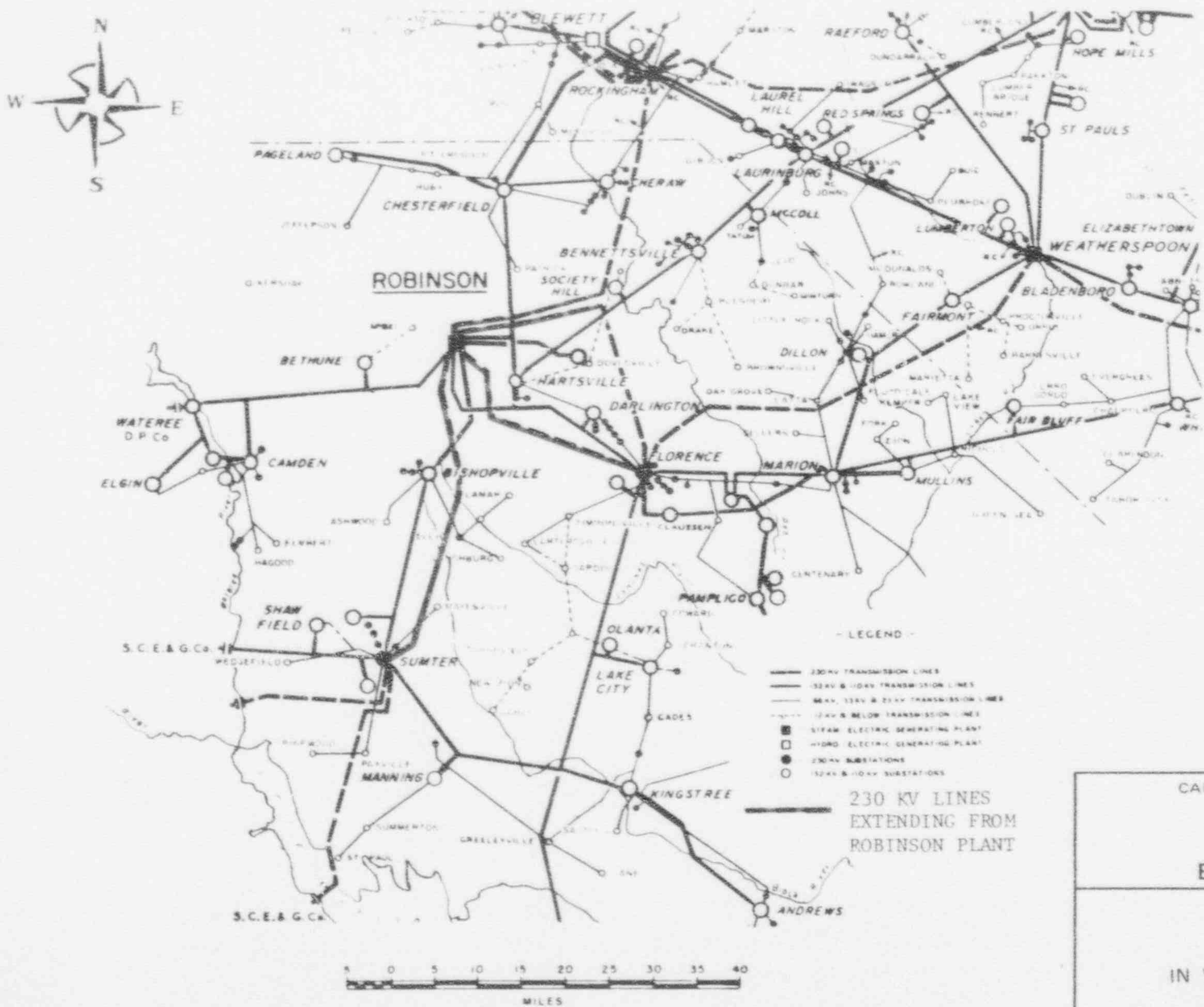
FIG. NO. 3.6–16



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

ENVIRONMENTAL SAMPLING POINTS

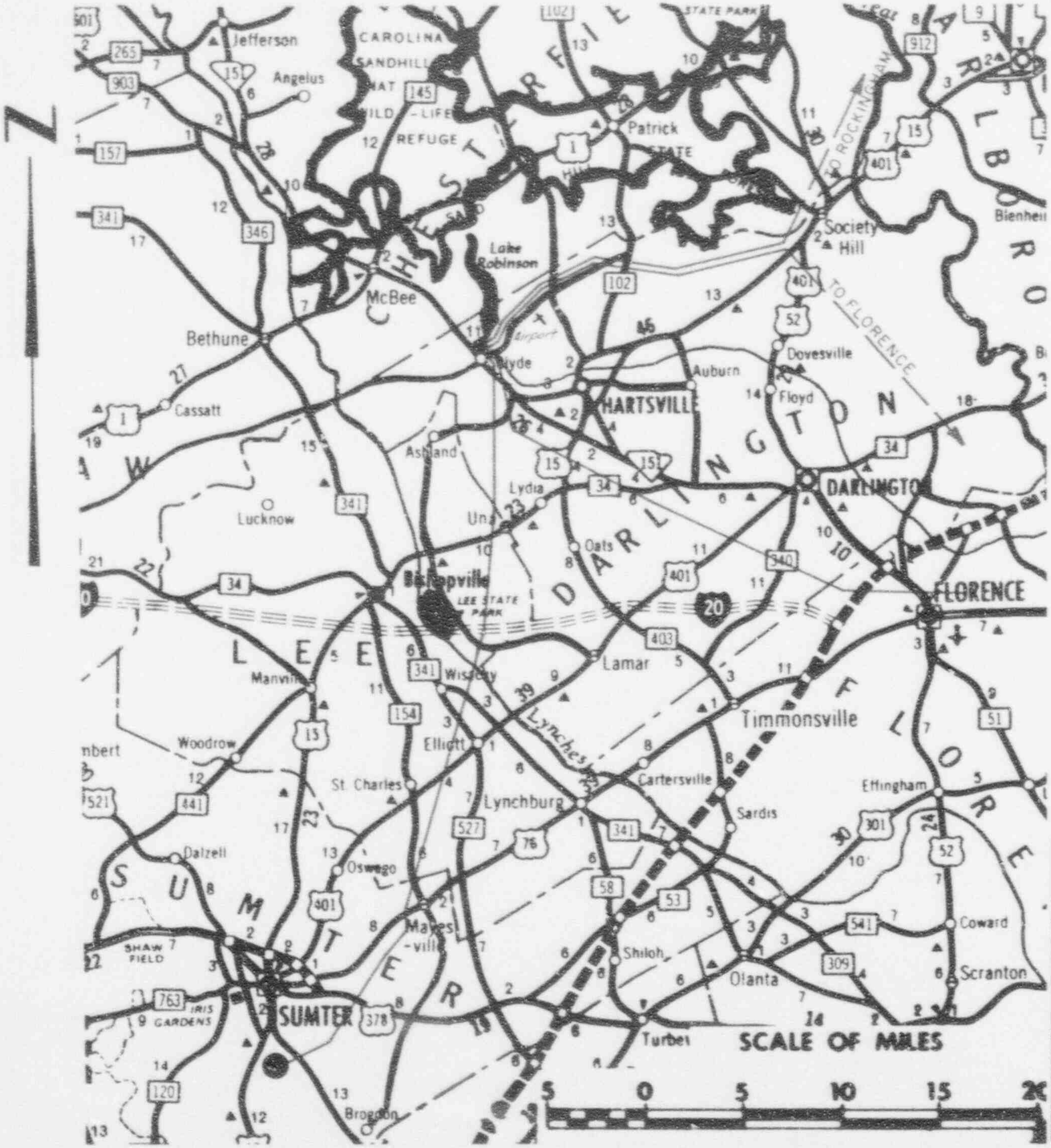
FIG. NO. 3.6–17



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

TRANSMISSION SYSTEM
IN VICINITY OF ROBINSON PLANT

FIG. NO. 3.10-1



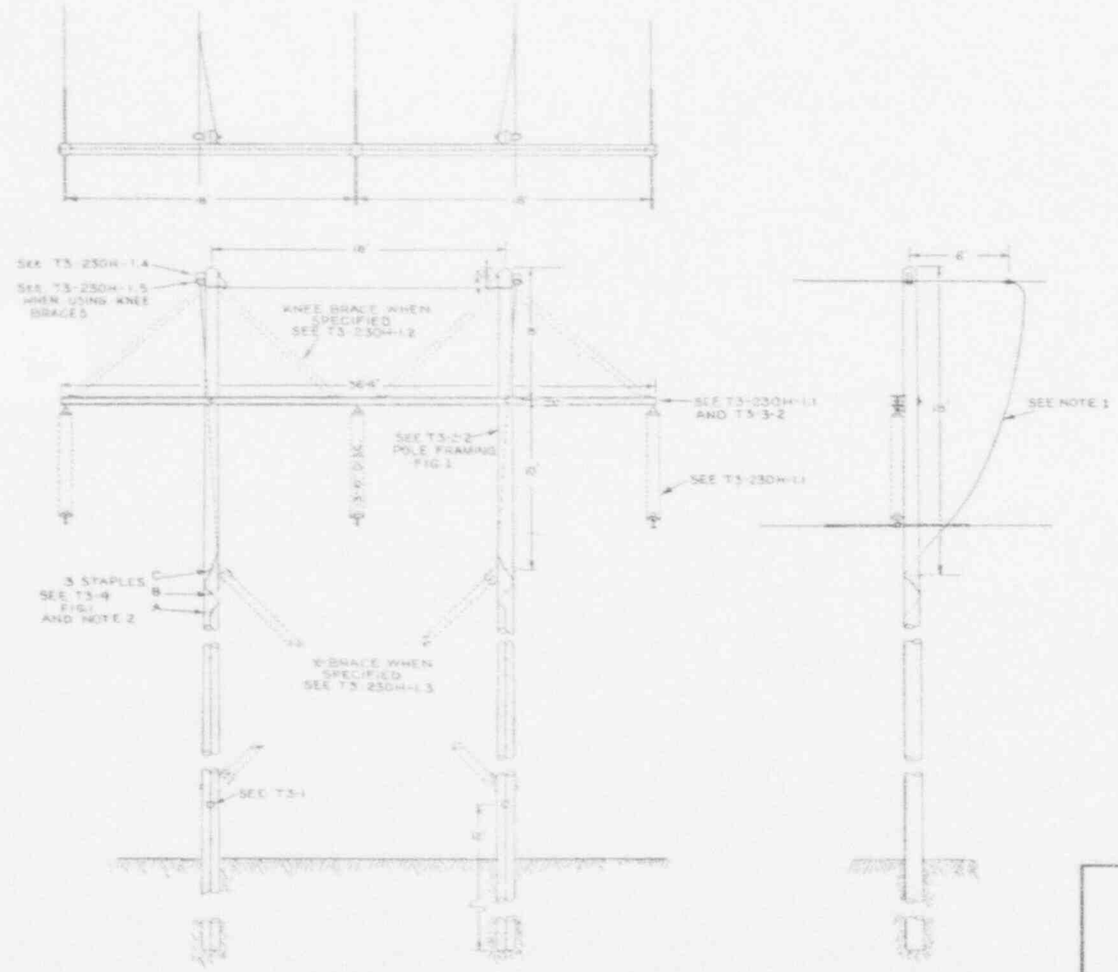
LEGEND

- 230 KV LINES EXTENDING FROM ROBINSON POWER PLANT
- EXISTING 230 KV LINES
- 230 KV SUBSTATION
- ROBINSON POWER PLANT

CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

LOCATION OF 230 KV TRANSMISSION LINES EXTENDING FROM ROBINSON PLANT

FIG. NO. 3.10–2



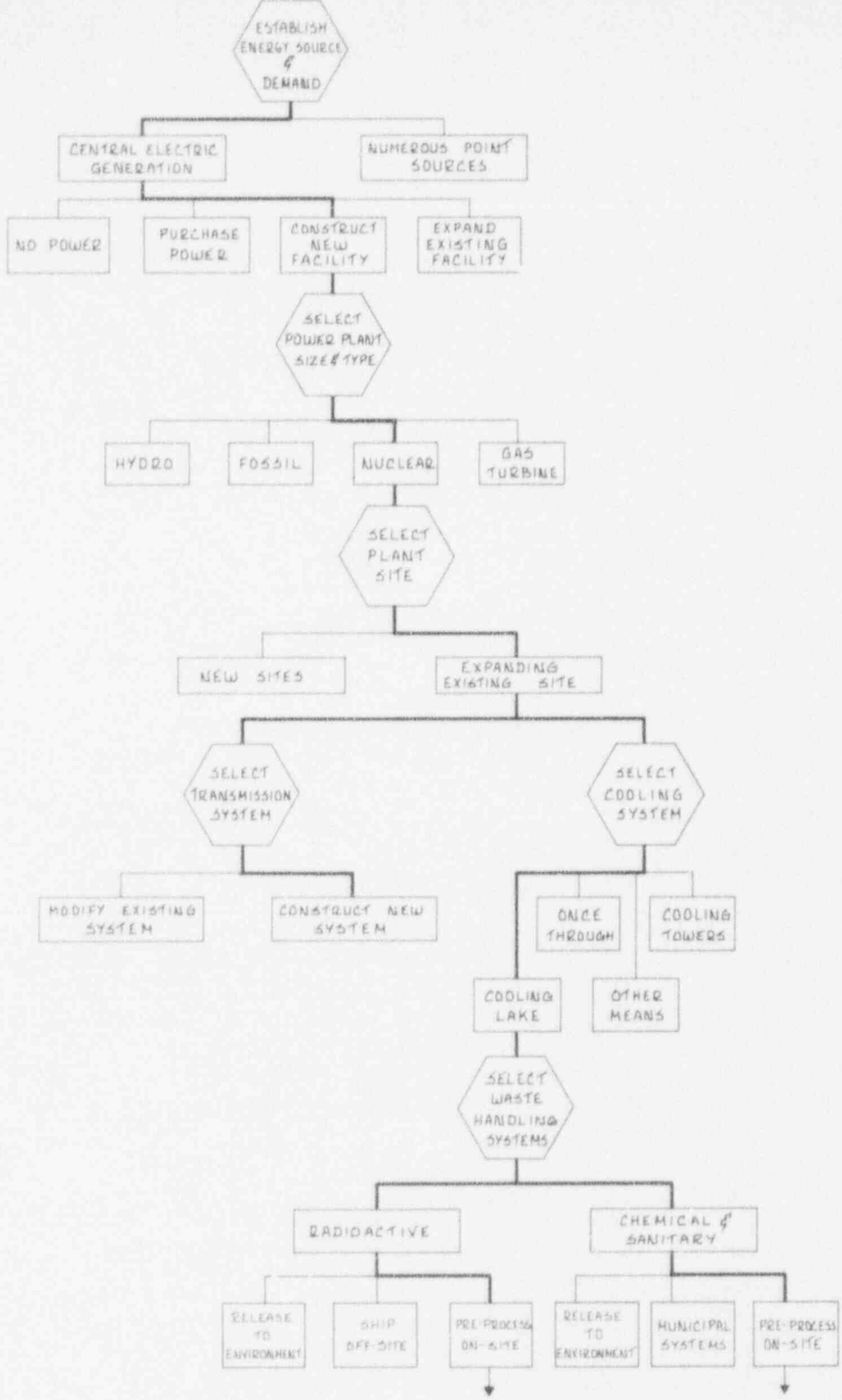
NOTES

1. FLYING TAP SHALL BE PULLED HAND TIGHT, DO NOT PULL STATIC DOWN.
2. EACH FLYING TAP GROUND WIRE SHALL FIT CLOSE AND SNUG TO EACH POLE AND STAPLED SO THERE IS NO ABRUPT BEND, AND LEAVE EACH POLE ON THE INSIDE OF STRUCTURE.
3. ALL COTTER KEYS USED IN CONNECTION WITH INSULATORS AND FITTINGS SHALL BE SPREAD AT LEAST 1/4 INCH, UNLESS THEY ARE OF THE NON-SPREADING TYPE. ALL COTTER KEYS SHALL BE ON THE POLE SIDE OF ALL INSULATORS, HARDWARE OR FITTINGS. IN ANY CASE WHERE PINS ARE INSTALLED VERTICALLY, PLACE THE PIN SO THAT THE COTTER KEY IS ON THE UNDER SIDE.

CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

230 KV TRANSMISSION LINE
TANGENT STRUCTURE

FIG. NO 3.10-3



CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON
STEAM ELECTRIC PLANT
UNIT NO. 2
Environmental Report

COST/BENEFIT DECISION PROCESS

FIG. NO. 8.1–1

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

NOV 06 1972

Docket No. 50-261

Carolina Power and Light Company
ATTN: Mr. J. A. Jones
Senior Vice President
336 Fayetteville Street
Raleigh, North Carolina 27602

Dear Mr. Jones:

During the course of the review of the Environmental Report for the H. B. Robinson Steam Electric Plant, Unit No. 2, it has been determined that additional information will be needed before we can complete our Environmental Statement. Accordingly, please submit the information identified in the enclosure to this letter. Your reply should consist of three signed originals and 297 additional copies as a sequentially numbered supplement to your Environmental Report.

In order to maintain our licensing review schedule we will need a completely adequate response by November 24, 1972. Please inform us within 7 days after receipt of this letter of your confirmation of the schedule or the date you will be able to meet. If you cannot meet our specific date or if your reply is not fully responsive to our requests, it is highly likely that the overall schedule for completing the licensing review for this project will have to be extended. Since reassignment of the staff's efforts will require completion of the new assignment prior to returning to this project, the extent of extension will most likely be greater than the extent of delay in your response.

Sincerely,

Daniel R. Muller

Daniel R. Muller, Assistant Director
for Environmental Projects
Directorate of Licensing

Enclosure:
As Stated

cc: George F. Trowbridge, Esquire
Shaw, Pittman, Potts, Trowbridge & Madden
910 - 17th Street, N.W.
Washington, D.C. 20006

ADDITIONAL INFORMATION

FOR H. B. ROBINSON STEAM ELECTRIC

UNIT NO. 2

1. OBJECTIVES OF THE FACILITY

a. Provide information on anticipated and projected power demands through 1975 or later.

b. Provide information on projected peak load figures for the period 1962-1972 and a comparison with actual peak load demand for this same period.

c. Describe additional plants or increase in capacity of present plants which are planned in the CP & L service area. Indicate distance to and location of any which will be closer than 100 miles from the H. B. Robinson site.

d. Describe agreements which exist for obtaining power from neighboring utility systems.

e. Indicate the status of the Refuse Act Permit Applications which were made to the U. S. Army Corp of Engineers and the S. C. Pollution Control Authority in June and September of 1971 (see p. 2.3-2 of ER). If the Company has received the permit to discharge into Lake Robinson, and certification under WQIA/70, what are the permit/certificate numbers, dates, etc.?

2. THE SITE

2.1 Site Location

a. Provide a map of the area which indicates the extent of the boundaries of the complete plant site. It should include all of Lake Robinson, show the run of the discharge canal and its point of discharge into the lake, and indicate run of transmission lines.

b. Provide a listing of the allocation of land area on site to its various uses in appropriate and convenient categories.

2.2 Demography and Land Use

a. Furnish estimates on water and shore side recreational use of Lake Robinson in terms of person hours in or on the lake and on-site per year.

b. Discuss action taken or planned, if any, and the CP & L basic philosophy for the encouragement of recreational utilization of Lake Robinson: e.g., boat ramps, fish stocking programs, etc.

c. Provide an estimate of the sport fishing yield of Lake Robinson (pounds per year) and Black Creek to and including Prestwood Lake.

d. Provide a detailed map or an aerial photograph showing the location of residences, farms, businesses and industry within a two-mile radius of the reactor.

e. Provide a copy of or a reference to the report of the study for Southern Bell Telephone Company and the South Carolina Development Board on population projections discussed in the ER, page 2.1-3, and of any other studies which have been made in addition.

f. Provide information on the economic impact of the plant on the surrounding community. Include numbers of persons employed, total wages, taxes paid, etc.

2.3 Historic and Natural Landmarks

Provide a copy of correspondence from the State of South Carolina Concerned Agency relative to the existence of any historic or natural landmark or site of archaeological significance on site or on the transmission lines' right-of-way.

2.4 Geology

Provide a copy of or a reference to the Dames and Moore report from which the geologic map Figure 2.1-9 was taken.

2.5 Hydrology

Provide a copy of the permit from the State of South Carolina for the use and control of water flow in Black Creek and Lake Robinson.

2.6 Meteorology

Provide joint frequency distribution of wind direction, wind speed and stability in the format requested in the AEC Safety Guide 23, in accordance with Sections 50.34 (a)(1) and 50.34 (b)(1) of 10 CFR Part 50, or provide data necessary to prepare this information.

2.7 Ecology

a. Provide lists of fauna and flora common to the Lake Robinson region.

b. Provide a copy of the student report on Lake Julian.

c. Provide information on fish stocking programs with threadfin shad and striped bass-white bass hybrids since 1968.

3. THE STATION

3.3 Plant Water Use

Provide information on the qualitative use of water at the plant with indication of flows to and from each use category during the various conditions of reactor operation and shutdown. Indicate the quality of the water from each system before it enters the general water discharge system as well as that of the general discharge system. Include water for sanitary as well as for industrial purposes.

3.4 Heat Dissipation System

a. Provide information on the design of the intake and outfall structures for the condenser cooling water system. Include design of screens, trash handling systems, canal intersection at lake, etc. Provide necessary sketches or drawings which describe these.

b. Provide information on flow velocity and transit time of water in the discharge canal during full power operation of H. B. Robinson Units 1 and 2.

c. Provide information on inside dimension of condenser tube and water velocity within them.

3.5 Radwaste Systems

a. Furnish copies of reports giving monthly releases of radioisotopes in liquid and gaseous effluents for the past year. Give isotopes breakdown if available.

b. Furnish distances from Plant to site boundary, nearest occupied dwelling, and nearest herd ($\geq$ 1 cow) in the 16 principal compass directions. Describe milk sampling program.

c. Describe operating procedures that govern use of extended treatment system for exhaust air from selected areas in the auxiliary building.

d. Response to question 17 for Source Term Data (letter J. A. Jones to E. J. Bloch, June 7, 1972) indicates that the containment air is purged through HEPA filters. Figure 5.3.3-1 of the FSAR indicates no treatment of containment purge. Please reconcile the apparent discrepancy.

e. Furnish details about the history of containment purges. Also furnish information from plant records regarding radiation levels (direct and air concentrations) measured in the containment building. To what extent are the recirculation filters operated.

f. Describe the plant history of primary coolant leakage (water, steam) to the containment and elsewhere. Describe its collection and treatment.

g. Describe process monitoring on release line from CVCS monitor tanks.

h. Furnish the following information about process radiation monitoring of gas and liquid effluent streams:

1. sensitivity limits in terms of expected radionuclide mix;
2. trip levels and alarm set points and basis for setting;
3. operation response to alarms or trips;
4. any changes (actual or expected) from monitors described in Section 11 of the FSAR.

i. Furnish history of radioactivity levels measured in the primary and secondary coolants.

j. Describe downstream use of Black Creek for potable water for a distance of 50 miles.

k. Furnish information on volume and flows into and out of Prestwood Lake.

l. Describe in more detail the vents and release points from which airborne or gaseous radioactive materials are emitted. Their height in relationship to adjacent buildings as well as effluent velocity and volume flow rate should be indicated.

m. Provide location relative to visitors center, nearest site boundary and nearest dwelling of any outside storage tanks which may contain radioactivity. Also give the capacity and expected concentrations of radionuclides of these storage facilities.

3.6 Chemical and Biocide Systems

a. Provide a detailed list of all chemicals discharged into Lake Robinson indicating frequency and quantities of discharge.

b. Describe methods which will be used to control chlorine residuals at discharge canal outlet to meet EPA requirements if it becomes necessary to use chlorine in connection with the operation of Unit 2 in the future.

3.7 Sanitary and Other Waste Systems

a. Provide the following information: the quantity of sanitary waste discharged to the lake per day, the residual chlorine level of discharged sanitary waste, the biochemical oxygen demand (BOD) of the discharged waste.

NB

b. Describe the disposal practices for other nonradioactive wastes (solid, liquid, and gaseous) including debris and fish from trash racks and screens in the condenser water supply system. Provide a copy of State regulations which control such disposal.

5. ENVIRONMENTAL EFFECTS OF PLANT OPERATION

5.1 Effects of Operation of Heat Dissipation System

a. Provide information on daily, weekly and monthly fluctuations in lake level during various seasons of the year with the operation of the plant. Values during spring are of special importance.

b. Provide representative temperature and dissolved oxygen concentration information from surveys during July or August and February or March for two years before startup of Unit 2 and for each year since.

c. Provide a copy of or reference to the EPA document on black waters. Provide a copy of available nutrients data for Lake Robinson.

d. Paragraph 3 on p. 8.5-2 of the ER states that natural solar radiation accounts for about 6°F of the 10°F temperature rise between the inlet and outlet waters of Lake Robinson. Please provide information on measurements which have been made to support this.

e. Provide a copy of the data on fish taken from the intake screens.

5.2 Effects of Operation of the Plant on Resources

Provide information on annual consumption of fuel for the diesel engines and auxilliary boiler which support Unit 2.

5.6 Effects of Operation and Maintenance of the Transmission System

Provide information on the effect of the existence of the transmission lines. Provide information on and break down into categories of land use of transmission line right-of-ways for Unit 2.

6. EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

a. List and describe all programs for monitoring the environmental impact of the operation of the plant. Radiological, chemical and sanitary effluents and their effects on the ecology should be included. Descriptions should be in detail covering such factors as frequency, type of sampling, method of collection, analytic methods, sample holding times and pre-analysis treatment, instrumentation used and its sensitivity, etc.

Monitoring programs being carried out by public or other agencies not supported by CP & L should be included. Include programs listed in Table 3.6-5 in the ER with additional information necessary to update it and provide the information requested above.

b. Provide information on the location of other wells being monitored (p. 3.7-9) in addition to the sampling point No. 23 listed in the Table.

9. ALTERNATIVE ENERGY SOURCES AND SITES

a. Provide information on the other CP & L site mentioned on p. 5.4-2 of the ER and describe the cooling water modifications that would have been necessary to accommodate a 700 MWe plant there.

b. Provide information on cost versus benefit studies of alternate types of power plants which may have been made. Include breakdown of costs considered such as capital, operating, fuel and others which affect the cost of generated power.

11. SUMMARY BENEFIT-COST ANALYSIS

Provide data on electrical production from Unit 2 since the beginning of operation in terms of dollars and kilowatt hours, and for a five-year projection.

12. TRANSPORTATION

a. Provide the following information concerning transportation of new fuel:

1. Source of supply;
2. Distance from supplier to plant;
3. Mode of shipment (truck or rail);
4. Number of shipments (rail cars or trucks) in initial loading;
5. Number of shipments annually of reload fuel.

b. Provide the following information concerning transportation of solid radioactive waste:

1. Location of burial site;
2. Distance of site from plant;

3. Mode of shipment (truck or rail);

4. Number of shipments (rail cars or trucks) per year.

1. OBJECTIVES OF THE FACILITY

Question 1.a

Provide information on anticipated and projected power demands through 1975 or later.

Response

This information is supplied in Table s1.a-1, "Carolina Power & Light Company Forecast Power Demands" covering the period 1972 through 1981.

TABLE s1.a-1

CAROLINA POWER & LIGHT COMPANY
FORECAST POWER DEMANDS

Year	MWe
1972	4279
1973	4766
1974	5315
1975	5942
1976	6591
1977	7318
1978	8106
1979	8971
1980	9912
1981	10951

Question 1.b

Provide information on projected peak load figures for the period 1962-1972 and a comparison with actual peak load demand for this same period.

Response

This information is contained in Table s1.b-1, "Carolina Power & Light Company Comparison of Annual Demands With Forecast Demands" covering the period 1962 through 1972.

TABLE s1.b-1

CAROLINA POWER & LIGHT COMPANY
COMPARISON OF ANNUAL PEAK DEMAND
WITH FORECAST DEMANDS

Year	Forecast MWe	Peak Demand MWe	Variance Percent
1962	1507	1516	-0.6
1963	1650	1638	0.7
1964	1810	1749	3.5
1965	1950	1943*	0.4
1966	2230	2184	2.1
1967	2437	2445*	-0.3
1968	2650	2834	-6.5
1969	3043	3171*	-4.0
1970	3415	3484	-2.0
1971	3818	3625	5.3
1972	4279	4119**	3.9**

*Winter Peak in January of following calendar year
**1972 Summer Peak

Question 1.c

Describe additional plants or increase in capacity of present plants which are planned in the Carolina Power & Light Company service area. Indicate distance to and location of any which will be closer than 100 miles from the H. B. Robinson Site.

Response

The planned capacity additions for the Carolina Power & Light system through 1980 are listed in Table s1.c-1. None of these additions are within 100 miles of the H. B. Robinson site. The Harris Plant site is located approximately 110 miles northeast of the Robinson site. The Company has purchased 630 MW of IC turbines, but the location for the turbines has not been decided as of this date. It is possible that they might be within the 100-mile radius.

TABLE s1.c-1

CAROLINA POWER & LIGHT COMPANY
SCHEDULE OF CAPACITY INSTALLATIONS

Unit	Size (MW)	Type	Site	Expected In Service Date
Roxboro #3	720	Fossil	Extension	3/1/73
Brunswick #2	821	Nuclear	New	3/1/74
Brunswick #1	821	Nuclear	Extension	3/1/75
Roxboro #4	720	Fossil	Extension	3/1/76
Harris #1	900	Nuclear	New	3/1/77
Harris #2	900	Nuclear	Extension	3/1/78
Harris #3	900	Nuclear	Extension	3/1/79
Harris #4	900	Nuclear	Extension	3/1/80

Question 1.d

Describe agreements which exist for obtaining power from neighboring utility systems.

Response

Carolina Power & Light Company has contracts for purchases of firm capacities with the Appalachian Power Company for 100 MW and with South Carolina Electric & Gas Company for 53 MW. Additionally, there is an agreement which allows the purchase of unit capacity for 61 MW from South Carolina Electric & Gas Company. There are no other long-term purchases being made from others.

Carolina Power & Light does have interchange agreements which permit short-term and emergency exchanges of capacity and energy with all of the neighboring utility companies with which it is interconnected. These interchange agreements with Virginia Electric & Power Company, Duke Power Company, Appalachian Company, the Tennessee Valley Authority, and South Carolina Electric and Gas Company permit the exchange of capacity and energy between companies for the purpose of enhancing the reliability of each company. However, they do not provide for the long-term purchase of capacity in the amount of or the type required to replace the base load-carrying capability of a unit such as Robinson No. 2.

Question 1.e

Indicate the status of the Refuse Act Permit Applications which were made to the U. S. Army Corps of Engineers and the S. C. Pollution Control Authority in June and September of 1971 (see p. 2.3-2 of ER). If the Company has received the permit to discharge into Lake Robinson, and certification under WQIA/70, what are the permit/certificate numbers, dates, etc.?

Response

The permit application filed with the U. S. Army Corps of Engineers on June 29, 1971 as required under the Refuse Act Permit Program is pending. The South Carolina Pollution Control Authority which, on the same date, was requested to certify that continued operation of the Robinson Plant is not likely to contravene State Water Quality Standards has issued a letter of certification dated November 16, 1972. A copy of this letter of certification is shown on page sl.e-2.

South Carolina
Pollution Control Authority

HUBERT J. WEBB, PH.D.
EXECUTIVE DIRECTOR
OWEN BUILDING
1321 LADY STREET P. O. BOX 11628
Columbia, South Carolina 29211

AREA CODE 803
TELEPHONE: 758-2915

November 16, 1972

Carolina Power and Light Company
Raleigh
North Carolina

Re: H. B. Robinson
Steam Electric Plant
Unit No. 2

Dear Sir:

The South Carolina Pollution Control Authority has evaluated information supplied to the Authority by Carolina Power and Light Company. Based on this information the Pollution Control Authority certifies that there is reasonable assurance that this project will not violate applicable water quality standards.

Yours very truly,

H. J. Webb

H. J. Webb
Executive Director

HJW/CRJ:as

2. THE SITE

2.1 Site Location

Question 2.1a

Provide a map of the area which indicates the extent of the boundaries of the complete plant site. It should include all of Lake Robinson, show the run of the discharge canal and its point of discharge into the lake, and indicate run of transmission lines.

Response

An aerial photograph with the property boundary and transmission line runs indicated is provided in Figure 2.1a-1.

Question 2.1b

Provide a listing of the allocation of land area on site to its various uses in appropriate and convenient categories.

Response

Of the total 4,750 acres in the Robinson Plant site area shown on Figure 2.1a-1, 2,250 acres are devoted to the lake; 1,000 acres to utility property, including the Visitor's Center; 1,300 acres to forestry and watershed protection; and 200 acres are leased to a farm management program.

2.2 Demography and Land Use

Question 2.2a

Furnish estimates on water and shore side recreational use of Lake Robinson in terms of person hours in or on the lake and on-site per year.

Response

The following estimate is derived from conversations with people in the area.

Weekends for 31 weeks of the year		
50 people at 4 hours per trip	-	6,200 person hours
Weekdays for 31 weeks of the year		
10 people per day at 4 hours per trip	-	6,200 person hours
Weekends for 21 weeks of the year		
5 people at 4 hours per trip	-	420 person hours
Weekdays for 21 weeks of the year		
2 people per day at 4 hours per trip	-	840 person hours
Total	-	13,660 person hours

Question 2.2b

Discuss action taken or planned, if any, and the CP&L basic philosophy for the encouragement of recreational utilization of Lake Robinson. e.g., boat ramps, fish stocking program, etc.

Response

A picnic area has been constructed near the lake by CP&L. However, as the primary purpose of Lake Robinson is to serve as a cooling device, there are no plans for further recreational development.

Two boat ramps (Atkinson Landing and Easterlings Landing) and one marina (J&M Marina) are located on the lake.

The South Carolina Wildlife Resources Department stocked 850,000 hybrid fry (white bass x striped bass) into Lake Robinson during the period 1967-69. In the winter of 1971 threadfin shad were stocked. A sampling program was performed in December, 1972, at which time no hybrid fish or threadfin shad were collected.

Question 2.2c

Provide an estimate of the sport fishing yield of Lake Robinson (pounds per year) and Black Creek to and including Prestwood Lake.

Response

In the absence of creel census data, a quantitative estimate in pounds per year of the sport fishing yield of Lake Robinson would amount to no more than untenable speculation. However, a series of news articles from the Darlington County Tribune provides some valuable information conconerning the sport fishing opportunities at Lake Robinson. According to a November 9, 1972, article titled "Lake Robinson Offers Good Fishing," ...."the lake has provided excellent fishing for largemouth bass, crappie, bluegill, pickerel and catfish." The article further states that "Largemouth bass fishing along the entire edge of the lake along the eastern shore and from the 'hot hole' northward on the western shore is excellent during the spring, summer, and early fall." Bluegill fishing is also rated as excellent during the spring and summer months.

Similar information for Black Creek and Prestwood Lake is not available.

Question 2.2d

Provide a detailed map or an aerial photograph showing the location of residences, farms, businesses and industry within a two-mile radius of the reactor.

Response

This information is provided on Figure 2.1a-1 submitted in response to Question ?.1a.

Question 2.2e

Provide a copy of or a reference to the report of the study for Southern Bell Telephone Company and the South Carolina Development Board on population projections discussed in the ER, page 2.1-3, and of any other studies which have been made in addition.

Response

In developing the population projections for the area surrounding H. B. Robinson Unit 2, prior dicennial census data from 1940 onward was used. The numbers which appear on Figures 2.1-5 and 2.1-6 were arrived at using the most optimistic growth projections based on historical data. No out-migration was assumed; if losses occurred during the previous dicennial census data, the population projection was taken to be a constant value and no further losses were assumed. Southern Bell Telephone has a very intimate knowledge of how the region is developing both industrially and residentially. Each year, Southern Bell performs a house-count of their service area and assumes about 3.6 persons per house for projecting residential growth. Additionally, Southern Bell representatives meet with industrial representatives and are well-informed with regard to the industrial growth anticipated for their region. Southern Bell Telephone data was used in all cases where the historical projections were less optimistic. Due to yearly update and elapsed time, Southern Bell Telephone's 1966 projections are no longer available.

Question 2.2f

Provide information on the economic impact of the plant on the surrounding community. Include number of persons employed, total wages, taxes paid, etc.

Response

The addition of the Robinson Unit No. 2 has had a substantial and positive effect upon property taxes in Darlington County. In 1971, CP&L paid $540,484 in property taxes. This was 15 percent of the total county tax revenues. In 1972, the first year CP&L will pay on the basis of the total nuclear operation, the tax bill will amount to about $1,272,000. This will represent 29 percent of the real taxable property in Darlington County. CP&L is the largest taxpayer in the county.

Since 1966 when the nuclear plant was announced, $431,270,000 has been invested in new and expanded industries through 1971 in the South Carolina area served by CP&L. This has resulted in the creation of 22,796 new jobs with an added payroll of $95,556,000.

The nuclear plant requires some 77 permanent employees, whose annual payroll is about $776,000. According to a United States Chamber of Commerce economic research study, these 77 workers residing in the same community would produce the following economic results:

77	more households
24	more school children
278	more people
75	more passenger cars
50	more employed in non-manufacturing or non-industrial
2	more retail establishments
$1,084,200	more personal income
$ 349,048	more bank deposits
$ 505,237	more retail sales

2.3 Regional Historic and Natural Landmarks

Question 2.3

Provide a copy of correspondence from the State of South Carolina Concerned Agency relative to the existence of any historic or natural landmark or site of archaeological significance on site or on the transmission lines' right-of-way.

Response

The H. B. Robinson plant site at Hartsville, South Carolina, and the transmission lines' right-of-way associated with the Robinson No. 2 unit do not lie upon nor pass near enough to any known historic, natural, or archaeologically significant properties to adversely affect them. Page 2.3-2 is a copy of a letter from the South Carolina Department of Archives and History validating the above statement.

South Carolina Department of Archives and History
1430 Senate Street
Columbia, S.C.

P. O. Box 11,188
Capitol Station 29211

October 10, 1972

Mr. Robert W. McDonald
Principal Engineer
Carolina Power & Light Company
P. O. Box 1551
Raleigh, North Carolina 27602

Dear Mr. McDonald:

This letter will acknowledge the fact that we have been informed of the Robinson Steam Plant at Hartsville, South Carolina, and that we have on file the mapping of the three areas affected by the Carolina Power and Light Company lines.

No National Register properties are located in these areas; nor do we know of any other historically significant properties near enough to adversely affected.

Enclosed is a list of the 195 South Carolina properties currently on the National Register of Historic Places. In addition, our Historic Preservation Division has an inventory of more than 3,500 South Carolina places of historic interest. We will be happy to identify these for Carolina Power and Light in any future environmental impact studies.

Sincerely,

Charles E. Lee

Charles E. Lee
State Liaison Officer
for Historic Preservation

CEL:czf
Enclosure

2.4 Geology

Question 2.4

Provide a copy of or a reference to the Dames and Moore report from which the geologic map Figure 2.1-9 was taken.

Response

The geologic map shown on Figure 2.1-9 was taken from the Dames & Moore report "Site Environmental Studies Proposed H. B. Robinson Nuclear Power Plant." A copy of this report was provided directly to Dr. Mike Novick, Argonne National Laboratory. (Letter dated January 2, 1973).

2.5 Hydrology

Question 2.5

Provide a copy of the permit from the State of South Carolina for the use and control of water flow in Black Creek and Lake Robinson.

Response

A copy of permit No. 307 dated June 24, 1964 and issued by the South Carolina Pollution Control Authority for operation of Lake Robinson as a cooling facility is included in this Supplement on page s2.5-2.

G. S. T. PEEPLES, M.D.
STATE HEALTH OFFICER
CHMN. WATER POLLUTION
CONTROL AUTHORITY

W. T. LINTON, DIRECTOR
DIVISION OF SANITARY ENGINEERING
EXEC. DIR., WATER POLLUTION
CONTROL AUTHORITY

South Carolina State Board of Health

Division of Sanitary Engineering

AND

Water Pollution Control Authority

COLUMBIA, SOUTH CAROLINA

PERMIT

For the Discharge of Sewage, Industrial Wastes and Other Waste

---

In accordance with the provisions of Chapter No. 3, Title 70, Vol. 6, 1952 South Carolina Code of Laws, and Regulations of the South Carolina Water Pollution Control Authority.

PERMISSION IS HEREBY GRANTED TO

Carolina Power & Light Company
Hartsville, South Carolina, Generating Station

FOR THE DISCHARGE OF

industrial cooling water

into Robinson Lake(Black Creek) — *Receiving Stream* — Pee Dee — *Drainage Basin*

in accordance with the application filed on March 10, 19 59 in this office and in conformity with plans, specifications and other data submitted in support of the above application, all of which are filed with and considered as a part of this permit together with the following conditions and requirements:

Discharge of cooling water to Robinson Lake by way of canal. Canal to be extended upstream as generating capacity is increased, in accordance with engineering report of Ebasco Services, Inc., Engineers, dated May 1, 1958.

Ash sluice water and boiler and evaporator blowdown discharged to settling basin. Effluent from settling basin returned to Robinson Lake.

Discharge from Lake Robinson dam to be maintained at or above 1.47 times flow measured by U.S.G.S. gauge on Black Creek near McBee, South Carolina.

Flow ratio subject to review at 5-year intervals as data accumulates, or as major construction may indicate a need.

This Permit supersedes: WPC Permit to Discharge #217 - 5/13/61
Ref: WPC Permit to Construct #179 - 5/12/58

NOTICE--This permit shall not be construed to authorize the creation or maintenance of a nuisance. Also, it may be revoked because of material changes in the amount of wastes discharged or failure to maintain treatment processes or other conditions of discharge specified above. The Water Pollution Control Authority should be notified of any such major change.

Issued this 24 day of June 19 64

G.S.T. Peeples, M.D.

W. T. Linton

Permit No. 307

2.6 Meteorology

Question 2.6

Provide joint frequency distribution of wind direction, wind speed and stability in the format requested in the AEC Safety Guide 23, in accordance with Section 50.34(2)(1) and 50.34(b)(1) of 10 CFR 50, or provide data necessary to prepare this information.

Response

The above information was provided directly to Dr. James Carson, Argonne National Laboratory. (Letter dated December 5, 1972).

2.7 Ecology

Question 2.7a

Provide lists of fauna and flora common to the Lake Robinson region.

Response

A species list of dominant plants observed at or near Lake Robinson September 21, 1972 follows:

Trees

Longleaf Pine (*Pinus palustris*)
Mockernut Hickory (*Carya tormentosa*)
Black Willow (*Salix niger*)
Dogwood (*Cornus floridanus*)
Mimosa (*Allizzia* spp.)
Persimmon (*Diospyros virginiana*)
Red Cedar (*Juniperus virginiana*)
Water Oak (*Quercus nigra*)
American Walnut (*Juglans nigra*)
Chinaberry (*Melia azedarach*)
Loblolly Pine (*Pinus taeda*)
Sweet Bay (*Magnolia virginiana*)
Tulip Poplar (*Liriodendron tulipifera*)
Red Maple (*Acer rubra*)
Laurel Oak (*Quercus laurifolia*)
Black Gum (or Tupelo) (*Nyssa sylvatica*)
Sweet Gum (*Liquidambar styraciflua*)
Southern Red Oak (*Quercus falcata*)
Blackjack Oak (*Quercus marilandica*)
Turkey Oak (*Quercus laevis*)
Black Cherry (*Prunus serotina*)
Sassafrass (*Sassafras albidum*)
Post Oak (*Quercus stellata*)
Scarlet Oak (*Quercus coccinea*)
Red Bay (*Persea borbonia*)
American Holly (*Ilex opaca*)

Shrubs

Wild Plum (*Prunus* sapp.)
Smooth Sumac (*Rhus glabra*)
Huckleberry (*Gaylussacia* spp.)
Wax Myrtle (*Myrica cerifera*)
Alder (*Alnus serrulata*)
Honeysuckle (*Lonicera* spp.)
Summer Grape (*Vitis* spp.)

Herbaceous

Numerous weeds of the Aster and Chenopodiace families
Dandelion (*Taxaracum* spp.)
Polk Weed (*Phytolaca* spp.)
Beggar's Lice (*Desmodium* spp.)
Blackberry (*Rubus* spp.)
Ragweed (*Aster* spp.)
Cane (*Arundinaria* spp.)
Bear Grass (*Yucca* spp.)
Spatterdock (*Nuphar advena*)
Crab Grass (*Digittaria* spp.)
Wire Grass (*Aristida stricta*)
Smart Weed (*Polygonum* spp.)
Water Lily (*Nymphaea* spp.)

List of amphibians, reptiles and mammals common to the H. B. Robinson site:

Turtles

Snapping turtle (*Chelydra serpentina*)
Stinkpot (*Sternotherus odoratus*)
Mud turtle (*Kinosternon subrubrum*)
Spotted turtle (*Clemmys guttata*)
Box turtle (*Terrapene carolina*)
Cooter (*Pseudemys florida*)
Pond slider (*Pseudemys scripta*)

Lizards

Eastern fence lizard (*Sceloporus undulatus*)
Slender glass lizard (*Ophisaurus attenuatus*)
Six-lines racerunner (*Cnemidophorus sexlineatus*)
Ground skink (*Lygosoma laterale*)
Five-lines skink (*Eumeces fasciatus*)
Broad-headed skink (*Eumeces laticeps*)
Southeastern five-lined skink (*Eumeces inexpectatus*)

Snakes

Common water snake (*Natrix sipedon*)
Brown water snake (*Storeria delsayi*)
Red-bellied snake (*Storeria occipitomaculata*)
Ribbon snake (*Thamnophis sauritus*)
Common garter snake (*Thamnophis sirtalis*)
Smooth earth snake (*Haldea valeriae*)
Eastern hognose snake (*Heterodon platyrhinos*)
Eastern ringneck snake (*Diadophis punctatus*)
Worm snake (*Carphophis amoenus*)
Black racer (*Coluber constrictor*)
Eastern coachwhip (*Masticophis flagellum*)
Rough green snake (*Opheodrys aestivus*)
Corn snake (*Elaphe guttata guttata*)

Black rat snake (*Elaphe obsoleta obsoleta*)
Gray rat snake (*Elaphe obsoleta spiloides*)
Pine snake (*Pituophis melanoleucus*)
Prairie kingsnake (*Lampropeltis calligaster*)
Common kingsnake (*Lampropeltis getulus*)
Milk snake (*Lampropeltis doliata*)
Scarlet snake (*Cemophora coccinea*)
Crowned snake (*Tantilla coronata*)
Copperhead (*Agkistrodon contortrix*)
Cottonmouth (*Agkistrodon piscivorus*)
Pigmy rattlesnkae (*Sistrurus miliarius*)
Timber rattlesnake (*Crotalus horridus*)
Eastern diamondback rattlesnake (*Crotalus* spp.)

Salamanders and Newts

Greater siren (*Siren lacertina*)
Spotted salamander (*Ambystoma maculatum*)
Marbled salamander (*Ambystoma opacum*)
Tiger salamander (*Ambystoma tigrinum*)
Newt (*Diemictylus viridescens*)
Amphiuma (*Amphiuma means*)
Dusky salamander (*Desmognathus fuscus*)
Slimy salamander (*Plethodon glutinosus*)
Mud salamander (*Pseudotriton montanus*)
Two-lined salamander (*Eurycea bislineata*)
Long-tailed salamander (*Eurycea longicauda*)

Toads

Common American toad (*Bufo terrestris*)
Woodhouse's toad (*Bufo woodhousei*)

Frogs

Cricket frog (*Acris gryllus*)
Spring peeper (*Hyla crucifer*)
Pinewoods treefrog (*Hyla femoralis*)
Barking treefrog (*Hyla gratiosa*)
Little grass frog (*Hyla ocularis*)
Gray treefrog (*Hyla versicolor*)
Chorus frog (*Pseudacres nigrita*)
Bullfrog (*Rana catesbiana*)
Green frog (*Rana clamitans*)
Leopard frog (*Rana pipiens*)

Mammals

Opossum (Didelphis marsupalia)
Southeastern shrew (Sorex longirostris)
Short-tailed shrew (Blarina brevicauda)
Least shrew (Cryptotis parva)
Eastern mole (Scalopus aquaticus)
Little brown myotis (Myotis lucifugus)
Silver-haired bat (Lasionycteris noctivagaus)
Eastern pipistrelle (Pipistrellus suliflavus)
Big brown bat (Eptesicus fuscus)
Red bat (Lasiurus borealis)
Hoary bat (Lasiurus cinereus)
Evening bat (Nycticeius humeralis)
Rafinesque's big-eared bat (Corynorhinus rafinesquii)
Eastern Cottontail (Sylvilagus floridanus)
Marsh rabbit (Sylvilagus palustris)
Gray squirrel (Sciurus carolinensis)
Fox squirrel (Sciurus niger)
Southern flying squirrel (Glaucomys volans)
Beaver (Castor canadensis)
Marsh rice rat (Oryzomys palustris)
Eastern harvest mouse (Reithrodontomys humulis)
White-footed mouse (Peromyscus leocopus)
Cotton mouse (Peromyscus gossypinus)
Golden mouse (Peromyscus nuttalli)
Hispid cotton rat (Sigmodon hispidus)
Pine vole (Microtus pinetorum)
Muskrat (Ondatra zibethicus)
Norway rat (Rattus norvegicus)
Black rat (Rattus rattus)
House mouse (Mus musculus)
Red fox (Vulpes fulva)
Gray fox (Urocyon cinereoargenteus)
Black bear (Euarctos americanus)
Raccoon (Procyon lotor)
Long-tailed weasel (Mustela frenata)
Mink (Mustela vison)
Striped skunk (Spilogale putorius)
River otter (Lutra canadensis)
Bobcat (Lynx rufus)
White-tailed deer (Odocoileus virginianus)

Question 2.7b

Provide a copy of the student report on Lake Julian.

Response

The student report was provided directly to Dr. Mike Novick, Argonne National Laboratory. (Letter dated December 19, 1972).

Question 2.7c

Provide information on fish stocking programs with threadfin shad and striped bass-white bass hybrids since 1968.

Response

The fish stocking program at Lake Robinson is being conducted by the Fish Division of the South Carolina Wildlife Resources Department. In 1973, some 800,000 two-day old hybrid fry were stocked in Lake Robinson bringing the total number (since 1967) to 1,650,000.

During 1971, 2,500 threadfin shad were stocked. Plans were to stock threadfin shad again in December, 1972; however, they were not available at this time. According to Mr. Logan of the South Carolina Wildlife Resources Department threadfin shad will be stocked as they become available, probably in January or February 1973. Also, a sampling program was performed in the Lake during December, 1972, and no hybrid striped bass x white bass or threadfin shad were collected.

3.3 Plant Water Use

Question 3.3 -

Provide information on the qualitative use of water at the plant with indication of flows to and from each use category during the various conditions of reactor operation and shutdown. Indicate the quality of the water from each system before it enters the genera water discharge system as well as that of the general discharge system. Include water for sanitary as well as for industrial purposes.

Response

In the operation o. Robinson Unit No. 2, some chemical wastes are produced in the processing of high quality feedwater and in the operation of certain auxiliary systems. These chemicals include corrosion products such as iron and copper, corrosion inhibitors such as potassium chromate and sodium phosphate; acids and bases such as boric acid, sulfuric acid, sodium hydroxide, lithium hydroxide (Li_7OH) and small quantities of various chemicals used in the plant laboratory.

Figure 3.3-1 is a functional flow diagram of water uses at H. B. Robins Unit No. 2. The following paragraphs discuss the water uses and chemic s outlined in Figure 3.3-1. Table s3.3-1 summarizes the plant water use.

Line A.

The fire water system is supplied by two pumps. The fire water pump and the emergency fire water pump each have a capacity to supply water at a rate of 2500 gpm for a combined maximum capacity of 5000 gpm. Under normal plant operation, no water is used and no chemicals are introduced into the water.

Line B.

The condenser water is supplied by the circulating water pumps at a rate of 482,100 gpm. The water flows through the condenser tubes for cooling of the exhaust steam leaving the turbines. In the cooling process, there is an 18 F temperature rise in the water being discharged into the canal.

A chlorinating system capability is provided for use when necessary to inhibit the growth of algae in the condenser and the circulating water tunnels. This system uses sodium hypochlorite and would normally be operated for two 30-minute cycles per day during June, July, and August. Chlorine residuals in the water leaving the condenser will be controlled so that concentration would not exceed more thar 0.5 ppm. The residual is further dissipated in the discharge canal so that no more than a trace of chlorine is in the lake. Minute particles of corroded materials may also be passed into the lake due to corrosion of the circulating water system materials. To date, the chlorinating system has not been utilized for H. B. Robinson Unit No. 2. If it is ever deemed necessary, it would be operated in accordance with the above description.

Line C.

The service water is supplied by the service water pumps with a design capacity of 32,000 gpm. Under normal plant operation, 24,000 gpm is suppled by three of the service water pumps. The service water is used to supply the water needed to cool the component cooling water and a 14 F temperature rise occurs before the water is discharged to the canal. The system also incorporates the chlorinating system explained in the preceding paragraph.

Line D_1

The water uses under the miscellaneous section consist of such systems as the water coolers, lab sinks, washing of machinery, and emergency seal water at the intake structure. This water consists of well water and is not processed but sent directly to the storm drains.

Line D_2

The Robinson sewage and sanitary waste treatment system consists of a 3000 gpd septic tank, sand filter, and chlorine contact chamber. The wastes are collected and pumped to the septic tank where the solids are allowed to settle and undergo aerobic digestion. The septic tank produces an odorless liquid effluent and a granular sludge which is accumulated in the tank. The sludge is periodically removed for offsite disposal in accordance with state and local regulations. The liquid effluent from the septic tank drains from the tank through the sand filter and is collected and chlorinated before being discharged into the condenser cooling water system canal. The removal of solids and reduction in BOD, as a result of this treatment, is in excess of 90%. Permit No. 216, issued by the South Carolina Pollution Control Authority on May 15, 1961, covers the operation of the sewage treatment system and the discharge of its effluent into the condenser cooling water system.

Lines E_1 and E_2

The turbine and reactor cycles are supplied by well water that has been demineralized by the makeup water demineralizers. Under normal plant operation, some leakage of reactor secondary coolant and turbine coolant water escapes from the system through valve seals, packing, and pump seals. Steam generator blowdown is processed through the liquid radioactive waste processing system or discharged from a flash tank to the circulating water system in the absence of radioactive contamination. The steam generator blowdown water also contains some phosphates which are used to control scaling. Because of the extremely small quantities of phosphate that are discharged and the natural low levels of phosphate in the lake water supply, this disposal does not have any discernible effect on the environment. Some potassium chromate waste is evolved through valve leakage and maintenance activities. This waste is collected and processed for disposal through Line E_2. The release of chromate through Line E_2 is covered by liquid waste disposal Permit No. 1732, issued November 25, 1970, by the South Carolina Pollution Control Authority and limits the amount of chromates in the lake to 50 ppb and is not in excess of the U. S. Public Standards for drinking water.

The liquid radioactive waste treatment consists of a system capable of collecting, storing, and processing radioactive or potentially radioactive waste (gases, liquids, and solids) for offsite shipment or disposal. The waste processing system enables the plant to comply with all applicable regulations for the release of radioactivity to the environment.

Radioactive fluids entering the waste processing system are collected in tanks until determination of subsequent treatment can be made. They are analyzed to determine the quantity of radioactivity, with periodic isotopic identification and then processed. There is no recycle of liquids in the CVCS System. All liquids are processed through the boric acid evaporator and discharged to the circulating water system. Most of the liquids (85 percent) which are shown as discharged through E_2 would come from the CVCS. Processed waste from waste disposal is discharged through a monitored line into the circulating water discharge system.

Line F

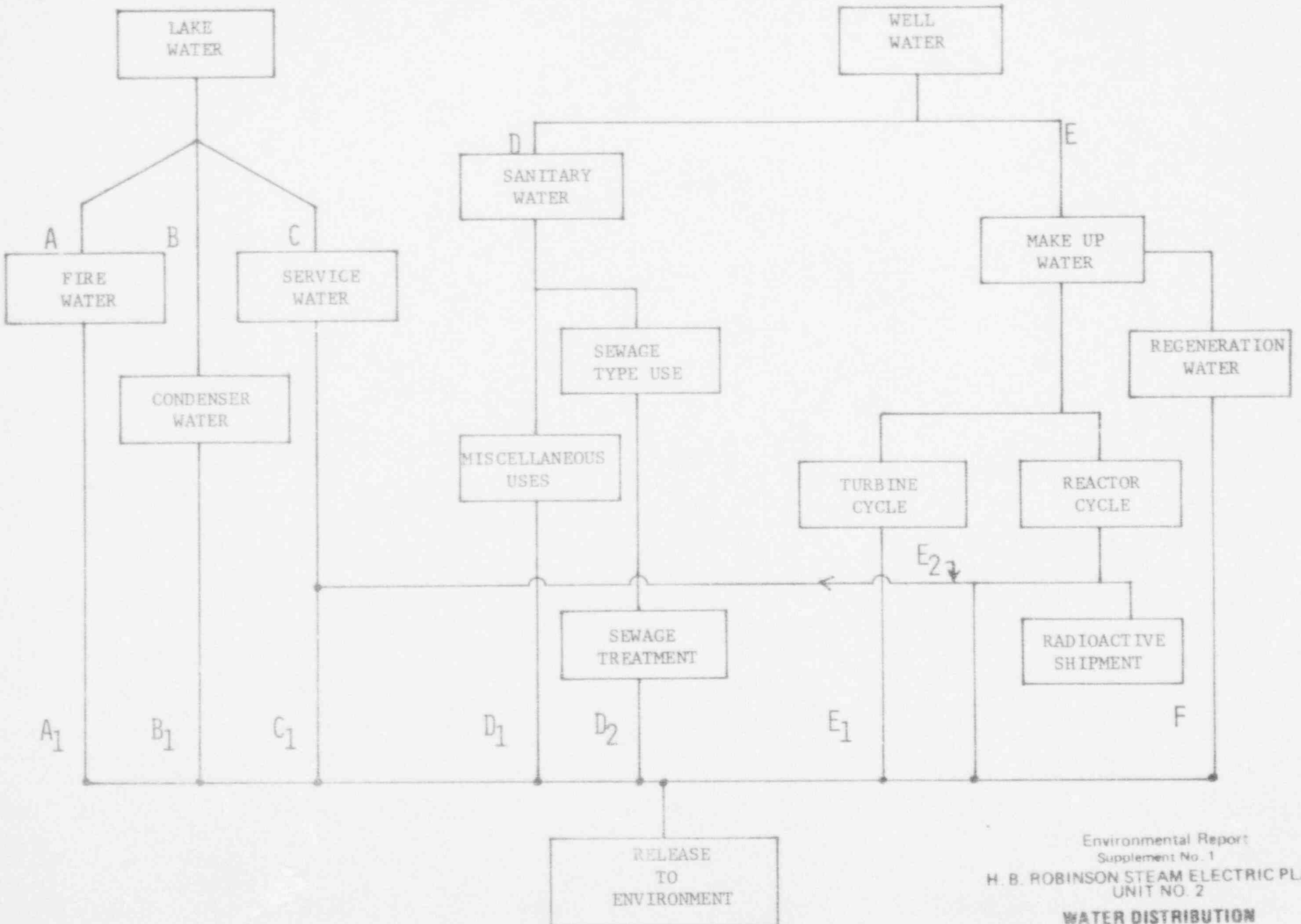
The regeneration water contains sodium hydroxide (NaOH) and sulfuric acid (H_2SO_4) which are used to regenerate the makeup water demineralizer. After use, these solutions are neutralized and subsequently discharged into the service water system where dilution of the mineral water can take place before entering the lake.

TABLE s3.3-1

WATER USAGE DATA

Line*	Design Capacity	Normal Use
A	5,000 gpm	0
B	482,100 gpm	482,100 gpm
C	32,000 gpm	24,000 gpm
D	3,538 gpd	3,538 gpd
E	250 gpm	10 pm
A_1	5,000 gpm	0
B_1	482,100 gpm	482,100 gpm
C_1	32,000 gpm	24,000 pm
D_1	538 gpd	538 gpd
D_2	3,000 gpd	3,000 gpd
E_1	25,000 gpd	7,382 gpd
E_2	5,750 gpd	4,673 gpd
F	75 gpm	710 gpd

*These lines are shown on Figure 3.3-1 of Supplement No. 1.



Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2

WATER DISTRIBUTION
Figure 3.3–1

3.4 Heat Dissipation System

Question 3.4a

Provide information on the design of the intake and outfall structures for the condenser cooling water system. Include design of screens, trash handling systems, canal intersection at lake, etc. Provide necessary sketches or drawings which describe these.

Response

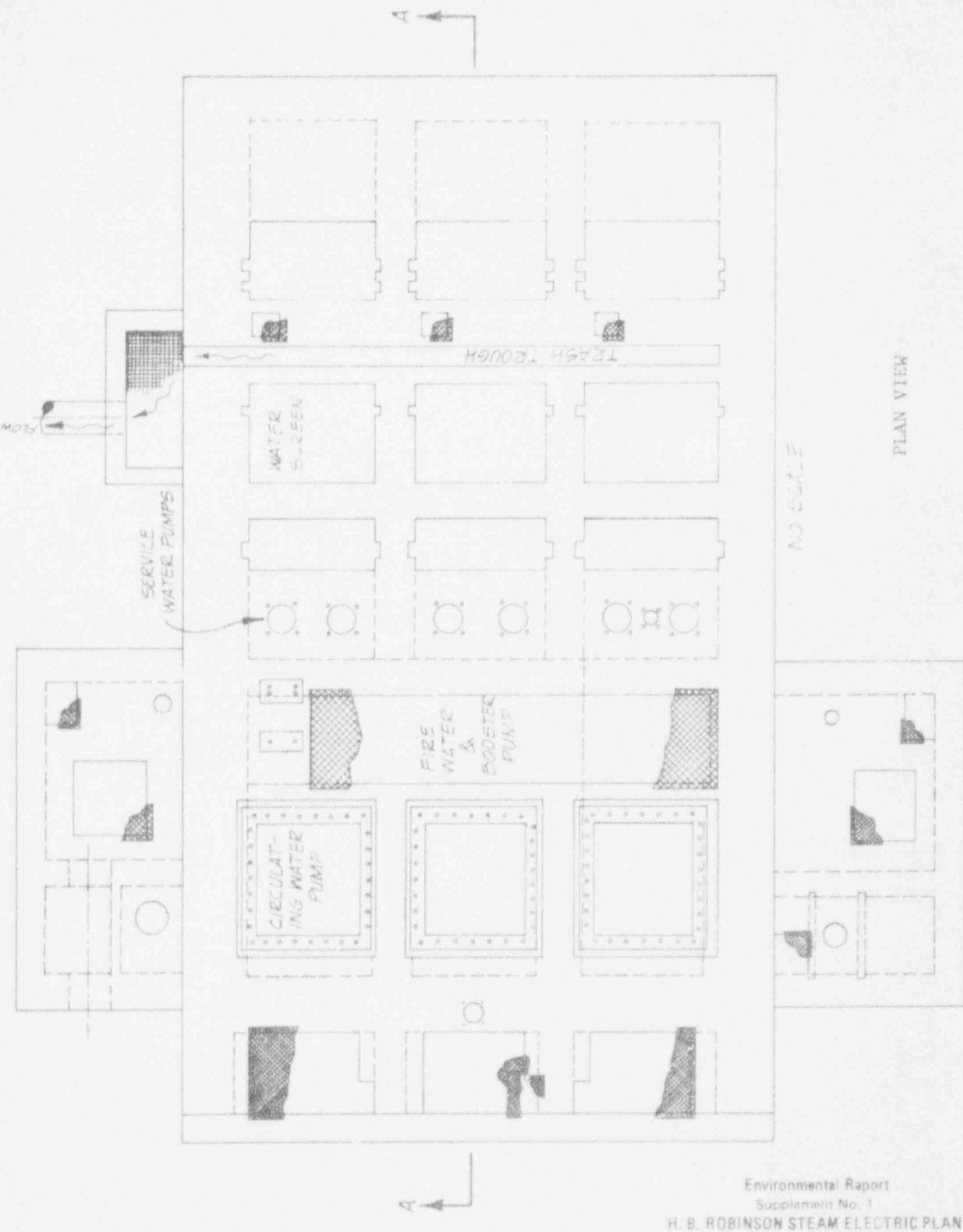
The intake structure is a reinforced concrete structure that contains the circulating water pumps which provide water to the condenser cooling system. The structure also contains traveling water screens. Slots are installed in the concrete for the future installation of stop logs, fine log screens, and coarse log screens. Figures 3.4a-1 and 3.4a-1a show the intake structure and a cross section of the structure.

The sealwell structure is made from reinforced concrete and is designed to reduce the velocity of the water entering the discharge canal. The structure combines the use of splitter walls and vanes to change the direction and reduce the velocity of the water to prevent erosion and rapid flowing water into the discharge canal. Figures 3.4a-2 and 3.4a-2a show the sealwell structure.

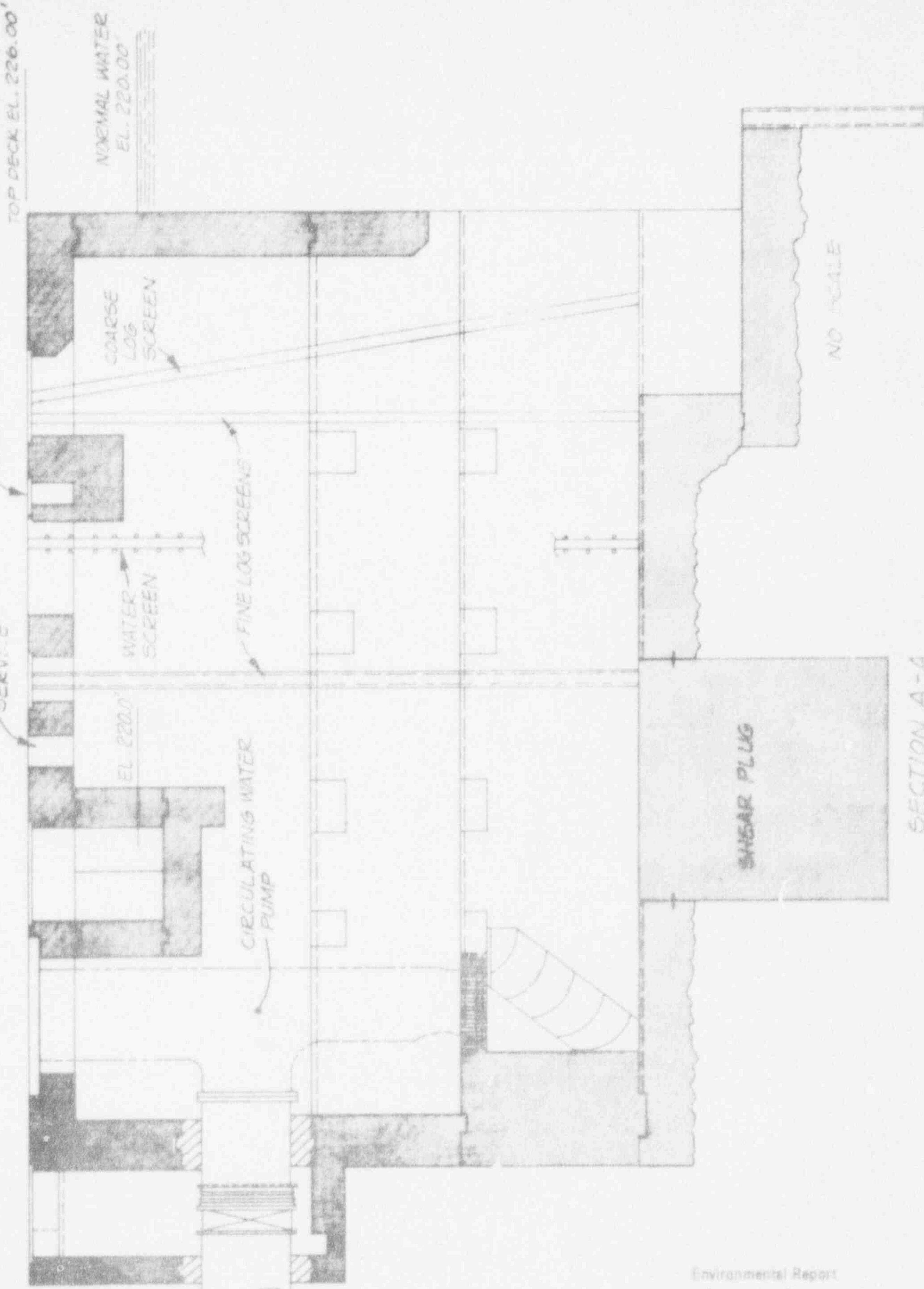
The traveling water screens consist of a motor and chain which drive the continuous screens that are cleaned by spraying water at 50 psi through them. All trash removed from the screens is washed through a concrete trough to a junction and then through a pipe to the storm drains. The traveling screens are shown on Figure 3.4a-3.

The intersection of the discharge canal and the lake is a weir made from reinforced concrete and is designed to prevent erosion of the canal sides and bottom. The intersection is shown on Figures 3.4a-4 and 3.4a-4a.

The discharge canal, as shown on Figure 3.4a-5 is 115 feet wide, 16 feet 6 inches deep and the normal water depth is 13 feet.



Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
INTAKE STRUCTURE
Figure 3.4 a–1



Environmental Report

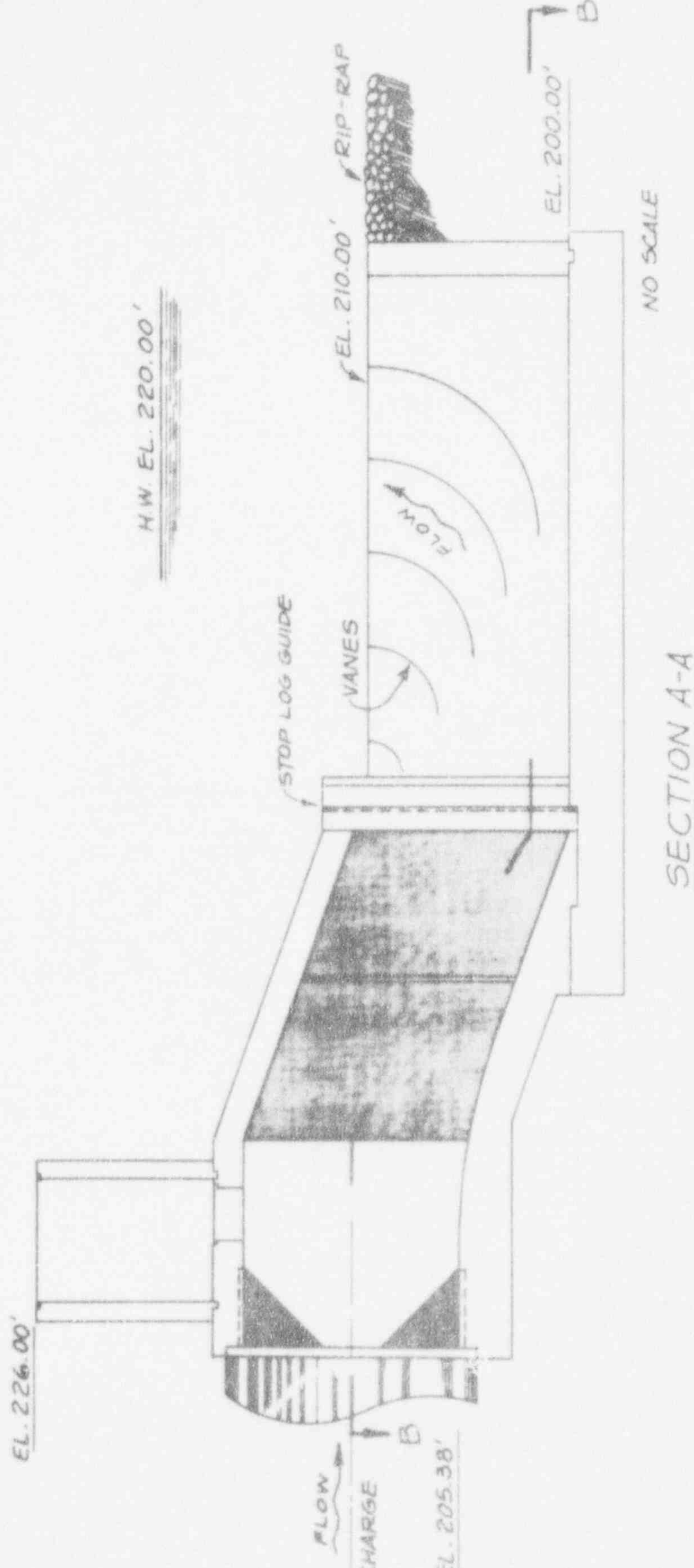
Supplement No. 1

H. B. ROBINSON STEAM ELECTRIC PLANT

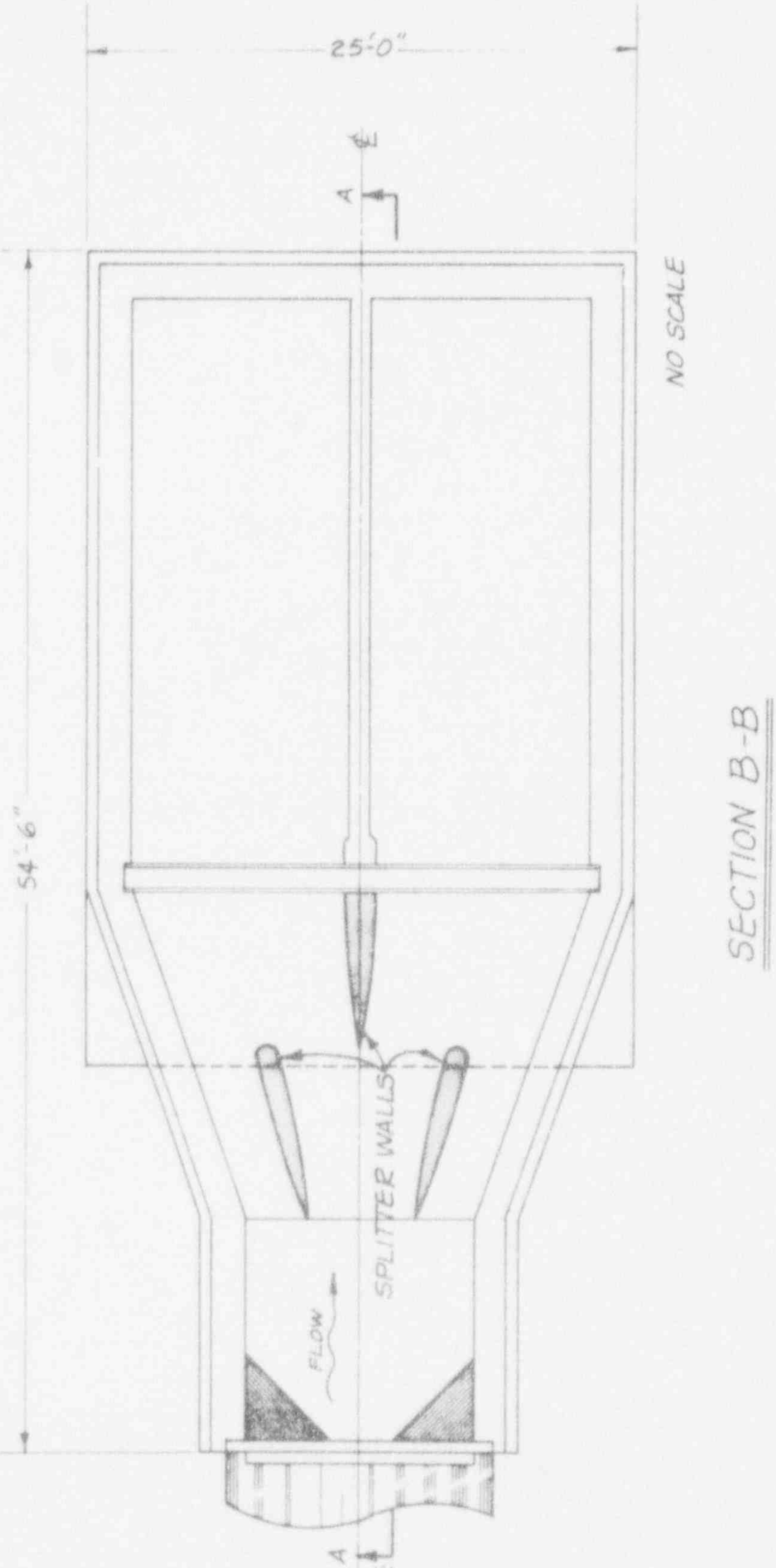
UNIT NO. 2

INTAKE STRUCTURE

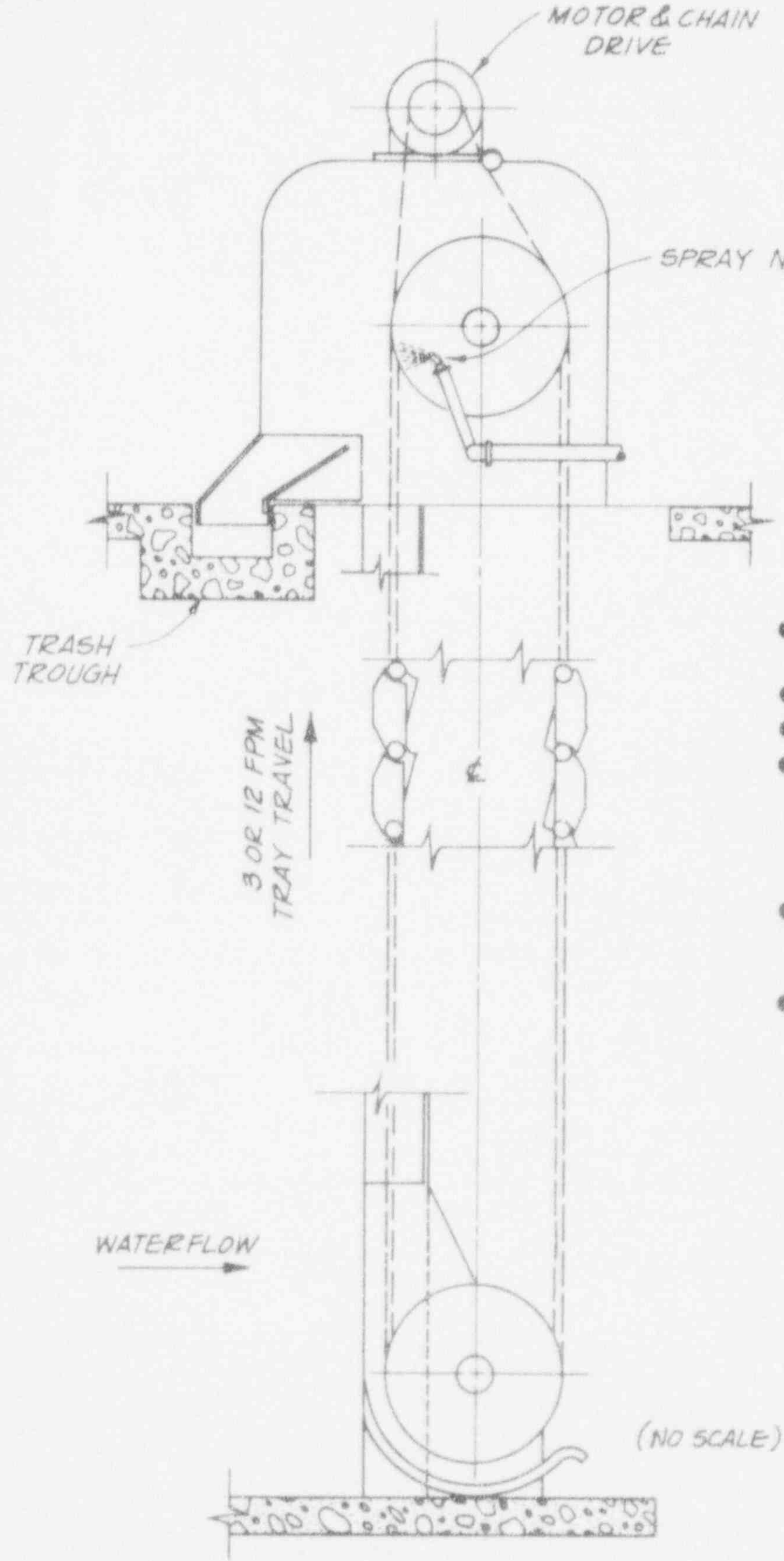
Figure 3.4 a–1a



Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
SEALWELL STRUCTURE
Figure 3.4a–2



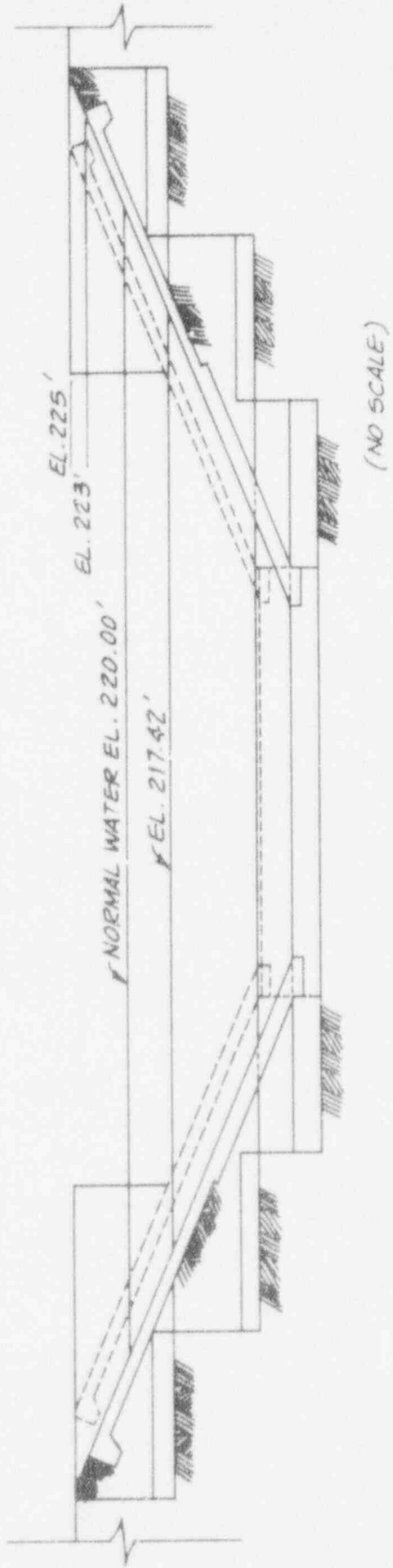
Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
SEALWELL STRUCTURE
Figure 3.4a-2a



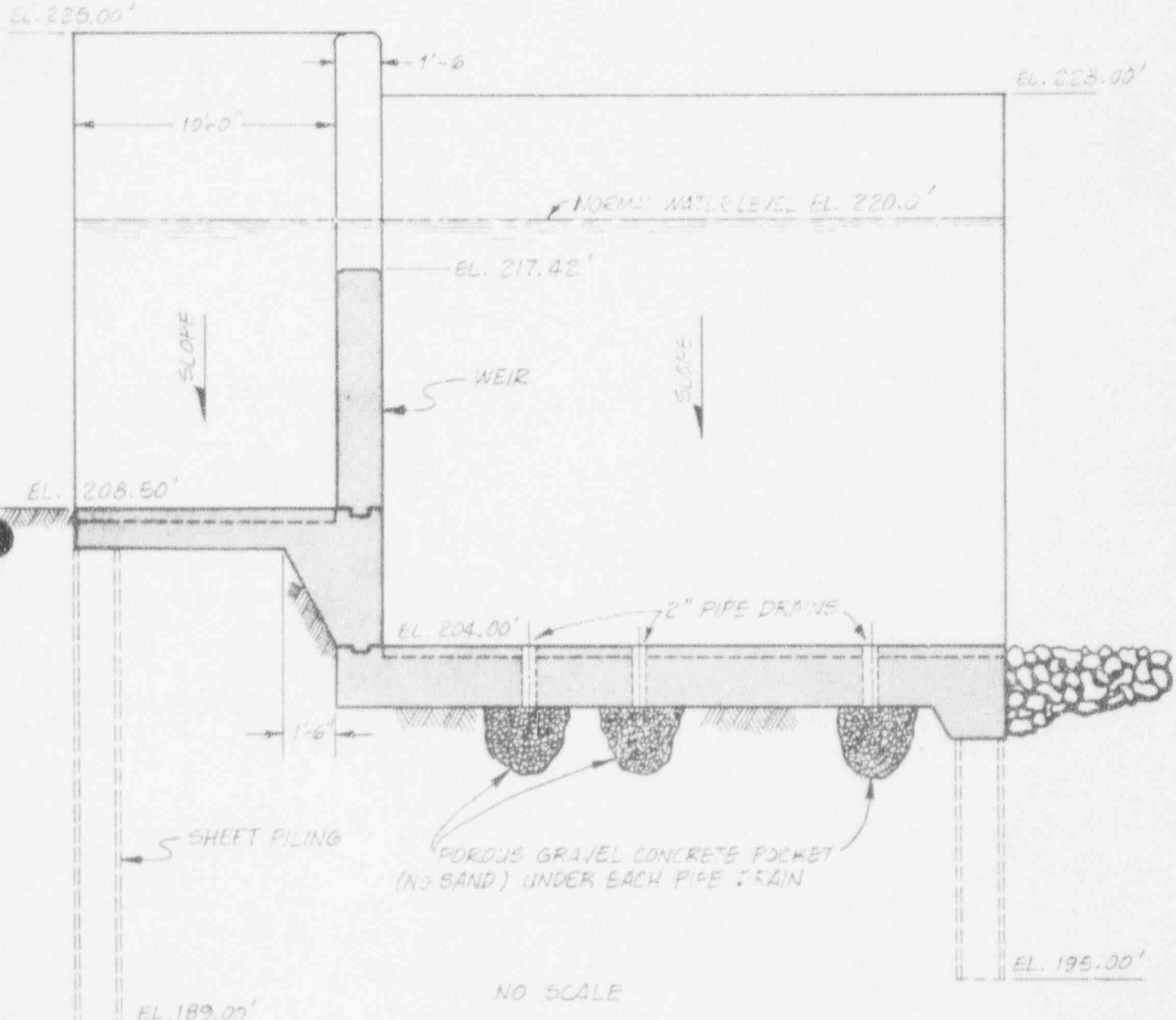
NOTES:

- MODEL 45A SCREEN, 41'-0" SHAFT CENTERS, 10'-0" WIDE TRAYS
- NUMBER OF UNITS — 3
- WEIGHT PER UNIT — 28,735 LBS.
- CAPACITY — WATER SCREEN WILL OPERATE AT 162,900 GPM WITH NORMAL WATER DEPTH AT 34'-0" AT A VELOCITY OF 1.82 FPS THRU 100% CLEAN SCREEN CLOTH
- SPRAY WATER — 248 GPM AT A PRESSURE OF 50 PSI AT THE SPRAY NOZZLES
- SPRAY NOZZLES — 14 BRASS NON-CLOGGING NOZZLES

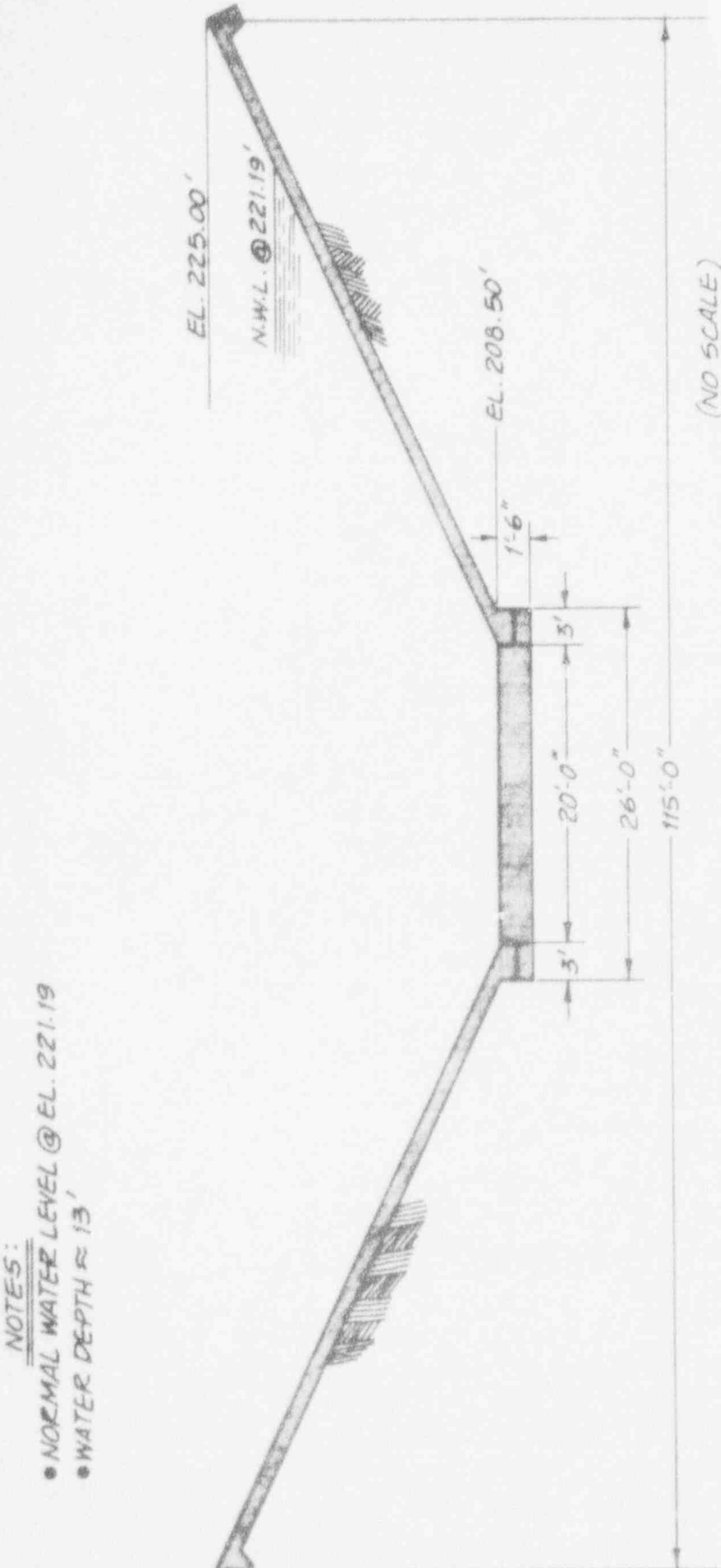
Environmental Report
Supplemental No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
WATER SCREENS
Figure 3.4 a–3



Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
DISCHARGE CANAL INTERSECTION
WITH LAKE
Figure 3.4 a–4



Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
DISCHARGE CANAL INTERSECTION WITH LAKE
Figure 3.4 a–4e



Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
DISCHARGE CANAL
Figure 3.4a-5

Question 3.4.b

Provide information on flow velocity and transit time of water in the discharge canal during full power operation of H. B. Robinson Units 1 and 2.

Response

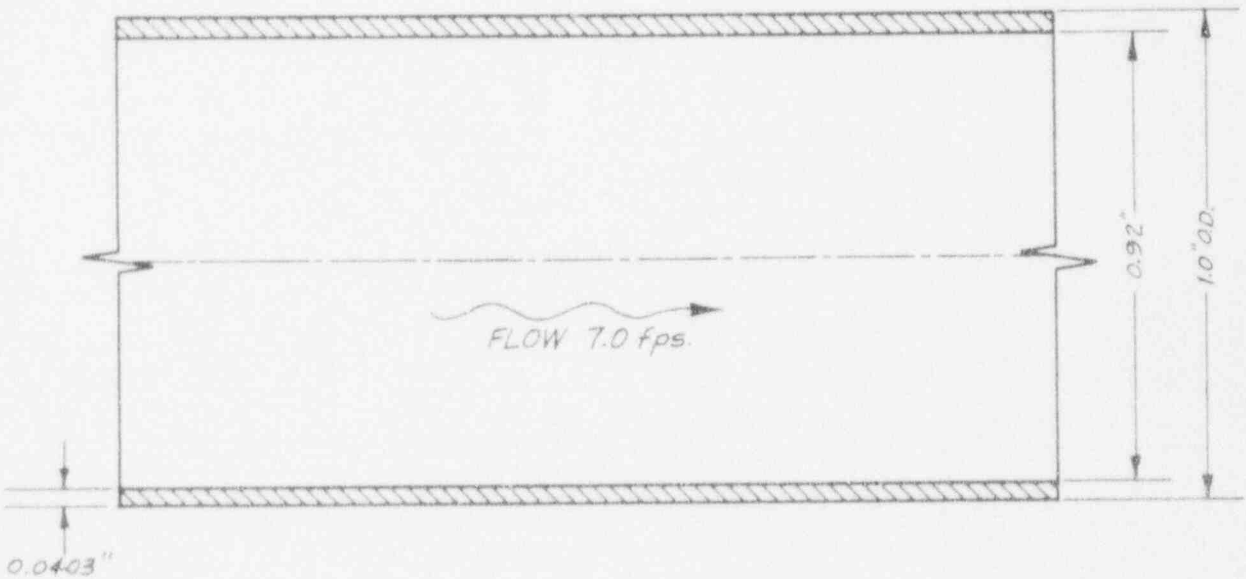
During full power operation of H. B. Robinson Units 1 and 2, the flow velocity in the discharge canal is approximately 1.75 feet per second and the transit time of water in the discharge canal is approximately 3.5 hours.

Question 3.4C

Provide information on inside dimension of condenser tubes and water velocity within them.

Response

The condenser tubes have an inside diameter of 0.92 inches and a water velocity of 7.0 fps. Figure 3.4c-1 shows a cross-section of a condenser tube.



Condenser tube length = 50 feet

Environmental Report
Supplement No. 1
H. B. ROBINSON STEAM ELECTRIC PLANT
UNIT NO. 2
CONDENSER TUBE
Figure 3.4c-1

3.5 Radwaste Systems

Question 3.5a

Furnish copies of reports giving monthly releases of radioisotopes in liquid and gaseous effluents. Give isotopes breakdown if available.

Response

Table s3.5a-1 is a copy of radioactivity released in liquid and gaseous effluents with isotopic breakdown for the period of January 1, 1972, through June 30, 1972. Monthly effluent summaries are included in the four Operating Reports for the periods September 20, 1970, to March 20, 1971, March 20, 1971, through September 30, 1971, and October 1, 1971, through March 31, 1972 and April 1, 1972 through September 30, 1972. These reports have been submitted to the AEC. During the period covered by these four Operating Reports, radioactive effluents were low and isotopic identification was not required by the Tech Specs in the Operating License. Consequently, no data is available regarding the isotopic composition of these effluents.

Facility HB Robinson, Unit 2 Docket 50-261 Year 1972

I. LIQUID RELEASES

	Units	Jan.	Feb.	Mar.	Apr.	May	June
1. Gross Radioactivity (β,γ)							
a) Total release	Curies	0.0716	0.0309	0.0549	0.0234	0.0721	0.0586
b) Average concentration released (24 hours)	μCi/ml	7.35×10^{-9}	5.45×10^{-9}	9.04×10^{-9}	2.67×10^{-9}	7.60×10^{-9}	4.27×10^{-9}
c) Maximum concentration released (24 hours)	μCi/ml	4.72×10^{-8}	3.50×10^{-8}	3.64×10^{-8}	1.69×10^{-8}	3.88×10^{-7}	1.26×10^{-8}
2. Tritium							
a) Total release	Curies	38.067	32.339	29.832	20.636	65.172	19.724
b) Average concentration released (24 hours)	μCi/ml	3.91×10^{-6}	5.70×10^{-6}	4.91×10^{-6}	1.83×10^{-6}	6.86×10^{-6}	1.44×10^{-6}
3. Dissolved noble gases							
a) Total release	Curies	$0 \pm 1.36 \times 10^{-7}$	→	→	→	→	→
b) Average concentration released	μCi/ml						
4. Gross Alpha Radioactivity							
a) Total release	Curies	$0 \pm 4.18 \times 10^{-7}$	→	→	→	→	→
b) Average concentration released	μCi/ml						
5. Volume of liquid waste to discharge canal	liters	1.15×10^{6}	2.62×10^{5}	2.65×10^{5}	2.58×10^{5}	1.24×10^{6}	1.46×10^{6}
6. Volume of dilution water	liters	9.74×10^{9}	5.67×10^{9}	6.07×10^{9}	1.13×10^{10}	9.50×10^{9}	1.37×10^{10}
7. Isotopes Released	Curies						
Ba-La-140		$0 \pm 1.0 \times 10^{-7}$	→	→	→	→	→
Sr-89		$0 \pm 1.17 \times 10^{-7}$	→	→	→	→	→
I-131		0.00165	0.00033	0.00063	0.00083	0.00285	0.00138
Xe-133		$0 \pm 9.53 \times 10^{-7}$	→	→	→	→	→
Xe-135		$0 \pm 1.36 \times 10^{-7}$	→	→	→	→	→
Cs-137		$0 \pm 2.79 \times 10^{-7}$	→	→	→	→	→
Cs-134		$0 \pm 1.04 \times 10^{-6}$	→	→	→	→	→
Co-60		0.01760	0.00611	0.01085	0.00772	0.01634	0.00861
Co-58		0.03732	0.01681	0.02985	0.01014	0.03835	0.03727
Cr-51		$0 \pm 2.21 \times 10^{-6}$	→	→	→	→	→
Mn-54		0.01503	0.00703	0.01248	0.00471	0.01457	0.01129
Zn-65		$0 \pm 7.8 \times 10^{-7}$	→	→	→	→	→
Sr-90		$0 \pm 1.17 \times 10^{-7}$	→	→	→	→	→
Others (specify)							
8. Percent of technical specification limit for total activity released	%	8.88	4.10	6.80	3.00	8.94	7.51

H. B. Robinson
Unit No. 2
TABLE s3.5a-1
RADIOACTIVITY RELEASES

TABLE s3.5a-1 (Cont'd)

AIRBORNE RELEASES

	Units	Jan.	Feb.	Mar.	Apr.	May	June
1. Total noble gases	Curies	0.0020	0.0013	0.1532	0.2192	15.685	0.2191
2. Total halogens	Curies	0 ± 7.95×10^{-10}					→
3. Total particulate gross radioactivity (β, γ)	Curies	0	0	0	0	0.0020	0
4. Total tritium	Curies	0.5931	0.0068	0.0397	0.1247	4.5604	0.0135
5. Total particulate gross alpha radioactivity	Curies	0 ± 5.4×10^{-10}					→
6. Maximum noble gas release rate	μCi/sec	0.210	0.163	100.6	5.587	505.3	6.723
7. Percent of applicable limit for:							
a. noble gases	%	5.06×10^{-6}	3.53×10^{-6}	3.81×10^{-4}	5.62×10^{-4}	[illegible] $\times 10^{-2}$	5.65×10^{-4}
b. halogens	%	0	0	0	0	0	0
c. particulates	%	0	0	0	0	0.25	0
8. Isotope released:	Curies						
Particulates							
Cs-137		0 ± 1.23×10^{-13}					→
Ba-La-140		0 ± 3.61×10^{-13}					→
Sr-90		0 ± 4.79×10^{-14}					→
Cs-134		0 ± 4.86×10^{-13}					→
Sr-89		0 ± 4.79×10^{-14}					→
Halogens							
I-131		0 ± 7.95×10^{-10}					→
I-133		0 ± 1.06×10^{-9}					→
I-135		0 ± 4.08×10^{-9}					→
Gases							
Kr-85		0 ± 8.0×10^{-5}					→
Xe-133		0.00189	0.00123	0.14252	0.20289	14.585	0.20380
Kr-88		0 ± 5.2×10^{-7}					→
Kr-87		0 ± 2.6×10^{-7}					→
Kr-85m		0 ± 2.0×10^{-7}					→
Xe-138		0 ± 1.7×10^{-7}					→
Xe-135m		0 ± 4.3×10^{-7}					→
Xe-135		0.00013	0.00008	0.00965	0.01374	0.98803	0.01351
Ar-41		0 ± 7.0×10^{-7}					→
Others as appropriate (specify)							
Co-58		0	0	0	0	0.00155	0
Mn-54		0	0	0	0	0.00048	0

Question 3.5b

Furnish distances from plant to site boundary, nearest occupied dwelling, and nearest herd ($\geq$ 1 cow) in the 16 principal compass directions. Describe milk sampling program.

Response

Distances from the plant to the site boundary and nearest occupied dwelling are shown on Table s3.5b-1. As shown on this table, the nearest site boundary and nearest occupied dwelling are south of the plant, 1400 and 1500 feet respectively.

The nearest dairy farms, presently in operation, are seven miles to the east and nine miles to the southwest of the site. There are no lactating cows within a two-mile radius of the site [1]. Since the nearest dairy herd is seven miles from the plant, the radiological environmental program does not include milk sampling.

(1) Personal conversation with Mr. Spivey Rowell, local dairy inspector for South Carolina State Board of Health and personal observation of plant employees.

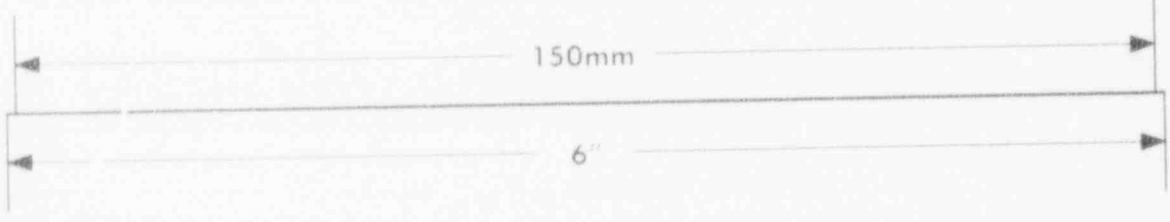
Table s3.5b-1

Distances from H. B. Robinson Plant

Sector	Nearest Site Boundary (ft.)	Nearest Dwelling (ft.)
N	13,750	15,250
NNE	6,500	8,250
NE	5,750	6,000
ENE	4,500	4,750
E	4,500	4,750
ESE	2,000	3,250
SE	1,600	5,000
SSE	1,600	1,750
S	1,400	1,500
SSW	2,000	2,150
SW	2,000	2,500
WSW	1,750	2,000
W	2,750	3,000
WNW	3,250	3,500
NW	6,250	7,000
NNW	7,500	15,000

1

IMAGE EVALUATION
TEST TARGET (MT-3)



1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

Question 3.5c

Describe operating procedures that gover⁻ use of extended treatment system for exhaust air from ⁻elected areas in the auxiliary building.

Response

The extended treatment system (HVE-5) for exhaust air from selected areas in the Auxiliary Building is designed to exhaust air from areas within the Auxiliary Building where potential iodine activity could exist through HEPA and charcoal filters before entering the plant vent. The system is operated whenever iodine activity is present in any of the areas served by the system as determined by air sampling. In addition to the above requirement, this exhaust system would be utilized during the recirculation phase of the safety injection system.

Question 3.5d

Response to question 17 for Source Term Data (Jetter J. A. Jones to E. J. Bloch, June 7, 1972) indicates that containment air is purged through HEPA filters. Figure 5.3.3-1 of the FSAR indicates no treatment of containment purge. Please reconcile the apparent discrepancy.

Response

Figure 5.3.3-1 of the FSAR is correct; containment purge does not pass through HEPA filters.

Question 3.5e

Furnish details about the history of containment purges. Also furnish information from plant records regarding radiation levels (direct and air concentrations) measured in the containment building. To what extent are the recirculation filters operated.

Response

The containment is purged prior to and during maintenance in the containment as required to reduce temperature and airborne activity. After the initial startup period, it was anticipated that containment purges would exceed four times per year. Also, the containment is purged from 0.5 to three minutes each month in order to perform the periodic test of the containment isolation system.

From January 1, 1972 through October 31, 1972 there were a total of seven containment purges lasting from a few minutes to several hours and a total of 11 purges for periodic testing which were typically of one minute duration. Total activity released during these purges were 22 curies of gaseous activity, 0.83 millicuries of particulate activity, 1.56 curies of tritium activity, and 0.039 curies of gross iodine activity.

Radiation levels in the containment are monitored using area monitoring badges (TLD), as well as other areas within the plant. Results of these area monitoring badges for a six-month period are shown on Table s3.5e-1.

At the present time, the recirculation filters in the Containment Building are run continuously. These recirculation filters contain both HEPA and charcoal filters.

Table s3.5e-1
MONITOR BADGE RESULTS *

Badge No.	Location	1972					
		April	May	June	July	August	Sept.
2001	North Fence	0	0	0	0	20	0
2002	South Fence	0	0	0	0	0	0
2003	East Fence	0	0	0	0	0	0
2004	West Fence	10	0	0	10	0	0
2005	Top Unit No.1	0	0	0	10	0	0
2006	Bottom Unit No.1	0	20	0	10	10	0
2007	Maintenance Shop	20	10	0	0	10	0
2008	Hot Lab.	10	70	120	50	110	60
2009	Charging Pump Rm.	490	2720	4620	3110	5010	1880
2010	Demineralizer Rm.	670	600	2200	1580	3350	1360
2011	Waste Evap. Rm.	570	10350	Lost	11440	8210	5550
2012	Boric Acid Evap. Rm.	480	1300	1450	2360	2870	930
2013	Control Rm.	0	0	0	0	0	0
2014	C. V. On Pressurizer Cubical	13720	820	13810	13170	23830	14930
2015	C. V. Polar Cran Wall, Across from Reg Hx.	0	4530	11820	10020	12400	4200
2016	Volume Control Tank Rm.	10370	5370	47710	26450	58000	47690
2017	Boron Analyzer Rm.	280	280	320	540	1350	350
2018	Waste Disposal System Boric Acid Panel	0	50	180	80	120	60
2019	C. V. Seal Table Rm., on 2nd Elev.	13350	3800	59160	29430	98570	43580
2020	Spent Fuel Storage Area	10	0	20	0	20	0
2021	New Fuel Building	460	330	510	720	2790	100
2022	H. P. Office	0	90	70	10	40	0
2023	Hot Machine Shop	10	50	110	110	140	70

*All Readings Are In MREM

Question 3.5f

Describe the plant history of primary coolant leakage (water, steam) to the containment and elsewhere. Describe its collection and treatment.

Response

Total primary coolant leakage is determined daily at the Robinson Plant. During the first 10 months of 1972, this leakage ranged from 0.1 gpm to 0.6 gpm with an average of 0.3 gpm. At least 50 percent of this leakage can be associated with leakage of the charging pump seals. The leakage from the charging pumps is collected and returned to the CVCS holdup tanks. This leakage is subsequently processed through the boric acid evaporators. Of the total leakage, another 30 percent would be leakage in the Auxiliary Building, most of which would be associated with sampling. Leakage in the Auxiliary Building is collected in the waste holdup tank and is processed through the waste evaporator prior to discharge. Leakage to the Containment Building accounts for the remaining 20 percent. Leakage in the containment is collected in the reactor coolant drain tank which is processed through the CVCS system or the building sump which is processed through the waste processing system.

Question 3.5g

Describe process monitoring on release line from CVCS monitor tanks.

Response

The CVCS monitor tanks are discharged through the same release line as the waste condensate tanks. This line is monitored by the Waste Disposal System Liquid Effluent Monitor (R-18) as described in Section 11.2.3 of the FSAR.

Question 3.5h

Furnish the following information about process radiation monitoring of gas and liquid effluent streams:

1. Sensitivity limits in terms of expected radionuclide mix;
2. Trip levels and alarm setpoints and basis for setting;
3. Operation response to alarms or trips;
4. Any changes (actual or expected) from monitors described in Section 11 of the FSAR.

Response

1. The radiation monitoring system is described in detail in Section 11.2.3 of the FSAR. Included in the description of the instrumentation are sensitivity limits of the individual instruments. Sensitivity limits are based on an individual isotope rather than an isotopic mix since the radionuclide mix is variable and is controlled by many factors, such as percent failed fuel and/or primary system leakage.

2. Trip levels and alarm set points and the basis for these settings are as follows:

R-11 Containment or Plant Vent Air Particulate Monitor

This monitor measures the air particulate radioactivity in the containment with an additional function to ensure that the release rate during containment purge does not exceed 10CFR20 and technical specifications. The alarm closes the purge valves, terminating the purge. The alarm setpoint, as calculated below, is to be used during containment purging and does not have any real basis at other times. The alarm point is based on sampling from the containment atmosphere during the purging operation. During times other than purging, the alarm should be set at MPC for unidentified activity in a restricted area of 3×10^{-9} µci/cc. The alarm setpoint is calculated using the following assumptions:

(1) Containment purge rate = 35,000 cfm (1.65×10^{7} cc/sec)

(2) MPC for particulates in an unrestricted area $= 1.43 \times 10^{-13}$ µci/cc (contains the 1/700 factor required by the technical specifications).

(3) Annual average $X/Q = 2 \times 10^{-5}$ sec/m^3

(4) Setpoint is calculated as follows:

$$\frac{1.43 \times 10^{-13}\ ci/m^3 \times 10^6\ \mu ci/ci \times 60\ sec/min}{2 \times 10^{-5}\ sec/m^3 \times 3.5 \times 10^4\ ft^3/min \times 2.83 \times 10^4\ cc/ft^3} = 4.35 \times 10^{-10}\ \mu ci/cc$$

R-12 Containment or Plant Vent Gaseous Monitor

As with R-11, this monitor measures the gaseous activity in the Containment Building with the additional function to ensure the release rate of gaseous radioactivity during purging does not exceed limits set by the technical specifications and 10CFR20. The alarm closes the purge valves, terminating the purge. The alarm point, as calculated below, is to be used during containment purge. This monitor does not have the required sensitivity to monitor the containment atmosphere at the MPC level for A-41 in a restricted area (4×10^{-8} µci/cc). The alarm setpoint is calculated using the following assumptions:

(1) Containment purge rate = 35,000 cfm

(2) MPC for noble and activation gases of 3×10^{-8} µci/cc in an unrestricted area.

(3) Annual average $X/Q = 2 \times 10^{-5}$ sec/m^3

(4) Setpoint is calculated as follows:

$$\frac{3 \times 10^{-8}\ ci/m^3 \times 10^6\ \mu ci/ci \times 60\ sec/min}{2 \times 10^{-5}\ sec/m^3 \times 3.5 \times 10^4\ ft^3/min \times 2.83 \times 10^4\ cc/ft^3} = 9.1 \times 10^{-5}\ \mu ci/cc$$

R-14 Plant Vent Gas Monitor

The purpose of this monitor is to detect radioactive gases being discharged through the plant vent and to ensure that releases to the environment are maintained within limits. The alarm set point is calculated using the following assumptions:

(1) Annual average $X/Q = 2 \times 10^{-5}$ sec/m^3

(2) Flow rate up plant vent = 50,000 cfm

(3) MPC for gaseous activity at the site boundary = 3×10^{-8} μci/cc

(4) Setpoint is calculated as follows:

$$\frac{3 \times 10^{-8} \text{ ci/m}^3 \times 10^6 \text{ μci/ci} \times 60 \text{ sec/min}}{2 \times 10^{-5} \text{ sec/m}^3 \times 5 \times 10^4 \text{ ft}^3\text{/min} \times 2.83 \times 10^4 \text{ cc/ft}^3} = 6.4 \times 10^{-5} \text{ μci/cc}$$

R-15 Condenser Air Ejector Gas Monitor

The purpose of this monitor is to give an indication of primary-to-secondary leaks and ensure that (in such cases) limits at the plant boundary are not exceeded. An alarm setting equal to one percent of technical specifications should be used to give an early warning of leaks and to divert the effluent to the plant vent for iodine and particulate monitoring as well as gaseous monitoring. The setpoint is calculated using the following assumptions:

(1) Annual average $X/Q = 2 \times 10^{-5}$ sec/m^3

(2) MPC for gaseous activity = 3×10^{-8} μci/cc

(3) Exhaust rate from air ejector = 45 cfm

(4) Setpoint is calculated as follows:

$$\frac{3 \times 10^{-8}\ ci/m^3 \times 10^6\ \mu ci/ci \times 60\ sec/min \times .01}{2 \times 10^{-5}\ sec/m^3 \times 45\ ft^3/min \times 2.83 \times 10^4\ cc/ft^3} = 7.1 \times 10^{-4}\ \mu ci/cc$$

R-16 Containment Fan Cooling Water Monitor

The purpose of this monitor is to indicate a leak from the containment atmosphere to the containment fan cooling water during a loss-of-coolant accident. Upon indication of an alarm, each heat exchanger should be sampled to determine which unit is leaking. There is no real basis for determining a setpoint for this monitor. Westinghouse has shown a level of 5×10^{-5} μci/cc which is sufficiently above the maximum sensitivity of the instrument to avoid false alarms. The setpoint should be based on Co-60 activity. From the graph, the setpoint corresponding to Co-60 activity of 5×10^{-5} μci/cc is 3000 cpm.

R-17 Component Cooling Liquid Monitor

This monitor serves to indicate a leak from primary coolant to the component cooling system and closes the component cooling surge tank vent before technical specification offsite dose limits are exceeded. The primary function of this monitor should be to give early notification of a primary system leak to the component cooling system. A setting of 5×10^{-5} μci/cc should be adequate to do this and is sufficiently above the maximum sensitivity of the instrument. In addition, this will close the surge tank vent before reaching 10 percent of offsite release concentrations. This conclusion is arrived at by making the following conservative assumptions:

(1) Offsite MPC = 3×10^{-8} μci/cc

(2) There is an instantaneous surge volume in the component cooling system of 1000 gallons.

(3) Air activity in the vent is the same as the activity of the water.

(4) Annual average $X/Q = 2 \times 10^{-5}$ sec/m^3

$$\frac{3 \times 10^{-8} \text{ ci/m}^3 \times 10^6 \text{ µci/ci}}{2 \times 10^{-5} \text{ sec/m}^3 \times 3.75 \times 10^6 \text{ cc/sec}} = 4 \times 10^{-4} \text{ µci/cc}$$

R-18 Waste Disposal Liquid Effluent Monitor

The purpose of this monitor is to continuously monitor liquid releases from the plant and prevent the release of radioactive liquid waste by automatically closing the discharge valve when the alarm setpoint is reached. The controlling release limit is 26 millicuries per day to the lake of unidentified beta-gamma activity. If we continuously discharged so as to maintain a concentration of 1×10^{-8} µci/cc in the discharge canal with the dilution of all three circulating water pumps running, we would discharge a total of 26 millicuries in a 24-hour period. If, however, we administratively maintain this 26 millicurie per day limit, then we can go up to 1×10^{-7} µci/cc in the circulating water system with periodic releases. Assuming this MPC of 1×10^{-7} µci/cc in the circulating water canal, then the setpoint actually has two variables: (1) the liquid discharge flow rate and (2) the dilution water flow rate. In actual practice, this alarm point should be calculated and set for each release. A typical example would be a waste discharge flow rate of 20 gpm and a circulating water flow with one pump running of 175,000 gpm.

$$1 \times 10^{-7} \text{ µci/cc} \times \frac{175{,}000 \text{ gpm}}{20 \text{ gpm}} = 8.8 \times 10^{-4} \text{ µci/cc}$$

If, however, the waste discharge flow rate was 10 gpm and all three circulating water pumps were running with a dilution flow of 482,000 gpm, then the setpoint would be:

$$1 \times 10^{-7} \text{ µci/cc} \times \frac{482{,}000 \text{ gpm}}{10 \text{ gpm}} = 4.82 \times 10^{-3} \text{ µci/cc}$$

R-19 Steam Generator Liquid Sample Monitor

The purpose of this monitor is to indicate a primary to secondary leak and automatically close the blowdown and sample isolation valves and blowdown tank spray valve when the alarm level is reached. The setpoint should be calculated considering the limiting release to the lake in the blowdown liquid. Since it is desirable to detect leaks as early as possible, the monitor should be set at 10 percent of our liquid release limit. This will give an earlier indication of leaks and will limit releases to the lake to less than 10 percent. The following assumptions are used in the calculation:

(1) Alarm will be set at 10 percent of release limits. Since this is considered a continuous release, the limit will be 2.6 mci per day.

(2) Blowdown rate = 12.5 gpm per steam generator for a total of 37.5 gpm.

(3) Setpoint is calculated as follows:

$$\frac{2.6 \times 10^{4}\ \mu ci/day \times 0.1}{1.44 \times 10^{3}\ min/day \times 37.5\ gal/min \times 3.8 \times 10^{3}\ cc/gal} = 1.3 \times 10^{-5}\ \mu ci/cc$$

R-20 Fuel Handling Building Basement Exhaust Monitor

This monitor monitors the exhaust ventilation from the Fuel Handling Building basement and gives an indication of a leak in the gas decay or liquid holdup tanks. Upon reaching the alarm, this monitor will automatically shut down the ventilation system (HVE-14) in this area. This monitor should be set at 10 percent of the offsite MPC in order to get an early warning of leaks and have time to take corrective action before reaching limits. The setpoint is calculated using the following assumptions:

(1) MPC for gaseous activity at site boundary = 3×10^{-8} μci/cc

(2) Annual average $X/Q = 2 \times 10^{-5}$ sec/m^3

(3) Normal exhaust flow rate for HVE-14 = 10,200 cfm

(4) Setpoint is calculated as follows:

$$\frac{3 \times 10^{-8} \text{ ci/m}^3 \times 10^6 \text{ µci/ci} \times 0.1 \times 60 \text{ sec/min}}{2 \times 10^{-5} \text{ sec/m}^3 \times 1.02 \times 10^4 \text{ ft}^3\text{/min} \times 2.83 \times 10^4 \text{ cc/ft}^3} = 3.2 \times 10^{-5} \text{ µci/cc}$$

R-21 Fuel Handling Building Upper Level Exhaust Monitor

This monitor monitors the exhaust ventilation from the upper levels of the Fuel Handling Building, including the new and spent fuel storage areas. Upon reaching the alarm setpoint, the monitor will automatically shut down the ventilation system (HVE-15). As with R-20, this monitor should be set at 10 percent of MPC for the same reasons. The setpoint is calculated using the following assumptions:

(1) MPC for gaseous activity at site boundary - 3×10^{-8} µci/cc

(2) Annual average $X/Q = 2 \times 10^{-5}$ sec/m^3

(3) Normal Exhaust flow rate for HVE-15 = 13,400 cfm

(4) Setpoint is calculated as follows:

$$\frac{3 \times 10^{-8} \text{ ci/m}^3 \times 10^6 \text{ µci/ci} \times 0.1 \times 60 \text{ sec/min}}{2 \times 10^{-5} \text{ sec/m}^3 \times 13.4 \times 10^4 \text{ ft}^3\text{/min} \times 2.83 \times 10^4 \text{ cc/ft}^3} = 2.4 \times 10^{-5} \text{ µci/cc}$$

Plant Vent Iodine and Particulate Monitors

These monitors continuously sample the plant vent for particulate and iodine activity. The sample is drawn through a particulate filter paper, and then an activated charcoal cartridge. These filters are removed and counted in the counting room on a regular schedule and serve as the permanent record for offsite releases of particulate and iodine activity. The maximum permissible concentration of particulates or iodines in the stack is calculated using the following assumptions:

(1) MPC at the site boundary = 1.43×10^{-13} µci/cc for both iodine and particulate activity.

(2) Annual average X/Q = 2×10^{-5} sec/m^3

(3) Normal flow rate in plant vent = 50,000 cfm

$$\frac{1.43 \times 10^{-13} \text{ ci/m}^3 \times 10^6 \text{ µci/ci} \times 60 \text{ sec/min}}{2 \times 10^{-5} \text{ sec/m}^3 \times 5 \times 10^4 \text{ ft}^3\text{/min} \times 2.83 \times 10^4 \text{ cc/ft}^3} = 3 \times 10^{-10} \text{ µci/cc}$$

The particulate and iodine monitors should each be set to alarm at a level equivalent to sampling either particulate or iodine activity at the average annual release rate (3×10^{-10} µci/cc) for a period of eight hours - 480 min (480 MPC-min); and assuming a sampling flow rate of six cfs, the alarm point should be:

$$3 \times 10^{-10} \text{ µci/cc} \times 480 \text{ min} \times 6 \text{ ft}^3\text{/min} \times 2.83 \times 10^4 \text{ cc/ft}^3 \times 2.22 \times 10^6 \text{ dpm/µci} = 5.43 \times 10^4 \text{ dpm}$$

As shown above, the particulate and iodine monitors should be set to alarm when a total of 5.43×10^4 dpm has been collected on either filter. Corresponding alarm points for each monitor are as follows:

(1) The particulate monitor has a SC-2B beta scintillation detector with an approximate efficiency of 32 percent. Using this 32 percent efficiency and the 5.43×10^4 dpm alarm level, the corresponding setpoint on the count rate meter is 1.74×10^4 cpm.

(2) The iodine monitor has a SC2-1S gamma scintillation detector with a gross efficiency of approximately 17 percent. Using this 17 percent efficiency and the 5.43×10^4 dpm alarm level, the corresponding setpoint is 9.2×10^3 cpm.

3. All process radiation monitoring instrumentation that monitors gaseous and liquid effluents has automatic response which would terminate the release if the setpoint is exceeded. This automatic response for each instrument is described in detail in Section 11.2.3 of the FSAR.

4. The only change in process radiation monitoring instrumentation from that described in Section 11 of the FSAR is the addition of a particulate and iodine monitor on the plant vent. This monitor was manufactured by Nuclear Measurements Corp. and is their Model No. AM-221.

Que.tion 3.51

Furnish h.story of radioactivity levels measured in the primary and secondary coolants.

Response

Radioactivity levels in the primary coolant have ranged from 0.1 uci/ml to a maximum of 0.5 uci/ml during the proceeding year. Primary coolant activities have generally increased over the past six months and generally follow a linear regression curve, $y=0.001x + 0.323$, based on a least squares fit. In the above equation, y is the primary system coolant activity in microcuries per milliliter and x is the day of the year using June 1, 1972 as 1. The above activities are based on counting a primary coolant sample dried on a planchet after 15-minutes decay. Seven day activities are generally about 1 percent of the 15-minute activities.

Secondary coolant activities at the present time range from about 1×10^{-6} uci/ml in "A" steam generator to about 2×10^{-7} uci/ml in "B" and "C" steam generators. Iodine activity in the secondary system ranges from about 2×10^{-7} uci/ml in "A" steam generator to less than 1×10^{-7} uci/ml in "B" and "C" steam generators. The above activities are typical of secondary system activities since leaking tubes were plugged during the period of May 13, 1972 to June 5, 1972.

Question 3.5j

Describe downstream use of Black Creek for potable water for a distance of 50 miles.

Response

Black Creek flows into the Pee Dee River 40 to 45 miles downstream from Lake Robinson. There is no potable water use of Black Creek prior to its junction with the Pee Dee River.

Question 3.5k

Furnish information on volume and flows into and out of Prestwood Lake.

Response

Exact flow information for Prestwood Lake is not available at this time. However, there are no significant tributaries to Black Creek between Lake Robinson and Prestwood Lake. Consequently, the only difference between flows shown for Lake Robinson, as described in Section 2 of the FSAR, and Prestwood Lake flows would be the small amount of runoff between the two lakes. For purposes of defining the dilution capability of Prestwood Lake, it should be adequate to use the flows shown for Lake Robinson.

Question 3.51

Describe in more detail the vents and release points from which airborne or gaseous radioactive materials are emitted. Their height in relationship to adjacent buildings as well as effluent velocity and volume flow rate should be indicated.

Response

Since all release points for gaseous effluents are below the height of the Containment Building, no credit has been taken for elevated releases in dose calculations for the Robinson Plant (all calculations are based on a ground release). Specific points of release of gaseous effluents are described as follows:

1. Plant Vent - The Reactor Auxiliary Building ventilation and the containment purge are exhausted through the plant vent. The reactor auxiliary ventilation is approximately 50,000 cfm and the containment purge is normally 35,000 cfm. The plant vent is 54" in diameter and exhausts at elevation 375', or 149' above ground elevation of 226'.

2. Fuel Handling Building Upper Level Exhaust - This system (HVE-15) exhausts ventilation air from the upper levels of the Fuel Handling Building including the new and spent fuel storage areas. The flow through this system is 13,400 cfm. The system exhausts below the roof elevation (302') of the Fuel Handling Building. At the present time this is being revised to exhaust through the plant vent. This modification will take another approximately two months.

3. Fuel Handling Building Lower Level Exhaust - This system (HVE-14) exhausts ventilation air from the lower levels of the Fuel Handling Building; including gas decay tank room, CVCS holdup tank areas, hot machine shop, and cask decon area. The system has a normal capacity of 10,200 cfm. The exhaust is below the roof elevation of the Fuel Handling Building.

4. Condenser Air Ejector - This system exhausts air required to maintain a vacuum on the condenser. The normal flow is about 15 cfm with a maximum capacity of 45 cfm. The exhaust is below the 292' elevation.

5. <u>Steam Generator Blowdown Tank Vent</u> - Blowdown from all three steam generators is routed to a flash tank which is vented to atmosphere through an 18-inch vent below the 292' elevation. The system has a maximum blowdown capacity of 12.5 gpm per steam generator with normal blowdown being about 5 gpm per steam generator. Approximately 30 percent of the liquid entering the flash tank excapes through the vent as steam.

Question 3.5m

Provide location relative to Visitor's Center, nearest site boundary, and nearest dwelling of any outside storage tanks which may contain radioactivity. Also give the capacity and expected concentrations of radionuclides of these storage facilities.

Response

Outside storage tanks which could contain radioactivity are the two CVCS monitor tanks (10,000 gal. capacity each), the refueling water storage tank (350,000 gal. capacity) and the primary water storage tank (150,000 gal. capacity). All of these tanks are at the same location; directly north of the Reactor Auxiliary Building. These tanks are approximately 1000 feet from the Visitor's Center, 1,500 feet from the nearest site boundary, and 1,600 feet from the nearest dwelling. The Reactor Auxiliary Building, Containment Building, and Turbine Building are located between these tanks and the Visitor's Center, nearest site boundary, and nearest dwelling thus providing shielding from any radiation from the tanks. Maximum expected activity in these tanks is about 1×10^{-3} uci/ml.

3.6 Chemical and Biocide Systems

Question 3.6a

Provide a detailed list of all chemicals discharged into Lake Robinson indicating frequency and quantities of discharge.

Response

The chemicals discharged into Lake Robinson and their amounts are given on Table s3.6a-1.

TABLE s3.6a-1
H. B. ROBINSON UNIT NO. 2
CHEMICAL DISCHARGE ESTIMATES TO LAKE ROBINSON

Source	Quantity (Gallons/Year)	Chemical Content	Concentration Prior to Dilution	Released to
CVCS	2×10^6	Boric Acid	0.2 ppm	Circ. Water
WDS (Waste Disposal System)	3×10^5	Chromate Detergent Boric Acid	<1 ppb 1 ppm 0.1 ppm	Circ. Water
Steam Generator	8×10^6	Hydrazine Ammonia Cyclohexy-lamine Phosphate	0.02 ppm 0.3 ppm 5 ppm 25 ppm	Circ. Water
Makeup Water Treatment Sys.	4×10^6	Sulfate Salts	11,500 ppm	Circ. Water
Sewage Treatment	1.5×10^6	Residual Cl_2	0.3 ppm	Circ. Water

Question 3.6b

Describe methods which will be used to control chlorine residuals at discharge canal outlet to meet EPA requirements if it becomes necessary to use chlorine in connection with the operation of Unit 2 in the future.

Response

Although the chlorinating system has not been necessary since the start-up of Unit No. 2, when a chlorinating system is in operation at Robinson Unit No. 2, samples are taken regularly from the sealwell to determine the concentration of chlorine residual. If the chlorine residual rises above 0.5 ppm, the chlorinating system will be taken out of operation until the problem can be corrected. The Company has not experienced difficulties in controlling chlorine residuals at our other plants.

3.7 Sanitary and Other Waste Systems

Question 3.7a

Provide the following information: the quantity of sanitary waste discharged to the lake per day, the residual chlorine level of discharged sanitary waste, the biochemical oxygen demand (BOD) of the discharged waste.

Response

The maximum quantity of sanitary waste discharged to the lake is approximately 3000 gallons per day and has a residual chlorine level of 0.3 ppm. Biochemical oxygen demand (BOD) has not been measured on the Robinson Plant sanitary waste effluent. However, from tests at other plants, the BOD is normally around 10 ppm for the sanitary waste effluent.

Question 3.7b

Describe the disposal practices for other nonradioactive wastes (solid, liquid, and gaseous) including debris and fish from trash racks and screens in the condenser water supply system. Provide a copy of state regulations which control such disposal.

Response

Solid waste from the plant is transported to an open pit and burned. Such burning is controlled by Regulation No. 2A of the S. C. Air Pollution Control Regulations and Standards. Trash collected on the intake screens of the circulating water system is washed off the screens and into the storm drainage system. Waste from the makeup water demineralizer is discharged to the circulating water system.

A copy of state regulations on on open burning is included on pages s3.7b-2 and s3.7b-3.

REGULATION NO. 2A

OPEN BURNING

SECTION I - PROHIBITION OF OPEN BURNING

Open burning is prohibited except as provided below:

Open burning may be conducted in certain situations if no "undesirable levels" are or will be created. The authority to conduct open burning under this Regulation does not exempt or excuse the person responsible for the burning from the consequences of or the damages or injuries resulting from the burning and does not exempt or excuse anyone from complying with other applicable laws and with ordinances, regulations, and orders of governmental entities having jurisdiction, even though the burning is otherwise conducted in compliance with this Regulation. The situations which are exempt from this Regulation and the conditions for exemption are enumerated in the following paragraphs (A--J):

A. Open burning of leaves, tree branches or yard trimmings originating on the premises of private residences or dwellings of four families or less, and burned on those premises.
B. Open burning in connection with the preparation of food for immediate consumption.
C. Campfires and fires used solely for recreational purposes or for ceremonial occasions.
D. Fires purposely set to forest lands for specific forest management purposes in accordance with practices acceptable to the South Carolina Pollution Control Authority.
E. Fires purposely set to agricultural lands for purposes of disease, weed and pest control and for other specific agricultural practices acceptable to the South Carolina Pollution Control Authority.
F. Open burning of trees, brush, grass and other vegetable matter for game management purposes in accordance with practices acceptable to the South Carolina Pollution Control Authority.
G. Open burning in other than predominantly residential area for the purpose of land clearing or right-of-way maintenance. This will be exempt only if the following conditions are met:
   1. Prevailing winds at the time of the burning are away from any city or town, the ambient air of which may be significantly affected by smoke from the burning.
   2. The location of the burning is at least one thousand (1,000) feet from any dwelling located in a predominantly residential area other than a dwelling or structure located on the property on which the burning is conducted.
   3. The amount of dirt on the material being burned is minimized.
   4. Heavy oils, asphaltic materials, items containing natural or synthetic rubber, or any materials other than plant growth which produces smoke of a shade darker than No. 2 on the Ringelmann Chart are not a part of the material burned.
   5. The initial burning may be commenced only between the hours of 9:00 A.M. and 3:00 P.M.; no combustible material is added to the fire between 3:00 P.M. of one day and 9:00 A.M. the following day.

6. No more than one pile 60' x 60' or equivalent will be burned within a six acre area at one time.
7. In the case of land clearing, all salvageable timber and pulpwood must be removed.
8. A written report or warning to a person of a violation at one site shall be considered adequate notice of the Regulation and subsequent observed violations at the same or different site will result in immediate appropriate legal action by the Authority.

H. Fires set for the purposes of training public fire-fighting personnel when authorized by the appropriate governmental entity, and fires set by a private industry as a part of an organized program of drills for the training of industrial fire-fighting personnel will be exempt only if the following condition is met:
   1. The drills are solely for the purpose of fire-fighting training and the duration of the burning held to the minimum required for such purposes.

I. Open burning of rubbish and garbage on the premises of and originating from private residences or dwellings of four families or less where services for the disposal of such materials are not available and open burning on the property where it occurs of trade waste from building and construction operations will be exempt only if the following conditions are met:
   1. The location of the burning is at least five hundred (500) feet from any dwelling located in a predominantly residential area other than a dwelling or structure located on the property on which the burning is conducted.
   2. Heavy oils, asphaltic materials, items containing natural or synthetic rubber, or any other trade waste which produce amounts of smoke of a shade darker than No. 2 on the Ringelmann Chart is not burned.
   3. The initial burning is commenced only between the hours of 9:00 A.M. and 3:00 P.M.; no additional fuel shall be added before 9:00 A.M. of the following day.

J. Open burning, in remote or specified areas:
   1. Of such trade waste as constitutes rubbish as defined in this Regulation provided smoke of shade darker than No. 2 on the Ringelmann Chart is not emitted except for a reasonable period to get the fire started, and the burning is conducted in accordance with Section I. G. of this Regulation.
   2. Of highly explosive or other dangerous material for which there is no other feasible method of disposal.
   3. For non-recurring unusual circumstances.
   4. For experimental burning for purposes of data gathering and research.

However, a written permit for these types of burning (in sub-paragraph J. above) must be obtained in advance from the Authority.

The Authority reserves the right to impose other or different restrictions and exemptions on open burning in addition to those enumerated above, whenever in the judgement of the Authority, this is necessary to realize the purpose of this Regulation.

5. ENVIRONMENTAL EFFECTS OF PLANT OPERATION

5.1 Effects of Operation of Heat Dissipation System

Question 5.1a

Provide information on daily, weekly and monthly fluctuations in lake level during various seasons of the year with the operation of the plant. Values during spring are of special importance.

Response

Table s5.1a-1 shows lake elevation data for Lake Robinson from October 1, 1970 to September 30, 1971. Examination of the data reveals the maximum net change (1.4 feet) in terms of lake level rise occurred in November, 1970, and the minimum net change (0.3 feet) in terms of lake level rise occurred in January and February, 1971. A similar compilation of data for October 1, 1971 to November 30, 1972, is not available at this time; however, maximum and minimum lake levels for each month from January, 1972 through November, 1972, are available. These values are given on Table s5.1a-2.

Data similar to Table s5.1a-1 for 1967-68, 1968-69, and 1969-70 show the largest net change in terms of lake level rise to be 1.0 feet, 1.8 feet and 0.9 feet, respectively. Since the data for the largest net change in terms of lake level rise for the years 1967-71 are all much greater than the largest net change (0.7 feet) given in Table s5.1a-2 and since the maximum and minimum values given in Table s5.1a-2 are of the same order of magnitude as the values given in Table s5.1a-1, it is reasonable to assume that daily and weekly data for January, 1972 through November, 1972, would not be very different from the data presented in Table s5.1a-1.

TABLE s5.1a-1
LAKE ELEVATION DATA
TAKEN DAILY AT MIDNIGHT

From Oct. 1, 1970
To Sept. 30, 1971

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	220.6	221.4	220.8	220.9	221.3	221.3	221.6	221.3	221.0	221.3	221.6	221.6
2	220.6	221.5	220.8	220.9	221.3	221.2	221.6	221.2	221.0	221.2	221.4	221.6
3	220.6	221.7	220.8	220.9	221.2	221.4	221.6	221.2	221.0	221.3	221.3	221.6
4	220.6	221.7	220.8	220.9	221.1	221.7	221.5	221.1	221.0	221.2	221.4	221.5
5	220.6	221.6	220.8	221.0	221.2	221.7	221.5	221.1	221.0	221.1	221.3	221.5
6	220.6	221.4	220.8	221.0	221.2	221.7	221.6	221.0	221.0	221.2	221.3	221.5
7	220.6	221.4	220.8	221.0	221.2	221.8	221.5	221.0	220.9	221.1	221.4	221.4
8	220.6	221.2	220.8	220.9	221.4	221.7	221.5	221.0	220.8	221.1	221.6	221.4
9	220.6	221.1	220.7	COMPUTER OUT OF SERVICE	221.4	221.5	221.5	221.0	220.8	221.1	221.6	221.3
10	220.6	221.1	220.7		221.4	221.3	221.5	221.0	220.8	221.1	221.5	221.3
11	220.6	221.1	220.7		221.4	221.2	221.5	221.0	220.8	221.1	221.4	221.3
12	220.6	221.1	220.7		221.4	221.2	221.5	221.0	220.8	221.1	221.5	221.4
13	220.6	221.1	220.7		221.4	221.2	221.5	220.9	220.8	221.0	221.5	221.4
14	220.5	221.1	220.7		221.4	221.3	221.4	221.0	220.8	220.9	221.4	221.4
15	220.6	221.1	220.7		221.3	221.3	221.3	221.1	220.8	220.9	221.3	221.4
16	220.6	221.0	220.9		221.3	221.4	221.3	221.5	220.8	220.9	221.4	221.4
17	220.5	221.0	221.1		221.2	221.4	221.2	221.6	220.9	220.9	222.1	221.5
18	220.5	221.0	221.1		221.2	221.4	221.2	221.6	221.0	220.9	222.1	221.5
19	220.6	221.0	221.1		221.2	221.4	221.2	221.5	221.1	220.9	222.0	221.6
20	220.6	221.0	221.1		221.2	221.4	221.1	221.5	221.3	221.1	222.2	221.6
21	220.7	221.0	221.1		221.2	221.4	221.1	221.4	221.4	221.1	222.1	221.6
22	220.8	220.9	221.1	221.1	221.2	221.4	221.1	221.2	221.5	221.3	221.8	221.6
23	220.8	220.9	221.1	221.1	221.4	221.3	221.1	221.1	——	221.3	221.6	221.6
24	220.7	220.9	221.2	221.1	221.3	221.3	221.2	221.1	221.4	221.5	221.5	221.7
25	220.8	220.9	221.1	221.1	221.3	221.2	221.2	221.0	221.4	221.7	221.4	221.7
26	220.9	220.3	221.1	221.1	221.3	221.3	221.2	221.0	221.4	221.7	221.4	221.7
27	220.9	220.8	221.0	221.2	221.3	221.4	221.2	221.0	221.5	221.8	221.4	221.7
28	220.9	220.9	220.9	221.1	221.3	221.4	221.2	221.0	221.5	221.8	221.3	221.6
29	220.9	220.8	220.9	221.1	——	221.5	221.3	221.0	221.4	221.8	221.3	221.6
30	221.1	220.9	220.9	221.1	——	221.6	221.3	221.0	221.4	221.9	221.4	221.6
31	221.4	——	220.9	221.2	——	221.6	——	221.0	——	221.8	221.5	——
Max	221.4	221.7	221.2	221.2	221.4	221.8	221.6	221.6	221.5	221.9	222.2	221.7
Min	220.5	220.3	220.7	220.9	221.1	221.2	221.1	220.9	220.8	220.9	221.3	221.3
Net Change	0.9	1.4	0.5	0.3	0.3	0.6	0.5	0.7	0.7	1.0	0.9	0.4

TABLE s5.1a-2

LAKE ELEVATION DATA

Month	Maximum/Minimum	Net Change
January, 1972	221.7/221.0	0.7
February, 1972	221.4	
March, 1972	221.4/221.1	0.3
April, 1972	221.4/220.9	0.5
May, 1972	221.1/220.9	0.2
June, 1972	221.1/220.5	0.6
July, 1972	221.0/220.6	0.4
August, 1972	221.0/220.5	0.5
September, 1972	220.7/220.4	0.3
October, 1972	221.0/220.5	0.5
November, 1972	221.3/220.7	0.6

Question 5.1b

Provide representative temperature and dissolved oxygen concentration information from surveys during July or August and February or March for two years before startup of Unit 2 and for each year since.

Response

Data for the months of January, March, and July, 1963; and March & July 1972 has been sent directly to Dr. Mike Novick, Argonne National Laboratory (letter dated January 12, 1973).

Question 5.1c

Provide a copy of or reference to the EPA document on black waters. Provide a copy of available nutrients data for Lake Robinson.

Response

The reference to the EPA document on black waters is: Warner, Richard W.; R. Kent Ballentine; and Lowell E. Keup, 1969, "Black-Water Impoundment Investigations." Technical Advisory and Investigations Branch, Federal Water Pollution Control Administration, U. S. Department of Interior, Cincinnati, Ohio 45213.

The nutrients data for Lake Robinson are shown in Table s5.1c-1.

TABLE s5.1c-1

LAKE ROBINSON NUTRIENTS

	Phosphorus (as P) mg/l	Kjeldahl Nitrogen mg/l	Nitrates (as N) mg/l
November 3, 1971			
Intake	0.0	0.70	0.0
Discharge	0.0	0.70	0.01
December 15, 1971			
Intake	<0.1	2.10	<0.05
Discharge	<0.1	1.68	<0.05
January 18, 1972			
Intake	<0.1	0.28	<0.05
Discharge	<0.1	0.42	<0.05
February 17, 1972			
Intake	<0.1	0.28	<0.05
Discharge	<0.1	0.28	<0.05
March 17, 1972			
Intake	1.0	0.28	<0.05
Discharge	1.0	0.28	0.06
April 27, 1972			
Intake	3.7	0.42	0.06
Discharge	<0.1	0.42	0.07
May 18, 1972			
Intake	0.9	0.21	<0.05
Discharge	3.5	0.28	<0.05
June 21, 1972			
Intake	0.3	0.28	<0.05
Discharge	1.0	0.28	<0.05
July 19, 1972			
Intake	<0.1	0.42	<0.05
Discharge	<0.1	0.42	<0.05

Question 5.1d

Paragraph 3 on p. 8.5-2 of the ER states that natural solar radiation accounts for about 6°F of the 10°F temperature rise between the inlet and outlet waters of Lake Robinson. Please provide information on measurements which have been made to support this.

Response

Table s5.1d-1 shows the yearly average temperature rise between the inlet and outlet waters of Lake Robinson.

Unit 1 was the only unit in operation until August 1971. At that time, Unit 2 began operation. In 1962, Unit 1 was shut down for the entire month of October. The temperature rise between the inlet and outlet waters of Lake Robinson was monitored during this time period. The average temperature rise for the month of October 1962 was 7.8 F (five measurements). Table s5.1d-2 shows the average monthly temperature rise for October during the last five years.

Comparing this data with data from October 1962 when Unit 1 was not in operation, it appears that there is very little heat input to Lake Robinson from Unit 1. Based on this finding and the fact that the yearly average temperature rise for Lake Robinson from 1967 to 1971 ranged from 5 F to 5.8 F, it was concluded that natural solar radiation accounted for about 6 F of the 10 F temperature rise between the inlet and outlet waters of Lake Robinson.

TABLE s5.1d-1

Year	Yearly Average Temperature Rise Δt
1972*	10.7°
1971	6.2°
1970	6°
1969	5°
1968	6.8°
1967	6.4°

*The average for 1972 represents the first nine months excluding May and August.

TABLE s5.1d-2

Year	Average Δt	No. of Measurements
October 1967	8.24	4
October 1968	9.25	4
October 1969	7.6	5
October 1970	5.7	3
October 1971	7.8	4
October 1972	Not Available	

Question 5.1e

Provide a copy of the data on fish taken from the intake screens.

Response

The number of fish collected on the intake screens has been low since the startup of Unit No. 2 of the H. B. Robinson Plant. The primary species found on the screens have been of the centrachid family although occasionally pickerel, minnows, and suckers are collected from the screens.

In order to better assess species composition and numbers, fish counts were made for various time periods on October 7, 8, and 9, 1972. The results of these counts are presented in the Table s5.1e-1.

TABLE s5.1e-1

FISH COUNTS

DATE	COLLECTION TIME ON SCREENS	TIME	SPECIES	NUMBER/INCH CLASS	TOTAL
7 Oct. 72	48 hrs.	0245 hrs.	Bluegill (*Lepomis macrochirus*)	201/2, 9/4, 3/6	213
			Black Crappie (*Pomoxis nigromaculatus*)	21/2, 3/6	24
					237
8 Oct. 72	24.3 hrs.	0310 hrs.	Pickerel (*Esox* spp.)	1/13	1
			Bluegill (*Lepomis macrochirus*)	173/2, 12/4, 2/7	187
			Black Crappie (*Pomoxis nigromaculatus*)		29
			Golden Shiner (*Notemigonus crysoleucas*)	1/4	1
					217
9 Oct. 72	12.2 hrs	1520 hrs.	Bluegill (Lepomis *macrochirus*)	16/2, 33/3, 6/4	55
					55

5.2 Effects of Operation of the Plant on Resources

Question 5.2

Provide information on annual consumption of fuel for the diesel engines and auxiliary boiler which support Unit 2.

Response

The annual consumption of fuel for Unit No. 2's diesel generators and auxiliary boiler for the year November 1971 through October 1972 was 11,375 and 80,215 gallons respectively.

5.6 Effects of Operation and Maintenance of the Transmission System

Question 5.6

Provide information on the effect of the existence of the transmission lines. Provide information on and break down into categories of land use of transmission line right-of-ways for Unit 2.

Response

The transmission corridors prior to construction were, to a large degree, under cultivation and required no clearing as such. The forested areas of the right-of-way were cleared of timber and underbush generally by the use of a shearing blade attached to a tractor which leaves no stumps more than four inches above the ground. Material so cleared was then pushed into brush rows along and within boundaries of the right-of-way.

The effect of the existence of the transmission lines associated with the Robinson Unit No. 2 has been minimal. The lines have caused no change in population patterns and will have minimum effect on land use in future years. No residents were moved or affected. The only lands committed to the lines are the areas they traverse. The ownership of the land is retained by the property owners who continue to use it for agricultural, recreational or other purposes not inconsistent with the operation of the line.

Approximately 1024 acres of right-of-way were secured for the transmission lines (see Table s5.6-1). Of this acreage, 53 percent (or 545 acres) are pasture land and/or land that was in cultivation prior to the construction of the lines. The effect of a line across a pasture or a cultivated field is minimal, with almost the entire right-of-way being available for agricultural purposes, since each tangent transmission structure occupies an approximate area of four square feet and structures are separated (on an average) by 650 feet.

Approximately 46 percent (or 468 acres) was woodlands. Although this woodland was taken out of possible timber production, these acres afford other important potential uses not inconsistent with the operation of transmission lines. Already developing are secondary uses of the right-of-way, e.g., strip gardening, public access roads, horse trails, etc.

Through a continued program of cooperation with property owners and state and local authorities, secondary uses of the rights-of-way are being found to obtain a maximum usage for each acre of right-of-way cleared for the lines.

Approximately one percent (or 11 acres) of new right-of-way was in use either as public access corridors (i.e., roads, railroads) or other utilities prior to the existence of the lines. The transmission lines are generally located to minimize any visual impact in these areas of public access. The lines are designed with low-profile H-frame structures, colored to blend with the natural surroundings. A plan for screening at public crossings has been designed and a copy was transmitted to Argonne National Laboratory personnel at a meeting in Raleigh, N.C. on October 11, 1972. This plan is being implemented.

TABLE s5.6-1
H. B. ROBINSON UNIT NO. 2
COMPARISON
TRANSMISSION LINE R.O.W. VS/LAND USEAGE

Line	Total R.O.W. Acreage	Agricultural Useage		Woodland		Other*	
		%	Acres	%	Acres	%	Acres
1. Robinson-Sumter	419	56	234	43	180	1	5
2. Robinson-Florence South	293	55	161	44	129	1	3
3. Robinson-Society Hills (Robinson-Rockingham) (Robinson-Florence North)	312	48	150	51	159	1	3
TOTALS	1024	53	545	46	468	1	11

*Other Uses Such As: Other Utility Corridors and Public Access Routes

6. EFFLUENT AND ENVIRONMENTAL MEASURENTS AND MONITORING PROGRAMS

Question 6.a

List and describe all programs for monitoring the environmental impact of the operation of the plant. Radiological, chemical, and sanitary effluents and their effects on the ecology should be included. Descriptions should be in detail covering such factors as frequency, type of sampling, method of collection, analytical methods, sampling holding times and pre-analysis treatment, instrumentation used and its sensitivity, etc.

Monitoring programs being carried out by public or other agencies not supported by CP&L should be included. Include programs listed in Table 3.6-5 in the ER with additional information necessary to update it and provide the information requested above.

Response

The current radiological environmental surveillance program for the H. B. Robinson site is shown on Table s6.a-1. This program has been expanded somewhat from that shown in Table 3.6-5 of the Environmental Report, particularly in the expanded scope of isotopic identification.

All sample analyses are performed by a contractor, Eberline Instrument Company, who has recently opened laboratory facilities in Columbia, South Carolina, where all sample analyses for this program are currently being performed. Procedures used by Eberline Instrument Company are the same as or equivalent to those recommended by the Environmental Protection Agency. Standards supplied by the National Bureau of Standards, Health and Safety Laboratory of the U.S.A.E.C., Environmental Protection Agency, and the International Atomic Energy Agency are used for calibration of equipment and procedures. Eberline Instrument Company also participates in inter-laboratory comparison programs. Their quality control program includes the use of internal tracers whenever possible, analysis of blank samples, and analysis of samples to which known amounts of radioactive material have been added.

Results of the radiological environmental monitoring program are tabulated and evaluated on a six-month basis and are incorporated in the six-month operating report for the Robinson Plant. Each of these reports contain details of sampling and monitoring techniques, analytical procedures, and instrument and procedure sensitivities.

Details of the program and analytical procedures are summarized below:

PROGRAM DESCRIPTION

RADIATION LEVELS

Thermoluminescent dosimeters (TLD) are used to document radiation levels. Each badge consists of five (5) LiF chips, 1/8" x 1/8" x 0.035", selected for uniform response, in a small black polyethylene bag which is sealed with identification in a clear polyethylene bag (30 mg/cm^2 total plastic). Each of the five chips are read twice, with the second reading (instrument background) subtracted. The reading thus obtained represents total radiation exposure from time of annealing to time of reading. The dosimeters are annealed to erase any accumulated background radiation immediately prior to shipment to CP&L.

AIRBORNE PARTICULATE

Air particulate samples for alpha-beta determination are collected on two-inch diameter filters at a volumetric flow rate of approximately one (1) cubic foot per minute. Samples are collected on a weekly basis from two sampling stations; one located at the Visitor's Center onsite about 1400 feet to the southwest and the other located in the center of Hartsville, South Carolina, at the Carolina Power & Light Company Substation about six (6) miles to the southwest of the site.

Each week the filters are removed and held for at least 72 hours prior to analysis to permit decay of most of the radon daughter radioactivity that may have been collected.

WATER

Surface water samples are collected weekly from the plant intake (Station 5), at the discharge canal outfall (Station 8), from below the dam spillway (Station 11), and from Prestwood Lake (Station 32). Grab samples are collected twice weekly from Station 11 and composited into a single weekly sample. Water samples are collected quarterly from Black Creek above the outfall (Station 21) and from two wells that supply drinking water at the site. These samples were analyzed for gross beta and tritium.

BOTTOM SEDIMENTS

Bottom sediment samples are collected with an Eckman dredge in the discharge canal (27), near the discharge canal outfall in Lake Robinson, near the dam in Lake Robinson, and upstream above the discharge canal outfall. All sediment samples are analyzed for gamma radioactivity with a GeLi system and for Sr-90.

SOIL

Two surface soil samples are collected each quarter. Each sample is collected from an unvegetated area by digging up the soil in a one square foot area to a depth of approximately four inches. The sample is then mixed in place and a one-pound sample is reserved for analysis. All soil samples are analyzed for Sr-90, Cs-137, and gross beta.

FISH

Fish samples are collected quarterly. Both free swimmers and bottom feeders are collected each collection period. Fish samples are analyzed for gamma radioactivity with a GeLi gamma spectrometry system and then radiochemically for Sr-90.

AQUATIC VEGETATION

Aquatic vegetation samples are collected from two locations in the lake each quarter and are analyzed for gross beta and gamma radioactivity by high resolution GeLi analysis.

ANALYTICAL PROCEDURES

AIR PARTICULATE SAMPLES

Gross Beta

Air particulate samples are mounted in two-inch counting dishes and counted directly for beta activity. A Beckman Wide Beta II low background beta counter is used to measure beta activity for each sample and reported in pCi/m^3.

Gross Alpha

Air particulate samples are alpha counted utilizing a Wide Beta I or Wide Beta II low background counter. The results are reported in pCi/m^3.

WATER SAMPLES

Gross Beta

The entire water sample is acidified and an aliquot taken for the analysis. The sample is chemically ashed to destroy any organic matter. The residue is dissolved in dilute acid and transferred to a two-inch tared metal planchet. The planchet is beta counted utilizing a Beckman Wide Beta I or Wide Beta II low background counter. The result is corrected for self-absorption losses (greater than 1 mg/cm^2) and reported in pCi/l.

Gross Alpha

The entire water sample is acidified and an aliquot taken for analysis. The sample is chemically ashed to destroy organic matter. The residue is dissolved in dilute acid and transferred to a two-inch tared metal planchet. The planchet is counted on the alpha plateau of a low background internal gas flow proportional counter. The result is corrected for self-absorption losses (greater than 1 mg/cm^2) and reported in pCi/l.

Tritium (by Gas Counting)

A 1-2 ml aliquot is converted to hydrogen by means of a heated (400 C - 418 C.) granular zinc conversion column, collected on activated charcoal, expanded into a one-liter gas proportional counter (adding methane) and counted.

SOLID SAMPLES (SOIL, SILT, AND AQUATIC)

Gross Beta

Samples are dried, ground blended, and chemically ashed to white salts with nitric acid and hydrogen peroxide. The sample material is transferred with nitric acid to a weighed two-inch diameter stainless steel planchet and counted in a Beckman Wide Beta I or Wide Beta II low background counter. Results are corrected as previously stated in Gross Beta in Water and are reported in pCi/g (dry).

Cesium-137

Cesium-137 is determined by precipitation as chloroplatinate after interfering radionuclides are scavenged with iron hydroxide. The cesium precipitate is filtered, washed, dried, and counted in a Sharp Low Beta counter.

Strontium-90

Strontium-90 is separated using Dowex 50W-X8 ion exchange resin. Interfering nuclides are extracted with di-2-ethylhexyl phosphoric acid (HDEHP) in toluene. The sample is stored for two weeks to allow Y-90 to approach equilibrium with the Sr-90. The Y-90 daughter is separated with HDEHP, back extracted with acid and precipitated as yttrium oxalate. The precipitate is mounted on a glass fiber filter paper and beta counted utilizing a Sharp Low Beta counter. This procedure is highly selective for Sr-90. Strontium recovery is determined for each sample using a Sr-85 internal tracer and yttrium recovery is based on stable yttrium carrier.

GAMMA SCAN OF SOIL, SILT, AND AQUATIC

Two systems are used for gamma spectrometry. One system uses a high resolution GeLi detector optimized for counting environmental samples. The analyzer system is a Nuclear Data 4420 with ND 812 Computer and has 16,000 separate data storage locations for spectra and programs. The GeLi system has a 2.75" diameter detector with a 1.5" diameter x 0.010" thick beryllium window. The sensitive volume is 55 cc. The resolution is 2.2 KEV for the 1170 KEV peak of ^{60}Co and the peak-to-compton ratio is 32:1 for ^{60}Co gamma. The system has been calibrated for counting 75 grams of dried or ashed sample mounted in a three-inch diameter x 0.75" thick Petri dish. IAEA standards were used to calibrate the system. The minimum detectable activity (MDA), defined as three times the standard deviation of background, is listed below for the sample size and geometry described above and 400-minute counting time. The practical reporting level may be higher than the MDA value and is a function of spectrum complexity, detector resolution, and peak-to-compton ratio. One reason this particular system was selected for environmental samples was the excellent resolution and peak-to-compton ratio.

Isotope	Peak Used To Quantify (KEV)	MDA for GeLi (EIC System) Ci/Sample*
^{22}Na	511	4
^{40}K	1460	200
^{51}Cr	320	37
^{54}Mn	835	5
^{57}Co	122	7
^{58}Co	810	5
^{60}Co	1173	7
^{65}Zn	1115	13
^{95}Zr	724 & 756	4
^{95}Nb	765	4
^{103}Ru	497	6
^{131}I	364	5
^{134}Cs	605	4
^{137}Cs	662	4
^{140}Ba	537	7
^{141}Ce	145	7
^{144}Ce	134	7
^{203}Hg	279	5
^{226}Ra	185	150

*Based on 100 MM diameter Petri dish geometry and 200-minutes counting time

The other gamma spectrometry system uses a four-inch diameter by 4-inch thick NaI(Tl) detector and a 400-channel pulse height analyzer. This system is used for direct gamma spectrometric analysis of samples that may contain ^{131}I and for samples that do not require high resolution gamma spectrometry. This system has been calibrated with IAEA standards for the geometry of a small sample next to the detector and for 2.5 liters (liquid or solid sample) in a Marinelli beaker. MDA values listed below are based on three times the standard deviation of background and a 100-minute counting time. The practical reporting level may be significantly higher than the MDA value for samples with complex spectra, e.g., sediment. The GeLi system will be used when the spectrum is complex.

Isotope	Peak Used to Quantify (KEV)	MDA for 4" x 4" NaI(Tl) Detector (pCi/Sample) Small Sample	2.5 Liters
^{57}Co	122	10	33
^{144}Ce	134	18	60
^{203}Hg	279	15	50
^{51}Cr	320	125	420
^{131}I	364	13	44
^{103}Ru	497	15	50
^{22}Na	511	8	26
^{134}Cs	605	11	37
^{137}Cs	662	12	40
$^{95}Zr\text{-}Nb$	724, 756 & 765	6	20
^{54}Mn	835	13	43
^{58}Co	865	13	43
^{65}Zn	1115	21	70
^{40}K	1460	200	660
^{140}Ba	537	20	60
^{141}Ce	145	18	60

ERROR TERM AND SENSITIVITY

The two sigma error is reported based on counting statistics. A value of 0.0 ± 0.2 means that the sample count was less than or equal to background. The true value can be reported as less than 0.2 with 95 percent confidence. Sensitivity (minimum detectable activity) is calculated as three times the standard deviation of background.

OTHER MONITORING PROGRAMS

In addition to the radiological environmental monitoring program being conducted by CP&L in the environs surrounding the H. B. Robinson Plant, independent programs are geing conducted by the S. C. Division of Radiological Health and the Environmental Protection Agency.

The program being conducted by the S. C. Division of Radiological Health includes direct radiation measurements with TLDs, air monitoring, ground and surface water monitoring, and analysis of fish samples. In addition to this program, the S. C. Division of Radiological Health is under contract with the U. S. Atomic Energy Commission to monitor inplant effluents. This program includes reviewing effluent records and obtaining samples of both gaseous and liquid effluents to verify plant records. These effluent samples are split three ways; one being analyzed in the plant, one analyzed by the AEC, and the third being analyzed by the S. C. Division of Radiological Health.

The monitoring program being conducted by the Environmental Protection Agency is primarily directed toward the aquatic environment. This program is a cooperative effort between the Environmental Protection Agency, the U. S. Atomic Energy Commission, the South Carolina Division of Radiological Health, and Carolina Power and Light Company. Complete details of the agreement for this program and its scope and objectives are contained in the copy of the letter beginning on page s6a-

TABLE s6.a-1

ENVIRONMENTAL SURVEILLANCE PROGRAM
H. B. ROBINSON STEAM ELECTRIC PLANT

Sample Type	Sampling Point & Description	Sampling Frequency	Sample Size	Sample Analysis	Remarks
Air Samples	(2) Visitor's Center SW of Reactor (22) Hartsville	Weekly	1/3 cycle - 1.5 hrs. on - 3.0 hrs. off - 1 cfm	Gross beta after 72 hrs. decay. Gross alpha on one set/month	Isotopic Identification if >10 pci/m^3
Ground Water	(23) 2 wells - 1 entrance to Unit 1 1 by Unit 2	Quarterly	One gallon	Gross beta tritium (1)	Gamma spectra and Sr-90 if >30 pci/
Surface Water	(11) Dam spillway	Weekly (2)	One gallon	Gross beta	
	(5) Plant Intake	Weekly (3)	One gallon (3)	Tritium (4) (5)	(3)
	(8) Lake-downstream of canal outfall	Weekly	One gallon		
	(21) Bridge at north end of lake	Quarterly	One gallon	(6)	
	(32) Prestwood lake	Weekly (3)	One gallon (3)		(3)
Bottom Sediments	(21) Bridge at north end of lake (24) Near dam in lake (8) Lake-downstream of canal outfall (27) In discharge canal	Quarterly	One pound	Isotopic Identification for CO-58 & 60, Cs-134 & 137, Sr-90 Gross beta	
Soil	(25) West of lake (26) East of lake	Semi-Annual	One pound	Gamma spectra gross beta, Sr-90 and Cs-137	
Fish (bottom feeders and free swimmers)	(8) Lake - near discharge canal outfall (7)	Quarterly	2 lbs. each - Bottom feeders & free swimmers	Isotopic identification Co-58 & 60, Sr-89 & 90, Cs-134 & 137, Ba-La-140	Sr-90 in Bone
Benthic Organisms (8)	(8) Lake-downstream of canal outfall (21) Bridge at north end of lake	Semi-Annual	(8)	Gross beta, Co-58 & 60, Cs-134 & 137, Sr-90	
Aquatic Vegetation (Alge)	(27) In Discharge Canal (8) Lake Downstream of Canal Outfall	Quarterly	50 grams	Gross beta, Co-58 & 60, CS-134 & 137	
Air Radiation Dosimeters	(22) Hartsville (10) Picnic area (17,18,19,20) East shore of lake (1,3,4,12) South property line (13,15,16) West property line (11) Below dam (9) Microwave tower (14) Four corner area (6,7) Unit 1 (28,29,30,31) South of Plant in prevailing wind direction	Monthly		Gamma	TLD

(1) The four samples for each 6-month report will be composited and analyzed for tritium by gas analysis.

(2) Samples at station 11 will be collected twice weekly and composited into one weekly sample as long as the continuous sampler is out of service.

(3) Monthly samples will also be collected at Stations 5 and 32 by drawing a 200 liter sample through an ion exchange resin column. The resin will be analyzed for Co-58 & 60, Cs-134 & 137, Sr-89 & 90, and Ba-La-140.

(4) Quarterly composites of surface water samples from Stations 5, 8, 11, and 32 will be analyzed for tritium by gas analysis.

(5) Gross alpha analysis will be run quarterly on one set of surface water samples from Stations 5, 8, 11, and 32.

(6) The two samples for each 6-month report will be composited and analyzed for tritium by gas analysis.

(7) Location for fish collection will vary as necessary to obtain representative specimens.

(8) Benthic organisms will be segregated from the bottom sediments collected at these sampling points and analyzed as indicated. If there is an insufficient quantity of benthic organisms for a separate analysis, the benthic organisms will be included in the analysis of bottom sediments.

H. B. Robinson
Unit No. 2

CAROLINA POWER & LIGHT COMPANY
RALEIGH, NORTH CAROLINA 27602

COPY

October 27, 1970

Dr. James E. Martin
Acting Chief
Nuclear Facilities Branch
Bureau of Radiological Health
U. S. Public Health Service
Rockville, Maryland 20852

Dear Dr. Martin:

The final draft of your proposal for "Study of Long Term Buildup of Liquid Radioactive Waste Discharges in a Small Impoundment" which you transmitted to us on October 9, 1970, is acceptable. However, we would like to receive copies of all laboratory sample results as they are generated. Copies should be sent to the general office and to the plant.

We would also like to be notified of all field trips to the plant. Notification of the plant and the general office staff would be appreciated.

All correspondence should be addressed to me with copies to Mr. Larry E. Smith and Mr. N. B. Bessac in our Raleigh office. In addition, Mr. G. P. Beatty should be shown for a copy at the plant. Please designate the distribution list for correspondence to your agency.

Yours very truly,

E. E. Utley
Manager
Generation & System Operations

LES/sb

cc: Mr. G. P. Beatty
Mr. N. B. Bessac
Mr. L. E. Smith

Bureau of
Radiological Health

OCT 9 1970

Mr. E. E. Utley, Manager
Generation & System Operations
Carolina Power and Light Company
Raleigh, North Carolina 27602

Dear Mr. Utley:

The meeting of October 1, 1970, of participants in the H.B. Robinson environmental study was a most delightful experience. We were especially encouraged by the extremely cooperative attitude on the part of all those involved. We wish to convey a special thanks to the Carolina Power and Light Company staff for their hospitality and extensive efforts which made the meeting such a success.

As a follow-up to the meeting, we are herewith submitting the final draft of the project plan for your approval. We would appreciate it if we could receive your concurrence as soon as possible so that field work can be started. It is presently anticipated that the first field trip by staff members from our Southeastern Radiological Health Laboratory will be in the first part of November 1970. If you should note any errors or problem areas in the plan, please call us so we can make immediate revisions. Our telephone number is 301 443-1385. It should also be realized that mutually acceptable revisions to the plan can be made as the study continues.

Sincerely yours,

James E. Martin, Ph.D.
Acting Chief
Nuclear Facilities Branch

Enclosure

cc:

Mr. Harold Denton	Mr. Andy McCanuey
Mr. Jack Sutherland	Mr. Heyward Shealey
Mr. Larry Smith	Mr. Ron Shearin
Mr. Guy Beatty	Mr. Richard Payne

A PROJECT PROPOSAL

STUDY OF LONG TERM BUILDUP OF LIQUID RADIOACTIVE WASTE DISCHARGES IN A SMALL IMPOUNDMENT

Nuclear Facilities Branch
Division of Environmental Radiation
Bureau of Radiological Health
Environmental Health Service
Public Health Service
U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

INTRODUCTION

One of the major environmental concerns in the proliferation of nuclear power plants is the long-term buildup of radioactivity in the hydrosphere. Several facilities are already proposed for small lakes made by impounding a stream to provide sufficient cooling water for the plant in question. This trend is likely to continue as the number of good power plant sites on large bodies of water decreases. A nuclear power plant located on a small lake impoundment usually recirculates the water through the condenser, and liquid waste discharged into the condenser water can, by this recycling mechanism, buildup in the impoundment over a period of time. If long-term buildup is to be significant in the environment, it should first appear in these small impoundments. The purpose of this proposal, therefore, is to outline a study to determine the buildup of radioactive liquid waste discharge in a small lake impoundment and to ascertain its effects on environmental quality and public health.

The H.B. Robinson station operated by the Carolina Power and Light Company is located on Lake Robinson, a small impoundment formed by a dam on Black Creek. This particular site is representative of impounded cooling lakes and therefore, is proposed for the study. H.B. Robinson #2, a pressurized water reactor nuclear power station, is scheduled for operation the latter part of 1970 and, for this reason, is also a timely site for the study.

OBJECTIVES

1. To characterize preoperational levels of radionuclides in a small lake impoundment that will contain a nuclear power station.

2. To determine, over a period of several years of operation, the discharges of radionuclides into the impoundment and any recirculation, long-term retention, and migration of these nuclides from the lake's system.

3. To establish models from discharge and hydrological data that describe the buildup of radioactivity in the lake and to infer from these models the population dose potential of various water or food pathways from the lake.

IMPLEMENTATION

The technical aspects on this study will be conducted by the Southeastern Radiological Health Laboratory with periodic consultation with the Nuclear Facilities Branch of the Division of Environmental Radiation. The development and execution of the study will be done in full cooperation with the Carolina Power and Light Company, the South Carolina State Health Department, and the Atomic Energy Commission. In this respect the study will be similar to those sponsored previously by the Division of Environmental Radiation at other laboratories for other nuclear facilities.

Since the reactor will begin operation in late 1970, pre-site studies should begin as soon as possible. These studies will be followed by characterizations of liquid waste discharges after the reactor has had sufficient time to build an inventory of radionuclides that will be available for release. Two to three field trips per year for several years are expected to be made to determine long-term changes in radioactivity in the lake system. Three such trips are planned for the first year of the study and these will be conducted according to the study plan detailed in Appendix A. Attempts will be made in carrying out the study procedures to avoid duplication of samples currently provided by surveillance activities of the Company and the South Carolina State Board of Health.

PARTICIPANTS

A. Bureau of Radiological Health (BRH)

The responsibilities of individual units will be as indicated below:

1. Nuclear Facilities Branch, Division of Environmental Radiation

   a. Assume necessary headquarters responsibility for the study.

   b. Coordinate the study with other State and Federal agencies and the facility operators.

   c. Participate in preliminary review of facility.

   d. Assist the Southeastern Radiological Health Laboratory in implementing the study, and in analyzing, interpreting, and reporting the data.

   e. Review study reports and carry out administrative functions relative to their publication.

2. Southeastern Radiological Health Laboratory

   a. Conduct all technical aspects of the study including field sampling and laboratory analyses.

   b. Prepare reports and publications on study results.

3. Region IV, Radiological Health Representative

Assistance in coordinating activities with the South Carolina Board of Health and assist in arranging for an initial meeting of participants.

B. South Carolina State Board of Health

The South Carolina State Board of Health will be asked to carry out the following responsibilities:

1. Participation in the design and implementation of the study.

2. Provide liaison between the Bureau of Radiological Health and the facility operator.

3. Provide liaison between the Bureau of Radiological Health and members of the public relative to sample collection in the environs of the facility and in determining population data.

4. Provide existing State data relative to the facility.

C. Carolina Power & Light Company

The utility company will be asked to carry out the following responsibilities:

1. Permit access to the facility site for the purpose of obtaining samples.

2. Provide samples from in-plant and effluent liquid and gaseous streams.

D. U.S. Atomic Energy Commission

The Regulatory program of the AEC will be asked to assist in this study in the same manner as in previous studies. In this respect, the AEC will provide effluent data and other data normally supplied by the licensee and will assist in arrangements with the licensee to obtain special information on plant operation or other activities that may involve the licensee and his operations. The AEC will also participate by appropriate representation in planning and executing the details of the study and will be invited to comment on the data obtained prior to publication.

REPORTS

Since the goals of the study will be research oriented, reports will be developed to disseminate the data obtained and its implication relative to the long-term buildup of radioactivity in small lakes. The results of the first year of the study will be compiled into a comprehensive report upon completion of the field work and all laboratory analyses. This report will detail the observed levels and will characterize the in-plant and environmental parameters relative to them. The report will be circulated in draft form to all participants for review and comment prior to publication or release of the data.

H. B. ROBINSON STUDY PLAN

I. Study Objective

It is recognized that a nuclear facility will normally release radioactive wastes to its environs at levels well below "allowable limits" of release. There occurs, however, a discharge of long-lived radionuclides to the environs at a rate that exceeds the decay rate of these nuclides. This results in a continuing buildup of radioactivity somewhere in the environment. It is the objective of this study to identify and determine such radionuclide buildup rates from an installation where the buildup effect will be optimized in an environmental system and thereby provide the greatest sensitivity for measurements.

The study will be conducted at Lake Robinson, an impounded cooling lake of the H. B. Robinson Plant, operated by the Carolina Power and Light Company at Hartsville, South Carolina. H. B. Robinson Unit 2 is a pressurized water reactor which utilizes water from an impounded lake to dissipate waste heat from the plant's turbines by means of condenser cooling. The condenser cooling water is returned to the lake for natural cooling after which it is available for another cooling cycle. Low-level liquid wastes are periodically discharged into the cooling water, a practice that may tend to concentrate many of the long-lived radionuclides within Lake Robinson. This study will focus on this practice in order to achieve the following goals:

A. Identification and quantitation of the long lived radionuclides released to the environment by the nuclear power plant;

B. Determination of the detectability of such radionuclides in environmental samples representing the biosphere of the lake system and the rate of radionuclide buildup within the lake system;

C. Predictions of the population doses resulting from the radionuclide buildups by extrapolating the observed buildup rates over the expected lifetime of the facility.

II. Study Plan

In order to meet the above objectives, we propose to conduct the study on the lake system utilizing methodology which parallels studies that analyze the biological uptake of radionuclides by humans. This uptake arises from the following expressions:

$$\frac{dq}{dt} = P - \lambda_{eff} q$$

q = quantity of radionuclide in the lake system

P = rate at which the nuclide is introduced into the lake system

λ_{eff} = fractional rate of loss of nuclide

Integration of the expression and evaluation of constants yields the following if P and λ_{eff} are assumed constant:

$$q = \frac{P}{\lambda_{eff}} (1 - e^{-\lambda_{eff} t})$$

Therefore we can view the real-life situation over a longer period of time as one in which radionuclides are being introduced into the system at an approximate constant annual rate. Then we see that at some later time the quantity of a given radionuclide in the system will reach an equilibrium level determined by the rate at which the nuclide is delivered and the rate at which it disappears from the system.

Expressing the lake system as the sum of its parts, we divide it as follows:

1. aqueous solution
2. solids suspended in liquid
3. benthic deposits (silt)
4. benthic geology (bottom soils)
5. aquatic flora
6. aquatic fauna

The expression for the activity in any one component is

$$qf_c = \frac{P_c}{\lambda_{eff_c}} (1 - e^{-\lambda_{eff_c} t})$$

f_c = fraction of total radionuclide content in the component of interest.

To begin to untangle this problem, we propose to follow radionuclides through the lake system with a "cost accounting" approach such that all amounts going into the system are currently accounted for. We propose to carry along with the study observations of influencing parameters such as stable element make ups, pH, and temperature. Significant correlations between these parameters and transfer coefficients (components of λ_{eff_c}) might be detected and descriptive transfer mechanisms can thereby be developed and later tested.

Now the objectives of the study reduce to determining the "f_c" and "λ_{eff_c}" for all the radionuclides introduced into the lake system in sufficient quantities to allow measurements to be made.

To achieve this it is obvious that the "P" value or rate of radionuclide delivery to the lake must be followed with a high degree of accuracy. Thus the study involves one of closely watching the radionuclide source, the lake system, and the radionuclide escape routes" from the lake system.

III. A Mathematical Model Development

To demonstrate the analytical format of this study the following example is presented:

1. Assume tritium is introduced into the liquid waste hence to the lake at the rate of $3.82 \times 10^9\ \mu Ci/yr.^*$
2. Assume the only significant transfer mechanisms of this tritium is from radioactive decay and release of the solution downstream over the dam at 239 cfs (2 - 17 of FSAR).
3. Assume the volume of dilution $1.21 \times 10^9\ ft^3$ (Average of wet and dry month figures in 2.6.4.1 FSAR).

The mean residence time of a particle of aqueous solution in the dilution pool would be:

$$\frac{1.21 \times 10^9\ ft^3}{239\ ft^3/sec \times 8.64 \times 10^4\ sec/day \times 365\ days/yr} = .16\ yrs\ (58\ days)$$

$$\lambda\ discharge = \frac{1}{mean\ residence\ time} = \frac{1}{.162\ yr} = 6.2\ yrs^{-1}$$

$$\lambda_{eff} = \lambda\ radioactive\ decay + \lambda\ discharge = .057 + 6.2\ yrs^{-1}$$

$$\lambda_{eff} = 6.26\ yrs^{-1} \approx 6.2 = \lambda\ discharge$$

Using the equation:

$$qf_c = \frac{P}{\lambda_{eff}} (1 - e^{-\lambda t})$$

where f_c = fraction of total q in aqueous solution

$$qf_c = \text{activity in aqueous solution} = \frac{P}{\lambda_{eff}} \text{ at equilibrium}$$

or where $\lambda_{eff}t > 4$ or $t > .645$ yrs or 237 days

* See Table 11.1-5 FSAR H. B. Robinson Plant (Amendment 4).

$$\frac{qf_c = 3.82 \times 10^9 \text{ nCi/yr}}{6.2 \text{ yr}^{-1}} = 6.2 \times 10^8 \text{ nCi}$$

The concentration in the lake would be

$$\text{Conc}_{^3H} = \frac{162 \times 10^9 \ \mu\text{Ci}}{1.21 \times 10^9 \text{ ft}^3} = .512 \ \mu\text{Ci/ft}^3$$

$$= 1.81 \times 10^{-5} \ \mu\text{Ci/cm}^3$$

$$= 18 \ \frac{\text{pCi}}{\text{cm}^3}$$

An equilibrium concentration greater than this value might indicate an actual dilution volume considerably less than that assumed. By observing the rate of increase and time to reach equilibrium we can calculate an actual λ_{eff}. Comparing this to the data collected at discharge point the assumption of λ discharge essentially equal to λ_{eff} can be tested. Such testing can ultimately lead to a determination of the true effective aqueous dilution volume. Now accurately defined, discharge rates can be used for other radionuclide models. Departure of observed concentrations from these models might indicate significant transfer to another lake component. Such indications will be verified by an appropriate field test.

Study Plan

A. Initial Site Survey

1. Identify and quantitate the radionuclides produced by the plant and subsequently discharged through the condenser cooling water system. This would be accomplished by the plant providing small aliquots from routine samples of:

   a. waste condensate tanks

   b. waste holdup tank

   c. sump tank (fuel handling and building drains)

d. su tank (floor and equipment dra .)

e. laundry and hot shower tanks

f. reactor coolant drain tank

2. Relate plant analyses of above samples to PHS specific analyses of the same samples.

3. Ascertain what would constitute representative sampling of the following lake components feasibly available:

a. aqueous solution in lake

b. suspended solids in lake

c. aquatic flora

d. aquatic fauna

e. benthic deposits (silts)

f. bottom soils

g. lake discharges

4. Sample according to (2) above.

5. Infer current radionuclide content of the lake and relate parameter data, i.e., stable element make-up, pH, temperature, from analytical data collected.

B. Continuing Routine

1. Obtain aliquots of samples taken by South Carolina State Board of Health (SCSBH) and Carolina Power and Light Company (CP&L) on routine basis which are pertinent to the study.

2. Obtain regularly reported results published by SCSBH and CP&L on surveillance performed by these organizations.

C. Subsequent Surveys

1. Initially quarterly samples of the lake components will be collected by SERHL.

2. When the plant achieves a normal production level a specific tritium survey will be made preceding and following the

discharge of a waste condensate tank. The purpose of this survey will be to define the mixing action with the hot condenser cooling water circulation and the lake.

D. Survey Analyses

1. Identify radionuclides within the lake system which accumulate within the system sufficiently to be detected and evaluated. Arrange in the order of significancy.
2. Identify lake components containing the radionuclides in (1) above, collating radionuclides with the proper components.
3. Determine transfer coefficients from component to component as well as into and out from the total lake system.
4. Infer a population dose to a hypothetical "most-significantly-exposed" member of the general public as well as an estimated average population dose to the public.

E. Reports

Report to SCSBH, CP&L, AEC, and PHS the results as significant evaluations are available. Prior to official publication of such reports a meeting will be held with the interested parties on the progress of study. Discussions here will aid in the future guidance of the study and adjustments to meet specific needs.

Question 6.b

Provide information on the location of other wells being monitored (p. 3.7-9) in addition to the sampling point No. 23 listed in the table.

Response

Two wells are included as sampling point No. 23. The first well is by the entrance road to Unit No. 1, about 50 feet east of the lake. The second well is located in Unit No. 2 switchyard, about 800 feet east of the lake and 500 feet south of the Reactor Containment Building.

9. ALTERNATIVE ENERGY SOURCES AND SITES

Question 9.a

Provide information on the other CP&L sites mentioned on page 5.4-2 of the ER and describe the cooling water modifications that would have been necessary to accommodate a 700 MWe plant there.

Response

The other CP&L site mentioned on page 5.4-2 of the ER is the Weatherspoon Plant located near Lumberton, North Carolina which presently has approximately 181 MWe installed capacity and a once-through cooling lake of 225 acres. To install a 700 MWe unit at this location would have required an expansion of the existing cooling lake and the installation of cooling towers for supplemental cooling. Cooling towers would have been required due to insufficient acreage available for a cooling lake to serve both the existing generation and a 700 MWe nuclear plant.

Question 9.b

Provide information on cost versus benefit studies of alternate types of power plants which may have been made. Include breakdown of costs considered such as capital, operating, fuel, and others which affect the cost of generated power.

Response

The cost benefit analysis is summarized in the Environmental Report on Table 8.8-1. In addition to this qualitative cost benefit analysis, an economic study was made in 1965 prior to the selection of the unit now known as H. B. Robinson No. 2. In the economic study the alternatives of hydroelectric, internal combustion turbine, fossil fired steam and nuclear fired steam capacity were considered. The hydroelectric alternative was ruled out because of the lack of a site that could be developed. The I-C turbine alternative was ruled out because this type of capacity was not suitable for supplying the base load energy requirements. A detailed evaluation was made for the remaining two alternatives--fossil fired and nuclear fired steam units. The results of this evaluation indicated that the nuclear unit would provide the most economic means of supplying the base load capacity needed on the CP&L system. A summary of the results of this study is shown on Table s9.b-1.

TABLE s9.b-1

EVALUATION OF ALTERNATIVE CAPACITY ADDITIONS
FOR ROBINSON #2 UNIT (DECEMBER 1965)

(12 Year Averages)

	Fossil Mills/KWH	Nuclear Mills/KWH
Capital	1.34	1.87
Fuel	2.43*	1.54
Operation, Maintenance & Insurance	0.25	0.35
Total	4.02	3.76

*Based on coal cost of 26.4c/MBtu

11. SUMMARY BENEFIT - COST ANALYSIS

Question 11

Provide data on electrical production from Unit 2 since the beginning of operation in terms of dollars and kilowatt hours, and for a five-year projection.

Response

The actual energy production and costs for the years 1970 and 1971, the estimated energy production and cost for 1972 and the projected energy production and costs for the five-year period 1973-1977 are shown in Table s11-1.

TABLE s11-1

CAROLINA POWER & LIGHT COMPANY
H. B. ROBINSON NO. 2 OPERATING COST AND ENERGY PRODUCTION

Year	Production Cost Including OM&I ($)	Energy Production (MWH)
1970	160,989	3,335 "Testing"
1971	7,407,053	2,414,172
1972*	11,689,417	4,892,540
1973**	9,820,473	4,258,872
1974**	14,710,000	5,109,663
1975**	15,178,000	5,000,895
1976**	14,819,000	5,077,365
1977**	12,623,000	5,087,942

*10 Months Actual, 2 Months Estimated

**Projected

12. TRANSPORTATION

Question 12.a

Provide the following information concerning transportation of new fuel:

1. Source of supply;
2. Distance from supplier to plant;
3. Mode of shipment (truck or rail);
4. Number of shipments (rail cars or trucks) in initial loading;
5. Number of shipments annually of reload fuel.

Response

1. Fabricated fuel assemblies for the first and second cores will come from Westinghouse fabrication facilities. The initial core was delivered to the plant in 1970; it came from Cheswick, Pennsylvania. Assemblies in the first three reload regions will come from Columbia, South Carolina. The first reload region has been delivered, and the second and third reloads are expected to be delivered in late 1973 to early 1974 and in late 1974 to early 1975, respectively. A fuel fabricator beyond this third reload has not yet been selected.

2. The Westinghouse, Columbia, South Carolina facility is about 60 to 70 miles from the plant.

3. All shipments have been by exclusive use of trucks. Rail shipment is not anticipated.

4. Fourteen truck shipments were required to deliver the initial core.

5. CP&L expects to reload 52 assemblies on an annual basis. This will require approximately five shipments by truck.

Question 12.b

Provide the following information concerning transportation of solid radioactive waste:

1. Location of burial site;
2. Distance of site from plant;
3. Mode of shipment (truck or rail);
4. Number of shipments (rail cars or trucks) per year.

Response

1. The burial site is located in Barnwell County, South Carolina, about 1-1/2 miles NW of Snelling, South Carolina.

2. The site is approximately 150 miles from the Robinson Plant.

3. and 4. All shipments have been by exclusive use truck, requiring twenty-five (25) trucks per year.

CP&L

Carolina Power & Light Company

January 24, 1975

Troup
Docket File

RECEIVED JAN 28 1975 U.S. ATOMIC ENERGY COMMISSION Regulatory Mail Section

Mr. Edson Case, Acting Director
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

RE: DOCKET NO. 50-261

Dear Mr. Case:

On December 31, 1974, Mr. William H. Regan, Jr., Chief, Environmental Projects, Branch 4, transmitted five questions regarding the continued review of the H. B. Robinson Steam Electric Plant.

The Company is transmitting herewith 3 signed originals and 197 additional copies of the information requested in Mr. Regan's letter. This response is submitted as Supplement #2 to the H. B. Robinson Unit 2 Environmental Report, and the entire supplement has been prepared for insertion in the back of the Environmental Report binder.

Copies of this supplement have been served upon the Chief Executive Officer of Darlington County, South Carolina and upon Mr. John D. Whisenhunt. The original and thirty (30) copies of the Certificate of Service are enclosed.

As required by Commission Regulations, the supplement is signed under oath by a duly authorized officer of the Company.

Yours very truly,

J. A. Jones
Executive Vice President
Engineering, Construction & Operation

JAJ/mf
Enclosures

ATTEST:

J. L. Lancaster, Jr.
Secretary

Sworn to and subscribed before me this 24th day of January, 1975.

Margaret M. Cox
Notary Public

My commission expires: July 4 1975

890

UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

DEC 31 1974

Docket No. 50-261

Carolina Power & Light Company
ATTN: Mr. J. A. Jones
Senior Vice President
336 Fayetteville Street
Raleigh, North Carolina 27602

Gentlemen:

Continued review of your application for the H. B. Robinson Steam Electric Plant Unit No. 2 has indicated a need for additional information. The information requested is described in the enclosure to this letter.

To avoid delay in our review, the requested information must be submitted by January 24, 1975. If you cannot submit the additional information by this date, please inform us within seven (7) days after receipt of this letter of an alternate date for submittal so that we may reschedule our review accordingly.

Your reply should consist of three signed originals and 197 additional copies in the form of a sequentially numbered supplement to your ER.

If you have any questions concerning the requested information please contact Mr. G. L. Dittman, Environmental Project Manager at (301) 443-6990.

Sincerely,

for Wm. H. Regan, Jr., Chief
Environmental Projects Branch 4
Directorate of Licensing

Enclosure:
Request for Additional Information

cc w/encl: see attached list

Enclosure

Request for Additional Information
Carolina Power and Light Company
H. B. Robinson Steam Electric Plant Unit No. 2

1. Provide updated information on the following Tables contained in Supplement 1 to your Environmental Report:

   Table S1.b-1: Include 1973-74 data and provide an estimate of the 1974-75 winter peak load.

   Table S1.c-1: Indicate changes in planned additions and show latest status of each unit.

2. Provide a 10 year projection of annual peak loads and CPL capabilities based on the latest information available.

3. Provide updated information on agreements for obtaining or exchanging capacities with neighboring systems. (Reference: ER Supplement 1, S1.d-1.)

4. Provide an estimate of the 1974 total energy production for the Robinson 2 facility.

5. Describe conservation of energy methods that are being employed or promoted in the CPL service territory in accordance with FPC requirements.

H. B. Robinson
Unit No. 2

Question 1.a

Provide updated information on Table sl.b-1: include 1973-1974 information and provide estimate of 1974-1975 winter peak.

Response

This information is contained in the revised Table sl.b-1, "Carolina Power & Light Company Comparison of Annual Peak Demand With Forecast Demands" covering the period 1962 through 1974, and including the projected 1974-1975 winter peak.

TABLE sl.b-1

CAROLINA POWER & LIGHT COMPANY
COMPARISON OF ANNUAL PEAK DEMAND
WITH FORECAST DEMANDS

Year	Forecast MWe	Peak Demand MWe	Variance Percent
1962	1507	1516	-0.6
1963	1650	1638	0.7
1964	1810	1749	3.5
1965	1950	1943*	0.4
1966	2230	2184	2.1
1967	2437	2445*	-0.3
1968	2650	2834	-6.5
1969	3043	3171*	-4.0
1970	3415	3484	-[illegible].0
1971	3818	3625	5.3
1972	4279	4119	3.9
1973	4679	4711	-0.7
1974	5019	4771	5.2
1974/75 Winter	5019**	--	--

*Winter Peak in January of following calendar year
**Projected 1974/75 Winter Peak

Question 1.b

Provide updated information on Table sl.c-1: indicate changes in planned additions and show latest status of each unit.

Response

The planned capacity additions for the Carolina Power & Light system through 1984 are listed in Table sl.c-1. The Company operates 572 MW of IC turbines under lease in Darlington County, S. C., approximately 1 mile from the Robinson site. None of the other additions are within 100 miles of the H. B. Robinson site. The Harris Plant site is located approximately 110 miles northeast of the Robinson site.

TABLE sl.c-1

CAROLINA POWER & LIGHT COMPANY
SCHEDULE OF CAPACITY INSTALLATIONS

Unit	Size (MW)	Type	Site	Expected In Service Date
Roxboro #3	650	Fossil	Extension	In Service
Darlington County	572	IC Turbines	New	In Service
Brunswick #2	821	Nuclear	New	3/75
Brunswick #1	821	Nuclear	Extension	3/76
Uprate Existing Units	139	Fossil	Present	Prior to 1977 Summer
Roxboro #4	720	Fossil	Extension	3/78
Harris #1	900	Nuclear	New	3/81
Harris #2	900	Nuclear	Extension	3/82
Harris #3	900	Nuclear	Extension	3/84
Harris #4	900	Nuclear	Extension	3/83

H. B. Robinson
Unit No. 2

Question 2

Provide a ten year projection of annual peak loads and CP&L capabilities based on the latest information available.

Response

This information is contained in the attached table s.2-1, "Carolina Power and Light Company Power Resources at Time of Summer and Winter Peaks, 1975-1984".

TABLE s.2-1

CAROLINA POWER & LIGHT COMPANY POWER RESOURCES AT TIME OF SUMMER AND WINTER PEAKS, 1975-1984

Units Are in Megawatts	Installed Capacity: Hydro	Installed Capacity: Fossil Steam	Installed Capacity: Nuclear Steam	Installed Capacity: IC Turbine	Installed Capacity: Total Cap. Installed	Net Purchases	Net Sales	Total Resources	Peak Load	Reserve	% Reserve
1975 Summer	214.0	3817	1486	1018	6535	227.5	117	6645.5	5292	1353.5	25.6
1975-76 Winter	211.5	3878	1521	1264	6874.5	228	117	6985.5	5292	1693.5	32.0
1976 Summer	214.0	3817	2307	1018	7356	227.5	117	7466.5	5718	1748.5	30.6
1976-77 Winter	211.5	3878	2342	1264	7695.5	228	117	7806.5	5718	2088.5	36.5
1977 Summer	214.0	3956	2307	1018	7495	227.5	---	7722.5	6180	1542.5	25.0
1977-78 Winter	211.5	4017	2342	1264	7834.5	228	---	8062.5	6180	1882.5	30.5
1978 Summer	214.0	4676	2307	1018	8215	227.5	---	8442.5	6678	1764.5	26.4
1978-79 Winter	211.5	4737	2342	1264	8554.5	228	---	8782.5	6678	2104.5	31.5
1979 Summer	214.0	4676	2307	1018	8215	227.5	---	8442.5	7217	1225.5	17.0
1979-80 Winter	211.5	4737	2342	1264	8554.5	228	---	8782.5	7217	1565.5	21.7
1980 Summer	214.0	4676	2307	1018	8215	127.5	---	8342.5	7800	542.5	7.0
1980-81 Winter	211.5	4737	2342	1264	8554.5	75	---	8629.5	7800	829.5	10.6
1981 Summer	214.0	4676	3207	1018	9115	75	---	9190	8429	761	9.0
1981-82 Winter	211.5	4737	3242	1264	9454.5	75	---	9529.5	8429	1100.5	13.1
1982 Summer	214.0	4676	4107	1018	10015	75	---	10090	9110	980	10.8
1982-83 Winter	211.5	4737	4142	1264	10354.5	75	---	10429.5	9110	1319.5	14.5
1983 Summer	214.0	4676	5007	1018	10915	75	---	10990	9846	1144	11.6
1983-84 Winter	211.5	4737	5042	1264	11254.5	75	---	11329.5	9846	1483.5	15.1
1984 Summer	214.0	4676	5907	1018	11815	75	---	11890	10642	1248	11.7
1984-85 Winter	211.5	4737	5942	1264	12154.5	75	---	12229.5	10642	1587.5	14.9

H. B. Robinson
Unit No. 2

Question 3

Provide updated information on agreements for obtaining or exchanging capacities with neighboring systems (reference ER Supplement 1, s1.d-1).

Response

Carolina Power & Light Company has contracts for purchases of firm capacities with the Appalachian Power Company for 100 MW and with South Carolina Electric & Gas Company for 53 MW. CP&L purchases capacity from the Southeast Power Administration (Kerr Project) of 45 MW and wheels an additional 30 MW to SEPA preference customers in the CP&L service area. Additionally, there is an agreement which allows the purchase of unit capacity of 52 MW from South Carolina Electric & Gas Company. This agreement expires April 30, 1975. There are no other long-term purchases being made from others.

Carolina Power & Light Company is presently selling 22 MW, 16 MW, and 5 MW of capacity from its Asheville #2 Unit to Duke Power Company, Virginia Electric & Power Company, and South Carolina Electric & Gas Company respectively. This sale will terminate on April 30, 1975. The company is also selling South Carolina Electric & Gas Company 117 MW of capacity from its Sutton #3 Unit. This sale will terminate on April 30, 1977.

Carolina Power & Light does have interchange agreements which permit short-term and emergency exchanges of capacity and energy with all of the neighboring utility companies with which it is interconnected. These interchange agreements with Virginia Electric & Power Company, Duke Power Company, Appalachian Company, the Tennessee Valley Authority, South Carolina Electric and Gas Company, and South Carolina Public Service Authority permit the exchange of capacity and energy between companies for the purpose of enhancing the reliability of each company. However, they do not provide for the long-term purchase of capacity in the amount of or the type required to replace the base load-carrying capability of a unit such as Robinson No. 2.

H. B. Robinson
Unit No. 2

Question 4

Provide an estimate for the 1974 total energy production for HBR Unit 2.

Response

The actual total net generation for 1974 for the Robinson Unit 2 was 4,813,207 MWH. Cumulative net generation through December, 1974 was 15,644,728 MWH.

Question 5

Describe conservation of energy methods that are being employed or promoted in the Carolina Power & Light Company service territory in accordance with FPC requirements.

Response

The attached letter to Mr. Kenneth Plumb of the Federal Power Commission explains Carolina Power & Light Company's efforts in the conservation of natural resources. This letter, along with its five attachments, was previously submitted to the AEC on July 15, 1974, in response to question #10 in the Shearon Harris Nuclear Power Plant docket. At that time, a number of copies of the letter and its attachments were docketed. Attachments to the letter consisted of booklets which were published by a department which no longer exists and the booklets are no longer published. Consequently, it is not possible to provide copies of those booklets* with this supplement. Copies are available in the Harris docket file (Docket Nos. 50-400, 50-401, 50-402, and 50-403) with the AEC.

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*Booklets were titled:

- "1973 Advertising Program - Energy Conservation"
- "Emphasis '73 - Conservation"
- "Make Conservation a Habit"
- "Marketing Today for Tomorrow"

Carolina Power & Light Company

Raleigh, North Carolina 27602

Samuel Behrends, Jr.
Vice President-Rates and Regulation

May 31, 1974

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
825 North Capitol St., N.E.
Washington, D. C. 20426

Re: Conservation of Natural Resources - 1973

Dear Mr. Plumb:

In accordance with Part 2.14 of the Commission's General Policy and Interpretations under the Federal Power Act, Carolina Power & Light Company files herewith the following statements concerning its efforts in the conservation of natural resources for the year ending December 31, 1973. The statements are numbered in accordance with Appendix I.

1. Carolina Power & Light Company was engaged in research and development through its association with and support of the Electric Power Research Institute. This support took the form of a pledge of financial contributions amounting to $3,450,000 over the ten-year period, 1972-1981, including $345,000 for the year 1973, toward the building of the demonstration liquid metal fast breeder reactor plant.

   The development of the fast breeder reactor will contribute to a substantial savings of valuable hydrocarbon fuels by multiplying the usefulness of our available uranium resources in the production of electric energy.

   In addition to this contribution, financial aid amounting to $400,170 was given to support other EPRI research and development programs in nuclear power generation, fossil fuels, advanced transmission and distribution systems, and energy systems design which should lead to increased efficiencies in the areas of generation, transmission, distribution, and consumption of electric energy.

   The Company has also been supporting an automatic meter reading research project with funding of $6,076 in 1973. The development of the technology for automatic interrogation of electric meters has a potential for providing the capability of not only monitoring consumption patterns but also of influencing such patterns through actual control of energy consuming devices. This influencing of end-use consumption patterns could lead to conservation of natural resources through improvements of system load factor.

In 1973 the Company distributed to its supervisory personnel and marketing employees the attached booklet entitled, "CP&L and Environment." While this booklet dealt more with the steps the Company is taking in the protection of the environment, it also emphasized the resources the Company has employed to further develop the use of nuclear power and some of the research and development programs in which the Company is participating.

2. Carolina Power & Light Company continually strives for conservation of natural resources by improvement in the efficiency of its operation in all areas of generation, transmission, and distribution.

The most economical generation for the future on the Company system is weighted heavily towards nuclear power. Not only is the economics to be considered, but there is also the conservation of fossil fuel resources. An example is the fact that Carolina Power & Light Company's H. B. Robinson nuclear unit, which was placed in service in 1971, produced a net generation of over 3.7 billion kilowatt hours during 1973. This unit thus conserved fossil fuel by eliminating the necessity of burning some 1.5 million tons of coal. (The BTU equivalent of 1.5 million tons of coal is approximately 37,500,000 million BTU's).

Another example of the results of the Company efforts to conserve natural resources is its emphasis on efficiency of operation. CP&L has traditionally ranked within the top five nationally among investor-owned electric utilities in efficiency of operation as measured by heat used per unit of generation.

The Company has a continuing program underway to upgrade its transmission and distribution systems. Major expansion of the transmission network is at 230 KV and 500 KV to provide for more efficient transmission of bulk energy. In order to meet the demand of load growth, portions of our lower voltage transmission system are being converted to 230 KV. Approximately 203 miles of 230 KV transmission lines were placed in service in 1973, of which 91 miles were conversions.

In order to minimize the cost penalties and losses associated with voltage transformations, the Company designs its system to step down from 230 KV directly to 23 KV for distribution when practical. This distribution voltage, which CP&L pioneered, was selected years ago as the most economical voltage to use to meet the demands of increased load growth. As of the end of 1973, some 68 percent of our distribution demand load was at 23 KV with the remainder at 12 KV. The Company has an on-going program to convert most of its distribution to 23 KV.

The overall result of this utilization of higher voltages is a reduction of system losses which constitutes a direct savings of natural resources.

3. Company's policy has always been to encourage the customer to use energy in the most economical manner applicable to his particular operations. However, Company's 1973 marketing programs emphasized in detail the conservation of our natural resources under the titles, "Emphasis '73 - Conservation" and "Marketing Today for Tomorrow." The attached booklets describe these programs.

   The objectives of the programs were to develop public appreciation of the need to conserve energy and natural resources, to encourage the prudent and efficient use of electricity and to recommend electricity when it was the best application consistent with benefits achieved. Under the programs the customer was encouraged to make use of off-peak electric facilities which resulted in the best utilization of Company's installed facilities and thereby conserve our natural resources. No activity during the year was directed towards loads which contribute to the Company's peak.

   Because of "Emphasis '73 - Conservation" 24 additional employees were hired. In the residential market, 25 Electric Consumer Consultants spent their full time on conservation. The Commercial Service Representatives and Industrial Power Engineers spent approximately 15% and 25% of their time respectively on conservation.

   During 1973 approximately 22,300 conservation calls were made, which resulted in a kilowatt hour savings of approximately 24 million. There were approximately 1,750 programs presented with an attendance of about 44,400. Approximately 1,850 television and radio programs were given and 750 articles appeared in newspapers dealing with the conservation of energy.

   During 1973 the Company conducted two competitive programs for the elementary school children emphasizing conservation of our natural resources. One of the programs, "Reddy Helpful" was conducted through the "Mini Page" appearing in the major local newspaper. Over 450 elementary school children participated in the "Reddy Helpful" contest. The second contest was conducted within the elementary schools and consisted of a poster contest emphasizing conservation. Over 1,900 students participated in this contest.

4. All of Company's media advertising in 1973 was directed to the conservation of energy. The attached booklet entitled, "1973 Advertising Program - Energy Conservation," outlines the specifics of our 1973 advertising program. The main theme of our 1973 program was "providing customers with assistance and information on using electric service more efficiently." During the months of February and March, we stressed the efficient use of water heating and electric space heating; during June and July, the efficient use of air conditioning; during August and September, the efficient use of all electric energy and during the months of November and December, the efficient use of space heating and the benefits of proper installation. Electric water heating, space cooling and space heating represent the primary residential use of electric service.

Over 200,000 copies of the booklet, "How to Save on Your Electric Bill" and 20,000 copies of the booklet, "Insulation Guides for Homes and Apartments" were distributed during 1973 to our customers, architects and engineers operating within our service territory.

During the last quarter of 1973, considerable time and effort was spent in developing the Company's continuing conservation program for 1974, including an extensive employee program. Attached is a copy of President Harris' memorandum of November 12, 1973, in which he announced certain in-company conservation measures which were effective immediately.

On all calls to industrial and commercial customers, our marketing services representatives stressed the wise use of our service, proper installation of new equipment, and proper insulation where this would be desirable. We worked with architects and engineers and other designers to encourage them to design structures which would make the best use of all energy.

Should the Commission desire additional information on the Company's 1973 conservation program, we will be happy to supply such information upon request.

Yours truly,

Samuel Behrends, Jr.

Samuel Behrends, Jr.

SBJr:pfb

CP&L
Carolina Power & Light Company

April 4, 1975

Mr. Edson G. Case, Acting Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

RE: H. B. ROBINSON UNIT NO. 2
DOCKET NO. 50-261

Dear Mr. Case:

On March 11, 1975, Mr. William H. Regan, Jr., Chief, Environmental Projects, Branch 4, transmitted a request for additional information concerning the H. B. Robinson Steam Electric Plant.

The Company is transmitting herewith 3 signed originals and 197 additional copies of the information requested in Mr. Regan's letter. This response is submitted as Supplement No. 3 to the H. B. Robinson Unit 2 Environmental Report, and the entire supplement has been prepared for insertion in the back of the Environmental Report binder.

Copies of this submittal have been served upon the Chief Executive Officer of Darlington County, South Carolina and upon Mr. John D. Whisenhunt. The original and thirty (30) copies of the Certificate of Service are enclosed.

As required by Commission Regulations, this supplement is signed under oath by a duly authorized officer of the Company.

Yours very truly,

J. A. Jones
Executive Vice President
Engineering, Construction & Operation

JAJ/jf
Enclosures

ATTEST: J. L. Lancaster, Jr.
Secretary

Sworn to and subscribed before me this 4th day of April, 1975.

Margaret M. Cox
Notary Public

My Commission Expires: July 4, 1975

336 Fayetteville Street • P. O. Box 1551 • Raleigh, N. C. 27602

3769

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAR 1 1 1975

Docket No. 50-261

Carolina Power & Light Company
ATTN: Mr. J. A. Jones
Senior Vice President
336 Fayetteville Street
Raliegh, North Carolina 27602

Gentlemen:

Our review of your application has indicated a need for additional information to bring the docket up to date. The information requested is described in the Enclosure to this letter.

To avoid delay in our review, the requested information must be submitted by April 14, 1975. If you cannot submit the additional information by this date, please inform us within seven(7) days after receipt of this letter of an alternate date for submittal so that we may reschedule our review accordingly.

Your reply should consist of three signed originals and 197 additional copies in the form of a sequentially numbered supplement to your Environmental Report.

If you have any questions concerning the requested information please contact Mr. G. L. Dittman, the Environmental Project Manager for the H. B. Robinson review at (301)443-6990.

Sincerely,

Wm. H. Regan, Jr., Chief
Environmental Projects Branch 4
Division of Reactor Licensing

Enclosures:
As stated

cc w/encl: (see attached list)

cc w/encl:

George F. Trowbridge, Esq.
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Enclosure

Request for Additional Information
Carolina Power and Light Company
H. B. Robinson Steam Electric Plan Unit No. 2

METEOROLOGY

1. Discuss the onsite meteorological measurements program in operation from 1967 through 1974, including tower location (with respect to the reactor buildings, cooling pond, and prominent topographic features), instrumentation accuracies, levels of measurement, and data collection and reduction procedures. Compare this program to the recommendations of Regulatory Guide 1.23.

2. Discuss the new meteorological measurements program with respect to the above criteria, and indicate the date of initiation.

3. Provide one copy of additional joint frequency summaries of wind speed and direction by stability class collected since 1969 in the format suggested in Regulatory Guide 1.23, with wind speed and direction measured at the 10 m level and atmospheric stability defined by vertical temperature gradient.

AQUATIC ECOLOGY

1. Provide one copy of the results of all ecological studies performed at the Robinson facility since the Environmental Report was issued. Of special interest are those studies concerned with fish impingement, entrainment, fish, benthic and plankton surveys and fish, egg and larvae sampling. The results of any other study you deem relevant should also be included.

2. Provide the date of initiation, estimated completion date and date of final evaluative summary report for the demonstration program being performed for EPA under Section 316(a) of the FWPCA.

THERMAL

1. Provide for calendar years 1973 and 1974, one copy of the following daily measurements taken on Lake Robinson. (If the measuring frequency was less than on a daily basis, provide the data at the frequency that was used.)

a. Cooling water temperatures at the intake structures and at the point of discharge to the canal for Units 1 and 2.

b. Volume and temperature of inflow to Lake Robinson from Black Creek.

c. Volume and temperature of outflow from Lake Robinson to Black Creek.

d. Method released at spillway.

e. Gross load in MWe, for Units 1 and 2.

RADIOLOGICAL DOSE ASSESSMENT

1. Radiological Environmental Monitoring Program

   a. Provide information on sampling locations, media sampled, frequency of sampling and analyses, and analyses to be performed.

   b. Provide a figure showing radiological environmental sampling locations indicating the media sampled.

2. Provide the location of the nearest garden (within 2 miles) in each meteorological sector.

3. Provide the distance and direction to milk animals (cows and goats, individual and dairies) within 7 miles of the plant.

4. Provide most recent data on fish catch (sport and commercial) in Lake Robinson.

5. Provide site boundary radiation dose estimates, dose estimates at the nearest residence, etc.

6. Provide direction and distance to the nearest points to the plant outside the exclusion boundry where recreational activities take place (boating, swimming, fishing, hunting, etc.)

METEOROLOGY

Comment No. 1

Discuss the onsite meteorological measurements program in operation from 1967 through 1974, including tower location (with respect to the reactor buildings, cooling pond, and prominent topographic features), instrumentation accuracies, levels of measurement, and data collection and reduction procedures. Compare this program to the recommendations of Regulatory Guide 1.23.

Response

During 1967, a set of Belfort Type M (1250-1275B) wind speed and direction transmitters were installed at a height of 120 feet on an existing microwave relay tower approximately 2,500 feet north of the reactor and 500 feet west of the discharge canal. The Belfort recorder was installed in the equipment shack at the base of the tower. Starting speed of the Belfort wind speed indicator is approximately two miles per hour.

Wind data from April of 1967 through April of 1969 was collected on the strip-chart recorder and reduced for analysis by manual methods. These data were keypunched on cards and processed by computer to provide seasonal and annual distributions of wind speed, wind direction, wind direction variance, and wind direction persistence. These data were compiled and a two-year report submitted to the United States Atomic Energy Commission.

Wind data were collected from 1969 through 1974 on strip charts; however, the data recovery was less than is recommended in Regulatory Guide 1.23. Also, the meteorological instrumentation was less than recommended by Regulatory Guide 1.23. These data have not been reduced.

Comment No. 2

Discuss the new meteorological measurements program with respect to the above criteria, and indicate the date of initiation.

Response

A meteorological monitoring system was installed during 1974 to comply with Regulatory Guide 1.23. Instrumentation installed on the tower includes wind speed and direction at approximately 11 meters and 61 meters above ground, temperature difference between the same two elevations, ambient temperature, and dewpoint.

The wind speed and direction instruments are Meteorological Research, Inc., Model 1074 with a starting speed of approximately 0.75 mph. There are two temperature difference systems installed on the tower at the same elevations and the sensors utilized are Rosemount Engineering Company Models 104ABG-1 and 104ABG-2. The reported accuracy of the sensors is $\pm$ 0.1°C.

Comment No. 3

Provide one copy of additional joint frequency summaries of wind speed and direction by stability class collected since 1969 in the format suggested in Regulatory Guide 1.23, with wind speed and direction measured at the 10 m level and atmospheric stability defined by vertical temperature gradient.

Response

The two years of data compiled as a report and submitted to the United States Atomic Energy Commission is the best data available for the H. B. Robinson site. However, data collected at the site since May, 1974, has been tabulated in the format recommended in Regulatory Guide 1.23 and one copy is included with this submittal.

THERMAL

Comment No. 1.

Provide for calendar years 1973 and 1974, one copy of the following daily measurements taken on Lake Robinson. (If the measuring frequency was less than on a daily basis, provide the data at the frequency that was used.)

a. Cooling water temperatures at the intake structures and at the point of discharge to the canal for Units 1 and 2.

b. Volume and temperature of inflow to Lake Robinson from Black Creek.

c. Volume and temperature of outflow from Lake Robinson to Black Creek.

d. Method released at spillway.

e. Gross load in MWe, for Units 1 and 2.

Response

A copy of the requested data, as available, has been attached. Lake inflow and outflow is provided from USGS data. Temperature data for inflow is taken at US 1 and Black Creek. All releases are over the spillway.

AQUATIC ECOLOGY

Comment No. 1

Provide one copy of the results of all ecological studies performed at the Robinson facility since the Environmental Report was issued. Of special interest are those studies concerned with fish impingement, entrainment, fish, benthic and plankton surveys and fish, egg and larvae sampling. The results of any other study you deem relevant should also be included.

Response

We are providing one copy of preliminary reports for the following studies at the Robinson Impoundment:

Water Quality
Plankton
Benthic Macroinvertebrates
Fisheries Studies
Terrestrial Ecology

Comment No. 2

Provide the date of initiation, estimated completion date and date of final evaluative summary report for the demonstration program being performed for EPA under Section 316(a) of the FWPCA.

Response

The demonstration program being performed for EPA under 316(a) of the FWPCA at H. B. Robinson was begun in the third quarter of 1974. A complete year of data is required; therefore, it is estimated that field work will be concluded in the third quarter of 1975. The NPDES permit for H. B. Robinson was issued on December 31, 1974. The permit requires that the final report on the 316(a) demonstration be provided to EPA by June 30, 1976. It is estimated that a final evaluative summary report will be available by the end of the second quarter of 1976.

RADIOLOGICAL DOSE ASSESSMENT

Comment No. 1

Radiological Environmental Monitoring Program

a. Provide information on sampling locations, media sampled, frequency of sampling and analyses, and analyses to be performed.

b. Provide a figure showing radiological environmental sampling locations indicating the media sampled.

Response

a. Sampling locations, media sampled, sampling frequency, and analyses to be performed are provided in Tables 1 through 3.

b. Figures 1, 2, and 3 show the Environmental Radiological Sampling Points.

Comment No. 2

Provide the location of the nearest garden (within 2 miles) in each meteorological sector.

Response

Distances from the plant to the nearest garden in each of the 16 principal compass directions are provided below:

Sector	Distance (ft.)
N	None
NNE	9200
NE	7600
ENE	None
E	None
ESE	3400

Sector	Distance (ft.)
SE	10,200
SSE	4200
S	1400
SSW	2100
SW	2800
WSW	2500
W	2600
WNW	3100
NW	None
NNW	None

Comment No. 3

Provide the distance and direction to milk animals (cows and goats, individual and dairies) within 7 miles of the plant.

Response

A single milk cow is located in the northeast sector at a distance of 3.35 miles and is milked for human consumption approximately 8 to 10 months per year.

A milk goat is located in the southwest sector at a distance of 2.34 miles. The goat is kept for the purpose of raising kids (baby goats). Milking for human consumption never exceeds 2 months per year.

As described in Environmental Report Supplement 1, Question 3.5b, there is a dairy farm 7 miles east of the plant.

Comment No. 4

Provide most recent data on fish catch (sport and commercial) in Lake Robinson.

Response

No creel census data is available for Lake Robinson.

Comment No. 5.

Provide site boundary radiation dose estimates, dose estimates at the nearest residence, etc.

Response

Dose estimate for the maximum exposed individual and the population dose are discussed in Sections 3.7.3 and 3.7.4 of the H. B. Robinson Unit No. 2 Environmental Report.

Comment No. 6

Provide direction and distance to the nearest points to the plant outside the exclusion boundry where recreational activities take place (boating, swimming, fishing, hunting, etc.).

Response

Recreational activities are permitted outside the exclusion boundary, 1400 feet from the plant. The lake will probably be the area most utilized for recreational purposes.

Table 1

ENVIRONMENTAL RADIATION SURVEILLANCE

Sample Station	Location	Sample Types	Sampling Frequency	Remarks
01	S. Property Line near const. road	(1) TLD	(1) Quarterly	
02	Visitor Center	(1) Air (2) Soil	(1) Weekly (2) Every 3 years	7 days (continuous)
03	S. Property Line near Visitor Center	(1) TLD	(1) Quarterly	
04	S. Property Line near RD.S-1623	(1) TLD	(1) Quarterly	
05	Plant intake	(1) Surface water (2) Bottom sediment	(1) Weekly (2) Semiannual	
06	At Robinson Unit 1	(1) TLD	(1) Quarterly	
07	At Robinson Unit 1	(1) TLD	(1) Quarterly	
08	Discharge canal outfall	(1) Surface water (2) Bottom sediments (3) Aquatic vegetation	(1) Weekly (2) Semiannual (3) Quarterly	
09	Microwave tower	(1) TLD (2) Air (3) Soil	(1) Quarterly (2) Weekly (3) Every 3 years	7 days (continuous)
10	Picnic area	(1) TLD	(1) Quarterly	
11	Black Creek and Road 1623	(1) Surface water (2) TLD (3) Ground water (85') (4) Ground water (120')	(1) Weekly (2) Quarterly (3) Quarterly (4) Quarterly	
12	Intersection of Roads 1623 and 1639	(1) TLD	(1) Quarterly	

Table 1 (Continued)

Sample Station	Location	Sample Types	Sampling Frequency	Remarks
13	W. property line near const. road	(1) TLD	(1) Quarterly	
14	Intersection area for RD.S-1623 and RT.151	(1) TLD	(1) Quarterly	
15	Pine Ridge Baptist Church and RT.151	(1) TLD	(1) Quarterly	
16	RT.151 - one-half mile N. of 1623	(1) TLD	(1) Quarterly	
17	East shore of lake across from plant intake	(1) TLD	(1) Quarterly	
18	East shore of lake (north of 17)	(1) TLD	(1) Quarterly	
19	East shore of lake (north of 18)	(1) TLD (2) Air (3) Soil	(1) Quarterly (2) Weekly (3) Every 3 years	 7 days (continuous)
20	East shore of lake (north of 19)	(1) TLD	(1) Quarterly	
21	Bridge at north end of lake	(1) Surface water (2) Bottom sediment (3) Aquatic vegetation (4) Ground water	(1) Weekly (2) Semiannual (3) Quarterly (4) Quarterly	
22	Hartsville	(1) Air (2) TLD (3) Soil (4) Ground water	(1) Weekly (2) Quarterly (3) Every 3 years (4) Quarterly	7 days (continuous)
23	Unit 1 well near site entrance	(1) Ground water	(1) Quarterly	
24	Well at west side of Unit 2	(1) Ground water	(1) Quarterly	

Table 1 (Continued)

Sample Station	Location	Sample Types	Sampling Frequency	Remarks
25	Not used			
26	Not used			
27	Black Creek at US-1 upstream of Robinson Impoundment	(1) Surface water (2) Bottom sediment (3) Aquatic vegetation	(1) Weekly (2) Semiannual (3) Quarterly	
28	Intersection of Transmission Lines and S. C. 151	(1) TLD	(1) Quarterly	
29	Intersection of S. C. 200 and S. C. 151	(1) TLD	(1) Quarterly	
30	Intersection S. C. 200 and S. C. 53	(1) TLD	(1) Quarterly	
31	Kelly Town	(1) TLD	(1) Quarterly	
32	Prestwood Lake	(1) Surface water (2) Bottom sediment (3) Aquatic vegetation	(1) Weekly (2) Semiannual (3) Quarterly	
33	Ditch behind Visitor Center	(1) Surface water (2) Bottom sediment (3) Aquatic vegetation	(1) Weekly (2) Semiannual (3) Quarterly	
34	End of construction road west of plant	(1) Air (2) Soil	(1) Weekly (2) Every 3 years	7 days (continuous)
35	Dam (west end)	(1) Air (2) Soil	(1) Weekly (2) Every 3 years	7 days (continuous)
36	Not used			
37	Not used			

Table 1 (Continued)

Sample Station	Location	Sample Types	Sampling Frequency
38	Site varies	(1) Fish a. Free swimmers b. Bottom feeders	(1) Quarterly
39	On St.R.102 near St.R.13	(1) Milk	(1) Monthly
40	On St.R.28 near St.R.403	(1) Milk	(1) Monthly
41	Site varies	(1) Feed crops	(1) Twice, during growing season
42	Site varies	(1) Feed crops	(1) Twice, during growing season
43	Site varies	(1) Tobacco	(1) Once during growing season and once after "curing."
44	Site varies	(1) Food crops	(1) Twice during growing season
45	Site varies	(1) Food crops	(1) Twice during growing season
46	Site varies	(1) Meat & eggs	(1) Semiannual
47	Site varies	(1) Meat & eggs	(1) Semiannual

Table 2

ANALYSIS OF SAMPLES

I. External Radiation Measurement

A. Twenty-two sampling locations with dosimeters at each location

B. Analysis: Change and read at least quarterly

II. Air Samples

A. Continuous 7-day samples at six (6) locations, filter and activated charcoal filter changed weekly

B. Analyses:

1. Filter

a. Gross beta

b. Gamma spectrum analysis, ^{89}Sr, ^{90}Sr (a monthly composite of each station)

2. Charcoal filter - ^{131}I

III. Surface Water

A. Weekly samples taken at seven sites

B. Analyses:

1. Gross beta

2. Tritium

a. Weekly liquid scintillation

b. For stations with all weekly samples during a month reporting less than the minimum detection limit of tritium by liquid scintillation, the monthly composite for that station will be analyzed for tritium by a method more sensitive than liquid scintillation

3. Either composites or ion exchange resins for each station will be analyzed monthly by gamma spectrometry.

4. Monthly composites for ^{89}Sr, ^{90}Sr.

Table 2

(Continued)

IV. Ground Water

A. Six quarterly samples taken at five (5) locations

B. Analyses:

1. Gamma spectrometry
2. Tritium

V. Soil

A. Six locations every three years

B. Analyses:

1. Gamma spectrometry
2. ^{90}Sr

VI. Bottom Sediment

A. Six locations semi-annually

B. Analyses: Gamma spectrometry

VII. Fish

A. Quarterly Sampling

B. This sample shall be separated into free swimmers and bottom feeders

C. Analyses: Gamma spectrometry

Table 2 (Continued)

VIII. Aquatic Vegetation

A. A quarterly sample will be collected at five stations

B. Analyses:

1. Gamma spectrometry
2. ^{89}Sr, ^{90}Sr

IX. Milk

A. Monthly samples will be collected at two sites

B. Analyses:

1. Gamma spectrometry
2. ^{89}Sr, ^{90}Sr
3. ^{131}I within seven days of collection

X. Feed Crops

A. Samples are collected twice during the growing season from two location

B. Analysis: Gamma spectrometry

XI. Food Crops

A. Samples are collected twice during the growing season from two location

B. Analysis: Gamma spectrometry

XII. Tobacco

A. Samples are collected from one location during the growing seacon and after it has been "cured."

B. Analysis: Gamma spectrometry

XIII. Meat and Eggs

A. Samples are collected from two locations semiannually.

B. Analyses: Gamma spectrometry

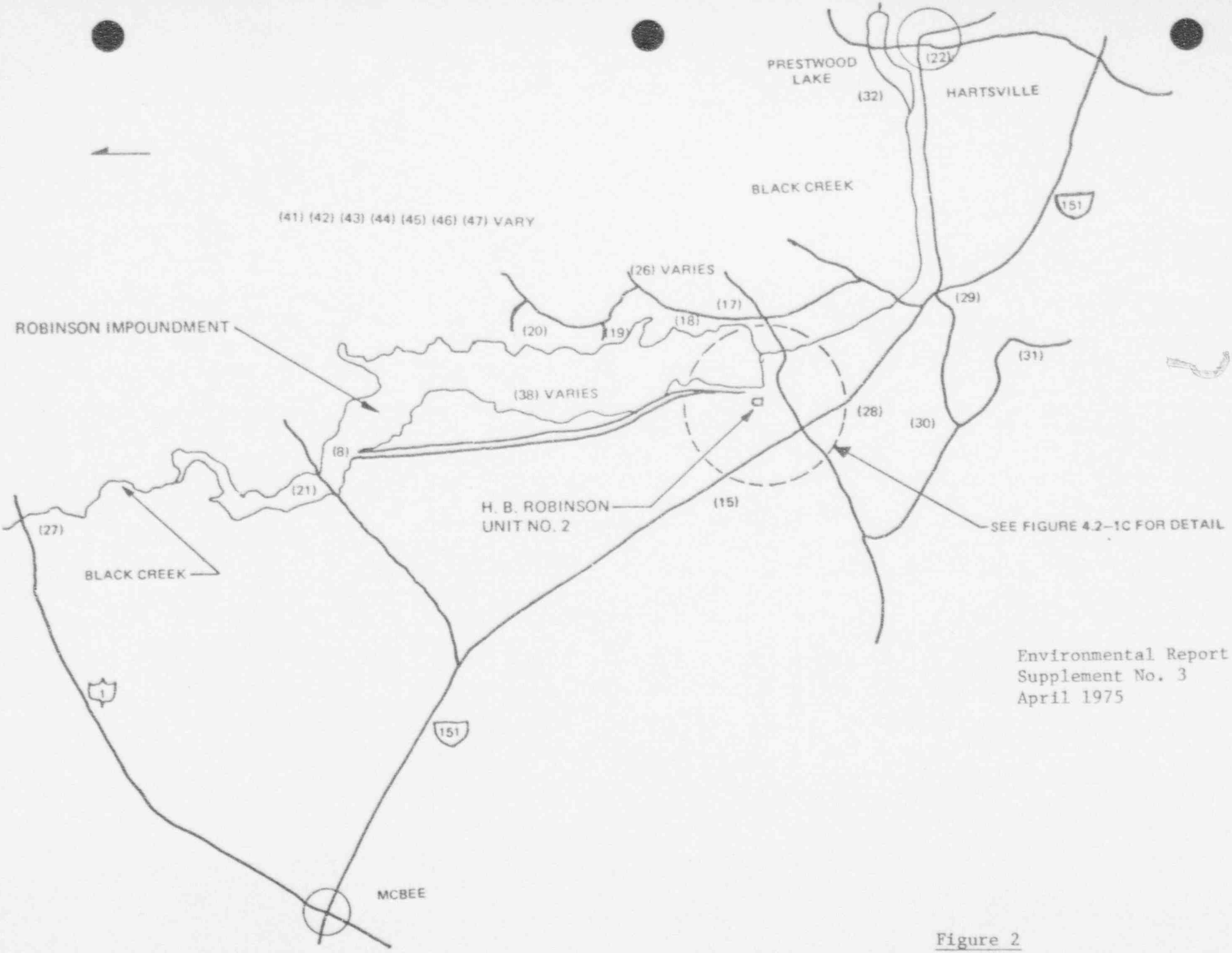
Table 3

Control Stations for RSEP
Environmental Radiological Monitoring Program

	Sample Type	Control Station Number	Control Station Location
1.	TLD	22	Hartsville
2.	Air Particulate	22	Hartsville
	Charcoal Filter	22	Hartsville
3.	Surface Water	27	Black Creek at U. S. 1
4.	Ground Water	22	Hartsville
5.	Feed Crops	42	Varies
6.	Food Crops	45	Varies
7.	Fish		None
8.	Aquatic Vegetation	27	Black Creek at U. S. 1
9.	Soil Samples	22	Hartsville
10.	Meat and Eggs	47	Varies
11.	Bottom Sediments	27	Black Creek at U. S. 1

Figure 1

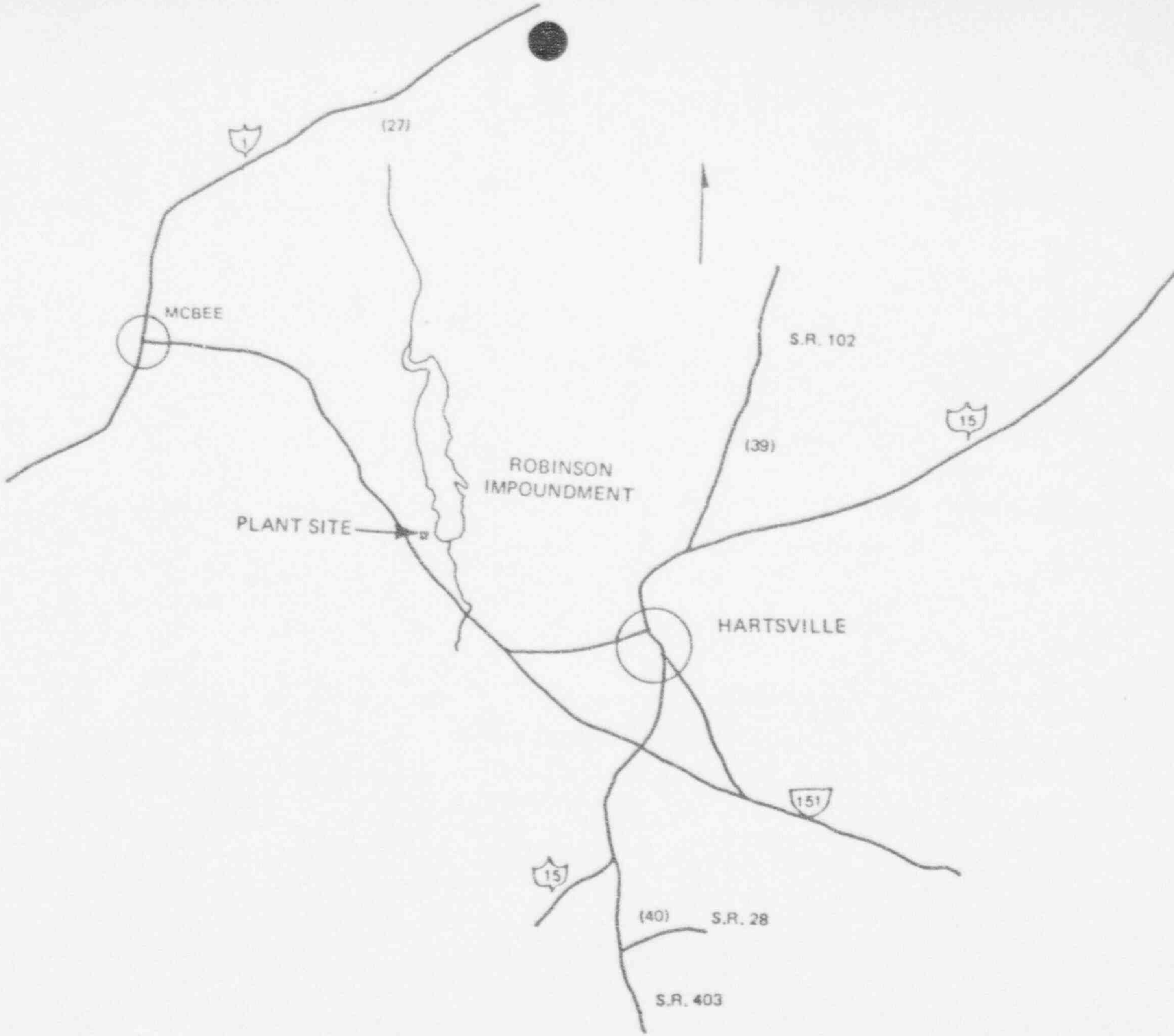
H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS



Environmental Report
Supplement No. 3
April 1975

Figure 2

H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS



Environmental Report
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Figure 3

H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS