ALABAMA POWER COMPANY'S ENVIRONMENTAL REPORT--OPERATING LICENSE STAGE

FOR THE
JOSEPH M. FARLEY
NUCLEAR PLANT

INTRODUCTION

The Environmental Report - Operating License Stage for the Joseph M. Farley Nuclear Plant Units 1 and 2 is submitted in response to the Atomic Energy Commission's revised Appendix D of 10 CFR 50. To achieve conformity with the Commission's Regulatory Guide 4.2, Preparation of Environmental Reports for Nuclear Power Plants, issued in final form in March, 1973, a cross-reference to the applicant's Environmental Report - Construction Permit Stage and the Commission's Environmental Statement has been developed as follows:

The Table of Contents of Regulatory Guide 4.2 was utilized as the base for the cross-reference system. Where material requested by Regulatory Guide 4.2 has been previously addressed in either the applicant's Environmental Report - Construction Permit Stage or the Commission's Environmental Statement, it is referenced to the appropriate section number in Regulatory Guide 4.2. Where supplemental information is supplied by the Environmental Report - Operating License Stage, appropriate reference to the added material is indicated.

It is the purpose of the cross-reference system to achieve conformity with Regulatory Guide 4.2 while avoiding repetition of material which has already been adequately covered in either the Environmental Report - Construction Permit Stage or in the Commission's Environmental Statement. This is consistent with the instructions given in General Discussion in Regulatory Guide 4.2, which state that the Environmental Report - Operating Stage is to be essentially an updating of the first report. Following the specific instructions of Regulatory Guide 4.2, additional information is furnished to:

1. Discuss differences between currently projected environmental effects of the nuclear plant and the effects discussed in the Environmental Report submitted at the Construction Stage.
2. Discuss the results of all studies which were not completed at the time of the pre-construction review and which were specified to be completed before the pre-operational review.
3. Describe in detail the monitoring programs which have been and which will be undertaken to determine the effects of the operating plant on the environment.
4. Discuss planned studies not yet completed.

Construction Permits CPPR-85 and CPPR-86 issued to the Alabama Power Company by the U.S. Atomic Energy Commission on August 16, 1972 were issued subject to the following four conditions for the protection of the environment:

(1) "The applicant will define a comprehensive environmental monitoring program (chemical, biological, thermal, and radiological), extending for at least one year of plant operation, and considered by the Regulatory staff to be adequate to determine changes which may occur in land and water ecosystems as a result of plant operations. If adverse effects are detected, the applicant will analyze the effects and provide a course of action to alleviate those attributed to plant operation. Data collected during the monitoring activities will be made available to the public through the Commission's local repository in Dothan, Alabama."

(2) "The applicant will develop and maintain a program for collecting comprehensive weather data from the site meteorological tower for a minimum of one year prior to the commencement of facility operations for the purpose of determining the frequency of natural occurring fogging

conditions; and by using analytical methods, calculate the extent of cooling tower plumes and determine the probability of incremental fogging over those sectors that can be attributed to plant facility operation. The information collected and the calculations will be made available to the public through the Commission's local repository in Dothan, Alabama. Although it appears unlikely, if significant adverse effects such as icing or fogging conditions which create a hazard to traffic are observed, the applicant will set up a system to warn the public about such hazards."

(3) "The applicant will obtain necessary specifications from the manufacturers of the cooling towers and the turbine generators and make a detailed calculation of the noise level at the site boundary paralleling Highway 95."

(4) "The applicant will install gaging equipment in the Chattahoochee River in the vicinity of the facility so that continuous flow conditions of the river can be recorded. Since the impact of entrainment of aquatic life depends upon the proportion of the total volume of river water that is diverted through the facility, the applicant will also make a further assessment of the impact of entrainment during minimum and average flow conditions."

Condition one above is specifically addressed in the following sections: 6.2.1 Radiological Monitoring; 6.2.2 Chemical Effluent Monitoring; 6.2.3 Thermal Effluent Monitoring; and 6.2.5 Ecological Monitoring.

Condition two of the Construction Permit is specifically addressed in Section 6.2.4, Meteorological Monitoring.

Condition three of the Construction Permit is addressed in Section 5.7.1, Cooling Tower Noise.

Condition four is addressed in Section 6.3.1, River Flow Monitoring.

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES APCO Environmental Report Construction Stage	 AEC Final Environmental Statement	ADDITIONAL INFORMATION SUPPLIED Section	 Page
1.	PURPOSE OF THE PROPOSED FACILITY				
1.1	Need for Power	1.1	X	1.1	1.1-1
1.1.1	Load characteristics	1.2	X		
1.1.2	Power supply	1.1 Appendix B.12	X		
1.1.3	Capacity Requirement	1.1 Appendix B.3	X		
1.1.4	Statement on area need			1.1.4	1.1-6
1.2	Other Objectives				
1.3	Consequences of Delay	Appendix B.3	X		
2.	THE SITE				
2.1	Site Location and Layout	1.2 2.1 2.2	II-A		
2.2	Regional Demography, Land and Water Use	2.4.8.1 through 2.4.8.10 2.4.4.1	II-B II-D	2.2	2.2-1
2.3	Regional Historic, Scenic, Cultural and Natural Landmarks	2.4.2	II-C		

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
2.4	Geology	2.4.3	II-D.1 II-D.3		
2.5	Hydrology	2.4.4 2.4.5 Appendix B.21 Appendix B.5	II-D.2		
2.6	Meteorology	2.4.6	II-D.4	2.6	2.6-1
2.7	Ecology	Appendix C-C 2.4.7 2.4.9	II-E	2.7 Appendix 1	2.7-1
2.8	Background radiological characteristics	4.1 4.8 Appendix B.20	V-D.5	2.8	2.8-1
2.9	Other Environmental Features				
3.	THE PLANT				
3.1	External Appearance	2.2 1.4.5	III-A		
3.2	Reactor and Steam-Electric System	2.2	I III-C		
3.3	Plant Water Use	2.2 3.2.4 3.3.1 3.3.2	V-B XII-C	3.3	3.3-1

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
3.3 (Contd.)	Plant Water Use (Contd.)	3.3.3.1			
		3.4.1			
		3.4.2			
		3.5.1			
		3.5.2			
3.4	Heat Dissipation System	2.2	III-C		
		3.2.4			
		3.3.3.1	III-B.1	3.4	3.4-1
		3.3.4			
		3.3.5	XII-C		
		3.4.1			
		3.6.4			
		3.6.5			
		Appendix B.1			
		B.5			
		B.6			
		B.7			
		B.8			
		B.11			
		B.13			
		B.14 thru			
		B.19			
3.5	Radwaste Systems	4.2	III-D.2	3.5	3.5-1
		4.3			
		Appendix A			
		Attach. K.8			

SECTION	TITAL ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
3.6	Chemical and Biocide Wastes	3.4.1 3.4.2 Appendix B.5 B.6 B.7 B.8 B.9 B.10 B.11 B.19	III-D.3 XII-B.5	3.6	3.6-1
3.7	Sanitary and Other Waste Systems	3.5	III-D.3		
3.8	Radioactive Materials Inventory	4.2.1		3.8	3.8-1
3.9	Transmission Facilities	2.2 2.3 3.2.1	III-B	3.9	3.9-1
4.	ENVIRONMENTAL EFFECTS OF SITE PREPARATION, PLANT AND TRANSMISSION FACILITIES CONSTRUCTION				
4.1	Site Preparation and Plant Construction	2.2 5.1 5.1.1 5.1.2 5.1.3 5.1.4 7.0	IV-A.1 VII-A		

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
4.1 (Contd.)	Site Preparation and Plant Construction (Contd.)	Appendix A Attach. K.15.5			
4.2	Transmission Facilities Construction	3.2.1 7.0	IV-A.2 VII-B	4.2	4.2-1
4.3	Resources Committed	7.0 8.0	IX		
5.	ENVIRONMENTAL EFFECTS OF PLANT OPERATION				
5.1	Effects of Operation of Heat Dissipation System	3.2.4 3.3.1 3.3.3.1 3.3.4 3.3.5 3.3.6 3.3.7 3.4.1 3.6.3 3.6.4 3.6.5 5.2.1 5.2.3 Appendix A Attach. K.1.1 K.1.2 K.2.1 K.2.2 K.3 K.4.1 K.11 Appendix B	V-A.3 V-B V-C VII-A XII	5.1	5.1-1
5.2	Radiological Impact on Biota Other Than Man			5.2	5.2-1
5.2.1	Exposure Pathways		V-C.1 V-C.2.d		5.2-1
5.2.2	Radioactivity in Environment	4.7	V-C.2.d V-C.1		5.2-1

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
5.2.3	Dose Rate Estimates		V-C.2.d V-C.1		5.2-3
5.3	Radiological Impact on Man			5.3	5.3-1
5.3.1	Exposure Pathways	4.4	V-D		5.3-1
5.3.2	Liquid Effluents	4.2.1.1 4.3.1 4.5.2 Appendix A Attach. K.8	V-C.2.d V-D.2 V-D.3.b		5.3-2
5.3.3	Gaseous Effluents	4.2.1.2 4.3.2 4.5.1 Appendix A Attach. K.8	V-D.1 V-D.3.a V-D.6 XII		5.3-3
5.3.4	Direct Radiation				
5.3.4.1	Radiation from Facility	4.4.1 4.6	XII-B		
5.3.4.2	Transportation of Radioactive Materials	4.2.1.3 3.2.2	V-E		
5.3.5	Summary of Annual Radiation Doses	4.5 4.6	V-D.3 V-E		5.3-3

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
5.4	Effects of Chemical and Biocide Discharges	3.4 Appendix A Attach. K.3 K.5.2 K.6	V-A.3 V-B V-C.2.C XII-B	5.4	5.4-1
5.5	Effects of Sanitary and Other Waste Discharges	3.5			
5.6	Effects of Operation and Maintenance of Transmission System	3.2.1	V-A.2		
5.7	Other Effects	3.2.3 Appendix A Attach. K.4.1	V-A.1 V-A.3	5.7	5.7-1
5.8	Resources Committed	7.0 8.0	VIII IX		
5.9	Decommissioning and Dismantling	Appendix B-30	IX		
6.	EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS				
6.1	Applicant's Preoperational Environmental Programs				
6.1.1	Surface Waters				

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
6.1.1.1	Physical and Chemical Parameters	2.4.4.2 2.4.5 3.7 Appendix B.5	V-C.3 XII-B	6.2.2 6.2.3 6.3	6.2-20 6.2-21 6.3-1
6.1.1.2	Ecological Parameters	2.4.5 2.4.7 2.4.9 3.7 3.8	V-C.3	6.2.5	6.2-24
6.1.2	Ground Water				
6.1.2.1	Physical and Chemical Parameters	2.4.4.1 3.3.2			
6.1.2.2	Models				
6.1.3	Air				
6.1.3.1	Meteorology	2.4.6 3.3.4	XII-B.3 XII-D	2.6	2.6-1
6.1.3.2	Models	Appendix A	V-A-3 XII-D		
6.1.4	Land				
6.1.4.1	Geology and Soils	2.4.3 2.4.4.1			
6.1.4.2	Land Use and Demographic Surveys	2.4.8.1 through 2.4.8.10	II-B		

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
6.1.4.3	Ecological Parameters	2.4.7 2.4.9	II-E		
6.1.5	Radiological Surveys	4.1 4.8	V-D.5	6.2.1.2	6.2-5
6.2	Applicant's Proposed Operational Monitoring Programs				
6.2.1	Radiological Monitoring				
6.2.1.1	Plant Effluent Monitoring System	4.2	V-D.5	6.2.1.1	6.2-1
6.2.1.2	Environmental Radiological Monitoring	4.7 4.8	V-D.5	6.2.1.2	6.2-5
6.2.2	Chemical Effluent Monitoring	3.3.4 3.4.1 3.4.2 3.4.3	XII-B.4	6.2.2	6.2-20
6.2.3	Thermal Effluent Monitoring	3.6.6 3.7	V-C.2.b	6.2.3	6.2-21
6.2.4	Meteorological Monitoring			6.2.4 2.6	6.2-23 2.6-1
6.2.5	Ecological Monitoring	3.6.6 3.7 3.8	V-C.3	6.2.5	6.2-24

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
6.3	Related Environmental Measurement and Monitoring Programs			6.3	6.3-1
7.	ENVIRONMENTAL EFFECTS OF ACCIDENTS				
7.1	Plant Accidents Involving Radioactivity	I. Introduction to 4.9	VI	7.1	7-1
3.0	Radwaste System Failure			7.2	7-13
3.1	Equipment Leakage or Malfunction	IV of 4.9	VI-A		
3.2	Release of Waste Gas Storage Tank Contents	IV of 4.9 IX of 4.9	VI-A		
3.3	Release of Liquid Waste Storage Tank Contents	IV-A of 4.9	VI-A		
5.0	Fission Products to Primary and Secondary Systems (PWR)			7.4	7-19
5.1	Fuel Cladding Defects and Steam Generator Leak	VI of 4.9	VI-A		

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
5.2	Off-design Transients That Induce Fuel Failures Above Those Expected and Steam Generator Leak (Such as Flow Blockage and Flux Maldistributions)	VI of 4.9	VI-A		
5.3	Steam Generator Tube Rupture	VI of 4.9	VI-A		
6.0	Refueling Accidents			7.5	7-28
6.1	Fuel Bundle Drop	VII of 4.9 VIII of 4.9	VI-A		
6.2	Heavy Object Drop onto Fuel in Core	VII of 4.9 VIII of 4.9	VI-A		
7.0	Spent Fuel Handling Accident			7.6	7-36
7.1	Fuel Assembly Drop in Fuel Storage Pool	VII of 4.9 VIII of 4.9	VI-A		
7.2	Heavy Object Drop onto Fuel Rack	VII of 4.9 VIII of 4.9	VI-A		
7.3	Fuel Cask Drop	VII of 4.9 VIII of 4.9	VI-A		

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
8.0	Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report			7.7	7-44
8.1	Loss of Coolant Accidents	IX of 4.9	VI-A		
	Small Pipe Break				
	Large Pipe Break				
8.1a	Break in Instrument Line from Primary System that Penetrates the Containment	III of 4.9	VI-A		
8.2a	Rod Ejection Accident	IX of 4.9	VI-A		
8.3a	Steamline Breaks (Outside Containment)	IX of 4.9	VI-A		
	Small Break				
	Large Break				
7.2	Other Accidents				
8.	ECONOMIC AND SOCIAL EFFECTS OF PLANT CONSTRUCTION AND OPERATION				

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
8.1	Benefits	3.1 3.2 Appendix A Attach. A C E F G	IV-4 XI-B		
8.2	Costs	Appendix A	IV-4 XI-B		
9.	ALTERNATIVE ENERGY SOURCES AND SITES				
9.1	Alternatives not Requiring the Creation of New Generating Capacity	1.0 6.0-A	XI-A		
9.2	Alternatives Requiring the Creation of New Generating Capacity				
9.2.1	Selection of Candidate Areas	1.2 1.3 1.5 6.0	I-A II-D.1 XI-A		
9.2.2	Selection of Candidate Site-Plant Alternatives	1.2 1.3 1.4 1.5 6.0	I-A II-D.1 XI-A		

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES APCO Environmental Report Construction Stage	AEC Final Environmental Statement	ADDITIONAL INFORMATION SUPPLIED Section	Page
9.3	Cost Effectiveness Comparison of Candidate Site-Plant Alternatives	1.2 1.3 1.4.3 1.4.4 1.4.5 1.4.6 1.4.7 1.5 6.0			
10.	PLANT DESIGN ALTERNATIVES				
10.1	Cooling System (Exclusive of Intake and Discharge)	3.2.4 3.3.3.2 3.4 1 6.0 Appendix A Appendix B.6 B.7 B.8 B.15 B.17	XI-A.3		
10.2	Intake System	6.0 Appendix B.14 B.16			
10.3	Discharge System				
10.4	Chemical Waste Treatment	6.0	XI-B.1.b		

SECTION	TITLE ENVIRONMENTAL REPORT (AEC GUIDE)	REFERENCES		ADDITIONAL INFORMATION SUPPLIED	
		APCO Environmental Report Construction Stage	AEC Final Environmental Statement	Section	Page
10.5	Biocide Treatment	3.4.1 6.0 Appendix B.6 B.7 B.8			
10.6	Sanitary Waste System				
10.7	Liquid Radwaste Systems				
10.8	Gaseous Radwaste Systems				
10.9	Transmission Facilities	3.2.1 6.0			
10.10	Other Systems	3.2.2 3.2.3 6.0	XI-A.4		
11.	SUMMARY BENEFIT-COST ANALYSIS	7.0 Appendix A Appendix B.9 B.22 B.23 B.24	XI-B	11.	11.-1
12.	ENVIRONMENTAL APPROVALS AND CONSULTATION	3.3.6 3.3.7 3.9 Appendix B.4	I-A	12.	12.-1

1.0 PURPOSE OF THE PROPOSED FACILITY

Some of the estimated peak load and generating capability figures contained in Section 1.1 of this report have been revised to reflect the most recent peak load forecasts, generating unit ratings and availability. For these reasons some of the figures in this section are not the same as corresponding data in the Construction Permit Stage Report and in testimony presented at the Environmental Hearing. In addition, because of various factors beyond the control of Alabama Power Company, the scheduled initial operation of Farley Unit No. 1 has been delayed. This delay is such that the unit will not be available during the 1975 summer peak load season. The schedule for Unit No. 2 will be essentially unchanged and the in-service date will be prior to the summer of 1977.

Table 1.1-1 shows the present estimate and two previous estimates of 1975 peak loads for Alabama Power Company and the other operating companies of the Southern system. This tabulation shows that the present estimate of the diversified Southern system peak load has been reduced by 609 MW since the load estimate of two years ago which was current at the time of the environmental hearing for the Farley Nuclear Plant on July 10-12, 1972. 1

At this environmental hearing, Mr. J. H. Miller, Jr., Senior Vice President of Alabama Power Company, testified that based on the planned additions of generating capacity and current estimates of 1975 peak loads, Alabama Power Company's generating reserves would amount to 21.7% with Farley #1 in service and 11.8% without Farley #1. He further testified that the Southern System generating reserves would amount to approximately 17.6% with Farley #1 in service and approximately 14.5%

without Farley #1. Using present estimates of 1975 load, plans for
generating additions, purchases, and sales, Alabama Power Company's
system reserves will amount to 8.9% of load without Farley #1. However, 2
the Southern System reserves will amount of 17.3% of load.

Alabama Power is planning to obtain power through contractural 1
arrangements with its neighboring companies of the Southern System as
needed during 1975 to insure reliable system operation.

Section 1.1.4 of this report contains a statement on area need for the southeastern region.

1.1 NEED FOR POWER

Alabama Power Company's maximum territorial peak hour demand reached 5248.6 megawatts on July 23, 1973. (This load does not include 78.1 megawatts of load supplied to certain municipalities and co-operatives for the account of the Southeastern Power Administration, nor do the load and generating capacity figures which follow include this amount of capacity. This peak includes 115.7 megawatts of load of customers with interruptible contracts that were interrupted at this time at the request of Alabama Power Company. The actual load supplied was 115.7 megawatts less or 5132.9 megawatts). 1

The Company's long-term average annual compounded growth rate has been approximately 8.3 percent over a 20 year period. Based on studies of trends of past load growth, as well as studies of expected increases in sales of energy at load factors consistent with past experience, the maximum territorial peak hour demands in future years are estimated as follows:

1974 - 5,586 megawatts

1975 - 6,059 megawatts

1976 - 6,576 megawatts

1977 - 7,136 megawatts

The long term growth trends and future estimated loads are shown graphically on Figure 1.1-1.

The estimated future load growth is based on the most recent projections of the actual load growth experienced through the summer of 1973.

This projected rate of load growth is consistent with the trend for the entire United States. Since 1965 the demand for electric power in the United States has increased at an annual average compounded rate of approximately 8 percent.[1] The Federal Power Commission in its National Power Survey,[2] published in 1964, demonstrated a long term growth rate for the period 1920-1963 equivalent to an annual average compounded growth rate of 7.2 percent. The 1970 National Power Survey[3] predicted an even higher annual rate of load growth in the future than the 1964 Survey. The estimated 1980 nationwide electric energy requirement was placed at 2.8 trillion kilowatt-hours in the 1964 Survey. The 1970 Survey predicted that the 1980 electric energy requirement will reach 3.07 trillion kilowatt-hours, and the 1990 level was placed at 5.8 trillion kilowatt-hours. President Nixon's Energy Message to Congress[4] in April 1973 recognized a continuation in the growth of electric load and assigned the highest priorities to the research and development needed to provide new sources of electric energy to meet expected requirements. These and other studies establish strong justification that the load growth experienced in the past will continue in future years.

Prior to the time that the Farley Nuclear Plant is constructed and placed in service, the Company plans to construct and place in service Gaston #5 coal fired generating unit of 910 megawatts net capability presently under construction.

With the completion of this generating unit, the assignment
of older coal fueled units to standby service and adjustment in planned
purchases and sales of power to other utilities, the Company's total
generating capability in 1975 will be 6598 megawatts. 2

To provide for adequate system reliability, Alabama Power
Company plans its generation additions so that each year its total
generating capability will exceed its estimated territorial system peak
hour load by approximately 20% of this load. This 20% reserve in 1
generation is based on 3% to account for load swings within the peak
hour, 2% for operating margins, and 15% to allow for forced outages of
generating units.

Comparing the above 1975 generating capability of 6598 2
megawatts with the forecast 1976 peak load of 6576 megawatts, it is
apparent that unless additional generating capacity is added in 1976,
the reserve margin will be only 0.33% of the estimated peak load in 2
1976. After Farley #1 is placed in service in 1976 as proposed, various
anticipated adjustments are made in the purchase and sale of capacity to
others, and the postponement of planned additional hydro capacity due
to licensing delays, the Company's total generating capability in 1976

will be 7416 megawatts. This will result in a generating reserve margin in 1976 amounting to 12.8% of load.

Comparing the above 1976 generating capability of 7416 megawatts with the forecast 1977 peak load of 7136 megawatts, it is apparent that unless additional generating capacity is also added in 1977, the reserve margin will be an unacceptable 3.9% of the estimated 1977 peak load. After Farley #2 and 100 megawatts of combustion turbines are placed in service in 1977 as proposed, various anticipated adjustments are made in the purchase and sale of capacity to others, and the postponement of planned additional hydro capacity due to licensing delays, the Company's total generating capability in 1977 will be 8335.0 megawatts. This will result in a generating reserve margin in 1977 amounting to 16.8% of load.

Alabama Power Company is a wholly owned subsidiary of the Southern Company and is closely interconnected with the other subsidiaries - Mississippi Power Company, Gulf Power Company and Georgia Power Company. Because of the physical integration of the facilities of all these companies in accordance with the Securities & Exchange Commission's approval under the Public Utilities Holding Company Act of 1935, consideration is also given to the needs of the entire Southern Company system in the planning of additional generating capacity on the Alabama Power Company system.

The peak hour load on the Southern Company system in 1976 is estimated to be 20,410 megawatts. At the end of 1975 it is estimated that the total Southern Company system generating capability will be

21,832 megawatts. In 1976 the estimated peak hour load plus generating reserve requirements, based on 20% of peak load, will amount to 24,492 megawatts. It is therefore apparent that additional generating capacity is needed in 1976 on the Southern Company System to meet acceptable reserve requirements. With the addition of Farley #1 in 1976 and other planned generating additions on the Southern System, it is estimated that the total generating capability in 1976 will be 24,277 megawatts resulting in a reserve margin of 19% of the estimated peak hour load.

The peak hour load on the Southern System in 1977 is estimated to be 22,480 megawatts. Comparing this load with the estimated 1976 generating capability of 24,277.0 megawatts, it is apparent that additional generating capacity is also needed in 1977 on the Southern System to meet acceptable reserve requirements. With the addition of Farley #2 in 1977 and other planned generating additions on the Southern System, it is estimated that the total generating capacity in 1977 will be 26,725.0 megawatts resulting in a reserve margin of 18.9% of the estimated peak hour load.

Information on capacity, load and reserves in 1975 without Farley No. 1 and in 1976 with and without Farley No. 1 is shown in Table 1.1-2.

---

[1] Electrical World, 22nd Annual Electrical Industry Forecast (September 15, 1972).

[2] National Power Survey, Vol. 1, U. S. Government Printing Office, 1964, p. 10.

[3] The 1970 National Power Survey, Part 1, U. S. Government Printing Office, December 1971, page 1-1-12.

[4] President Nixon's Energy Message to Congress, Vol. 19, No. 17, Atomic Energy Clearing House, dated April 23, 1973.

TABLE 1.1-1
1975 SYSTEM PEAK HOUR LOAD ESTIMATES

(Excluding SEPA)

Megawatts

	Year	Ala.	Ga.	Gulf	Miss.	Southern System (Diversified)
1. Load estimates of September 1971 (In effect at time of Farley environmental hearing of July 10-12, 1972.)	1975	6,111	10,578	1,269	1,443	19,219
2. Present load estimates of September 1973.	1975	6,059	10,028	1,285	1,412	18,610
3. Present load estimates as compared to load estimates at time of environmental hearing. (Comparison of Items 1 and 2.)	1975	- 52	- 550	+ 16	- 31	- 609

1

Amend. 1 - 11/30/73

TABLE 1.1-2

ESTIMATED GENERATING CAPABILITIES, LOAD AND RESERVES IN 1975 WITHOUT FARLEY NO. 1 AND IN 1976 WITH AND WITHOUT FARLEY NO. 1

Alabama Power Company

1975

Generating Capability without Farley No. 1	6598 MW
Estimated Peak Load	6059
Reserves	539
Reserves as % of Load	8.9

1976

Generating Capability with Farley No. 1	7416 MW
Estimated Peak Load	6576
Reserves	840
Reserves as % of Load	12.8
Generating Capability without Farley No. 1	6609 MW
Reserves without Farley No. 1	33
Reserves as % of Load	0.5

2

Southern System

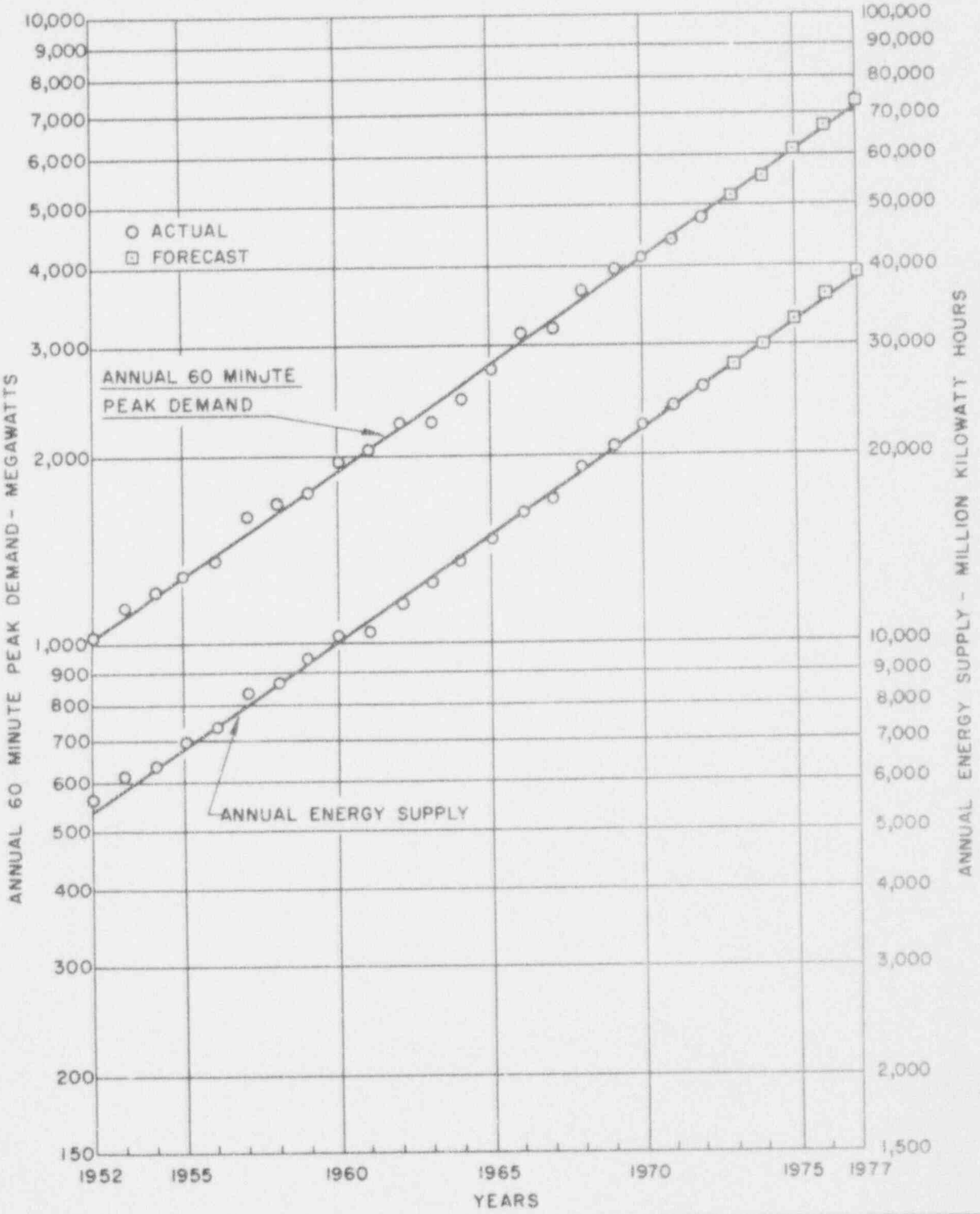
1975

Generating Capability without Farley No. 1	21832 MW
Estimated Peak Load	18610
Reserves	3222
Reserves as % of Load	17.3

1976

Generating Capability with Farley No. 1	24277 MW
Estimated Peak Load	20410
Reserves	3867
Reserves as % of Load	19.0
Generating Capability without Farley No. 1	23470 MW
Reserves without Farley No. 1	3060
Reserves as % of Load	15.0

NOTE: The above generating capabilities are based on the latest generation expansion plan 74A1.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ANNUAL 60 MINUTE PEAK DEMAND AND ANNUAL ENERGY SUPPLY

FIGURE 1.1-1

1.1.4 Statement of Area Need

Included in this section is a copy of the preamble of the Southeastern Electric Reliability Council's "Coordinated Bulk Power Supply Program - 1973-1982", dated April 1, 1973. This document was prepared in response to the Federal Power Commission's Order No. 383-2 of April 10, 1970. Copies of the complete report were supplied by the Southeastern Reliability Council to Dr. Paul C. Fine of the U.S. Atomic Energy Commission, Bethesda, Maryland, and to Mr. Tucker Arnold of the U.S. Atomic Energy Commission, Oak Ridge, Tennessee.

The preamble of this report is included here to show the need for the generating capapability of the Farley Nuclear Plant as part of the total capability of the Southeastern region.

As mentioned in the first page of this preamble, it is the consensus of the utilities in this region that an expression of reserves in percent of load is not necessarily a valid measure of the adequacy or reliability of power supply. Within the region are systems that experience peak loads in the summer and others with winter peaks. The types and inherent reliability of individual generating units in the region vary widely. Because of these and other factors, a uniform regional criteria for establishing minimum generating reserves has not been adopted.

Table III of the preamble is a tabulation of estimated regional summer and winter peak capabilities, load responsibilities, and reserves for the years 1973 through 1982. This tabulation includes the capability of Farley Unit No.1 beginning in 1975 and Unit No. 2 starting in 1977. The delay in the initial operating date of the Farley No. 1 unit until the fall of 1975 will reduce the 1975 regional summer capability from 106, 340 MW as shown in Table III to

105,533 MW. The regional reserves will be reduced from 21,534 MW to 20,727 and the regional reserves expressed as a percentage of load responsibility (net system load plus firm sales minus firm purchases) will be reduced from 25.0% to 24.0%.

The 1976 regional summer reserves, including Farley Unit No. 1, is estimated to be 22,518 MW or 23.9% of load responsibility, as shown in Table III. Withouth Farley No. 1 in 1976, the regional reserves would be reduced to 21,711 MW and 23.1%.

The 1977 regional summer reserve, including Farley Units No. 1 and No. 2, is estimated to be 22,714 MW or 22.2%, as shown in Table III. Without Farley No. 1 and No. 2, the regional reserves would be reduced to 21,063 MW and 20.6%.

From these comparisons, it can be seen that the Farley Nuclear Plant is very significant not only to supply the power needs of Alabama Power Company and the Southern system, but is an important and necessary resource in the southeastern region.

SOUTHEASTERN ELECTRIC RELIABILITY COUNCIL

Coordinated Bulk Power Supply Program

April, 1973

PREAMBLE

After the filing of the April, 1972 Report, the Southeastern Electric Reliability Council (SERC) adopted criteria for reliability in system planning, which are in keeping with the goals and objectives of SERC. They serve as guidelines for the planning within the region to avoid cascading-type outages.

The entire region is now reporting its load forecasts for one-hour net demands for normal weather. Uniform generator ratings are established under SERC guidelines which yield summer and winter ratings on a common definition.

Since most peak loads are highly weather sensitive, it should be recognized that on a probability basis, peaks in excess of those being reported are likely to occur. It is felt normal weather forecasts better suit the purpose of this and other reports, with respect to comparing day-to-day operations and reserves. It is the consensus that an expression of reserves in percent is not necessarily a valid measure of adequacy or reliability of power supply.

Those using this report should recognize summer and winter ratings of generators are not precise, as actual capability depends upon cooling water temperatures, air temperatures, hydro pond levels, cleanliness of heat transfer devices, quality of fuel, etc. Combustion gas turbine ratings are particularly sensitive to ambient air temperature.

Since SERC covers such a large geographical area and, in fact, its subregions spread over wide temperature zones, then a simple summation of load and capability by months and seasons can lead to erroneous conclusions because diversity of peaks is not analyzed in the statistics.

The tabulations in this report of future projects, particularly those in the second half of the reporting period, do not necessarily indicate a committed course of action; uncertainties in market conditions, rate relief, availability of sites, and many other extenuating factors dictate a prudent approach of providing for alternate courses of action wherever possible so that the latest information may be used before a decision is made.

TABLE I

ESTIMATED PEAK HOUR LOAD REQUIREMENTS - SERC (1)

Monthly Loads

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1973												
Peak Hour - MW	63785	62348	58967	55328	56935	66088	68295	69994	65940	60521	62369	67387
1974												
Peak Hour - MW	71197	69611	65602	61032	63128	73930	76028	77845	72300	66078	69006	73397

Seasonal Peak Loads

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Summer - MW	70018	77879	84806	92642	101000	110069	119911	130587	142072	154489
	1973-4	1974-5	1975-6	1976-7	1977-8	1978-9	1979-0	1980-1	1981-2	1982-3
Winter - MW	71197	77528	83959	91464	99273	107795	117016	126946	137634	149188

(1) Undiversified summation of loads of four subregions of SERC.

TABLE II

PROJECTED CAPACITY INCLUDING ADDITIONS BY TYPE - SERC

		End of Year									
		1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Fossil Steam	MW	62354	67627	72453	75888	78028	80276	84760	88167	92272	96026
	%	72.7	68.3	64.6	64.1	61.8	59.3	57.8	55.2	52.6	50.1
Nuclear Steam	MW	6563	12025	17688	19802	24839	28650	32781	39671	46211	49411
	%	7.7	12.2	15.8	16.7	19.7	21.4	22.3	24.8	26.3	25.8
Hydro & Pumped Storage	MW	9285	10040	11836	12136	12388	12628	14228	14568	14715	15640
	%	10.8	10.1	10.5	10.4	9.8	9.4	9.7	9.1	8.4	8.1
Comb. Turbine & Diesel	MW	7584	9303	10253	10553	10953	11591	12191	12769	13976	14126
	%	8.8	9.4	9.1	8.8	8.7	8.6	8.3	8.0	8.0	7.4
Undetermined	MW	-	-	-	-	-	1100	2750	4580	8280	16520
	%	-	-	-	-	-	0.8	1.9	2.9	4.7	8.6
Total	MW	85786	98995	112230	118379	126208	134245	146710	159755	175454	191723
	%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE III

ESTIMATED CAPABILITY - INTERCOUNCIL EXCHANGE - RESERVE - SERC

		Peak Hour Load - MW	Council Capability	Firm Power From			Total Capability	Load Respons.*	Reserve	
				ECAR	MAIN	SWPP			MW	% LR*
1973	Summer	70018	82800	+1050	-260	-1500	82090	71445	12072	16.9
1973-4	Winter	71197	86216	+ 400	+260	+1800	88676	68769	17479	25.4
1974	Summer	77879	93877	+ 650	-260	-1500	92767	79306	14888	18.8
1974-5	Winter	77528	99425	+ 100	+260	+1500	101285	75400	23757	31.5
1975	Summer	84806	107700	+ 400	-260	-1500	106340	86233	21534	25.0
1975-6	Winter	83959	112660	- 200	+260	+1500	114220	81831	30261	37.0
1976	Summer	92642	116520	+ 400	-260	-1500	115160	94069	22518	23.9
1976-7	Winter	91464	118809	- 200	+260	+1500	120369	89336	28905	32.4
1977	Summer	101000	125074	+ 400	-260	-1500	123714	102427	22714	22.2
1977-8	Winter	99273	126638	- 200	+260	+1500	128198	97125	28925	29.8
1978	Summer	110069	133066	+ 400	-260	-1500	131706	111496	21637	19.4
1978-9	Winter	107795	134675	- 200	+260	+1500	136235	105667	28440	26.9
1979	Summer	119911	143427	+ 400	-260	-1500	142067	121338	22156	18.3
1979-0	Winter	117016	147140	- 200	+260	+1500	148700	114888	31684	27.6
1980	Summer	130587	156002	+ 300	-260	-1500	154542	132114	23955	18.1
1980-1	Winter	126946	160185	- 300	+260	+1500	161645	124918	34699	27.8
1981	Summer	142072	171562	+ 300	-260	-1500	170102	143599	28030	19.5
1981-2	Winter	137634	175884	- 300	+260	+1500	177344	135606	39710	29.3
1982	Summer	154489	189823	+ 300	-260	-1500	188363	156016	33874	21.7
1982-3	Winter	149188	192153	- 300	+260	+1500	193613	147160	44425	30.2

* Load Responsibility is net system load plus firm sales and minus firm purchases.

1.4 ENERGY CONSERVATION

During a site visit on March 11-13, 1974, representatives of the Atomic Energy Commission requested information related to energy conservation. Their requests dealt with the advertising program of Alabama Power Company, the regulatory environment under which the Company operates, and several aspects of Alabama Power Company's interruptable loads and history of load shedding. The AEC staff members also asked about the impacts of energy conservation activities in Alabama Power Company's service area. This section of Amendment 2 of the Environmental Report is submitted in response to those inquiries. The AEC requests for information were as follows:

A. Describe the duration and intensity of the advertising programs conducted by the applicant during the last three years. If promotional advertising has been terminated, when was this type advertising terminated?

B. Identify the regulatory commissions or bodies that regulate the retail price of electricity in the applicant's service area.

C. Describe the various types of interruptible sale contracts that the applicant has. Provide the size (MWe) of interruptible sales for each type described.

D. Describe the applicant's record of load shedding and load curtailment methods used in the last five years. Information should be supplied as cumulative duration of time by month and by methods. This information should include 3% voltage reductions, 5% voltage reductions, curtailment of electric power usage by the utility, voluntary curtailment by large commercial and industrial customers, and discontinuing service to contractually interruptible loads.

2

E. Describe any impact on demand resulting from the recent conservation activities in the applicant's service area.

Responses to the above are given as follows in the order presented.

A. Information on Advertising Programs

Alabama Power Company's advertising includes both institutional and sales promotional advertising programs.

Institutional advertising informs the Company's customers about matters affecting their electric service and urges customers to use electricity more efficiently.

Sales promotional advertising is directed primarily toward increasing the acceptance of off-peak uses of electricity, such as electric heating and security lighting. 2

1971 Institutional advertising in 1971 called attention to the recreational value of the Company's lakes, explained efforts by the Company to restore service during emergency interruptions, encouraged industrial development in Alabama, promoted Alabama Power's Nuclear Visitors Center in Dothan, Alabama, and gave the Company's customers information about matters affecting their electric service.

A campaign entitled "Out of the Dark" was placed in newspapers and magazines and on television stations in early 1971. Subjects included an explanation of expenditures necessary for the Company to continue its extensive construction program, the Company's record for reliable service, the necessity to continue the Company's construction program to meet future customer demand for electricity, and efforts by the Company to maintain a reasonable balance between providing electric service and environmental quality.

Sales promotional advertising in 1971 included a campaign explaining the benefits of the electric heat pump, "rural promotion," a "commercial sales" campaign, "Parade of Homes" advertising, "incentive" advertising, and "dealer promotions."

Advertising supporting merchandise sales by the Company in 1971 included not only direct mail, newspaper and radio advertising, but also ten-second television commercials aired in Birmingham, Montgomery and Mobile.

Amond the brochures produced in 1971 were "The Joseph M. Farley Nuclear Visitors Center," "How to get the most from your electric heat pump," "Walk into the World of Nuclear Power . . .," "The Joseph M. Farley Nuclear Plant --Its vital statistics," a series of rural brochures, and "Assured service for your electric heat pump." 2

Alabama Power in 1971 also participated in "Southern Company" advertising and in the "Electric Companies Advertising Program" (ECAP). ECAP is an industry communications program which serves participating investor-owned electric light and power companies at the national level. The theme of "Southern Company" advertising in 1971 was "working toward tomorrow, today." As an operating member of The Southern Company system, Alabama Power pays a pro rata share of The Southern Company's advertising program. Ads placed in national magazines discussed efficiencies of "power-sharing," the System companies' investments for environmental protection, System recreational facilities provided by hydroelectric impoundments, research on solvent-refining of coal by the System companies, and other subjects.

Advertising under the ECAP program in 1971 included such topics as the safety of nuclear power generation and the country's growing demand for electric power.

1972 In 1972, the Company developed a campaign entitled "Electricity, How to use it for all it's worth." The energy conservation campaign included newspaper advertisements and thirty-second television commercials placed monthly in media in the Company's area: in daily and weekly newspapers, on television stations, and in selected magazines including Alabama School Journal, Alabama Clubwoman, Birmingham Magazine, Mr. County Commissioner, and Southern Living. This advertising suggested to customers ways to use electricity more efficiently for cooking, heating and cooling, lighting, and operating household appliances. The advertisements and commercials invited customers to send for a free brochure which contained 64 energy-saving tips. During 1972 and 1973, more than 84,000 of these brochures were distributed upon request at the Company's offices.

"Emergency interruptions to service" messages were aired on television and run in newspapers in the Company's area on an "as needed" basis. 2

Industrial development advertising in 1972 was placed to encourage those who influence industrial site selection to consider locations in the Company's area. Four-color and black-and-white advertisements were placed in magazines, including American Banker, Area Development, Chemical Week, and Iron Age.

To inform the public of the necessity for nuclear generating facilities and to attract visitors to the Company's Nuclear Visitors Center, newspaper and radio advertisements were prepared and placed primarily in media reaching audiences in the southeastern portion of the state.

Recreational advertising in 1972 was a continuation of the program begun in 1971, depicting the lakes created by the Company's eleven hydroelectric impoundments as excellent, free facilities for swimming, fishing, and other family activities. "Recreational" advertisements were placed in daily and weekly newspapers in the Company's area in May 1972 and in Birmingham Magazine. Flood easement ads were also placed as necessary, explaining and warning residents at the Company's lakes of flood easement areas.

In 1972, the Company again participated in "Southern Company" advertising and in the "Electric Companies Advertising Program." Among the subjects discussed by "Southern Company" advertising were efforts by The Southern Company system to protect natural resources, savings realized through the coordinated operation of the system's power pool program, 2 and experiments by the system to determine the economic feasibility of solvent refining of coal. ECAP advertising, placed in national magazines, discussed the value of electricity, nuclear power plants, electricity's role in efforts to improve the environment, and other subjects.

Through its sales promotional advertising in 1972, the Company continued to promote off-peak load by conducting "incentive" advertising programs. Qualifying builders and developers of all-electric homes, apartments, and commercial buildings, or dealers installing electric heating or electric heat pumps, and dealers of all-electric mobile homes received advertising for specified units of electric heating installed or sold.

The Company also produced an advertising campaign assisting dealers of electric appliances in the Company's area and produced campaigns in magazines directly encouraging builders to develop and build all-electric homes, apartments and commercial buildings.

"Rural" advertising was developed encouraging customers to contact Company Rural Sales Representatives for free consultation services to assist customers in a more effective utilization of electric heating systems, feed handling systems, outdoor lighting, electric motors, automatic timing devices, and other farm uses of electricity.

Merchandise advertising in 1972 promoted sales activities at the Company's offices. "Sales" were advertised in newspapers, on radio, and through direct mail.

"Brochures" produced by Alabama Power during 1972 included maps of the Company's lakes, "Wiring Assistance for Mobile Homes and Parks," and "Electricity. How to use it for all it's worth."

<u>1973</u> Institutional messages in 1973 discussed the Company's expenditures for construction to meet the growing demand for electricity, efforts by the Company to keep electricity a good value, reasons why customers' bills rise in summer months, and expenditures made by the Company to provide a proper balance between electric service and environmental quality. 2

Advertisements were placed in fourteen daily newspapers and eighty-four weekly newspapers in the Company's area with one advertisement being placed each month. Ninety-inch advertisements were placed in daily newspapers with morning and evening editions; seventy-inch advertisements were placed in other dailies, and thirty-inch advertisements in weekly newspapers.

Sixty-second television commercials were broadcast on stations in Birmingham, Montgomery, Mobile, Anniston, and Tuscaloosa.

In addition, advertisements explaining Company efforts to restore electric service during emergency interruptions were placed in local media when conditions warranted.

Industrial development advertising was prepared to attract new industry to Alabama. Advertising was directed primarily at metal smelting, metal fabrication, and chemical industries. Advertisements were placed one to six times during 1973 in a total of seven industry-oriented publications.

Recreation advertising explaining the recreational value of the lakes created by Alabama Power's hydroelectric impoundments was continued; a one-page, black-and-white advertisement was placed in Southern Living magazine in May and July for this purpose. Information on fishing opportunities and recreational maps was made available by the Company to interested persons. 2

Advertising also was placed in selected publications to explain the economics of the electric industry to business leaders and others who have an interest in the matter.

Sales promotional programs during 1973 included the promotion of electric applicance sales by dealers in the Company's area; a campaign highlighting the uses of electricity on the farm; promotions supporting total-electric home sales during "Parade of Homes" activities; and advertising used as incentrives to encourage the installation of electric heating by builders and dealers.

"Incentive programs" were conducted to encourage builders of homes and apartments and commercial building developers to install electric heating. Programs were also conducted to encourage mobile home dealers to stock and sell total-electric mobile homes and to encourage certified heating and heat pump dealers to sell and install electric heating.

In 1973, "commercial development" advertising was utilized by the Company for the first time. Its purpose--similar to that of industrial development advertising--was to encourage commercial developers and realtors to locate new shopping centers, department stores, and other commercial projects in Alabama. Two black-and-white, small-space ads were prepared and placed in National Real Estate Investor and in Shopping Center World.

Black-and-white advertisements ran in selected rural magazines calling attention to the Company's rural specialists as expert sources of free information concerning efficient uses of electricity on the farm.

"Parade of Homes" advertising was provided for local "home show" promotions when requested by the Company's six geographic divisions. 2

The "builder/realtor program" consisted of two black-and-white advertisements placed in construction industry magazines read primarily by builders, realtors, and architects. The ads were designed to inform electric heating prospects of Alabama Power's free consultation service regarding the efficient uses of electric lighting, year-round comfort conditioning, food service equipment, and water heating.

Advertising placed in city directories consisted of full-page, quarter-page, and one-sixteenth page black-and-white advertisements.

During 1973, two advertising campaigns promoting the sale of electric appliances by the Company were conducted. In addition, the Company participated in other advertising programs, providing a pro rata share of funds for advertising sponsored by The Southern Company.

During 1973, The Southern Company placed advertisements in national and regional magazines to discuss such topics as earnings, coal reserves, electric rates, construction requirements, and research and development.

Also, Alabama Power provided a pro rata share of funds for the Electric Companies Advertising Program.

B. Regulatory Commissions

The Alabama Public Service Commission is the only regulatory commission or body possessed with authority to regulate the retail price of electricity in the Company's service area.

C. Interruptible Sales Contracts

The Company has two basic types of interruptible sales contracts in force. One is to be used with customers served at Rate LPL (Light and Power - Large), and the other for use with customers served at Rate HLF (High Load Factor Industrial Power). The principal difference in the two is that the former provides for a credit to the customer of $9.00 per KVA per year (0.75 per KVA per month) for the interruptible capacity contracted for, whereas the latter provides for a credit of $10.00 per KW of the interruptible capacity contracted for. The remainder of the provisions is essentially the same, i.e. 2

(a) that normally, notice of such interruptions will be given to the customer 24 hours in advance but that in emergencies, the notice can be for substantially shorter periods, as little as 15 minutes;

(b) that the maximum number of interruptions shall be two per day, eight hours per day, 40 hours per week and 600 hours per year.

D. Load Shedding and Load Curtailment

1. Contingency plans for operating in emergency situations and for possible load reduction or curtailment are described in the letter (copy attached) from Mr. Jesse S. Vogtle to Mr. Kenneth F. Plumb, Secretary of the Federal Power Commission, dated July 12, 1973.

2. Attached are excerpts from the formal report of the Southern Company System disturbance of August 7, 1973, which depicts the load reduction by underfrequency relays in the affected area. This describes the method used by the applicant in effecting load shedding.

Throughout its history, Alabama Power Company has had a comprehensive program to design, construct and operate its electric system for maximum reliability. Over the years its service reliability has been 99.98 percent. 2

The system disturbance of August 7, 1973, described in the attachment, represents the only instance within the last five years where Alabama Power Company has experienced an involuntary load reduction, other than by acts of nature. Furthermore, it has not requested voluntary curtailment by large commercial or industrial customers within this period.

ALABAMA POWER COMPANY
600 NORTH 18TH STREET — P. O. Box 2641
BIRMINGHAM, ALABAMA 35291 — (205) 323-5341

JESSE S. VOGTLE
Vice President Public Affairs

July 12, 1973

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

Pursuant to the Commission's Order No. 445 (Docket No. R-405) issued January 11, 1972, adding a new Section 2.10 to the Commission's regulations with respect to reliability of electric service, the company voluntarily furnished in my letter of March 7, 1972, its contingency plans for operating in emergency situations and for possible load reduction or curtailment. The company now wishes to revise such contingency plan by adding a new procedure "e." and changing existing procedure "e." to "f." in the Voluntary Load Curtailment section. The revised contingency plan is as follows; and as requested, our submission is made in duplicate.

Alabama Power Company is a member of The Southern Company system. The Southern Company system is comprised of Alabama, Georgia, Gulf, and Mississippi Power Companies and is operated on a fully integrated and coordinated basis. Each of the operating companies is a member of the Southeastern Electric Reliability Countil (SERC) and through SERC is a member of the National Electric Reliability Countil (NERC). In addition to normal contractural agreements with interconnected neighbors, The Southern Company system has bilateral reliability agreements with the Virginia-Carolina Companies, Florida Power Corporation, Middle South System, and Tennessee Valley Authority. These agreements provide for coordination of planning and operation of generation and transmission facilities, maintenance schedules, selective load retainment programs, emergency operation, and other matters affecting bulk power supply. 2

Integrated and coordinated system operation is provided by the Power Coordination Office (PCO) of Southern Services, Inc., located in Birmingham, Alabama; and this office operates under guidelines established by an Operating Committee, comprised of operating representatives of the four operating companies and of Southern Services, Inc., a wholly owned service company of The Southern Company. A primary responsibility of this office is the coordination of operation of system resources in such a manner to assure reliability of bulk power supply. Current information available at the PCO includes the following:

1. Power flows on transmission tie lines with neighboring systems.

2. Power output of system generating resources.

3. System frequency

4. Availability of generating resources.

5. System operating reserves (load-capacity comparisons).

6. Capacity available from neighboring systems.

7. Load-capacity situation of neighboring systems.

8. General assessment of system transmission loadings and voltage conditions.

Most of the above information is obtained through the control offices of the respective operating companies and of neighboring systems. However, provisions are being implemented in a Power System Coordination Center (PSCC), now under construction, whereby system conditions (line loadings, voltages, etc.) will be available continuously in the PSCC. 2

General procedures for minimizing the consequences of bulk power supply interruptions or shortages are accomplished in the following order:

1. Load-capacity comparisons are continuously made and operating reserves assessed.

2. Operating reserves are estimated several hours in advance (as well as estimates for several days in advance), and the operating companies are advised of system conditions.

3. If operating reserves are anticipated to be below desired levels, interconnected neighbors are contacted and regional conditions generally assessed. Commitments for receipt of power are made as required and as available.

4. Should it become necessary to obtain additional operating reserves, the operating companies are requested to reduce interruptible loads under contract.

5. If operating reserves are anticipated to be less than desired, the respective control offices of the operating companies are notified for any preliminary action which may be required.

6. Continued shortages or reduction of operating reserves is monitored by the PCO, and requests would be next initiated to the operating companies to implement load curtailment based upon the procedures established by the individual operating companies.

Interruptible loads under contract would, if necessary, be reduced to prevent interconnected neighbors from interrupting firm customer load because of emergency conditions.

In summary, the role of the PCO is to act as a coordinating group and to assure adequacy of bulk power supply to the system. No actual switching orders are initiated by the PCO, since switching is under the direction of the operating companies, but proper coordination is made by the PCO should intercompany or interconnected transmission lines be involved.

In the event of a notice from the Power Coordination Office (PCO) of a pending bulk power supply shortage, Alabama Power Company plans to place into effect the following procedures to the extent considered necessary, and in the order named:

Voluntary Load Curtailment 2

a. Utilize the interruptible capacity available from industrial customers in accordance with provisions of contracts with such customers.

b. Reduce and reschedule production plant station service load in a manner that does not affect the reliability and integrity of generating capability.

c. Reduce nonessential electrical loads at all company offices and warehouse facilities. This load encompasses such areas as lighting, air conditioning, heating, etc.

d. Request preselected industrial customers to make capacity available by means such as increasing customer-owned generation, reducing nonessential load, reducing actual load and, if time permits, rescheduling processes to effect curtailment of load during a specified time period.

e. Request all customers to reduce unessential load, such as lighting and air conditioning, by public appeal through news media.

f. Request rescheduling of water pumping and other electrical load to effect a curtailment of load during a specified time.

Involuntary Load Curtailment

a. Place into effect, through standing orders and instructions, provisions for manual load shedding. This procedure incorporates length of interruption to preselected and classified feeders.

b. Automatic selective load shedding, underfrequency relays are installed as part of a selective load retention program for conditions where there is an excess of load over available generation which results in a rapid decline of system frequency and it is not possible to implement manual corrective action in time to avoid intolerable frequency levels. The purpose of this application is to interrupt load of sufficient magnitude to conserve essential load and enable the system to recover from the underfrequency condition.

In addition to the above, Alabama Power Company has designed and applied a scheme to automatically load its hydroelectric generating units when system frequency drops to a specified level. Operation of this scheme is initiated at a frequency above that at which underfrequency selective load retention would be initiated.

We are furnishing a copy of this plan, in duplicate, to the Alabama Public Service Commission and the Southeastern Electric Reliability Council. 2

Yours very truly,

Jesse S. Vogtle

JSV:gdt

cc: Alabama Public Service Commission
Post Office Box 991
Montgomery, Alabama 36102

Southeastern Electric Reliability
Council
c/o Mr. Wm. R. Brownlee
Administrative Manager
Daniel Building
Birmingham, Alabama 35233

General

The system disturbance was initiated at approximately 7:53 a.m. on August 7, 1973, and the approximate territorial load and resources serving the load on The Southern Company System were as follows:

System Gross Load	11,472 MW
System Gross Generating Including SEPA	10,234 MW
System Net Receipts	1,238 MW
Gross Available Capability Including SEPA	14,165 MW

Generation

Of the total generation shown above, there was approximately 3,745 MW of generation in the area which was subsequently isolated. This generation is shown in Table I.

2 A list of generation which was unavailable for service for various reasons is shown in Table II. Also included in Table II is the ICA peak-period net megawatt capability for the steam units not in service.

Unit	Normal Net Peak-Period Generation
Gorgas Unit No. 10 (Alabama Power Company)	697 MW
Bowen Unit No. 1 (Georgia Power Company)	690 MW
Hammond Unit No. 4 (Georgia Power Company)	495 MW
Branch Unit No. 3 (Georgia Power Company)	257 MW
	2,139 MW

Table II. Generating Units Not In Service

All the above steam units are located in the northern portion of The Southern Company system causing a deficit of generation in that portion. A large portion of that deficit was being supplied by generating plants in the subsequently isolated Gulf Coast quadrant of the system producing a heavy flow out of that area.

Hydroelectric output in the northern portion of the system was abnormally cut back to zero due to the requirement to conserve energy for use during the peak demand period of the day. SEPA (Southeastern Power Administration) hydroelectric plants were operating at practically zero output as they normally would for the early part of the day in question.

General Description of System Reaction

Upon the initial breaker operations which tripped from service all lines out of the McIntosh substation(1), a number of line outages occurred in a cascading fashion resulting in the complete isolation of the Southwest quadrant of The Southern Company system from the interconnection. 2

Immediately upon separation, frequency in the isolated area increased rapidly and stabilized at approximately 61.2 Hz.

Figures 1 and 2 are the strip charts from frequency recorders located in the Gulf Power Company Control Office and the Power Coordination Office in Birmingham, respectively. Figure 3 is an expanded time scale reproduction of frequency in the isolated area over the time of the disturbance - approximately 7½ minutes. It should be noted that at about 2 minutes after the initial disturbance, the frequency deviation shows the point at which apparently the Watson No. 4 unit was isolated from the network by breaker operation. At about 3 1/3 minutes, the effects of an unsuccessful reclosing of the Watson-SW Hattiesburg 230 kV line is seen. The chart also shows that at about 3½ minutes after the initial disturbance frequency began a slow downward trend reducing to below 60 Hz and triggering under-frequency relays.

Load reduction by underfrequency relays in the affected area was approximately as follows:

Alabama Power	130 MW
Mississippi Power	90 MW
Gulf Power	40 MW

Investigations thus far indicate that because of the continued oscillation of the various units, as well as continued high frequency, attempts were being made to reduce firing on the units to prevent subsequent damage. It is difficult to ascertain all of the automatic controls and operator action which may have been affecting the downward trend of generation, but the probable explanation is general reduction of generation, along with possible load increase during the morning pickup, resulted in sufficient deficit of generation to drive frequency through the first two steps of underfrequency relaying. 2

The reduction of load by underfrequency relaying apparently helped to arrest the frequency decline and to begin restoration toward 60 Hz at about the same time the Logtown breaker was reclosed, thus stabilizing the isolated area and resulting in subsequent automatic and manual reclosing of lines. System loads tripped by underfrequency were then reconnected to the system with all loads being restored by 8:45 a.m.

---

[1] Detailed discussion of initial breaker operations included in Section IV.

E. Impact of Recent Conservation Measures

The Company's projected and actual maximum territorial demands in kilowatts for the winter of 1973-1974 are given below:

	November	December	January	February
Projected	4,090,000	4,085,000	4,142,000	4,062,000
Actual	3,694,600*	4,024,400**	3,619,900	3,974,700***

* Includes actual 92.7 of interruptibles off on peak

** Includes actual 103.5 of interruptibles off on peak

*** Includes actual 130.8 of interruptibles off on peak

Above loads exclude 78.1 MW of load in Alabama supplied by Southeastern Power Administration (SEPA) and also excludes firm power sales to Alabama Electric Cooperative, Inc. 2

Due largely to the abnormally mild weather experienced throughout most of this period, it is difficult to determine how much of this reduction can be attributed to weather and how much can be attributed to conservation measures. The Company is currently developing methods to make that determination.

TABLE 1.4-1

INTERRUPTIBLE CUSTOMER CONTRACTS(1) (2)

Customer	Location	Total kVA	Interruptible kVA	Expected kW Reduction Upon Notice	Energy Rate Mills/kWh(5)
Alabama					
Abex Corporation	Calera	12,500 (3)	5,000	5,000	5.2
		15,000 (4)			(7)
Alpha Portland Cement	Birmingham	6,000	3,000	3,000	5.3 (8)
H. K. Porter Company	Birmingham	27,000	8,500	5,700	5.2
Coosa River Newspring	Childersburg	75,000	15,000	15,000	4.0 (6)
Diamond Shamrock Chemical	Mobile	16,000	6,500	6,300	4.0 (6)
Griffin Wheel Company	Birmingham	11,000	5,000	4,000	4.9
International Paper Co.	Mobile	16,000 (3)	5,000	4,100	5.2
		24,000 (4)			(7)
National Cement Company	Ragland	10,000	5,000	4,900	5.2
Republic Steel Corp.	Gadsden	75,000 (3)	20,000	-	5.2
		100,000 (4)			(7)
Southern Electric Steel	Birmingham	16,400	8,200	7,500	5.2
U.S. Steel Corp. - Fairfield	Birmingham	135,000	35,000	35,000	5.2
Woodward Iron Company	Birmingham	15,000	7,500	7,500	5.2
Total (As of March 1, 1974)		414,900 (3)	123,700	98,000	
		450,400 (4)			

Notes:
(1) Twenty-four hour notice time; in emergencies, a minimum of 15 minutes is required.
(2) Maximum of 2 suspensions per day; 8 hours per day; 40 hours per week; 600 hours per year.
(3) Effective 7AM-9PM.
(4) Effective 9PM-7AM.
(5) Basic rate does not include fuel cost adjustment or tax adjustment.
(6) Rate computed from 0.26¢ adjustment for each 0.1% departure from 90% load factor. Equivalent rate is about 4.0 mills.
(7) This contract has a Rate Rider RN (night time capacity).
(8) 5.2 mills plus 1.8% FT Tax adjustment or approximately 5.3 mills net.

2

2.2 Regional Demography, Land and Water Use

Figures 2.2-1 through 2.2-4 give revised projections of population distributions for the vicinity of the Joseph M. Farley Nuclear Plant. This revision was made to reflect the 1970 census.

Population projections within the 1 to 5 mile radius of the plant site were based on a dwelling count of the area. Population was then estimated on the "average population per occupied unit" from the 1960 census. Since the study was undertaken prior to 1970 census data, a comparison indicated the 1960 data gave a higher or more conservative estimate than the 1970 census.

Population projections within the 5-50 mile radius are based on estimates derived from reference 1. Population projections for the 5-50 mile radius were made in the following manner:

1. Total population and rural population for each county was projected for the years 1975, 1985, 1995, 2005, and 2015 by linear interpolation of the estimates mentioned above.
2. The major city population projections were based on percentage growth as estimated for the county.
3. The rural population of each county was divided by the area of that county.
4. The area of each county in the radial sectors was determined.
5. Rural population in a sector was determined as the product of the area and the population per square mile.
6. Total population was the sum of the rural population and the population of any cities in the sector.

---

1. Environmental Protection Agency, Region IV. Population By County-Historic (1940-1970) and Projected (1980-2020), Region IV. Atlanta, Georgia. EPA, 1972.

The Environmental Report - Construction Permit Stage, stated that there were no known downstream users of the Chattahoochee River or Apalachicola River for drinking water. Recent investigations have revealed that the city of Port St. Joe, Florida could possibly obtain water from the Apalachicola River.

The intake for the Port St. Joe Paper Company is on the Chipola River near the junction of the Chipola and Apalachicola. This is approximately 122 miles downstream of the Farley Plant. The city of Port St. Joe purchases water from the St. Joe Paper Company. 1

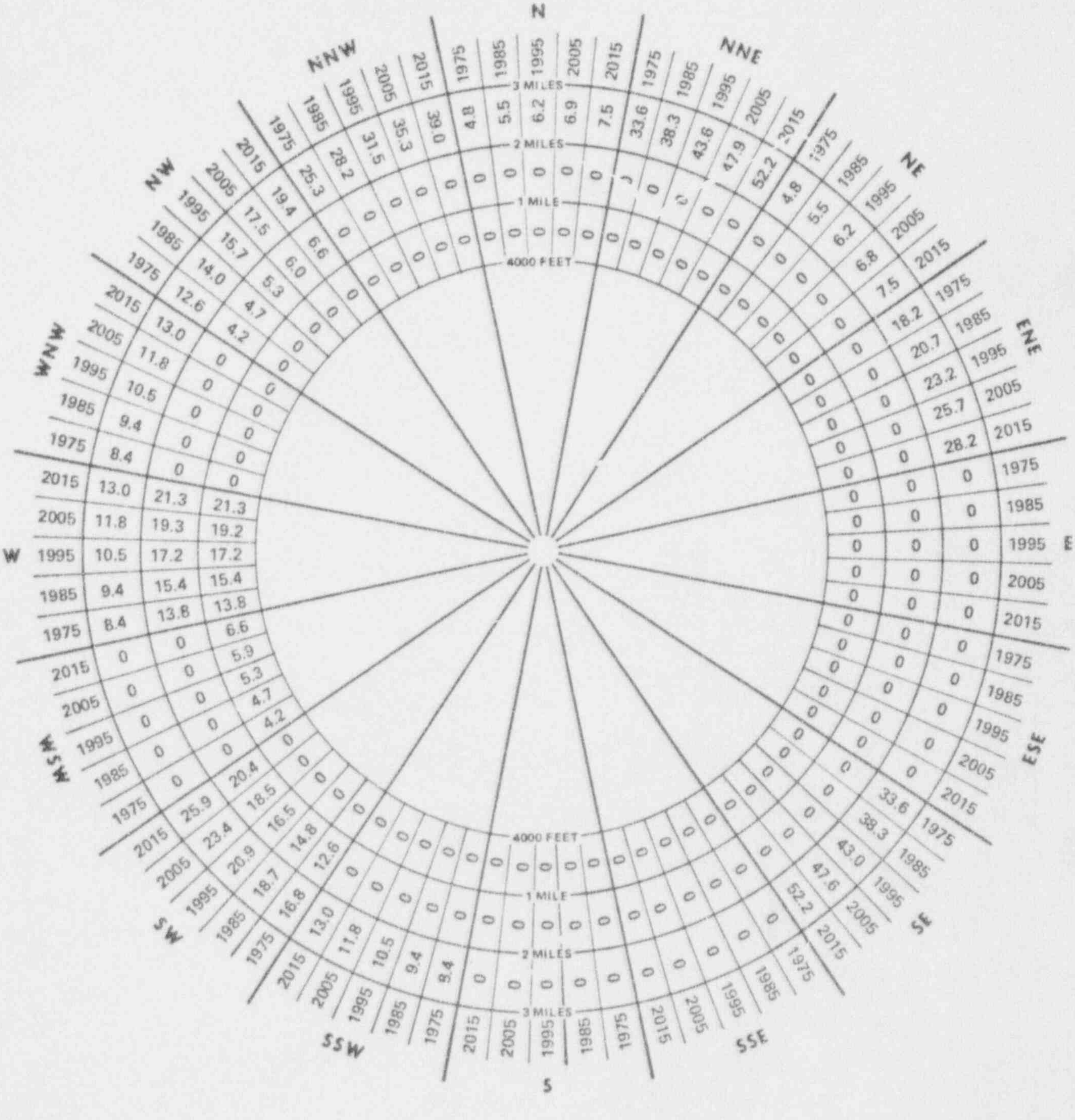
The paper company representatives have stated that under high flow conditions, the water drawn by their intake is mostly from the Apalachicola River while under low flow conditions the Chipola River water is predominate.

Table 2.2-1 list all downstream users of water which could be affected by the Farley Nuclear Plant.

TABLE 2.2-1

JOSEPH M. FARLEY NUCLEAR PLANT
DOWNSTREAM USERS OF RIVER WATER

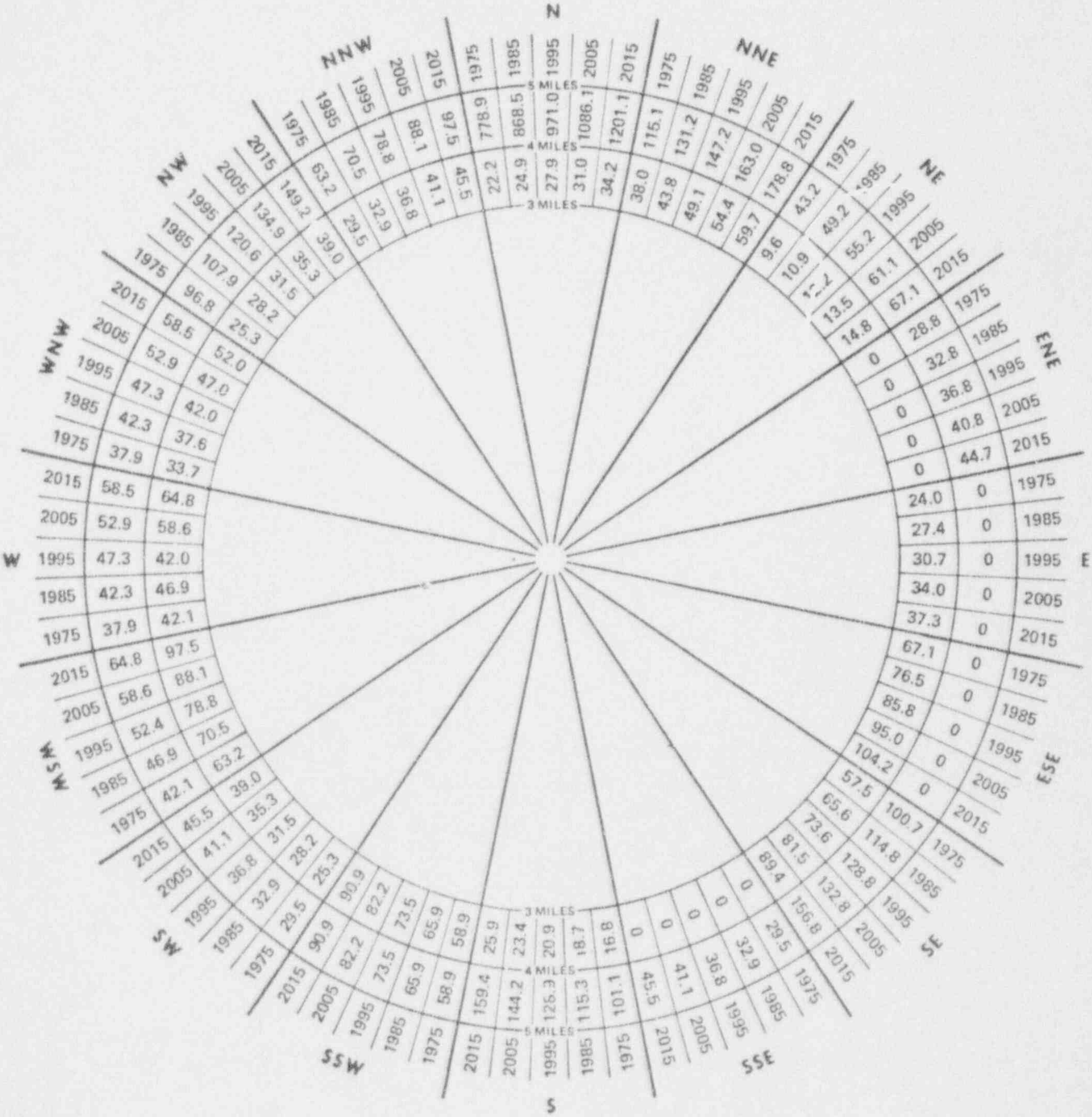
Agricultural		
Mr. Lemuel Mercer	Approximately 20 river miles downstream of Farley - Uses a maximum of 576,000 gallons per day during dry weather.	
Mr. Herman Rowan	Approximately 20 river miles downstream of Farley - Uses a maximum of 1,728,000 gallons per day during dry weather.	
Industrial		
Great Northern Paper Company	Approximately 4 river miles downstream of Farley - Average use 112 mgd.	1
St. Joe Paper Company	On the Chipola River approximately 122 river miles downstream of Farley - Maximum use of 48 mgd to supply the following: 1. St. Joe Paper Company 30 - 45 mgd. 2. Basic Magnesium Company 60 Mg per month 3. City of Port St. Joe, Florida - 20 Mg per month.	
Municipal		
City of Port St. Joe, Florida	As noted above	



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
0-3 MILES

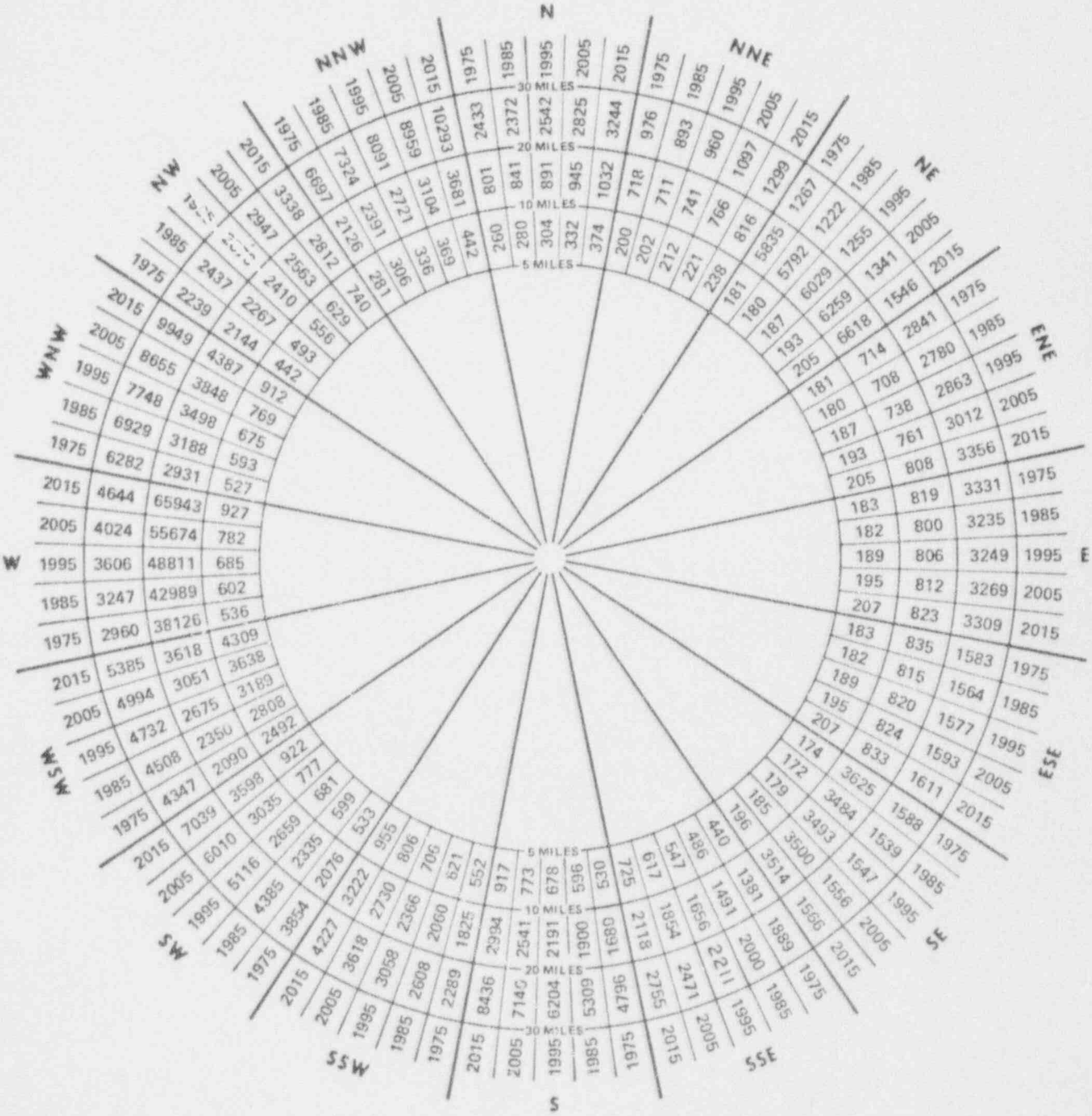
FIGURE 2.2-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
3-5 MILES

FIGURE 2.2-2

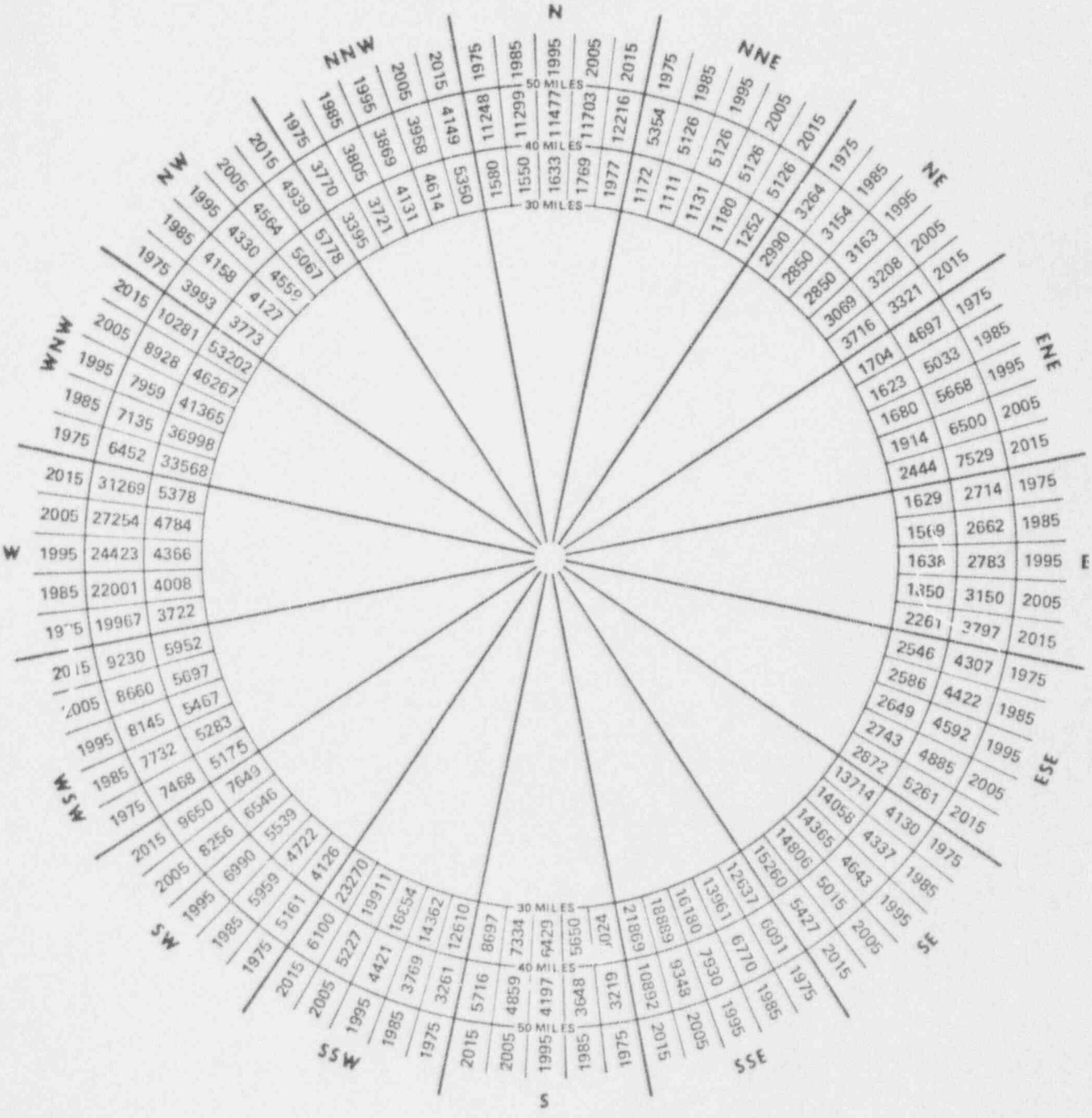


N	1975	2433	801	260
N	1985	2372	841	280
N	1995	2542	891	304
N	2005	2825	945	332
N	2015	3244	1032	374
NNE	1975	976	718	200
NNE	1985	893	711	202
NNE	1995	960	741	212
NNE	2005	1097	766	221
NNE	2015	1299	816	238
NE	1975	1267	5835	181
NE	1985	1222	5792	180
NE	1995	1255	6029	187
NE	2005	1341	6259	193
NE	2015	1546	6618	205
ENE	1975	2841	714	181
ENE	1985	2780	708	180
ENE	1995	2863	738	187
ENE	2005	3012	761	193
ENE	2015	3356	808	205
E	1975	3331	819	183
E	1985	3235	800	182
E	1995	3249	806	189
E	2005	3269	812	195
E	2015	3309	823	207
ESE	1975	1583	835	183
ESE	1985	1564	815	182
ESE	1995	1577	820	189
ESE	2005	1593	824	195
ESE	2015	1611	833	207
SE	1975	1588	3625	174
SE	1985	1539	3484	172
SE	1995	1547	3493	179
SE	2005	1556	3500	185
SE	2015	1566	3514	196
SSE	1975	1889	1381	440
SSE	1985	2000	1491	486
SSE	1995	2211	1656	547
SSE	2005	2471	1854	617
SSE	2015	2755	2118	725
S	1975	4796	1680	530
S	1985	5309	1900	596
S	1995	6204	2191	678
S	2005	7140	2541	773
S	2015	8436	2994	917
SSW	1975	2289	1825	552
SSW	1985	2608	2060	621
SSW	1995	3058	2366	706
SSW	2005	3618	2730	806
SSW	2015	4227	3222	955
SW	1975	3854	2076	533
SW	1985	4385	2335	599
SW	1995	5116	2659	681
SW	2005	6010	3035	777
SW	2015	7039	3598	922
WSW	1975	4347	2090	2492
WSW	1985	4508	2350	2808
WSW	1995	4732	2675	3189
WSW	2005	4994	3051	3638
WSW	2015	5385	3618	4309
W	1975	2960	38126	536
W	1985	3247	42989	602
W	1995	3606	48811	685
W	2005	4024	55674	782
W	2015	4644	65943	927
WNW	1975	6282	2931	527
WNW	1985	6929	3188	593
WNW	1995	7748	3498	675
WNW	2005	8655	3848	769
WNW	2015	9949	4387	912
NW	1975	2239	2144	442
NW	1985	2437	2267	493
NW	[illegible]	[illegible]	2410	556
NW	2005	2947	2563	629
NW	2015	3338	2812	740
NNW	1975	6697	2126	281
NNW	1985	7324	2391	306
NNW	1995	8091	2721	336
NNW	2005	8959	3104	369
NNW	2015	10293	3681	442

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
5-30 MILES

FIGURE 2.2-3



N	1975	1580	11248
N	1985	1550	11299
N	1995	1633	11477
N	2005	1769	11703
N	2015	1977	12216
NNE	1975	1172	5354
NNE	1985	1111	5126
NNE	1995	1131	5126
NNE	2005	1180	5126
NNE	2015	1252	5126
NE	1975	2990	3264
NE	1985	2850	3154
NE	1995	2850	3163
NE	2005	3069	3208
NE	2015	3716	3321
ENE	1975	1704	4697
ENE	1985	1623	5033
ENE	1995	1680	5668
ENE	2005	1914	6500
ENE	2015	2444	7529
E	1975	1629	2714
E	1985	1569	2662
E	1995	1638	2783
E	2005	1350	3150
E	2015	2261	3797
ESE	1975	2546	4307
ESE	1985	2586	4422
ESE	1995	2649	4592
ESE	2005	2743	4885
ESE	2015	2872	5261
SE	1975	13714	4130
SE	1985	14058	4337
SE	1995	14365	4643
SE	2005	14806	5015
SE	2015	15260	5427
SSE	1975	12637	6091
SSE	1985	13961	6770
SSE	1995	16180	7930
SSE	2005	18889	9348
SSE	2015	21869	10892
S	1975	024	3219
S	1985	5650	3648
S	1995	6429	4197
S	2005	7334	4859
S	2015	8697	5716
SSW	1975	12610	3261
SSW	1985	14362	3769
SSW	1995	16654	4421
SSW	2005	19911	5227
SSW	2015	23270	6100
SW	1975	4126	5161
SW	1985	4722	5959
SW	1995	5539	6990
SW	2005	6546	8256
SW	2015	7649	9650
WSW	1975	5175	7468
WSW	1985	5283	7732
WSW	1995	5467	8145
WSW	2005	5697	8660
WSW	2015	5952	9230
W	1975	3722	19967
W	1985	4008	22001
W	1995	4366	24423
W	2005	4784	27254
W	2015	5378	31269
WNW	1975	33568	6452
WNW	1985	36998	7135
WNW	1995	41365	7959
WNW	2005	46267	8928
WNW	2015	53202	10281
NW	1975	3773	3993
NW	1985	4127	4158
NW	1995	4559	4330
NW	2005	5067	4564
NW	2015	5778	4939
NNW	1975	3395	3770
NNW	1985	3721	3805
NNW	1995	4131	3869
NNW	2005	4614	3958
NNW	2015	5350	4149

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
30-50 MILES

FIGURE 2.2-4

2.6 Meteorology

2.6.1 Data Sources

Regular meteorological observations have been made at Dothan, Alabama, 16 miles to the west, and at Blakeley, 15 miles northeast of the plant site. Some observations of temperature, precipitation (24-hour rainfall) and wind have been recorded over a period of 30 to 50 years between 1902 and 1954, at Dothan and summarized in a "Climatological Summary" for Dothan.

Hourly wet bulb and dry bulb temperatures at Dothan Airport were obtained for the period 1940-52; records were also obtained from a rain gauge which was operated at the Airport during the 10-year period 1940-50. Observations of temperature and precipitation have been made at Blakeley from 1877 to the present.

The site elevation is about 150 feet lower than the meteorological station at Dothan Airport and the other locations in or near Dothan where the temperature observations were made before the present airport weather station was established. The site elevation is about 100 feet lower than the locations where the Blakeley observations have been made. Therefor the site should have slightly higher maximum temperatures, but probably by no more than one or two degrees, than those recorded and discussed below for Dothan and Blakeley. At the site, minimum temperatures are likely to be somewhat lower than recorded at Dothan and Blakeley because of the more "valley-like" location, but differences are not expected to be significant.

The closest "first order" meteorological stations are at Montgomery, Alabama, 100 miles to the northwest, and Apalachicola, Florida, 110 miles to the south-southeast of the site. The estimates of frequencies of strong winds, heavy precipitation and humidity over periods less than 24 hours are derived mainly by interpolation between these and other first order stations. This procedure is considered accurate for general meteorological information where the topography is relatively flat as it is in this region.

The on-site meteorological measurement program has been in operation since March, 1971. A one-year period of record of these data has been summarized in this section. A magnetic tape containing five years of WBAN records from the Dothan Airport was obtained from the National Climatic Center, and was evaluated for the period 1950-54. These data appear in the appropriate subsections below and are referred to as "Five Years of Record from Dothan Airport".

The instruments for measuring pertinent meteorological parameters at the site are installed on a 240-foot tower located in a cleared area north of the plant site. The data are not affected by large plant structures. Instrument elevations and descriptions are given in Table 2.6-1.

2.6.2 Temperature, Dewpoint and Humidity Data

Average daily mean, maximum and minimum temperatures, absolute highest and lowest temperatures during the period of record, frequencies that temperatures were above and below various limits in different calendar months, and other temperature statistics for Dothan and Blakeley are listed in Tables 2.6-2, 2.6-3 and 2.6-4. The periods of these records are not the same, being about 30 years, from 1925 through 1954 at Dothan and from 1941 through 1970 at Blakeley. Some of the differences in the average temperatures for the two stations are possibly due to a general cooling trend during the last two or three decades.

The average daily maximum temperature is highest during the period of June through August, being 92°F at Dothan and 91°F at Blakeley. The average maximum in December is 62°F and in January 63°F at Dothan. At Blakeley in December it is 62°F and January 61°F. The daily minimum temperatures average 41°F at Dothan and 40°F at Blakeley in December and January. The maximum on record at Dothan is 104°F, and 107°F at Blakeley. The lowest minimum temperature recorded for either station was -1°F at Blakeley on February 13, 1899. The lowest recorded at Dothan was 12°F. During the periods of the observations summarized in the references, the temperatures at Dothan and Blakeley remained at or below 32°F on less than one day in two years, and the maximum temperature exceeded 90°F on about 100 days a year at Dothan and 89 days at Blakeley.

Figure 2.6-1 shows the monthly averages and the average of the daily extremes of dry bulb temperatures, based on five years of record at the Dothan Airport.

Water Vapor

Average hourly relative humidity for each month of the year, based on observations made during the period 1940 through 1952 at Dothan are listed in Table 2.6-5. These illustrate that the climate is humid, with average afternoon humidities around 60% in winter and 55% in summer. The air is driest in spring and autumn, with average afternoon relative humidity of about 45% in May. Figures 2.6-2 and 2.6-3 show the monthly averages and averages of the daily extremes of wet bulb temperature and dewpoint temperature based on five years of record from the Dothan Airport. Figures 2.6-4 and 2.6-5 show the daily and monthly averages of extremes of relative and absolute humidity respectively, based on the same airport data

2.6.3 Wind Characteristics

The mean wind speed for each month and the most frequent wind direction for Dothan are listed in Table 2.6-6. The fastest monthly average winds occur in winter and spring, with a maximum of 10 mph in March; and the slowest, in summer, about six mph. Figures 2.6-6, 2.6-7 and 2.6-8 are monthly, seasonal and annual wind roses for the five years of record from the Dothan Airport. Figures 2.6-9, 2.6-10 and 2.6-11 are monthly, seasonal and annual wind roses for a complete year as measured at the 50 ft. level at the Farley meterological station. The strongest sustained winds on record are given in terms of the "fastest mile" of wind. This information is not available for Dothan or Blakeley. At Apalachicola, where the strongest sustained winds are due to hurricanes, the speed for the "fastest mile" during the period of record (26 years to 1970) was 67 mph in September, 1947. At Montgomery, the speed for the fastest mile on record is 69 mph, which occurred in March, presumably associated with an extratropical storm though this has not been verified. Fastest sustained winds at the site are expected to be due to extratropical storms in winter and spring, as at Montgomery. From the distribution of extreme winds analyzed by Thom(2) it is expected that the magnitudes of extreme sustained winds at Dothan will be somewhat less than those at Montgomery. Thom has fitted extreme wind data to a statistical distribution allowing extrapolation to higher speeds.

Atmospheric Stability

Parameters which can be used to determine atmospheric stability are being measured at the site at low levels (i.e., less than 200 ft.) in the on-site meteorology program. Table 2.6-7 shows joint frequencies of occurrence of wind speed and direction for seven vertical temperature difference groups, based on the first full year of on-site data. Table 2.6-8 shows joint frequency of occurrence of wind speed and direction for seven direction range groups, based on on-site data. Both tables are from the 50 ft. speed and direction instrument, with wind speed extrapolated to the 33 ft. level. Vertical temperature difference is that between the 200 ft. and 35 ft. levels.

2.6.4 Precipitation Data

Table 2.6-6, precipitation data, shows the average total monthly, the maximum and minimum observed in a month, and the maximum 24, 48, and 72-hour period totals observed at Dothan during the approximately 33-year period of record. The largest monthly totals occur in summer, and the largest monthly total on record is 20 inches. The maximum 24-hour precipitation recorded at Dothan was 9.0 inches. At Blakeley, the maximum 24-hour rainfall during the 1941-1970 period was 6.7 inches. Figures 2.6-12 and 2.6-13 are seasonal and annual precipitation wind roses, respectively, based on five years of record from Dothan Airport.

Due to the low relief of this region the terrain has relatively little influence on the meteorology. However, the topography affects the drainage of cold air in winter as illustrated by the statement that "there is considerable irregularity in the distribution of the last spring or first fall freezes in all sections".(1) Due to the inland location of the site, the strong winds associated with tropical storms and hurricanes are much reduced.

2.6.5 Storms Accompanied by High Velocity Winds

2.6.5.1 Heavy Precipitation

Heavy rain lasting for several hours in this region is usually associated with tropical storms or hurricanes. Heavy rainfall for shorter times is usually caused by thunderstorms in summer.

Rainfall estimates of 30 minute to 10 day recurrence periods have been presented in Technical Papers Nos. 40 and 49 (3,4), in the form of maps and are shown in Table 2.6-9. The maximum recorded rainfalls for periods of one hour to 24 hours at Dothan, 16 miles west of the site, in the ten-year period 1941-1950, when a recording raingage was in use, are listed in Table 2.6-10. These agree closely with the ten-year recurrence interval values for the corresponding times, shown in Table 2.6-9.

2.6.5.2 Hail

Severe hailstorms are infrequent in the area. The occurrences of heavy hail (greater than 3/4 inch) number approximately 5 in 13 years or about one every two or three years, for a one degree (latitude and longitude) "square" (see Figures 2.6-14 and 2.6-15).

2.6.5.3 Ice Storms

Freezing rain resulting in heavy ice loading is very rare in this area. Bennett(5) refers to one study in which no glaze storms were reported for the 28-year period ending with the winter of 1952-1953. However, one study referred to by Bennett showed at least one storm was observed in this area during the nine-year period 1928-1929 to 1936-1937. According to this study, the accumulation of ice did not reach 0.25 inches.

2.6.5.4 Thunderstorms

The incidence of thunderstorms is significant in relation to associated weather including strong winds, heavy precipitation and lightning. The frequency of strong winds associated with thunderstorms is included under the heading "strong winds", below, and heavy precipitation has already been discussed.

The average number of thunderstorms per year reported by observers at Montgomery, 100 miles to the northwest, is 61 with the majority occurring from April to September, and the peak in July. At Apalachicola, Florida, 110 miles to the south-southeast, the distribution is similar except that the peak number occurs in August, with an annual average of 62.

2.6.5.5 Tornadoes

The probability of a particular point being affected by a tornado is a function of the average number of tornadoes occurring in a given region and the average area covered by a tornado. Figures 2.6-16 and 2.6-17 give tornado occurrences in the United States by 2° and 1° squares respectively. Based on a 40-year record(6), the number of tornadoes reported for the two degree square in which the site is located, is one to two per year. In 1955-67 the average number of tornadoes for the one degree square, including the site, was about 1.5 per year, or approximately six per year for the two degree square. The recent increase is typical for these kinds of data, and arises in part from increased public awareness of tornadoes and more complete reporting. Since even the latter frequency may be an underestimate of the true frequency, a conservative estimate would be twice that reported for the latter period, or three per year for the one degree square.

A typical maximum tornado may be about a quarter of a mile wide; be in contact with the ground for about 10 miles; and cover an area of about 1-1/2 square miles. The one degree square at this latitude has an area of approximately 4000 square miles. A conservative estimate of the probability of a given point being affected by a tornado is therefore approximately one in 500, calculated as follows:

$$\frac{2\text{-}1/2 \times 3}{4000} = \frac{1}{500}.$$

Thus, a given point might be expected to be affected by a tornado once in 500 years.

2.6.5.6 Strong Winds

The frequency of strong winds, 50 knots or greater, as estimated from damage reports, has been analyzed in WBTM, FCST 12(7) for the 13-year period 1955 through 1967. The results given in Figures 2.6-18 and 2.6-19 show frequencies for two degree and one degree squares, respectively. For the site, the number of occurrences for the 13-year period is about 50 per two-degree square and 16 for the one-degree square. Since a considerable number of occurrences are likely to be overlooked or unreported, a reasonable conservative estimate would be about twice the given frequencies, or approximately 2-1/2 per year for the one-degree square of about 4000 square miles.

2.6.5.7 Probabilities of High Wind Speeds Due to Tornadoes

The probability of a given point in the site being exposed to strong winds, greater than a given value, has been estimated considering the joint probability of the following three events:

1. that the path of a tornado encompasses the site;
2. that the area covered by the very strong winds in a tornado includes the point considered, if the path of the tornado encompasses the site. This probability is estimated from the fraction of the area swept by a tornado that is subject to destructive winds, which is considerably less than one(4); and
3. that the destructive winds (consistent with the definition adopted under 2 above) are greater than a given value.

The joint probability is the product of the individual probabilities of these (presumed) independent events. The above individual probabilities were estimated from observations mainly in the Midwest and South Central United States, reported by Fujita(4). Item 1, the probability that a point in the site will be affected by a tornado, has already been estimated above. Little information is available for the estimation of the probabilities under 3. For the present purpose, we assume an average of 200 mph for the destructive winds in tornadoes, based mainly on Fujita's observations. The winds are assumed to be normally distributed with a standard deviation of 25 mph. Since there are few reliable estimates of wind speeds in tornadoes, the probabilities of the higher wind speeds given below may be subject to considerable uncertainty. Based on the above considerations, expected recurrence periods for winds greater than a given speed striking a given point are shown in the following table:

Maximum Wind (mph)	Recurrence Period (Years)
150	3,200
175	3,700
200	6,200
225	19,700
250	136,000
275	3,100,000

References - Section 2.6

1. U. S. Department of Commerce, Weather Bureau, "1955 Climatological Summary, Dothan, Alabama, 1902-1954".
2. Thom, H.C.S., "New Distributions of Extreme Winds in the U. S.", Journal of the Standards Division, Proceedings of the American Society of Civil Engineers", Volume 94, Number ST7, pages 1787-1801, 1968.
3. Rainfall Frequency Atlas of the U. S. (prepared by D. M. Hershfield), Technical Paper No. 40, U. S. Department of Commerce, U. S. Weather Bureau, 1963.
4. Fujita, T. T., "Lubbock Tornadoes of 11 May 1970," Report No. 88, Megometeorology Project, Department Geophysical Sciences, University of Chicago, 1970.
5. Bennett, I., "Glaze, Its Meteorology and Climatology, Geographical Distribution and Economic Effects:, U. S. Army, Quartermaster Research and Engineering Command, Technical Paper EP-105, 1959.
6. Wolford, L. V., "Tornado Occurrences in the U. S., "Technical Paper No. 20, ESSA (now NOAA), U. S. Department of Commerce, 1960.
7. Pautz, M. E. (ed), Severe Local Storm Occurrences, 1955-1967, Technical Memorandum, WBTM, FCST, 12, ESSA (now NOAA), U. S. Department of Commerce, 1969.

TABLE 2.6-1

WEATHER INSTRUMENTATION AT FARLEY SITE

Approximate Height Above Tower base (ft)	Sensed Parameter	Recorded Parameter	Instrument Characteristics
Ground	Rainfall	Rainfall	Climet Model 0501-1 Accuracy 1/2% of full scale
Ground	Solar radiation	Solar radiation	Pyrometer (Climet 503-1) - Responds to wave lengths of 0.32 to 2.5 microns
32.8	Wind Speed* and wind direction	Wind Speed and Wind Direction	Climet Model WS-011-1 (speed) - Accuracy of ±0.15 mph or 1% of full scale, whichever is greater. Response distance constant is 5 ft.; vane has 1 mph threshold and damping ratio of 0.4. Climet Model 012-10 (direction) - Accuracy ± 3 degrees, linearity ±1/2% of full scale.
32.8	Horizontal and elevation angle	Horizontal and elevation angle	Bivane Climet Model 012-11 - Accuracy ± 3 degrees, linearity ±1/2% of full scale.
	Temperature	Ambient Temperature	EG and G Model 110S-M thermistor in aspirated shield - Accuracy ±0.5 F over range of 0-100 F. 6
35	Dew point	Dew point	EG and G Model 110S-M - Accuracy ±0.5 F above dew point of -20 F - Responds 3 F per second above 32 F.
35	Temperature	Reference for T	Matched pair thermistors in aspirated solar radiation shield - Accuracy ±0.15 C.
100	Temperature	$T_{100}-T_{35}$	Thermistor in aspirated solar radiation shield - Accuracy ±0.15 C.
150	Wind Speed* and wind direction	Wind speed and wind direction	Same as 32.8 ft. level given above
200	Temperature	$T_{200}-T_{35}$	Thermistor in aspirated solar radiation shield - Accuracy ±0.15 C.

*Mounted on S.E. side of the tower.

TABLE 2.6-2

TEMPERATURE AVERAGES AND COMPARATIVE DATA FOR DOTHAN, ALABAMA

(deg F)

Month	Av Daily Maximum	Av Daily Minimum	Average	Av Daily Range	Absolute Highest	Year	Absolute Lowest	Year	Heating Degree Days	Av No. Hours 45° or Below	Av Hourly Dry-Bulb	Av Hourly Wet-Bulb	Av Hourly Dew-Point	Av Hourly Rel. Humid. (%)
Jan	63.4	41.4	52.4	22.0	83	1949	12	1940	400	228	52	48	45	77
Feb	65.3	43.0	54.2	22.3	84	1944	12	1951	322	181	54	49	45	73
Mar	71.1	48.1	59.6	23.0	88	1954*	21	1943	212	99	59	56	49	71
Apr	78.9	54.9	66.9	24.0	95	1942	31	1940	57	15	67	60	55	69
May	86.8	62.4	74.6	24.4	99	1953	44	1954	5	0	74	66	62	68
Jun	92.2	69.8	81.0	22.4	104	1952	52	1954	0	0	80	73	70	73
Jul	91.7	71.1	81.4	20.6	103	1952	62	1953*	0	0	80	74	72	80
Aug	92.2	70.6	81.4	21.6	103	1954*	60	1952*	0	0	80	74	72	79
Sep	87.6	66.2	76.9	21.4	100	1951*	47	1949*	2	0	75	70	67	78
Oct	80.9	55.9	68.4	25.0	98	1954	30	1952	43	11	67	61	57	72
Nov	69.4	44.8	57.1	24.6	88	1950*	17	1950	253	145	57	52	48	73
Dec	62.5	40.8	51.7	21.7	82	1951	18	1945	414	271	51	48	45	81
YEAR	78.5	55.8	67.2	22.7	104	Jun 1952	12	Jan 1940 Feb 1951	1708	950	66	61	57	75

*Also on Earlier Dates

TABLE 2.6.3

FREQUENCY OF PRECIPITATION AND TEMPERATURE, DOTHAN, ALABAMA

MONTH	PRECIPITATION (in)								TEMPERATURE (°F)									
									MAXIMUM				MINIMUM					
	.01 or more	.05 or more	.10 or more	.25 or more	.50 or more	1.00 or more	2.00 or more	90° or above	95° or above	100° or above	105° or above	32° or below	30° or below	25° or below	20° or below	15° or below	10° or below	5° or below
Jan	8	7	6	4	3	1	*	0	0	0	0	7	4	2	1	*	0	0
Feb	8	7	6	5	3	1	*	0	0	0	0	4	3	1	*	*	0	0
Mar	9	7	7	5	4	2	1	0	0	0	0	2	1	*	0	0	0	0
Apr	6	6	5	4	3	1	*	1	*	0	0	*	0	0	0	0	0	0
May	7	6	5	4	2	1	*	15	2	0	0	0	0	0	0	0	0	0
Jun	10	9	7	5	3	1	*	23	10	1	0	0	0	0	0	0	0	0
Jul	13	11	10	7	4	2	*	22	8	*	0	0	0	0	0	0	0	0
Aug	11	9	8	6	4	2	*	24	10	1	0	0	0	0	0	0	0	0
Sep	8	7	6	5	3	2	1	13	4	*	0	0	0	0	0	0	0	0
Oct	4	4	3	2	1	*	*	2	*	0	0	*	*	0	0	0	0	0
Nov	6	5	4	3	2	1	*	0	0	0	0	3	1	*	*	0	0	0
Dec	8	7	6	5	3	2	*	0	0	0	0	6	4	1	*	0	0	0
YEAR	98	85	73	55	35	16	4	100	35	3	0	22	13	4	1	*	0	0

* Less than one

TABLE 2.6-4

CLIMATOLOGICAL SUMMARY

MEANS AND EXTREMES FOR PERIOD 1941-1970

	Temperature (°F)							**	Precipitation Totals (Inches)									Mean number of days					
	Means			Extremes								Snow, Sleet							Temperatures				
																			Max.		Min.		
Month	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year	Mean degree days	Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year	Precip. .10 inch or more	90° and above	32° and below	32° and below	0° and below	Month
(a)	30	30	30	30		30		30	30	30		30	30		30		30	30	30	30	30	
Jan.	61.2	39.6	50.4	82	1949	7	1966	470	4.24	3.92	1963	0.1	1.5	1955	1.5	1955	7	0	*	9	0	Jan.
Feb.	64.3	41.6	53.0	85	1962	10	1951	350	4.60	4.57	1962	T	0.5	1958	0.5	1958	7	0	0	6	0	Feb.
Mar.	70.2	46.8	58.5	88	1967+	18	1943	250	6.13	6.74	1944	T	T	1969+	T	1969+	7	0	0	3	0	Mar.
Apr.	79.0	54.5	66.8	93	1942	32	1950	50	4.68	4.96	1946	0	0		0		6	1	0	*	0	Apr.
May	86.0	61.6	73.8	101	1941	43	1944	0	4.20	5.69	1961	0	0		0		6	10	0	0	0	May
June	90.5	68.1	79.3	107	1954	49	1956	0	4.60	4.12	1946	0	0		0		8	19	0	0	0	June
July	91.1	70.2	80.7	102	1952+	57	1967	0	6.62	4.14	1948	0	0		0		11	21	0	0	0	July
Aug.	91.2	69.7	80.5	104	1954	59	1967	0	5.13	4.75	1969	0	0		0		8	22	0	0	0	Aug.
Sep.	87.5	66.0	76.8	100	1954+	40	1967	0	4.33	4.47	1956	0	0		0		6	14	0	0	0	Sep.
Oct.	79.7	55.6	67.7	100	1954	30	1952	50	2.12	4.11	1948	0	0		0		3	2	0	*	0	Oct.
Nov.	69.3	45.0	57.2	88	1961	15	1950	250	2.85	2.81	1947	0	0		0		5	0	0	3	0	Nov.
Dec.	62.4	39.9	51.2	81	1955+	6	1962	440	4.81	5.33	1964	0.1	1.5	1943	1.5	1943	7	0	0	8	0	Dec.
Year	77.7	54.9	66.3	107	1954	6	1962	1860	54.31	6.74	1944	0.2	1.5	1955+	1.5	1955+	81	89	*	29	0	**Year**

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F (estimated from mean temperature)

+ Also on earlier dates, months, or years.

* Less than one half.

TABLE 2.6-5

AVERAGE HOURLY RELATIVE HUMIDITY, DOTHAN, ALABAMA

(PERCENT)

Month	A.M.												P.M.											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Jan	87	88	88	89	90	90	91	89	85	79	72	65	62	59	57	57	61	67	72	76	79	81	83	85
Feb	81	84	86	86	86	88	86	85	80	72	66	61	57	53	52	53	54	61	66	72	75	77	79	81
Mar	82	83	84	86	86	87	86	84	79	70	63	59	55	53	51	51	52	55	62	69	73	75	78	81
Apr	82	84	86	87	88	90	87	81	73	65	59	56	52	49	48	48	50	53	59	65	70	74	78	80
May	83	86	88	89	90	90	85	78	69	62	56	52	49	47	46	47	43	51	57	64	71	74	78	81
Jun	87	89	91	92	93	91	87	80	72	66	61	57	54	52	51	52	54	59	64	71	77	81	84	86
Jul	92	93	94	94	95	95	89	85	78	71	68	64	62	62	62	62	65	69	76	82	85	87	89	91
Aug	91	92	93	94	95	96	90	87	79	72	66	63	60	59	59	60	63	68	75	81	84	83	89	90
Sep	89	90	92	93	94	94	89	86	78	72	66	62	59	59	60	60	61	66	73	79	82	84	86	87
Oct	85	86	87	88	89	90	91	84	74	65	58	54	50	49	49	50	54	62	69	74	78	79	81	83
Nov	83	85	86	87	87	88	89	85	79	67	61	58	54	53	52	52	58	66	70	74	77	79	81	82
Dec	87	88	89	90	91	91	90	89	85	79	74	70	68	66	65	66	71	76	78	80	83	85	86	87
MEAN	86	87	89	90	90	91	90	89	78	70	64	60	57	55	54	55	58	63	68	74	78	80	83	85

TABLE 2.6-6

PRECIPITATION AVERAGES AND COMPARATIVE DATA FOR DOTHAN, ALABAMA

(Inches)

Month	Normal	Record Mean	Greatest 24-hour Amounts	Year	Greatest 48-hour Amounts	Year	Greatest 72-hour Amounts	Year	Greatest Monthly	Year	Least Monthly	Year	Average Snowfall	Prevailing Wind Direction	Av Hourly Wind Velocity (mph)
Jan	4.49	4.24	6.42	1936	6.42	19 6	7.30	1925	16.88	1936	0.34	1927	T	SE	8.8
Feb	5.24	4.68	4.26	1937	4.92	1940	5.77	1929	10.36	1939	0.93	1951	T	SW	9.7
Mar	5.15	6.15	9.[illegible]	1929	11.68	1929	12.34	1929	16.40	1929	0.89	1945	T	NW	10.0
Apr	4.16	4.18	4.75	1946	4.99	1946	4.99	1946	12.60	1928	0.60	1902	0	SE	8.2
May	3.18	3.10	4.10	1903	4.39	1903	4.59	1903	8.73	1947	0.58	1927	0	SW	6.6
Jun	4.63	4.47	4.76	1940	4.76	1940	4.83	1940	8.52	1942	1.10	1945	0	SW	6.6
Jul	5.92	6.07	6.73	1948	7.44	1948	7.45	1948	12.73	1948	2.22	1903	0	SW	6.3
Aug	5.43	5.38	5.80	1939	6.23	1939	6.96	1939	20.85	1939	2.20	1925	0	NE	5.8
Sep	5.16	5.08	8.00	1929	9.20	1926	10.45	1926	13.86	1929	0.63	1940	0	NE	7.3
Oct	2.77	1.88	7.37	1932	7.37	1932	7.37	1932	12.41	1932	T	1939	T	NE	6.9
Nov	3.05	3.44	4.50	1912	4.50	1912	4.50	1912	10.29	1930	0.05	1931	T	NE	7.7
Dec	4.85	4.74	3.90	1945	5.50	1927	5.50	1927	13.61	1953	0.53	1946	T	NW	9.3
YEAR	54.03	53.41	9.00	Mar 1929	11.68	Mar 1929	12.34	Mar 1929	20.85	Aug 1939	T	Oct 1939	T	SW	7.8

TABLE 2.6-7
(Sheet 1 of 4)

JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. VERTICAL TEMPERATURE

LAPSE RATE(DEG F/100FT) LESS THAN OR EQUAL TO -1.0

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	.1
1 MPH	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	.1
2 MPH	1	1	2	0	0	0	0	3	1	1	0	1	0	1	1	1	13	1.0
3 MPH	12	12	12	9	6	6	3	1	2	2	6	2	3	5	4	2	87	6.8
4 MPH	14	25	11	15	11	7	4	9	6	3	2	10	11	3	6	10	147	11.5
5 MPH	27	12	18	17	9	9	11	3	9	4	8	8	8	8	4	12	167	13.1
6 MPH	15	9	13	12	9	8	3	9	5	4	8	7	15	10	11	13	151	11.8
7 MPH	13	11	23	10	7	6	9	7	1	6	7	5	11	6	10	6	138	10.8
8 MPH	11	18	12	9	17	6	4	3	3	4	7	7	5	12	13	13	144	11.3
12 MPH	24	32	50	29	12	6	14	13	9	23	15	12	8	14	53	29	343	26.9
18 MPH	9	5	2	0	0	0	0	8	5	4	4	0	2	7	19	11	76	6.0
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	8	.6
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	127	126	143	101	71	48	48	56	41	51	57	52	63	67	128	97	1276	100.0
PERCENT	10.0	9.9	11.2	7.9	5.6	3.8	3.8	4.4	3.2	4.0	4.5	4.1	4.9	5.3	10.0	7.6	100.0	
AV SPD	5.2	6.4	6.7	6.1	6.0	5.4	6.4	7.4	6.8	8.2	7.1	5.9	5.9	7.6	9.3	7.6		

AVERAGE SPEED FOR THIS TABLE EQUALS 6.9

LAPSE RATE(DEG F/100FT) GREATER THAN -1.0 BUT LESS THAN OR EQUAL TO -.9

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
1 MPH	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	.2
2 MPH	1	4	2	2	1	2	0	1	0	4	1	0	1	0	2	0	21	3.7
3 MPH	3	9	9	4	6	6	2	3	1	6	6	7	3	2	6	3	76	13.2
4 MPH	6	8	5	6	6	7	11	4	8	3	3	5	4	6	4	6	92	16.0
5 MPH	5	7	9	6	6	4	7	6	3	2	5	9	8	6	5	6	94	16.4
6 MPH	3	2	7	10	5	2	1	4	5	6	14	6	8	8	4	3	88	15.3
7 MPH	2	3	9	3	4	4	1	3	4	2	9	3	4	4	5	2	62	10.8
8 MPH	2	4	5	3	3	1	1	1	1	2	2	1	2	1	5	2	36	6.3
12 MPH	3	4	7	8	2	1	2	5	11	9	10	2	2	4	9	7	86	15.0
18 MPH	0	0	0	0	0	0	0	0	4	5	2	0	0	0	4	1	16	2.8
24 MPH	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	2	.3
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	25	41	53	43	33	27	25	27	37	40	52	33	32	31	45	30	574	100.0
PERCENT	4.4	7.1	9.2	7.5	5.7	4.7	4.4	4.7	6.4	7.0	9.1	5.7	5.6	5.4	7.8	5.2	100.0	
AV SPD	5.1	4.6	5.4	5.5	4.8	4.3	4.5	5.5	7.4	6.9	6.3	4.7	5.1	5.5	7.1	6.2		

AVERAGE SPEED FOR THIS TABLE EQUALS 5.6

TABLE 2.6-7
(Sheet 2 of 4)

JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. VERTICAL TEMPERATURE

LAPSE RATE(DEG F/100FT) GREATER THAN -.9 BUT LESS THAN OR EQUAL TO -.8

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
1 MPH	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	,6
2 MPH	0	2	0	0	0	1	0	1	0	2	1	0	1	0	0	0	8	4,9
3 MPH	2	4	2	3	3	0	0	0	0	1	0	0	3	1	1	0	20	12,3
4 MPH	1	4	2	5	2	0	5	1	0	1	1	4	3	2	1	0	32	19,6
5 MPH	2	0	0	0	2	2	1	0	1	1	1	2	5	4	2	0	23	14,1
6 MPH	0	4	2	1	1	1	0	1	2	1	2	1	0	1	0	0	17	10.4
7 MPH	0	0	5	0	2	0	2	1	3	0	1	2	1	3	1	0	21	12,9
8 MPH	1	1	3	1	0	0	0	0	0	2	0	3	0	1	1	2	15	9,2
12 MPH	0	0	3	2	0	0	2	0	1	3	2	0	1	0	0	6	20	12,3
18 MPH	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	1	5	3,1
24 MPH	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	,6
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
TOTAL	6	15	17	12	10	4	10	4	9	13	9	13	14	12	6	9	163	100.0
PERCENT	3,7	9.2	10.4	7.4	6,1	2.5	6.1	2.5	5,5	8.0	5.5	8,0	8,6	7,4	3.7	5,5	100.0	
AV SPD	4,1	3.9	6.4	4.6	4,2	3.8	5,6	4,2	8,2	6,8	7,3	5,0	4,0	5,1	4.9	9,6		

AVERAGE SPEED FOR THIS TABLE EQUALS 5.5

LAPSE RATE(DEG F/100FT) GREATER THAN -.8 BUT LESS THAN OR EQUAL TO -.3

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	2	1	1	2	0	3	2	0	0	0	0	0	0	0	1	1	13	.6
1 MPH	0	2	1	0	2	2	0	0	2	1	2	0	1	0	2	1	16	,7
2 MPH	10	12	11	11	9	10	5	8	10	6	5	11	4	3	4	6	125	5,3
3 MPH	16	29	24	21	21	14	12	12	13	8	13	16	17	8	7	13	244	10,4
4 MPH	27	34	28	26	12	21	16	22	23	26	27	22	20	11	6	14	335	14,3
5 MPH	19	36	36	23	23	11	15	18	20	25	22	12	8	6	6	18	298	12,7
6 MPH	16	30	56	28	16	13	10	12	27	17	18	6	14	1	17	14	295	12,6
7 MPH	12	15	50	18	15	6	10	19	18	25	21	7	8	10	12	21	267	11,4
8 MPH	14	19	23	12	5	5	5	16	18	15	12	7	5	5	14	20	195	8,3
12 MPH	30	22	37	28	9	1	8	26	50	64	38	9	5	14	32	46	419	17,9
18 MPH	3	4	2	2	3	0	2	6	22	29	13	3	1	9	18	7	124	5.3
24 MPH	0	0	0	0	0	0	0	0	0	7	1	0	0	1	1	0	10	.4
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	149	204	269	171	115	86	85	139	203	223	172	93	83	68	120	161	2341	100.0
PERCENT	6,4	8.7	11.5	7.3	4,9	3.7	3.6	5,9	8,7	9,5	7,3	4,0	3,5	2,9	5.1	6,9	100.0	
AV SPD	5,6	5.1	5.7	5.4	4.9	3.9	5.0	6.0	7.0	8.1	6.6	4.8	4.6	7.2	7.7	6.7		

AVERAGE SPEED FOR THIS TABLE EQUALS 6.0

TABLE 2.6-7
(Sheet 3 of 4)

JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. VERTICAL TEMPERATURE

LAPSE RATE(DEG F/100FT) GREATER THAN -.3 BUT LESS THAN OR EQUAL TO .8

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	4	4	4	1	0	2	3	2	0	1	0	3	1	1	4	2	32	1.6
1 MPH	5	1	2	7	2	3	5	9	6	3	6	6	5	6	4	2	72	3.6
2 MPH	34	19	19	15	16	16	19	23	21	19	14	28	16	9	12	22	302	15.3
3 MPH	44	36	24	29	21	16	20	34	36	23	19	29	25	17	14	27	414	21.0
4 MPH	57	42	32	19	18	19	17	22	23	26	32	13	21	15	24	25	405	20.5
5 MPH	25	26	25	21	10	6	8	18	23	18	19	13	5	18	18	29	282	14.3
6 MPH	8	18	16	11	2	4	8	16	18	30	19	2	4	8	14	23	201	10.2
7 MPH	3	5	4	2	2	2	2	5	17	27	16	1	1	2	12	12	113	5.7
8 MPH	3	2	0	0	1	1	2	2	8	12	7	0	1	1	6	8	54	2.7
12 MPH	5	6	2	0	0	2	2	8	12	14	16	1	2	2	7	7	86	4.4
18 MPH	0	0	0	0	0	0	0	0	2	1	4	1	1	0	0	2	11	.6
24 MPH	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	.1
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	188	159	128	105	72	71	86	140	166	174	152	97	82	79	115	159	1973	100.0
PERCENT	9.5	8.1	6.5	5.3	3.6	3.6	4.4	7.1	8.4	8.8	7.7	4.9	4.2	4.0	5.8	8.1	100.0	
AV SPD	[illegible]	[illegible]	[illegible]	3.2	3.0	3.1	3.1	3.6	4.4	4.8	4.8	2.7	3.1	3.5	4.2	4.2		

AVERAGE SPEED FOR THIS TABLE EQUALS 3.8

LAPSE RATE(DEG F/100FT) GREATER THAN .8 BUT LESS THAN OR EQUAL TO 2.2

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	5	1	5	3	1	4	3	7	8	1	1	2	1	1	2	2	47	5.1
1 MPH	7	5	8	6	3	6	3	5	7	7	4	4	3	8	4	5	85	9.3
2 MPH	21	13	13	10	6	8	12	12	10	11	12	14	13	12	9	17	193	21.0
3 MPH	29	14	18	12	8	7	16	17	18	9	11	12	15	15	19	29	248	27.0
4 MPH	41	18	11	8	7	8	8	11	20	7	13	7	9	14	15	28	225	24.5
5 MPH	15	13	6	1	0	3	1	1	5	2	2	0	3	11	6	6	75	8.2
6 MPH	2	0	1	0	0	1	0	0	7	2	2	0	1	8	2	3	29	3.2
7 MPH	0	0	0	0	0	0	0	0	3	0	1	0	0	1	3	1	9	1.0
8 MPH	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	3	.3
12 MPH	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	3	.3
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	120	64	62	40	25	37	43	54	78	38	47	39	45	73	61	91	917	100.0
PERCENT	13.1	7.0	6.8	4.4	2.7	4.0	4.7	5.9	8.5	4.1	5.1	4.3	4.9	8.0	6.7	9.9	100.0	
AV SPD	2.7	2.8	2.3	2.0	2.1	2.2	2.1	2.2	2.8	2.3	2.6	2.0	2.4	3.2	3.0	2.7		

AVERAGE SPEED FOR THIS TABLE EQUALS 2.6

TABLE 2.6-7
(Sheet 4 of 4)

JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. VERTICAL TEMPERATURE

LAPSE RATE(DEG F/100FT) GREATER THAN 2.2

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	12	7	2	2	5	4	2	5	8	4	3	3	7	6	8	16	94	10,9
1 MPH	13	4	4	5	6	1	6	1	13	6	8	6	7	1	2	13	96	11,1
2 MPH	45	16	7	10	4	5	9	12	21	8	13	11	14	7	25	42	249	28,8
3 MPH	41	8	8	7	7	4	9	8	8	6	6	7	4	8	20	61	212	24,5
4 MPH	50	2	4	6	3	0	3	6	10	3	2	1	7	5	15	41	158	18,3
5 MPH	15	0	1	0	3	1	0	1	3	1	2	2	0	7	0	6	42	4,9
6 MPH	1	1	0	0	0	0	0	0	0	1	1	0	0	1	0	3	8	,9
7 MPH	1	1	0	0	0	0	0	0	0	1	0	0	0	2	0	0	5	,6
8 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
12 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
TOTAL	178	39	26	30	20	15	29	33	63	30	35	30	39	37	70	142	864	100.0
PERCENT	20,6	4.5	3.0	3.5	3,2	1.7	3.4	3.8	7,3	3,5	4,1	3,5	4,5	4,3	8.1	21.1	100.0	
AV SPD	2,4	1.7	1.9	1.8	1.9	1.5	1.7	1.9	1.7	1.9	1.7	1,7	1,5	2,7	2.0	2.3		

AVERAGE SPEED FOR THIS TABLE EQUALS 2.1

TABLE 2.6.8
(Sheet 1 of 4)

ON-SITE

JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. WIND DIRECTION RANGE (50 ft)

WIND RANGE LESS THAN OR EQUAL TO 12.0

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	7	2	2	1	2	2	2	7	9	4	3	3	4	3	4	3	58	39.7
1 MPH	4	3	1	2	2	2	5	1	11	4	1	1	2	2	0	6	47	32.2
2 MPH	4	0	0	0	0	0	2	6	3	1	2	1	0	1	0	4	24	16.4
3 MPH	2	0	0	0	0	0	0	2	1	1	0	0	0	1	0	1	8	5.5
4 MPH	0	1	0	0	0	0	0	2	2	0	1	0	0	1	0	0	7	4.8
5 MPH	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	.7
6 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
7 MPH	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	.7
8 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
12 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
18 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	17	6	3	3	4	4	9	18	27	11	7	5	6	8	4	14	146	100.0
PERCENT	11.6	4.1	2.1	2.1	2.7	2.7	6.2	12.3	18.5	7.5	4.8	3.4	4.1	5.5	2.7	9.6	100.0	
AV SPD	.8	.9	.3	.5	.3	.3	.7	1.1	1.0	1.2	.9	.5	.2	1.0	0.0	.8		

AVERAGE SPEED FOR THIS TABLE EQUALS .8

WIND RANGE GREATER THAN 12.0 BUT LESS THAN OR EQUAL TO 22.0

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	3	0	2	0	0	3	3	3	1	0	0	1	2	1	2	6	27	8.4
1 MPH	5	1	2	1	0	1	3	4	3	3	2	0	0	3	3	5	36	11.2
2 MPH	10	6	4	1	0	3	6	12	8	3	6	3	5	1	6	10	86	26.8
3 MPH	6	5	4	0	2	4	7	12	20	1	4	3	4	2	1	14	89	27.7
4 MPH	7	3	0	0	0	1	1	9	11	0	2	0	2	5	2	6	49	15.3
5 MPH	0	0	1	0	0	0	0	1	4	1	0	1	2	3	1	1	15	4.7
6 MPH	0	0	1	0	0	0	0	0	2	0	0	0	1	1	0	1	6	1.9
7 MPH	0	1	0	0	0	0	0	0	2	4	0	0	0	0	0	0	7	2.2
8 MPH	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	.6
12 MPH	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	3	.9
18 MPH	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	.3
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	31	16	14	2	2	12	20	41	52	17	14	8	16	16	17	43	321	100.0
PERCENT	9.7	5.0	4.4	.6	.6	3.7	6.2	12.8	16.2	5.3	4.4	2.5	5.0	5.0	5.3	13.4	100.0	
AV SPD	1.9	2.5	1.9	1.3	2.4	1.5	1.6	2.1	3.0	5.4	1.9	1.9	2.3	2.9	1.7	1.9		

AVERAGE SPEED FOR THIS TABLE EQUALS 2.3

TABLE 2.6-8
(Sheet 2 of 4)
JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. WIND DIRECTION RANGE (50 ft)

WIND RANGE GREATER THAN 22.0 BUT LESS THAN OR EQUAL TO 45.0

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	8	9	3	0	1	4	3	1	4	2	0	0	2	2	6	9	54	2,5
1 MPH	12	3	5	4	6	3	3	7	5	7	7	6	2	2	3	5	80	3,7
2 MPH	61	18	17	12	12	17	20	19	22	27	17	19	18	15	25	36	355	16.3
3 MPH	70	32	38	25	19	17	29	40	35	21	19	17	17	25	37	57	498	22,9
4 MPH	89	36	34	24	13	14	22	24	46	38	34	6	11	18	37	42	488	22,4
5 MPH	31	22	16	3	4	3	8	12	36	25	18	3	1	21	15	7	225	10,3
6 MPH	3	6	3	1	1	0	2	12	43	40	16	0	0	10	10	6	153	7,0
7 MPH	1	1	1	0	0	1	1	4	23	34	17	0	0	3	11	0	97	4,5
8 MPH	0	0	2	0	0	0	1	1	18	22	6	0	0	2	2	0	54	2,5
12 MPH	0	0	1	2	0	0	1	2	42	60	19	0	0	0	0	0	127	5,8
18 MPH	0	0	0	0	0	0	0	0	17	23	2	0	0	0	1	0	43	2,0
24 MPH	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	,1
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
TOTAL	275	127	120	71	56	59	90	122	291	301	155	51	51	98	147	162	2176	100,0
PERCENT	12,6	5.8	5.5	3.3	2,6	2.7	4.1	5.6	13.4	13.8	7.1	2,3	2,3	4,5	6.8	7,4	100.0	
AV SPD	2.7	2.9	3.0	2.8	2.4	2.4	2.8	3.2	5.6	6.4	4.7	2,2	2.2	3.4	3.3	2.6		

AVERAGE SPEED FOR THIS TABLE EQUALS 3.8

WIND RANGE GREATER THAN 45.0 BUT LESS THAN OR EQUAL TO 75.0

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	4	2	2	1	2	2	1	3	0	0	1	3	1	1	2	3	28	.9
1 MPH	3	2	5	4	2	4	2	1	7	2	4	7	4	2	4	3	56	1,8
2 MPH	24	26	16	17	13	14	10	11	12	9	10	21	17	9	7	29	245	7,9
3 MPH	45	40	24	36	31	18	16	14	15	18	21	32	23	12	15	49	407	13,1
4 MPH	60	54	36	28	22	25	18	21	11	17	32	28	24	14	16	54	462	14,9
5 MPH	38	57	52	36	22	16	20	20	11	17	27	18	8	23	15	40	420	13,5
6 MPH	15	40	66	23	6	11	11	21	14	18	31	8	8	6	27	26	334	10,8
7 MPH	6	17	61	16	8	6	14	20	19	18	28	9	11	14	23	19	289	9,3
8 MPH	12	26	24	6	8	4	7	20	9	9	15	10	5	6	24	18	205	6,6
12 MPH	18	41	58	24	3	2	21	46	39	47	57	15	4	30	69	37	511	16,5
18 MPH	2	5	3	1	1	0	2	14	18	17	17	3	1	8	27	9	128	4,1
24 MPH	0	0	0	0	0	0	0	0	0	6	2	0	0	2	9	0	19	,6
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,0
TOTAL	230	310	349	194	118	100	122	191	155	178	245	154	106	127	238	28.	3104	100.0
PERCENT	7,4	10.0	11.2	6.3	3,8	3.2	3.9	6.2	5,0	5,7	7,9	5,0	3,4	4,1	7.7	9,2	100.0	
AV SPD	4.2	5.1	5.7	4.7	3,9	3.7	5.3	6,5	6.8	7.3	6,5	4,2	3,8	6,5	7.9	4,9		

AVERAGE SPEED FOR THIS TABLE EQUALS 5,6

TABLE 2.6-8

(Sheet 3 of 4)

JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. WIND DIRECTION RANGE (50 ft)

WIND RANGE GREATER THAN 75.0 BUT LESS THAN OR EQUAL TO 105.0

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	1	0	2	4	1	2	1	0	1	0	0	1	0	1	0	0	14	.8
1 MPH	1	2	1	2	1	2	0	1	1	0	3	3	5	5	1	1	29	1.7
2 MPH	5	10	11	11	6	6	4	5	12	7	5	14	5	1	5	5	112	6.7
3 MPH	12	17	16	12	13	6	5	6	5	5	8	10	18	10	10	10	163	9.8
4 MPH	26	28	13	16	16	15	11	10	10	7	5	15	24	9	8	10	223	13.4
5 MPH	23	10	15	21	22	10	12	6	8	4	9	16	14	8	4	20	202	12.2
6 MPH	19	13	20	31	21	17	9	6	5	1	10	9	28	14	8	21	232	14.0
7 MPH	19	13	24	15	19	9	6	10	2	4	11	8	10	9	6	21	186	11.2
8 MPH	13	17	16	15	16	5	4	1	2	2	7	7	7	13	8	26	159	9.6
12 MPH	41	22	35	37	17	6	6	4	1	4	5	9	12	5	27	54	285	17.1
18 MPH	10	4	1	1	1	0	0	0	0	0	3	1	2	8	13	12	56	3.4
24 MPH	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	.1
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	170	136	154	165	133	78	58	50	47	34	66	93	125	83	90	180	1662	100.0
PERCENT	10.2	8.2	9.3	9.9	8.0	4.7	3.5	3.0	2.8	2.0	4.0	5.6	7.5	5.0	5.4	10.8	100.0	
AV SPD	6.3	5.5	5.8	5.7	5.4	4.7	5.0	5.0	3.6	4.6	5.4	4.6	4.9	6.0	7.4	7.1		

AVERAGE SPEED FOR THIS TABLE EQUALS 5.7

WIND RANGE GREATER THAN105.0 BUT LESS THAN OR EQUAL TO 135.0

SPEED		NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	1	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	4	1.0
1 MPH	0	1	1	3	2	0	0	1	0	1	1	0	1	0	1	1	13	3.1
2 MPH	4	3	3	3	2	2	0	3	3	3	3	5	1	0	5	0	40	9.6
3 MPH	6	10	7	8	3	6	0	1	1	4	3	8	5	1	0	2	65	15.7
4 MPH	6	7	6	12	3	6	8	7	5	3	3	6	8	4	3	7	94	22.7
5 MPH	9	5	4	4	1	2	2	6	3	2	3	4	9	4	2	3	63	15.2
6 MPH	3	3	3	6	5	1	0	3	0	2	5	4	3	5	2	4	49	11.8
7 MPH	4	3	5	1	3	2	2	1	0	0	0	1	4	2	2	0	30	7.2
8 MPH	5	1	1	2	3	4	0	0	1	0	0	1	1	1	4	1	25	6.0
12 MPH	3	1	5	4	3	2	0	1	0	0	0	0	1	0	5	4	29	7.0
18 MPH	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	3	.7
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	41	34	36	45	26	25	12	23	13	15	18	29	34	17	24	23	415	100.0
PERCENT	9.9	8.2	8.7	10.8	6.3	6.0	2.9	5.5	3.1	3.6	4.3	7.0	8.2	4.1	5.8	5.5	100.0	
AV SPD	4.6	3.8	4.6	3.9	5.4	4.7	4.1	3.9	3.5	3.2	3.4	3.5	4.6	4.8	5.3	5.6		

AVERAGE SPEED FOR THIS TABLE EQUALS 4.4

TABLE 2.6-8
(Sheet 4 of 4)

JOINT FREQUENCY OF WIND SPEED (33 ft) AND DIRECTION VS. WIND DIRECTION RANGE (50 ft)

WIND RANGE GREATER THAN 135.0

SPEED	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL	PERCENT
0 MPH	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	2	.7
1 MPH	0	1	0	3	0	0	1	0	1	0	2	0	2	1	0	0	11	3.8
2 MPH	4	4	3	4	4	0	3	4	4	1	3	2	3	5	3	4	51	17.5
3 MPH	6	8	8	4	4	4	5	0	1	4	6	3	3	5	8	2	71	24.4
4 MPH	8	4	2	5	5	1	4	2	5	4	3	8	6	5	5	5	72	24.7
5 MPH	7	0	7	4	5	5	1	2	2	4	2	4	3	1	4	6	57	19.6
6 MPH	2	2	2	1	0	0	0	0	0	0	2	1	2	1	1	1	15	5.2
7 MPH	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	2	6	2.1
8 MPH	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	3	1.0
12 MPH	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	.7
18 MPH	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	.3
24 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32 MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
32+ MPH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
TOTAL	29	19	22	22	13	10	15	8	14	13	20	18	20	18	25	20	291	100.0
PERCENT	10.0	6.5	7.6	7.6	6.2	3.4	5.2	2.7	4.8	4.5	6.9	6.2	6.9	6.2	8.6	6.9	100.0	
AV SPD	3.6	2.8	3.4	3.0	3.2	3.6	2.8	2.8	2.5	3.3	3.6	3.4	3.5	2.7	3.5	3.7		

AVERAGE SPEED FOR THIS TABLE EQUALS 3.3

TABLE 2.6-9

ESTIMATE OF RECURRENCE INTERVAL FOR VARIOUS RAINFALL RATES FOR DOTHAN

(in.)

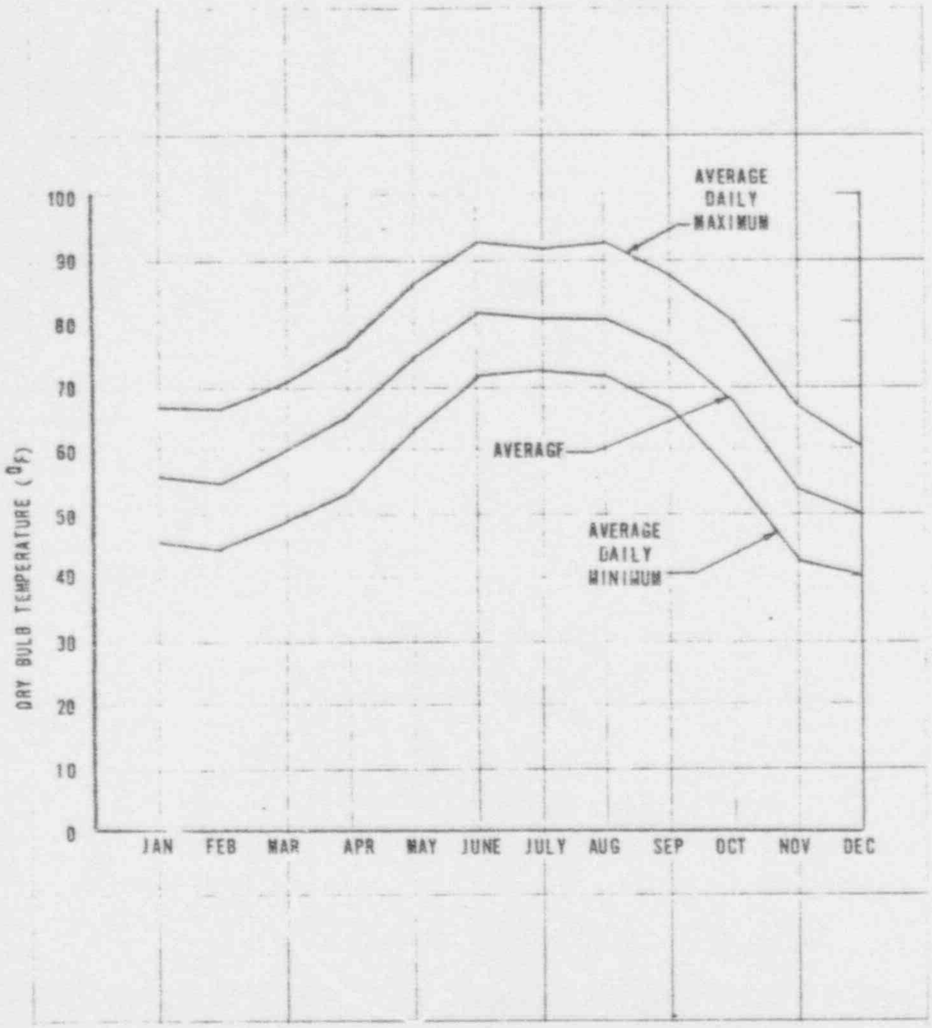
Period of Rainfall	Recurrence Interval (years)					
	1	2	5	10	50	100
30 min	1.5	1.7	2.0	2.2	2.8	3.0
1 hr	1.8	2.1	2.6	2.8	3.5	3.8
2 hrs	2.2	2.5	3.2	3.7	4.5	5.0
3 hrs	2.4	2.8	3.5	4.0	5.0	5.5
6 hrs	2.8	3.4	4.3	5.0	6.5	7.0
12 hrs	3.3	4.0	5.2	6.0	7.7	8.5
24 hrs	3.8	4.7	6.0	7.0	9.0	10.0
2 days		5.5	7.0	8.3	11.0	11.5
4 days		6.7	8.5	9.5	13.0	14.0
7 days		7.5	9.5	11.0	14.0	14.5
10 days		8.5	10.5	12.5	15.0	17.0

TABLE 2.6-10

MAXIMUM PRECIPITATION RECORDED FOR DOTHAN

(1941-1950)

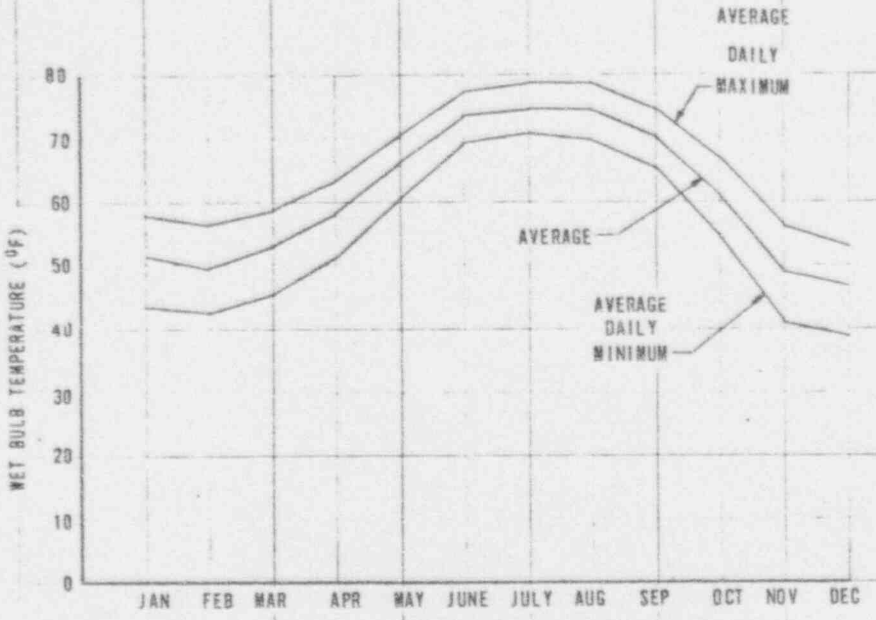
Period of Rainfall (hr)	Amount (in.)
1	3.28
2	3.60
3	3.65
6	3.67
12	4.39
24	6.75



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY AVERAGE AND AVERAGE DAILY EXTREMES OF DRY BULB TEMPERATURE (DOTHAN AIRPORT 1950-1954)

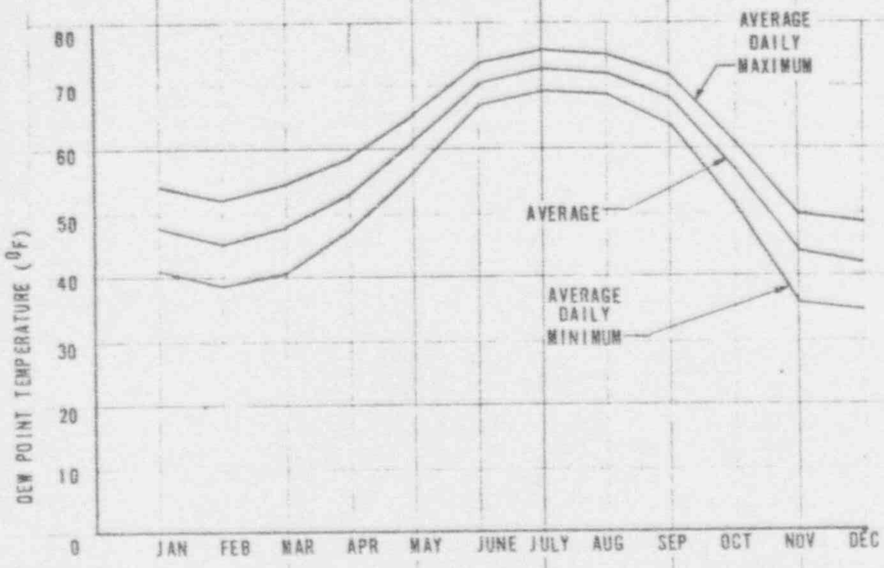
FIGURE 2.6-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY AVERAGE AND AVERAGE OF DAILY EXTREMES OF WET BULB TEMPERATURE (DOTHAN AIRPORT 1950-1954)

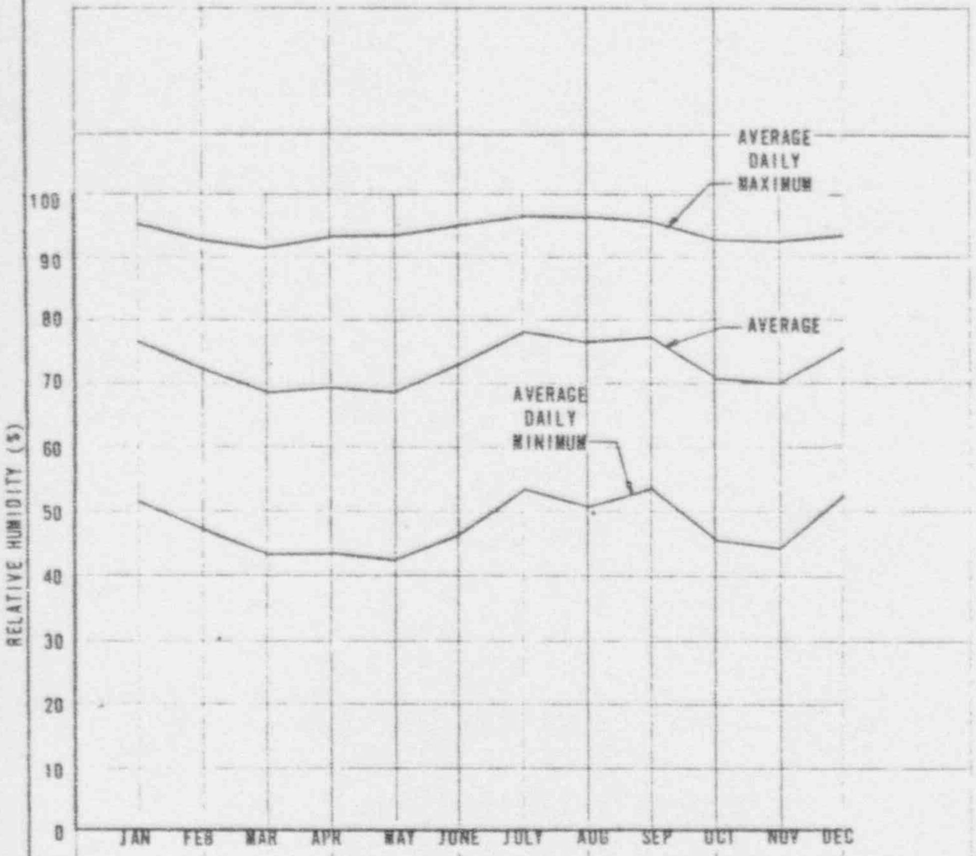
FIGURE 2.6-2



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY AVERAGE AND AVERAGE OF DAILY
EXTREMES OF DEW POINT TEMPERATURE
(DOTHAN AIRPORT 1950-1954)

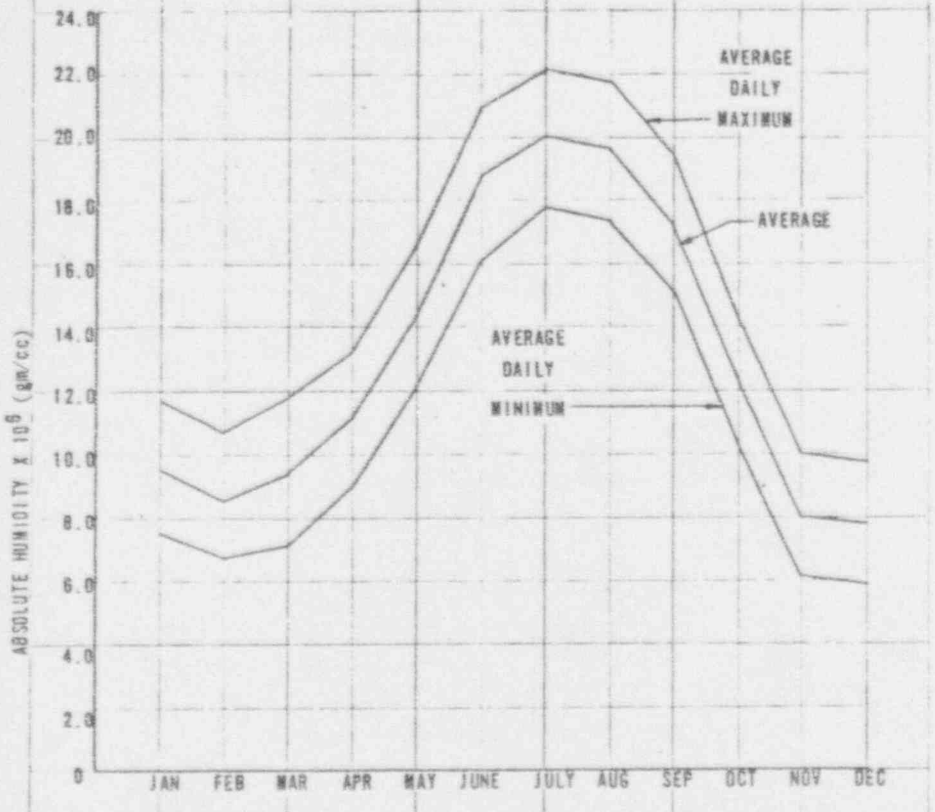
FIGURE 2.6-3



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY AVERAGE AND AVERAGE OF DAILY
EXTREMES OF RELATIVE HUMIDITY
(DOTHAN AIRPORT 1950-1954)

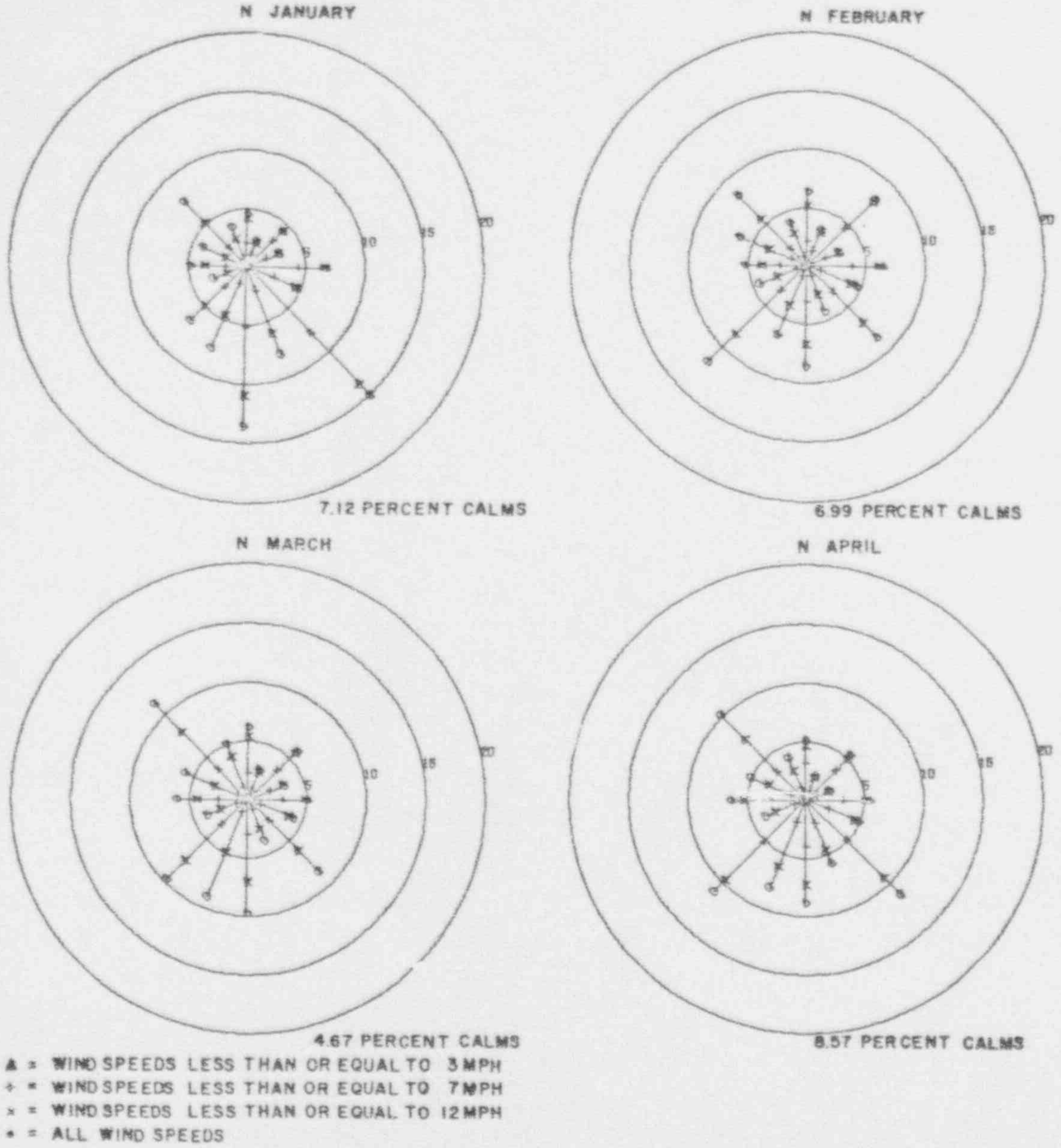
FIGURE 2.6-4



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY AVERAGE AND AVERAGE OF DAILY EXTREMES OF ABSOLUTE HUMIDITY (DOTHAN AIRPORT 1950-1954)

FIGURE 2.6-5

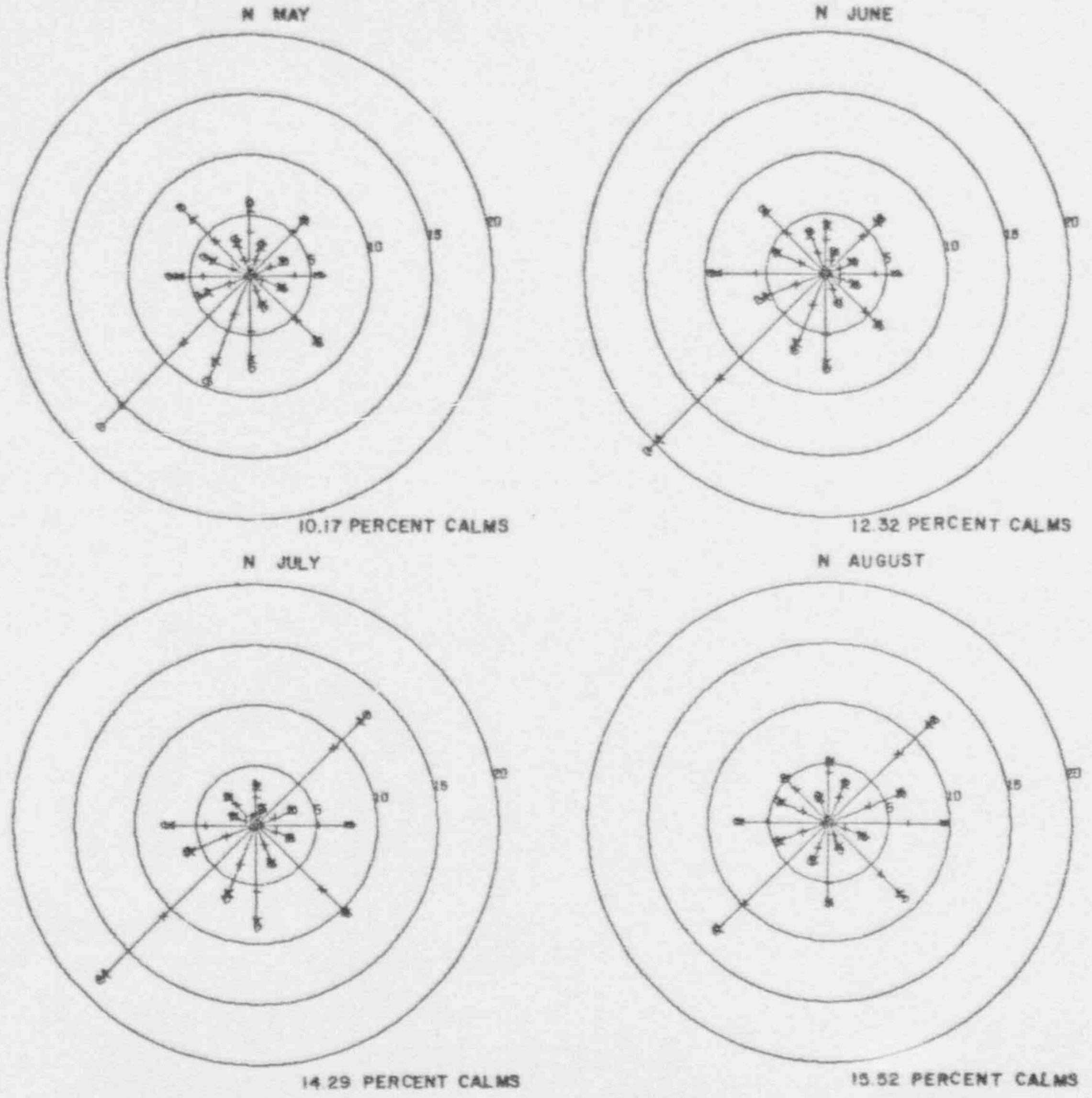


ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY WIND ROSES FOR DOTHAN AIRPORT

(1950-1954)

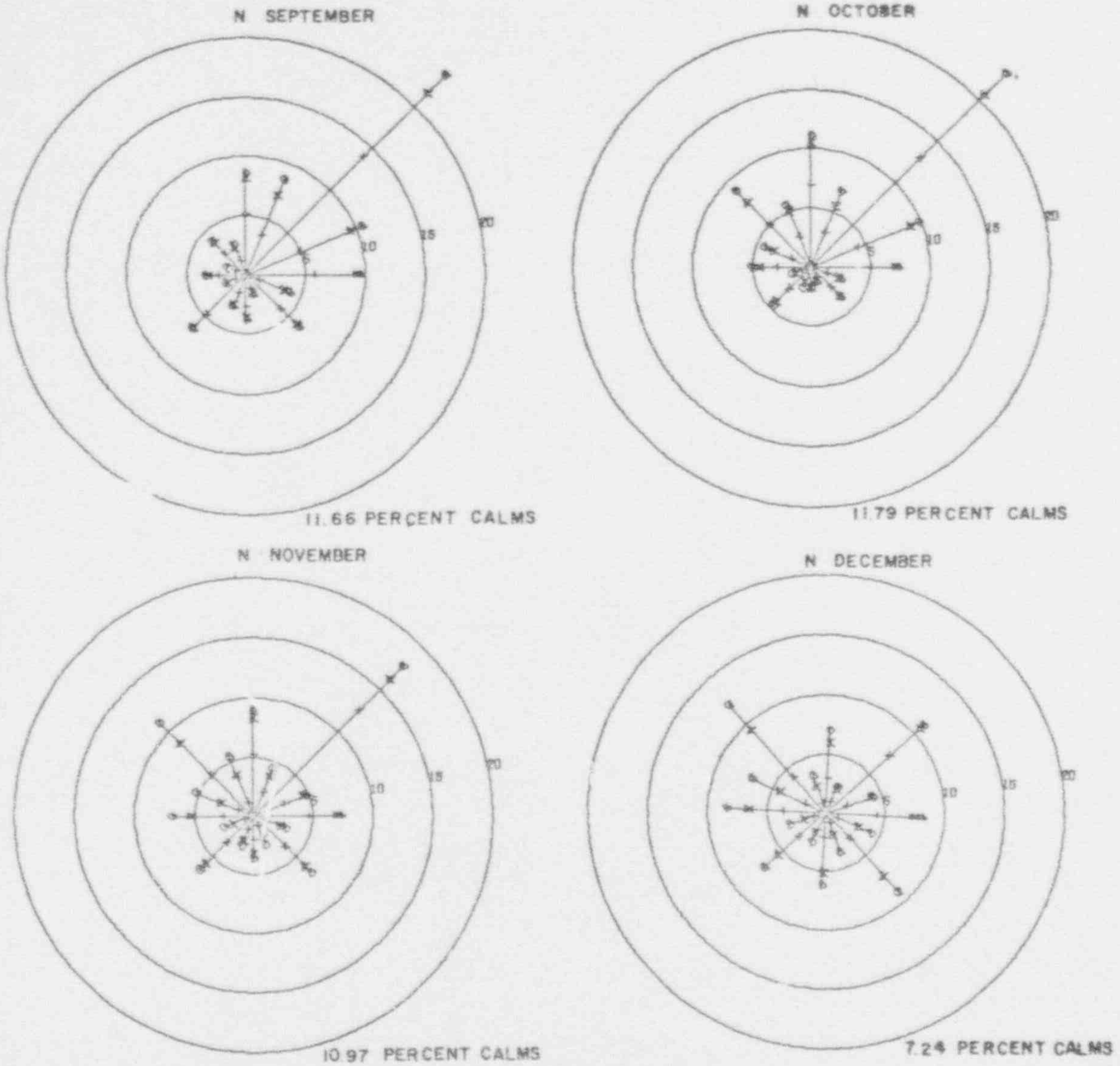
FIGURE 2.6-6



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY WIND ROSES FOR DOTHAN AIRPORT
(1950-1954)

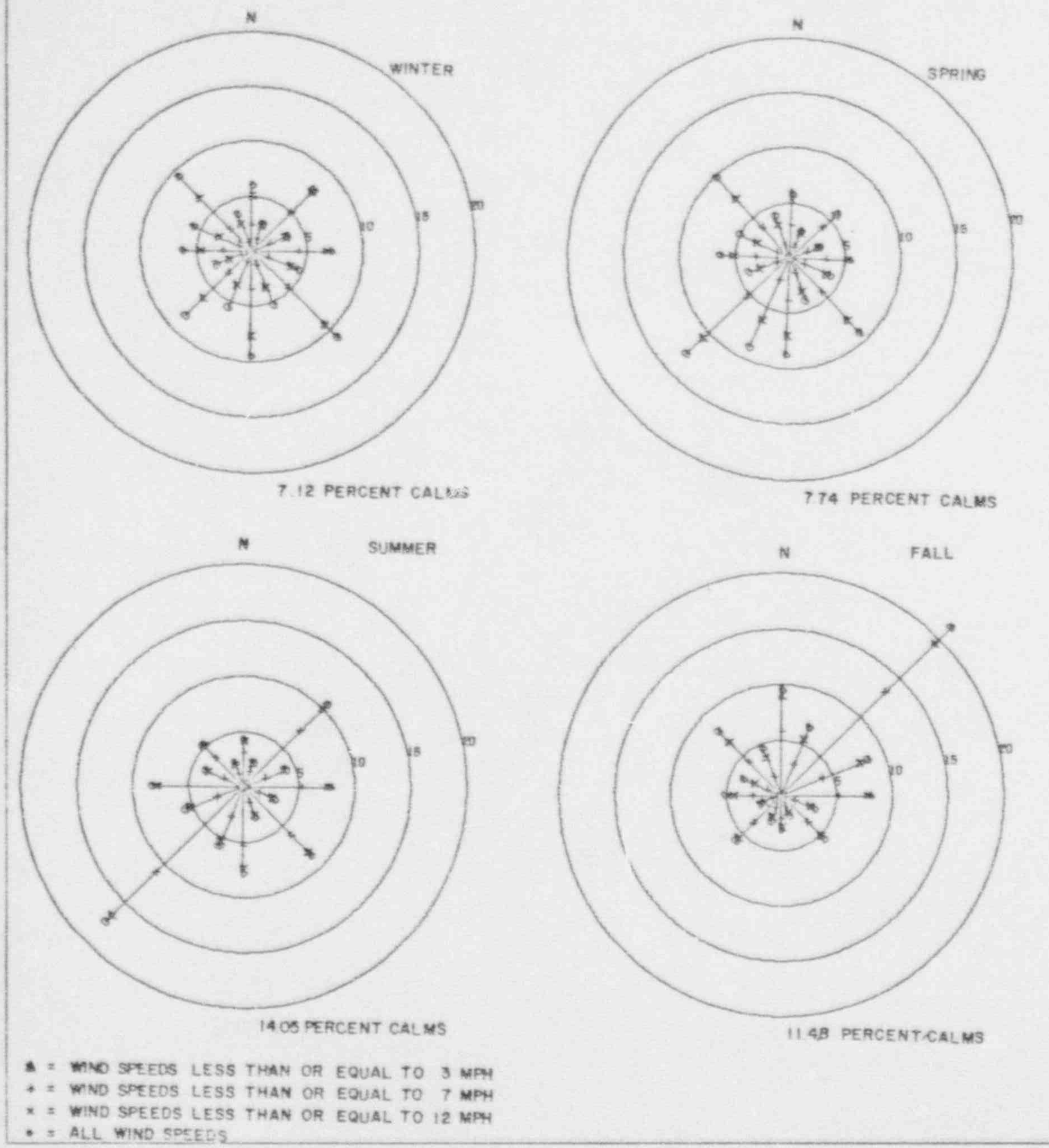
FIGURE 2.6-6 (CONT.)



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY WIND ROSES FOR DOTHAN AIRPORT
(1950-1954)

FIGURE 2.6-6(CONT.)

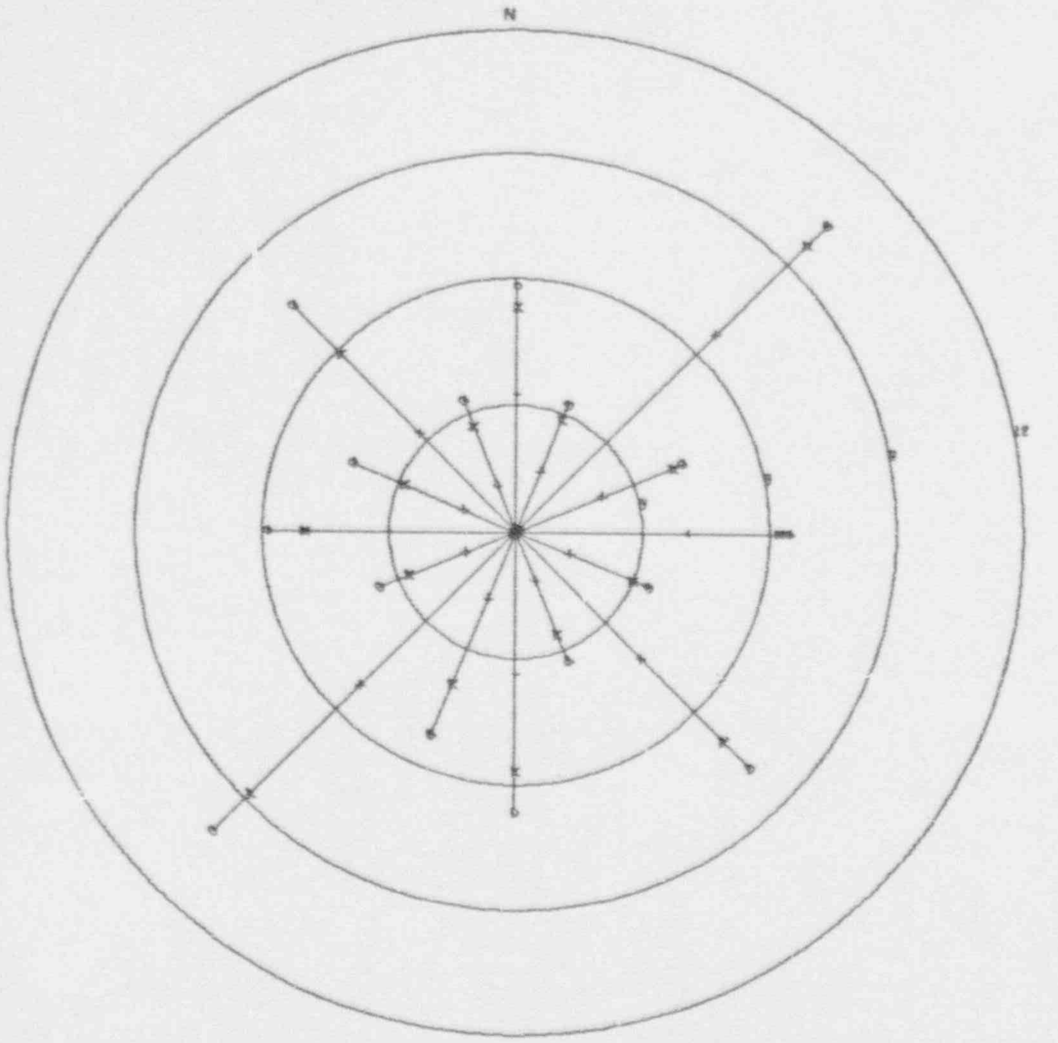


ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

SEASONAL WIND ROSES FOR DOTHAN AIRPORT

(1950-1954)

FIGURE 2.6-7

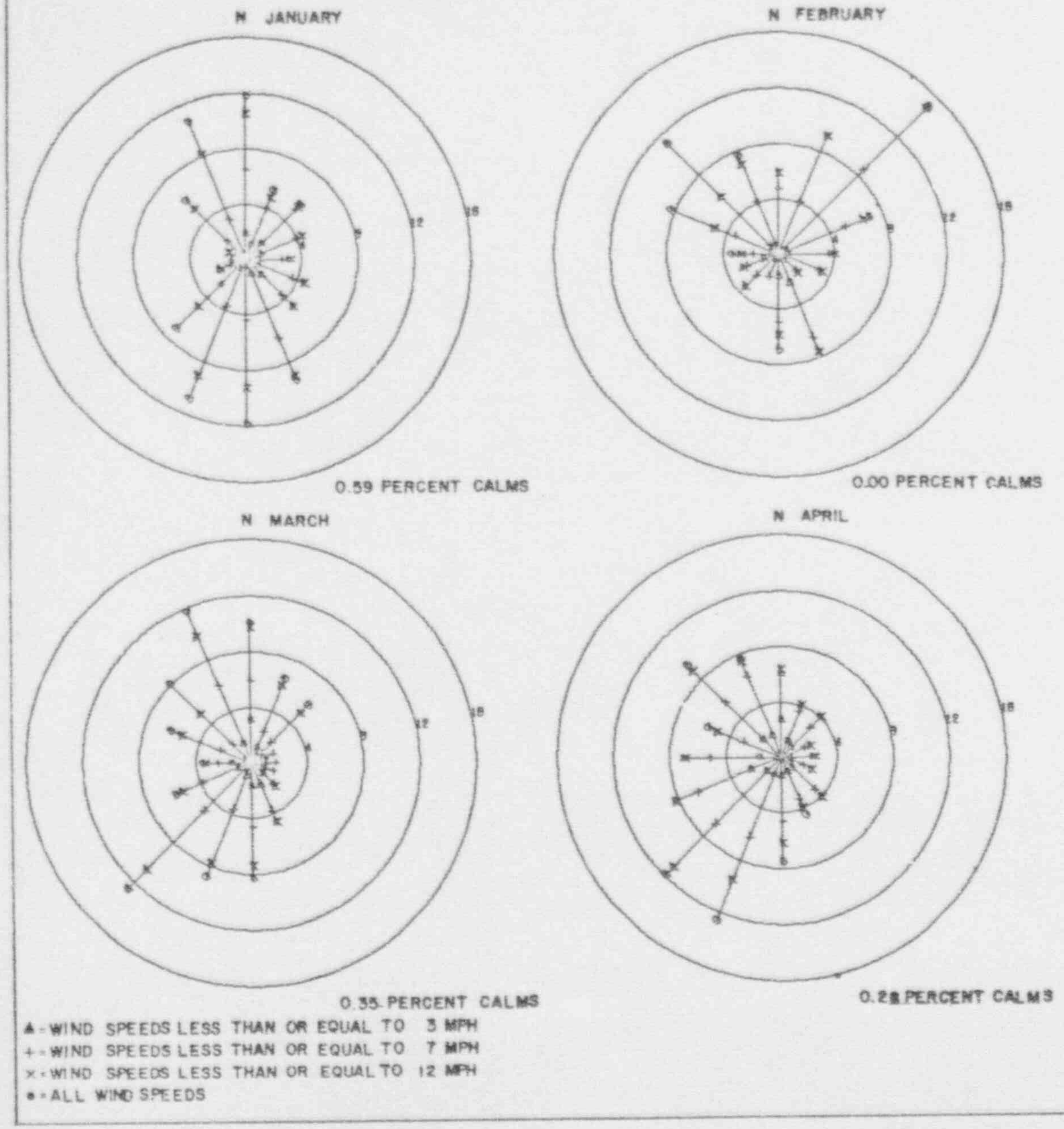


Δ= WIND SPEEDS LESS THAN OR EQUAL TO 3 MPH
+= WIND SPEEDS LESS THAN OR EQUAL TO 7 MPH
×= WIND SPEEDS LESS THAN OR EQUAL TO 12 MPH
●= ALL WIND SPEEDS

9.12 PERCENT CALMS

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

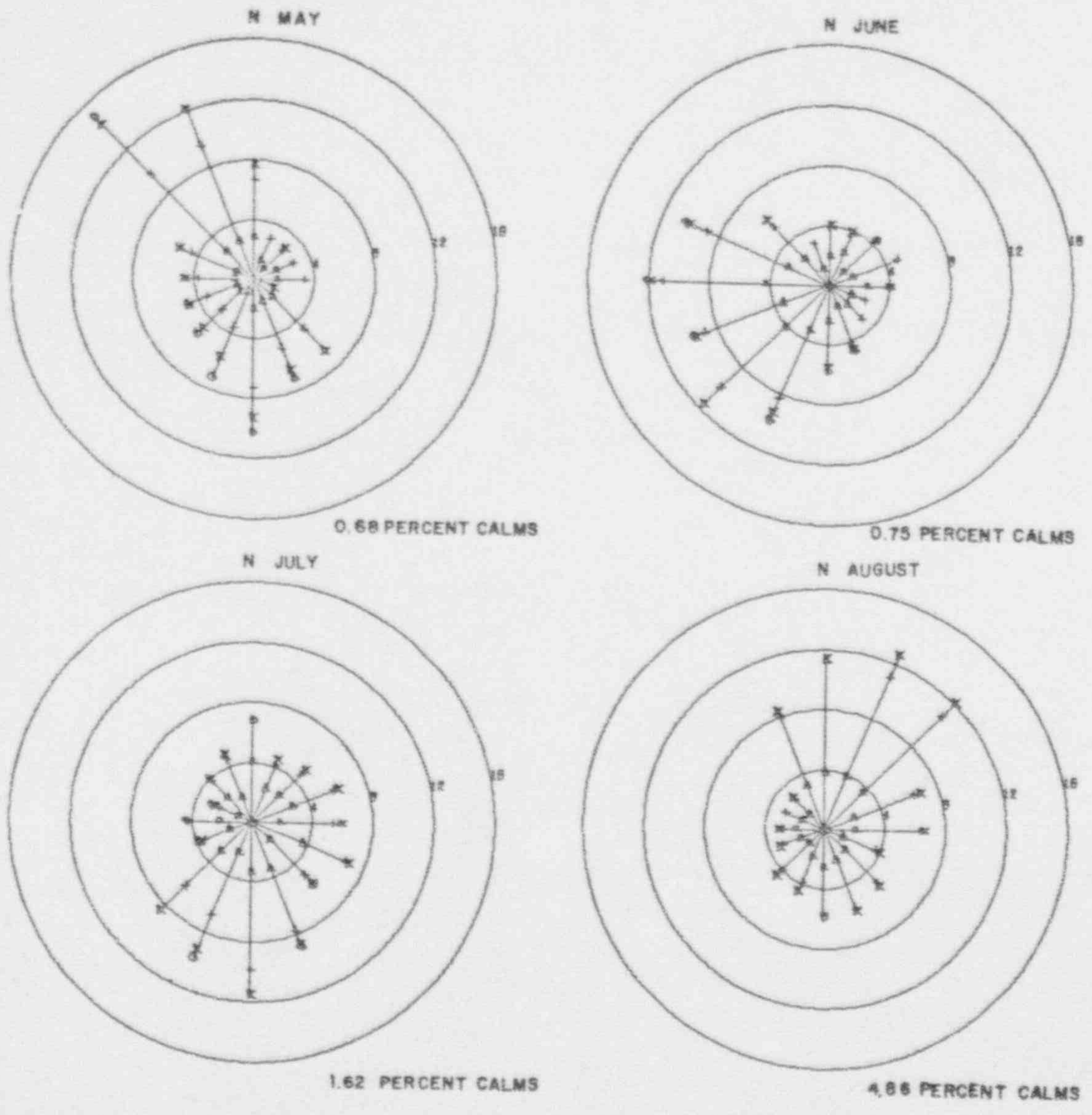
ANNUAL WIND ROSE FOR DOTHAN AIRPORT
1950-1954
FIGURE 2.6-8



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY WIND ROSES
FOR FARLEY SITE DATA (50 FT.)
(4/71-3/72)

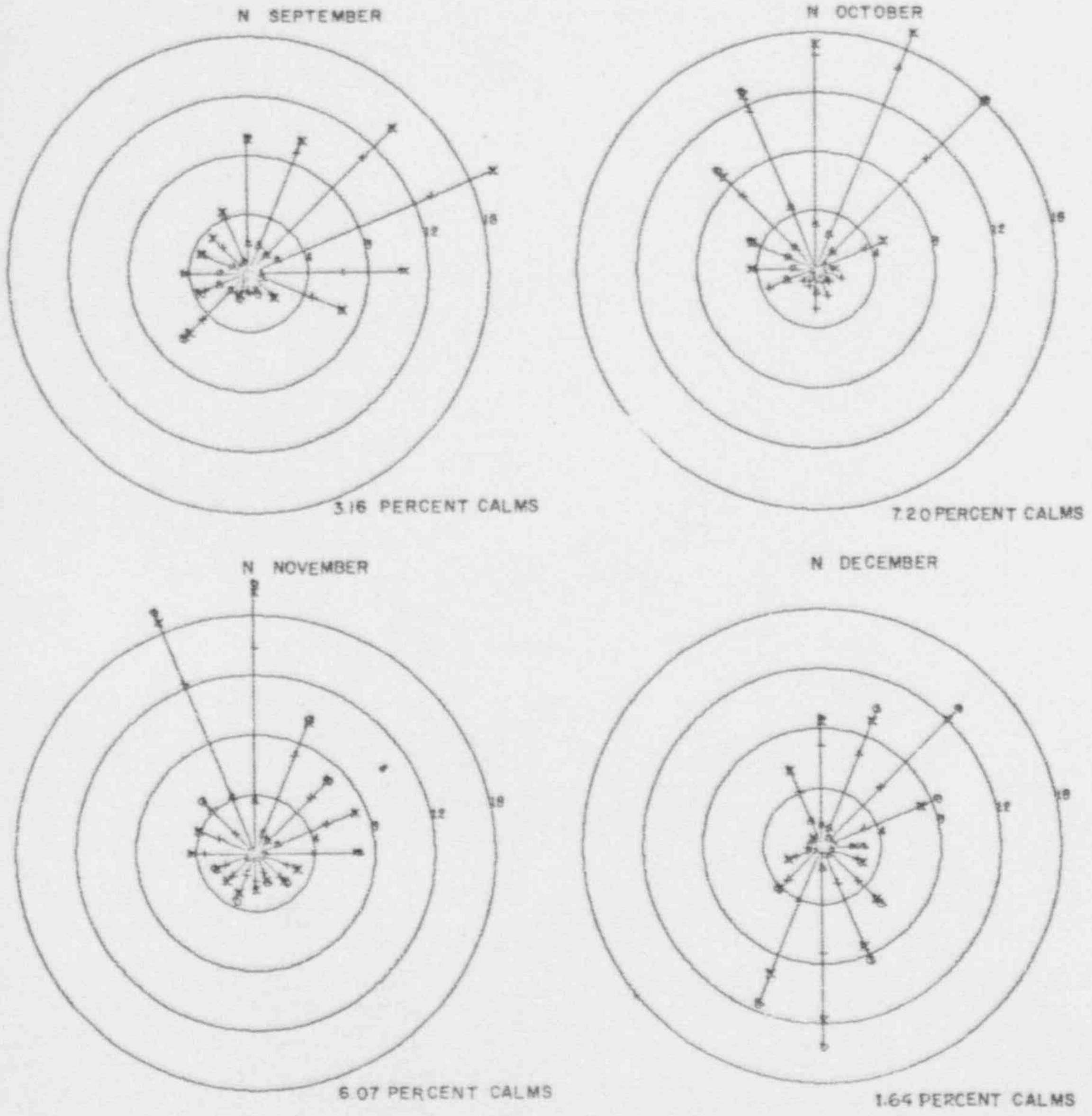
FIGURE 2.6-9



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

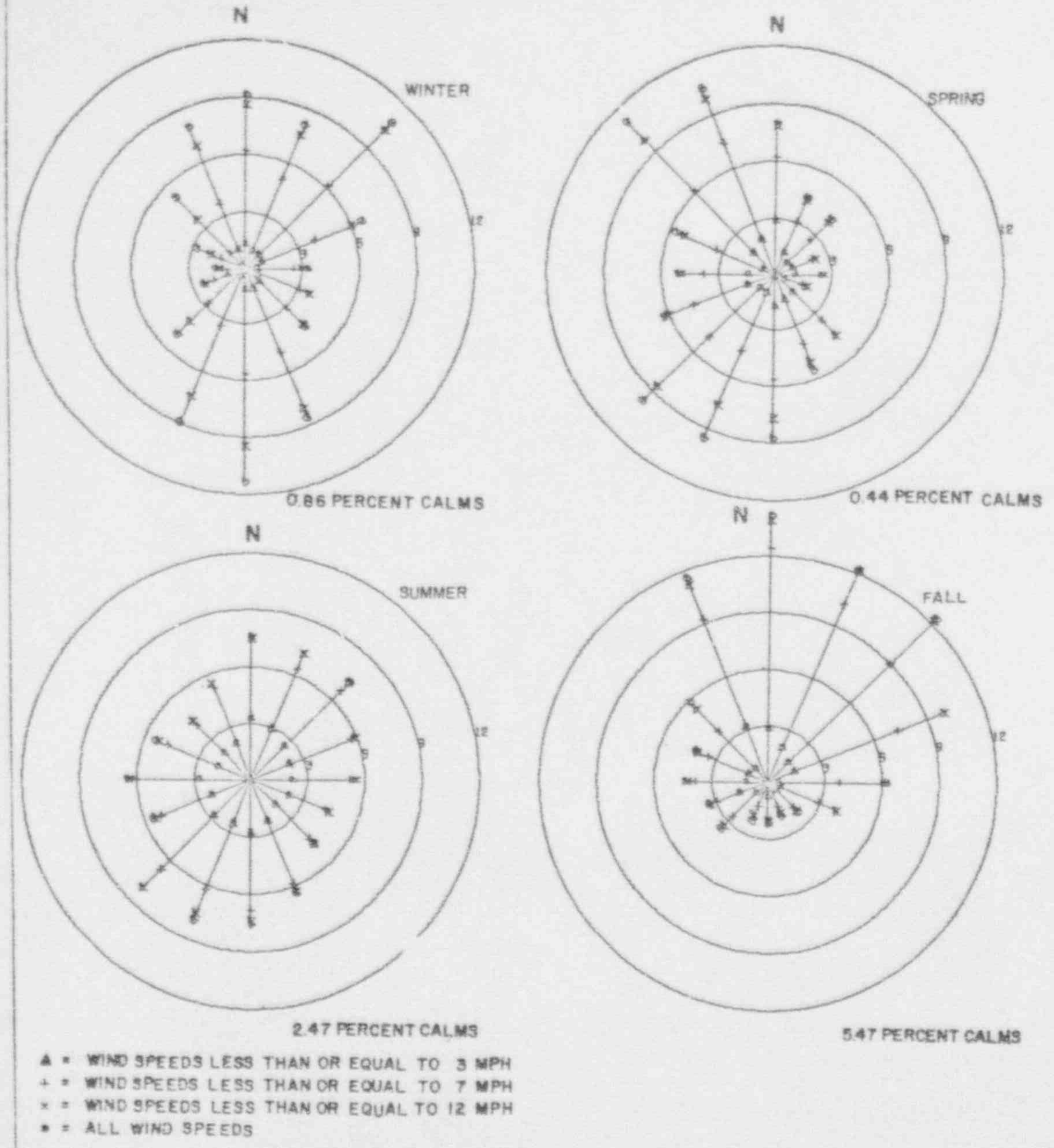
MONTHLY WIND ROSES
FOR FARLEY SITE DATA (50 FT.)
(4/71-3/72)

FIGURE 2.6-9 (CONT.)



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

MONTHLY WIND ROSES
FOR FARLEY SITE DATA (50 FT.)
(4/71-3/72)
FIGURE 2.6-9 (CONT.)

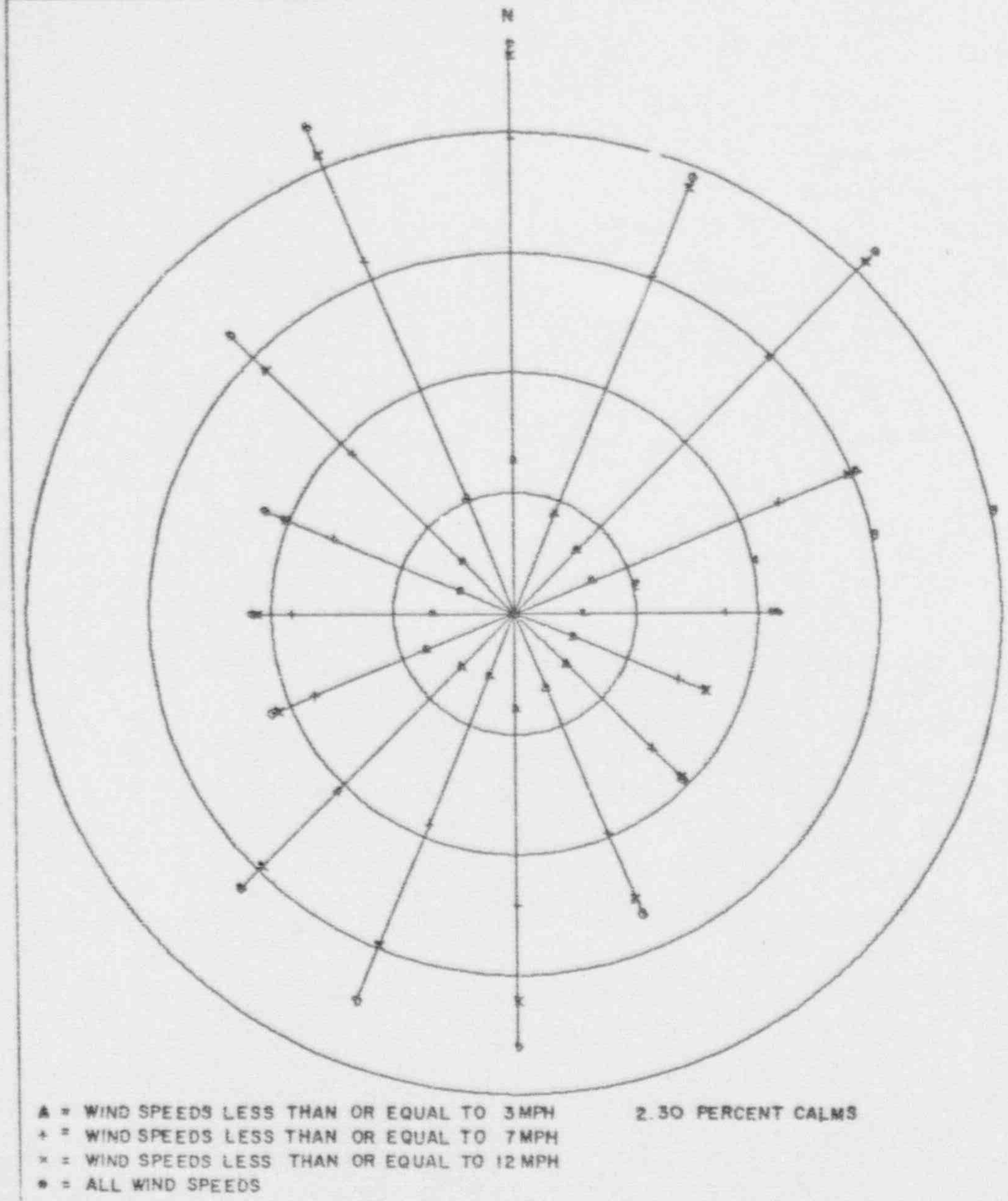


ON SITE

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

SEASONAL WIND ROSES
FOR FARLEY SITE DATA (50 FT.)
(4/71-3/72)

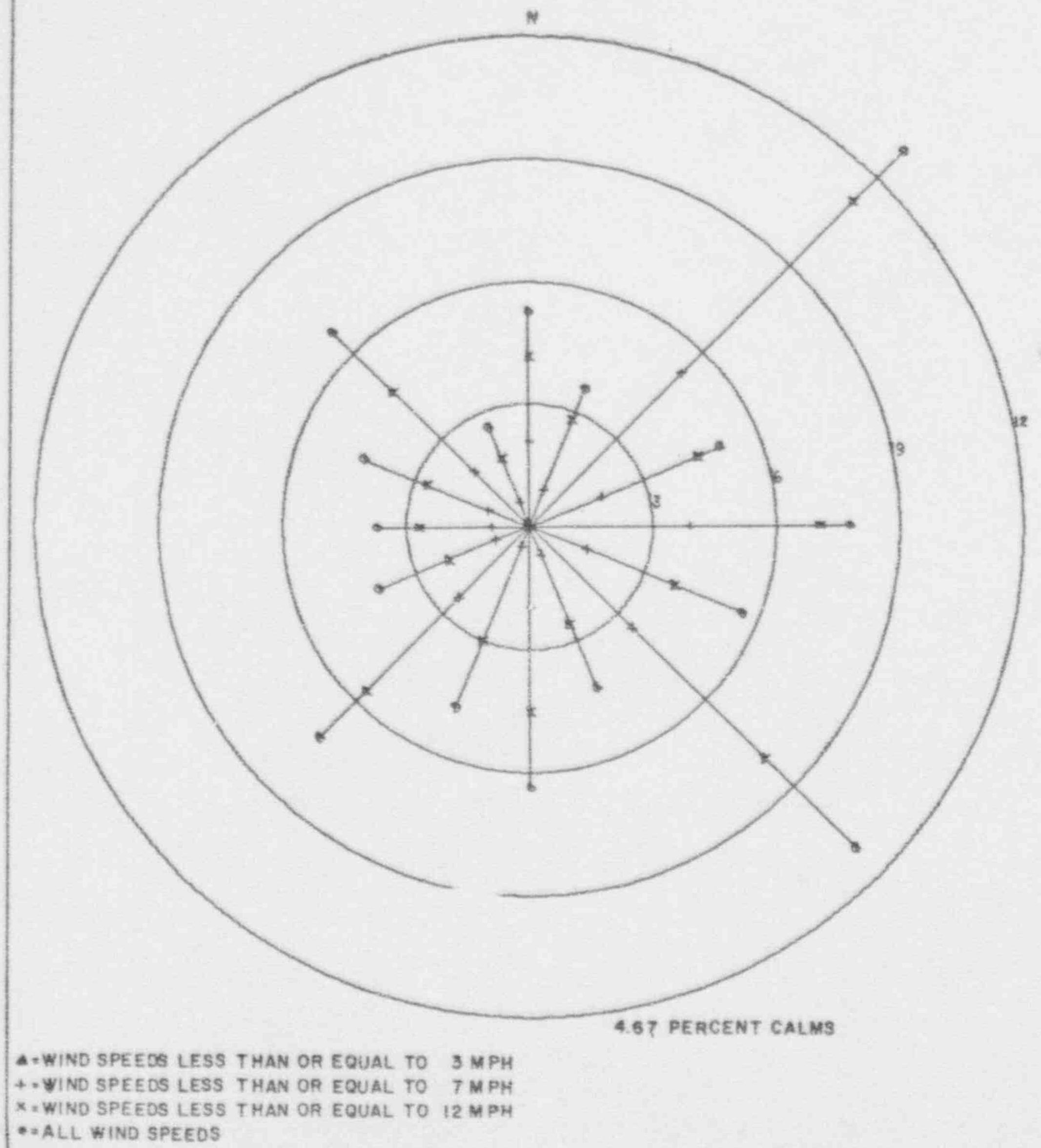
FIGURE 2.6-10



ON-SITE

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ANNUAL WIND ROSE FOR
FARLEY SITE DATA (50 FT.)
(4/71-3/72)
FIGURE 2.6-11

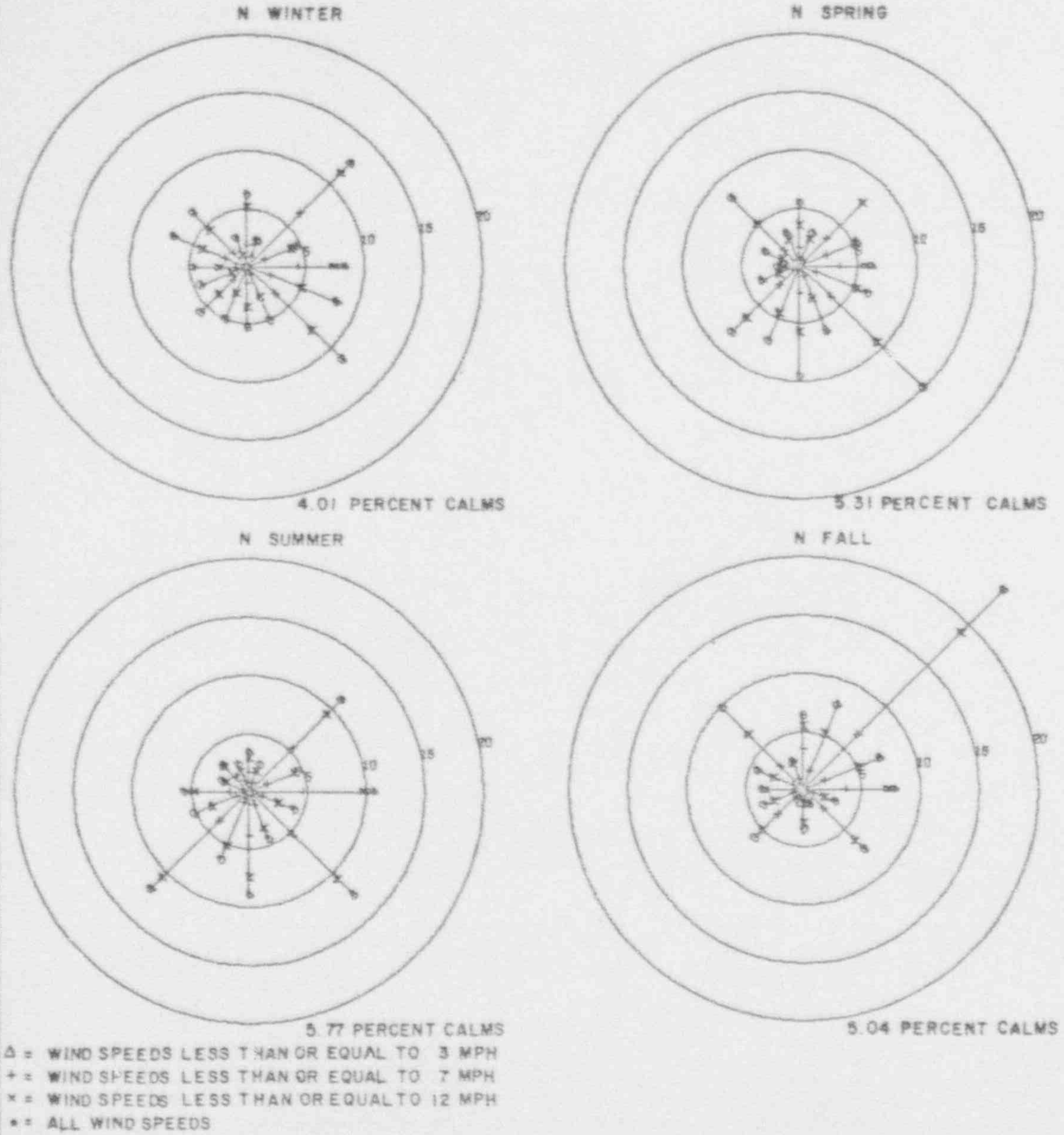


4.67 PERCENT CALMS

▲=WIND SPEEDS LESS THAN OR EQUAL TO 3 MPH
+=WIND SPEEDS LESS THAN OR EQUAL TO 7 MPH
×=WIND SPEEDS LESS THAN OR EQUAL TO 12 MPH
●=ALL WIND SPEEDS

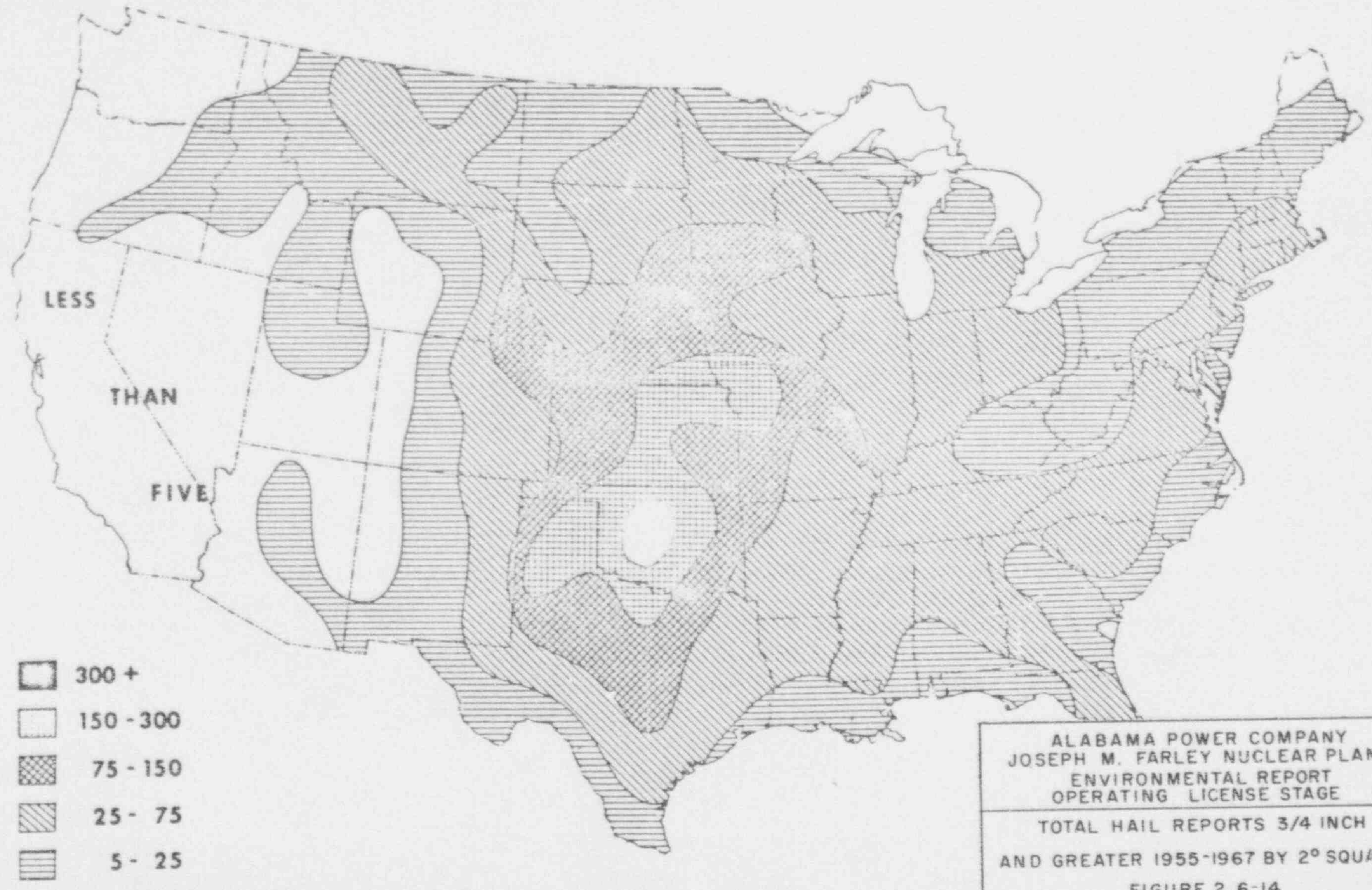
ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ANNUAL PRECIPITATION WIND ROSE
FOR DOTHAN AIRPORT
(1950-1954)
FIGURE 2.6-12



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

SEASONAL PRECIPITATION WIND ROSE
FOR DOTHAN AIRPORT
(1950-1954)
FIGURE 2.6-13

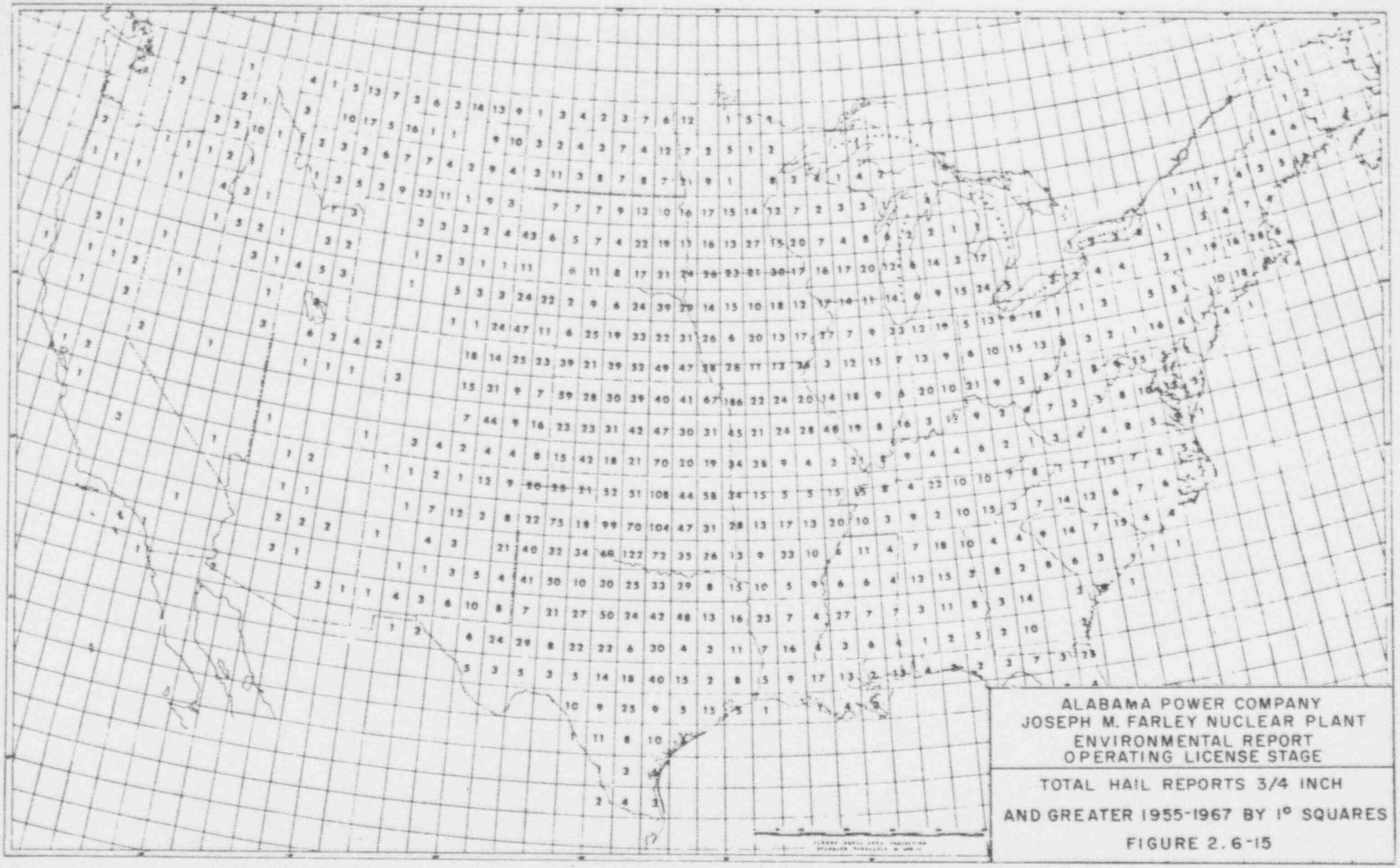


ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

TOTAL HAIL REPORTS 3/4 INCH

AND GREATER 1955-1967 BY 2° SQUARES

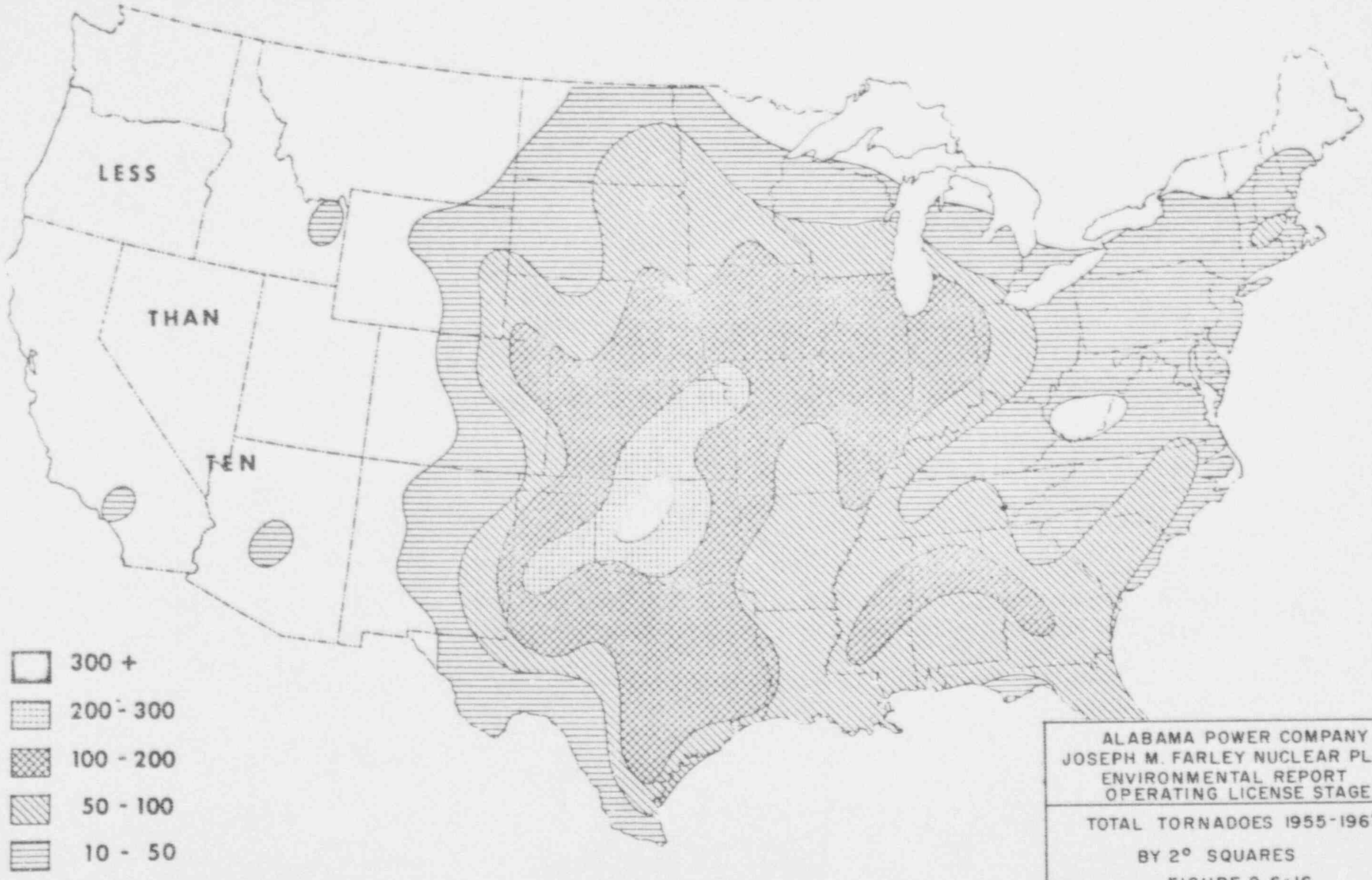
FIGURE 2.6-14



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

TOTAL HAIL REPORTS 3/4 INCH AND GREATER 1955-1967 BY 1° SQUARES

FIGURE 2.6-15

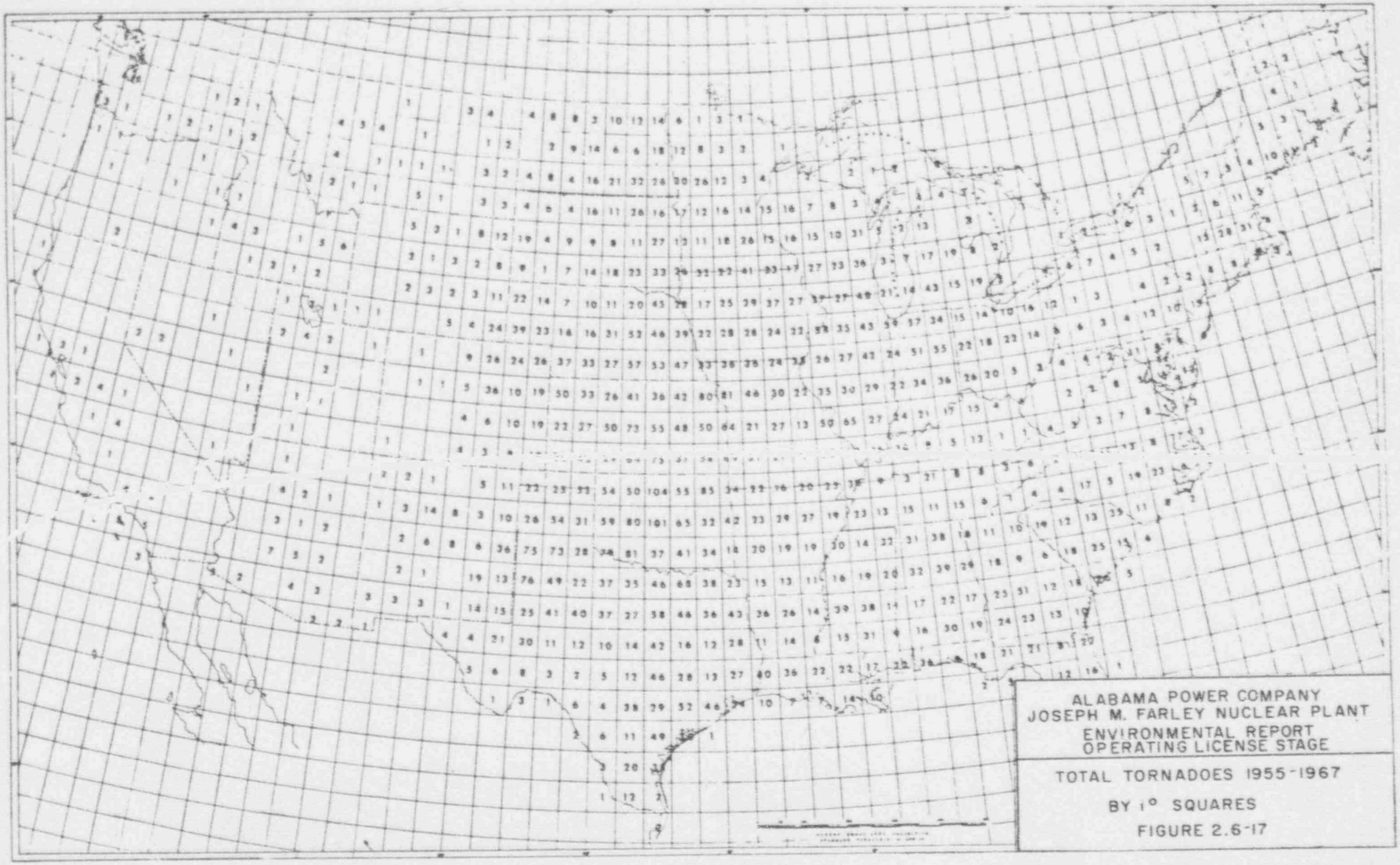


ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

TOTAL TORNADOES 1955-1967

BY 2° SQUARES

FIGURE 2.6-16

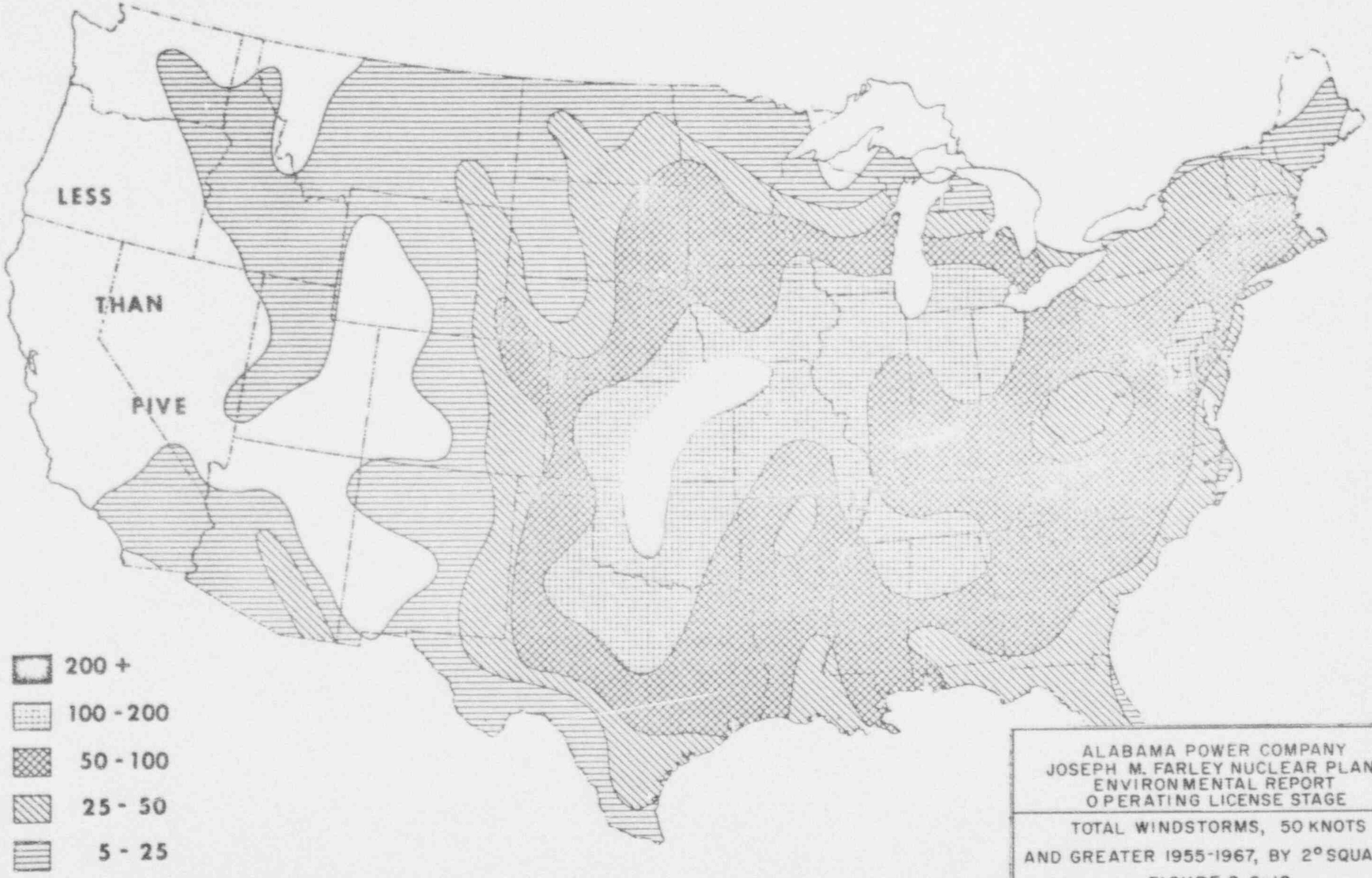


ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

TOTAL TORNADOES 1955-1967

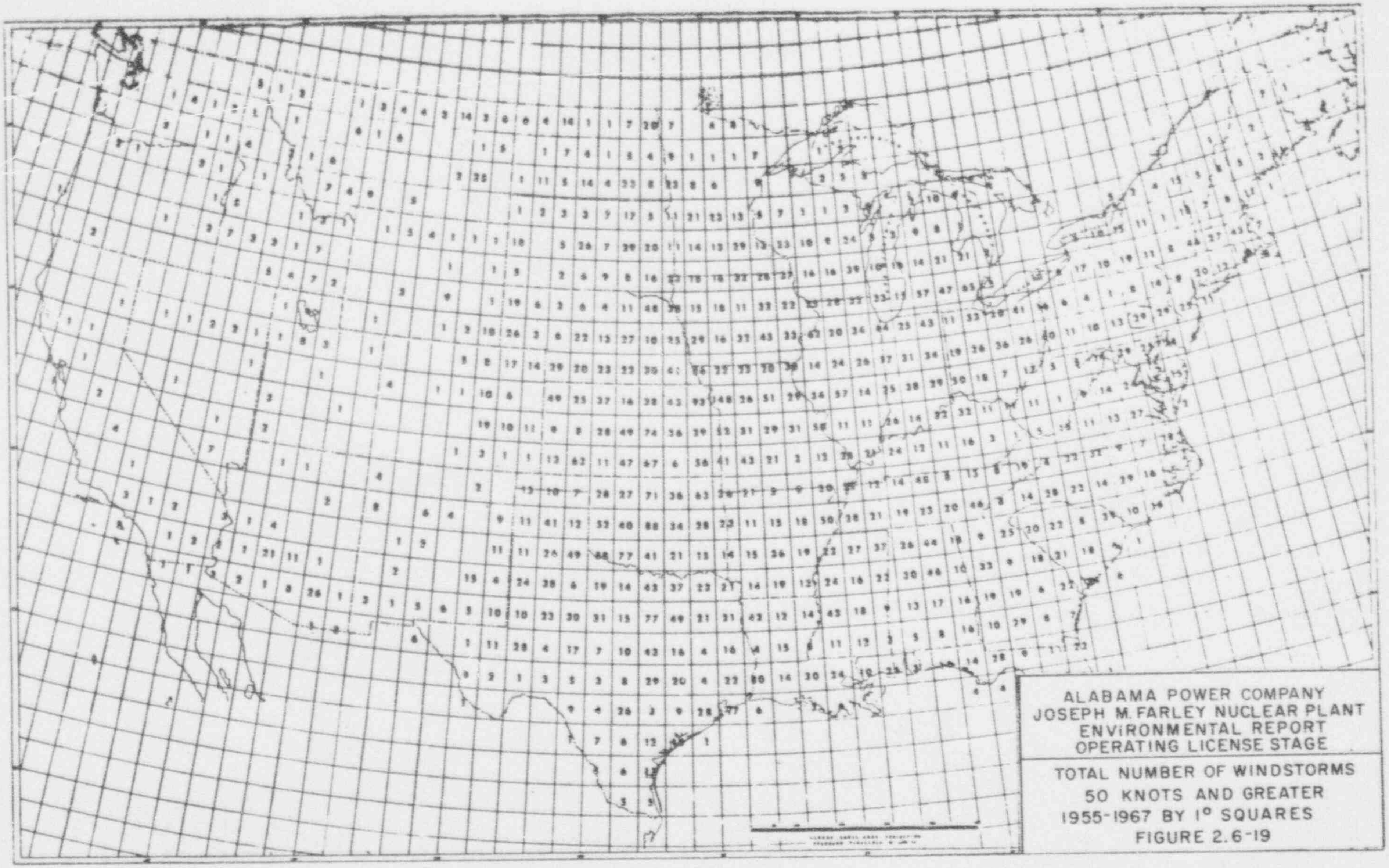
BY 1° SQUARES

FIGURE 2.6-17



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

TOTAL WINDSTORMS, 50 KNOTS
AND GREATER 1955-1967, BY 2° SQUARES
FIGURE 2.6-18



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

TOTAL NUMBER OF WINDSTORMS
50 KNOTS AND GREATER
1955-1967 BY 1° SQUARES
FIGURE 2.6-19

2.7 ECOLOGY

In the Environmental Report - Construction Permit Stage, a brief discussion was presented on the terrestrial flora and fauna at the Farley Nuclear Plant site. Extensive data and discussion were offered on the aquatic biota of the Chattahoochee River. For the Environmental Report - Operating License Stage, an extensive review of the biological literature was carried out for the Chattahoochee River and the counties that surround the Farley Nuclear Plant. This information is presented as Appendix 1. 2

Forestry and terrestrial botany, and aquatic invertebrates and botany were discussed in the AEC's Final Environmental Statement. 1 Information on terrestrial invertebrates, terrestrial and aquatic vertebrates presented in Appendix 1 was obtained from both published and unpublished studies. References and literature cited are presented after the narrative on each major taxon. In some cases the complete life histories and ecological requirements are not discussed since the standard references providing this information are cited in the references section.

<u>Rare and Endangered Vertebrates of Alabama - 1972</u> was used in citing species in an endangered or precarious status which might reside in the vicinity of the Farley Nuclear site and in the nearby Chattahoochee River. Consultation was sought from qualified vertebrate ecologists who are knowledgeable of the vertebrates residing in Houston County, Alabama. Alabama Power Company has consulted the College of Veterinary Medicine at the University of Georgia concerning wildlife diseases. Their letter,

which indicates no record of diseases involving wildlife, is attached. A letter is also attached from the Georgia Department of Natural Resources concerning populations of game animals in Early County, Georgia.

Since extensive ecological studies of aquatic and terrestrial biota were not required for the Environmental Report - Construction Stage, 1 the environmental impact of plant construction on rare and endangered species which might reside at the Farley Nuclear site and nearby Chattahoochee River can be based only on data and information presented in Appendix 1.

Section 1.3 of Appendix 1 presents information on commercial and sport species of fish which could be expected to use the stretch of river between the Columbia Lock and Dam and the site of the Joseph M. Farley Nuclear Plant. Section 1.3 of Appendix 1 contains information on the 2 spawning habits and species life history for those important species of fish. The information presented in Appendix 1 can be utilized to ascertain those species preferring river and headwaters habitat at various life stages in contrast to those species which might complete their life cycles in Lake Seminole.

The populations of any rare or endangered and any common species which might reside in the vicinity of the Farley Nuclear Plant site and in the nearby Chattahoochee River should not be adversely affected by the plant construction so far as genetic drift and reproduction, and distribution throughout their known ranges are concerned. Section 4.2 of this repoert presents the results of an aerial survey of Alabama Power Company transmission line rights-of-way conducted by Dr. Julian L. Dusi of Auburn University. The reconnaissance was to seek potential habitat and assess the impact of those species discussed in Section VII-B or the AEC Final Impact Statement. Dr. Dusi's report indicates no expected impact on those species.

COPY

ALABAMA POWER COMPANY

Birmingham, Alabama 35202

March 16, 1973

Dr. Frank A. Hayes, Director
Southeast Cooperative Wildlife Study
College of Veterinary Medicine
University of Georgia
Athens, Georgia 30601

Dear Dr. Hayes:

I am employed as a biologist by Alabama Power Company. I am in the process of compiling added ecological and environmental information relative to the Farley Nuclear Plant near Dothan, Alabama. The new AEC Guidelines request information specifically on wildlife disease outbreaks near nuclear plant sites. I would appreciate your contacting me by mail if there is documented information on wildlife disease outbreaks in Houston County, Alabama, Early and Seminole Counties, Georgia and Jackson County, Florida.

Your help in this matter would be greatly appreciated.

Sincerely,

Harold Wahlquist, Ph.D.
Aquatic Biologist
Room 635

HW:1

COPY

SOUTHEASTERN COOPERATIVE WILDLIFE DISEASE STUDY

PARASITOLOGY
COLLEGE OF VETERINARY MEDICINE
The University of Georgia
Athens, Georgia 30601

March 27, 1973

Dr. Harold Wahlquist
Aquatic Biologist
Room 635
Alabama Power Company
Birmingham, Alabama 35202

Dear Dr. Wahlquist:

In reply to your letter of March 16, 1973, our records do not indicate that any diseases involving wildlife have occured within the counties under consideration. In the event that such should occur, we will notify you immediately.

Very sincerely,

Frank A. Hayes, D. V. M.
Director

FAH/gm

COPY

ALABAMA POWER COMPANY

Birmingham, Alabama 35202

March 5, 1973

Mr. Jack Crockford, Director
Game and Fish Division
Department of Natural Resources
270 Washington St., S.W.
Atlanta, Georgia 30334

Dear Mr. Crockford:

I am writing to inquire about the availability of wildlife information from Early County near the Farley Nuclear Plant. I need information on the status and densities of game animals in this area for elaboration on the environmental impact statement. I would appreciate copies of Dingell-Johnson reports, or other reports, that have dealt with wildlife investigations in this area and information on possible incidents of wildlife disease outbreaks. Your consideration in this matter would be greatly appreciated.

Sincerely,

Harold Whalquist, Ph.D.
Aquatic Biologist
Room 635

HW/pak

COPY

DEPARTMENT OF NATURAL RESOURCES
Game and Fish Division

P. O. Box 911
Bainbridge, Georgia 31717
March 13, 1973

Mr. Harold Wahlquist, Ph.D.
Aquatic Biologist
Room 635
Alabama Power Company
Birmingham, Alabama 35202

Dear Dr. Wahlquist:

Your letter to Mr. Crockford for information of game populations and densities in Early County has come to my attention.

The only game surveys this Department has conducted in Early County was for deer and turkey. The river section has the highest deer population in the county. I would estimate on (1) deer per 60 acre which is not a high population, but based on other sections of this area is a fair population. There are very few turkey in Early County and most of those are in sections other than the river area.

Other game species found along the river area are squirrel (gray and fox), racoons, beaver, quail and dove. During winter months migrating waterfowl are available as well as resident wood duck at all seasons of the year.

There are no reports available concerning game for any of these species in this county. I apologize for the amount of data available but hope this will be a help to you.

If I can assist you again, please call on me.

Very truly yours,

Oscar Dewberry
Regional Game Supervisor
Region V

OD/bjm

2.8 Background Radiological Characteristics

There is no reason to believe that radiological conditions in the region of the Farley site differ in any significant degree from conditions elsewhere in southeastern United States.

The estimated whole-body dose from cosmic radiation in the state of Alabama is 40 mrem/year, that from natural terrestrial radioactivity is 70 mrem/year (A. W. Klement, Jr., et.al, Estimates of ionizing radiation doses in the United States 1960-2000, EPA report ORP/CSD 72-1, August 1972). Thus, the expected external dose rate from natural causes is expected to be about 110 mrem/year.

Recent data on radioactivity concentrations in the State of Alabama are summarized in Tables 2.8-1 through 2.8-4.

Table 2.8-5 summarizes the preliminary measurements of concentrations of radioactive materials on and around the Farley site. Figure 2.8-1 gives the locations of the sampling stations. The measurements of radiation and radioactivity planned for the pre-operational and operational phases of the program are described in Section 6.0.

TABLE 2.8-1

MONTHLY AVERAGE CONCENTRATIONS IN MILK, MONTGOMERY, ALABAMA*

	In 10^{-9} µCi/ml		
Month	Sr-90	I-131	Cs-137
1971			
July	6.	<10.	13.
August	-	<10.	15.
September	-	-	23.
October	8	-	<10.
November	-	-	11.
December	-	-	13.
1972			
January	8	-	<10.
February	-	-	<10.
March	-	-	19.
April	6	-	<10.
May	-	-	16.
June	-	-	15.
July	5	-	<10.

TABLE 2.8-2

AVERAGE CONCENTRATIONS OF TRITIUM IN WATER, ALABAMA*

	in 10^{-} µCi/ml		
Month	Tap water Montgomery	Precipitation, Montgomery	Tennessee River, Browns Ferry
1971			
April	<2.	<2.	5.
May	-	7.	-
June	-	3.	-
July	<2.	4.	6.
August	-	8.	-
September	-	<2.	-
October	3.	3.	4.
November	-	6.	-
December	-	<2.	-
1972			
January	2.	<2.	-
February	-	3.	-
March	-	<2.	-

---

*Radiological Health Data and Reports, Nov-Dec., 1971
Radiation Data and Reports, January-November 1972.

TABLE 2.8-3

GROSS RADIOACTIVITY IN AIR AND DEPOSITED ON THE GROUND, MONTGOMERY, ALABAMA*

Month	Air, µCi/ml ($\times 10^{-12}$)	Deposition, µCi/m^2 ($\times 10^{-3}$)
1971		
July	1	148
August	1	28
September	1	108
October	2	9
November	2	98
December	1	18
1972		
January	1	15
February	1	7
March	1	7
April	1	3
May	1	17
June	1	25
July	1	18

TABLE 2.8-4

STRONTIUM-90 DEPOSITION, BIRMINGHAM, ALABAMA*

Month	µCi/m^2 ($\times 10^{-4}$)
1970	
July	1.2
August	1.3
September	0.1
October	0.8
November	0.8
December	0.8

---

*Radiological Health Data and Reports, Nov.-Dec. 1971.
Radiation Data and Reports, Jan.-Nov., 1972.

TABLE 2.8-5

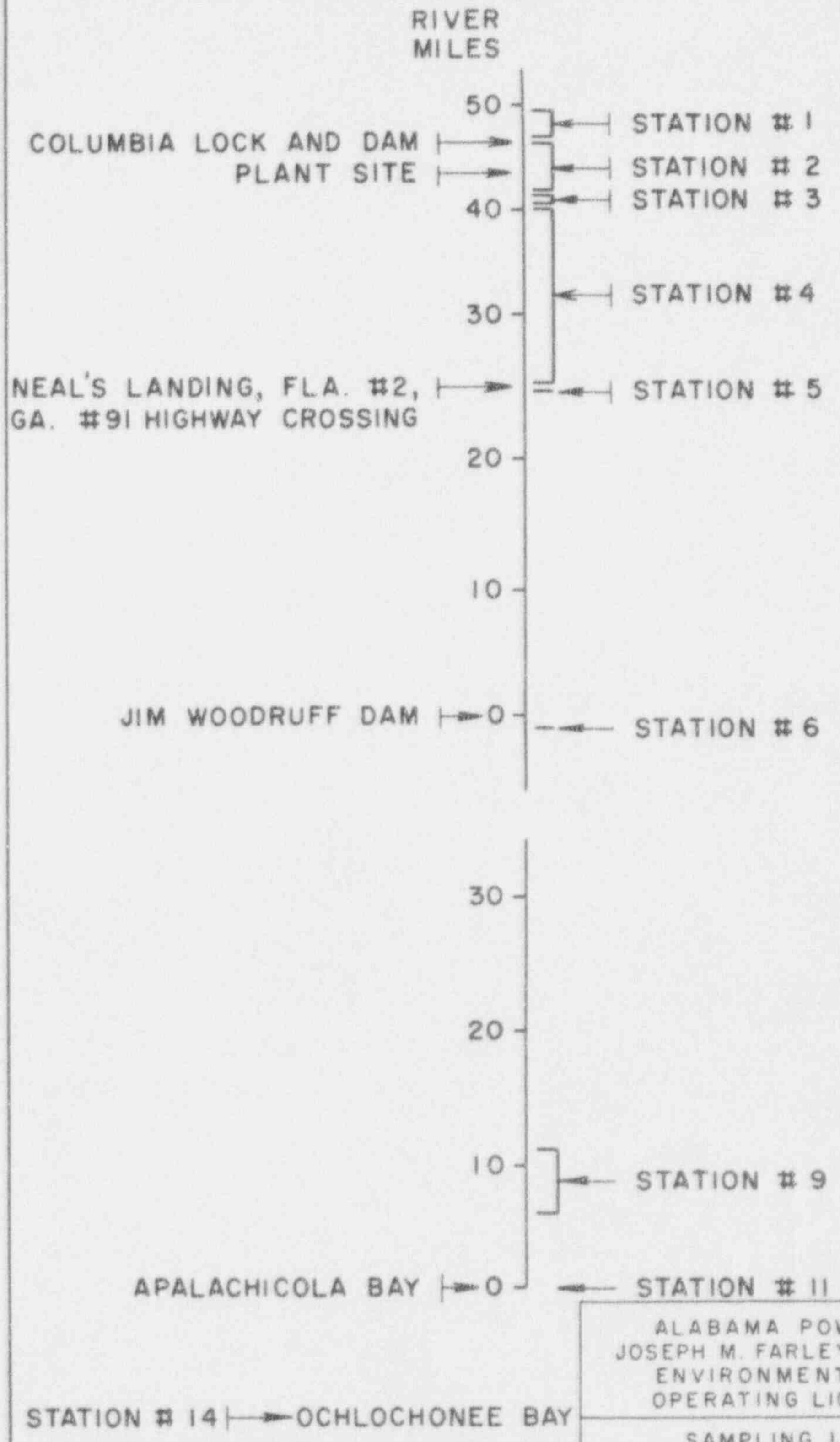
MEASURED CONCENTRATIONS OF RADIONUCLIDES*

Sample (location)**	Concentration, µCi/g (wet weight)				
	Sr-90	Ru-106	Cs-137	Ru-226	Th-232
Well water (site)	$1.4x10^{-10}$	-	-	-	-
River water					
(Sta. 1-8)	$2.3x10^{-11}$	-	-	-	-
(Sta. 9)	1.5x10-^{10}	-	-	-	-
Estuary water (Sta. 11,14)	$1.8x10^{-10}$	-	-	-	-
Bass					
(Sta. 1-8)	$9x10^{-9}$	-	$1.8x10^{-7}$	-	-
(Sta. 9)	$1.4x10^{-8}$	-	1.3x10-7	-	-
Mullet (Sta. 11,14)	$9.0x10^{-9}$	-	-	-	-
Oyster (Sta. 11,14)	$1.4x10^{-8}$	-	-	-	-
Juncus					
(Sta. 9)	$2.3x10^{-8}$	-	-	-	-
(Sta. 11,14)	$3.2x10^{-8}$	-	-	-	-
Milk (Silcox farm)	$4.5x10^{-9}$	-	$8.1x10^{-9}$	-	-
Corn (Silcox farm)	$2.3x10^{-8}$	-	-	-	-
Soil (Silcox farm)	$2.4x10^{-7}$	$2.8x10^{-7}$	$2.1x10^{-7}$	$8.0x10^{-7}$	$6.0x10^{-7}$
Sediment					
(Sta. 1-8)	$2.3x10^{-7}$	-	$1.6x10^{-7}$	$2.1x10^{-6}$	$2.2x10^{-6}$
(Sta. 9)	$1.6x10^{-7}$	-	$4.0x10^{-7}$	$1.3x10^{-6}$	$1.1x10^{-6}$
(Sta. 11,14)	$1.4x10^{-7}$	-	$7.2x10^{-8}$	$4.2x10^{-7}$	$3.4x10^{-7}$

---

*Stewart Laboratories, Inc., Alabama Power Company, Final Report, Radiological Survey, J. M. Farley Nuclear Power Plant, July 7, 1972.

**
Locations are shown on Figure 2.8-1.
Silcox Farm located approx. 10 miles WSW of Farley Nuclear Plant, Houston County.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

SAMPLING LOCATIONS

FIGURE 2.8-1

3.3 PLANT WATER USE

The Joseph M. Farley Nuclear Plant will require the use of surface and/or groundwater in the following major systems:

1. Circulating Water System
2. Service Water System
3. Potable Water System
4. Fire Protection System
5. Demineralizer Water System

Figure 3.3-1 is a schematic representation of the water use system.

Table 3.3-1 is a tabulation of water use for major systems under various plant operating conditions.

3.3.1 SURFACE WATER USE

Water withdrawn from the Chattahoochee River will provide service water and makeup water for the cooling towers and circulating water system. The withdrawal rate will be approximately 31,000 gpm for each unit during normal operation.

The service water system provides water for component cooling water heat exchangers, containment coolers, diesel generators, safeguard pump room coolers, letdown chillers and turbine room heat exchangers.

Makeup water will be required for the circulating water system to replace losses due to evaporation, drift, and blowdown. The makeup will be supplied from the service water system discharge. The makeup water requirement will be approximately 17,800 gpm per unit during normal operation. The remaining 12,800 gpm of service water flow will be mixed with other discharges and returned to the river. Consumptive loss of approximately 12,700 gpm will occur in the cooling tower circuit for each unit. This will be due to evaporation and drift from the cooling towers. Cooling tower blowdown will be discharged at the rate of approximately 5,100 gpm.

3.3.2 GROUNDWATER USE

The plant requires a maximum of 380 gal. per minute of groundwater for the following operations:

Make-up demineralizer	320 gpm
Domestic	60 gpm
TOTAL	380 gpm

Groundwater is also used to provide make-up for the fire protection system. Storage for 600,000 gallons of water for the fire protection system will be provided in two 300,000 gallon tanks. The maximum instantaneous demand on the ground water system would be 1.1 million gallons per day. This would occur if maximum use of the demineralizer and potable water supply was called for during a period when both fire protection tanks were being filled. As discussed below, this demand is significantly less than the reported yield of the major deep aquifer. 2

Two onsite water wells, located about 4000 feet to the north and about 2500 feet to the southwest of the plant, provide groundwater for plant operation. These wells are 775 and 980 feet deep respectively, and draw water from the major deep aquifer. The deeper well also draws from the underlying Providence formation. Each well is equipped to produce over 500 gal. per minute. The combined producing capacity of the two wells is more than twice the maximum plant usage.

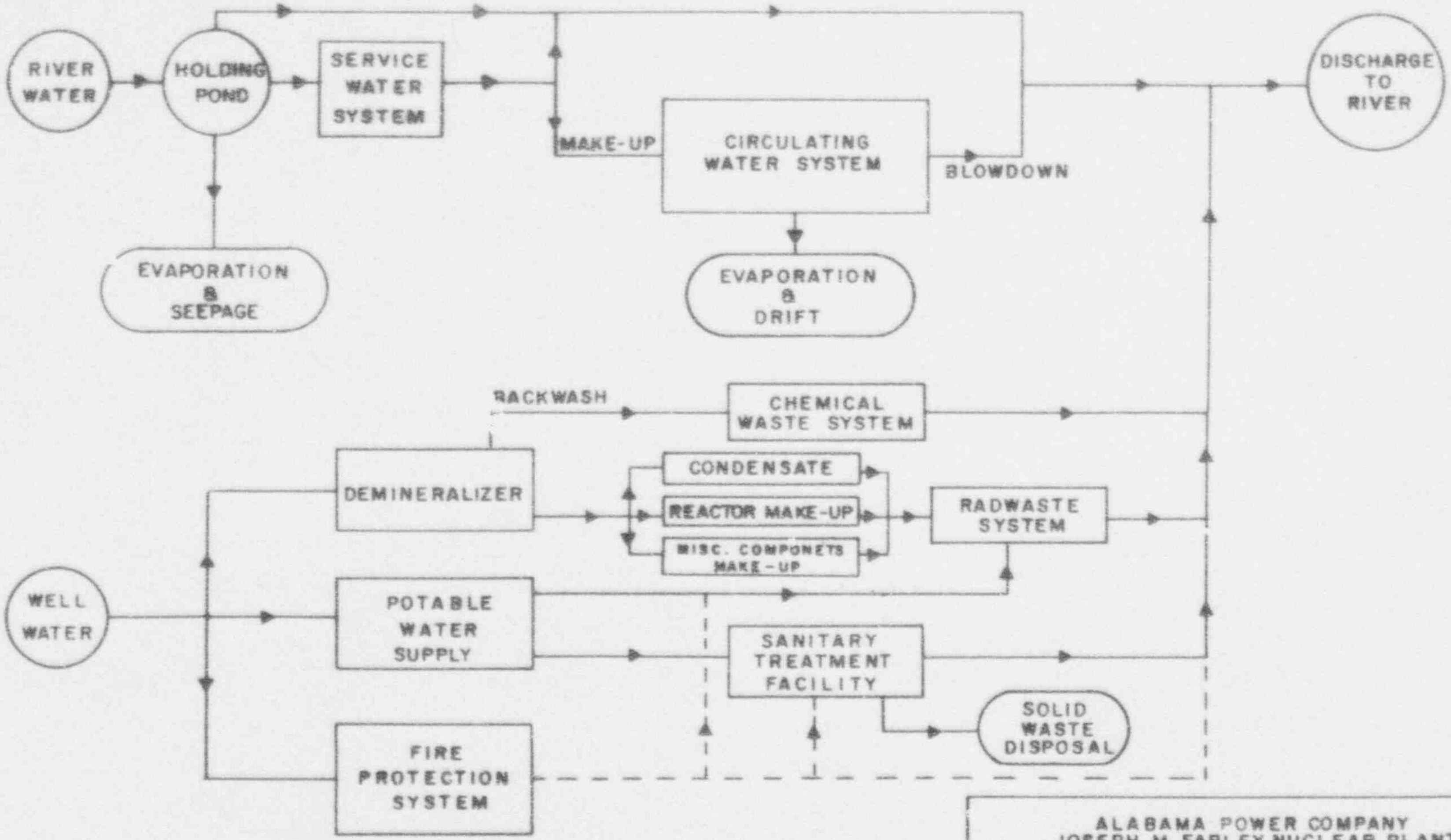
No adverse effects to offsite wells should occur as a result of onsite pumping from the major deep aquifer. Two wells within three miles of the site presently produce small quantities of water from the major deep aquifer for irrigation, stock, and domestic usage. The nearest area of concentrated withdrawal from this aquifer is at Columbia, Alabama, five miles north of the plant, where 62 gallons per minute are withdrawn. The Geological Survey of Alabama reported that the major deep aquifer will yield over one million gallons per day (700 gpm) to individual wells in all parts of Houston County. The maximum plant groundwater requirement that could be produced from a single well in the aquifer is about half that amount. The reported quantity of water available is such that offsite wells producing from the major deep aquifer should not be affected by onsite pumping.

In the unlikely event of an accidental release of radioactive contaminants onto the ground surface at the site, movement of contaminants into the ground water system would be affected by several factors. First, ion exchange and absorption properties of the soil deposits would restrict the migration of the contaminants to some extent. Secondly, downward movement of the contaminants would be limited to the unconfined aquifers of the upper portion of the major shallow aquifer. This limitation is due to the extensive claystone and siltstone aquiclude within the Lisbon formation, and to upward artesian pressures associated with the underlying confined aquifers. Seepage of contaminants into the major deep aquifer is unlikely because of an additional aquiclude formed by clays in the upper part of the Tuscahoma formation. Construction of the plant water wells (completed in the major deep aquifer and Providence formation) includes a cement grout seal to prevent seepage downward along the well bore. 2

The general direction of groundwater flow in the upper major shallow aquifers in the site vicinity is eastward, toward the Chattahoochee River. Since the plant property extends to the river, there are no potential ground water recharge areas within the influence of the plant.

No reversal of the eastward gradient should occur at the site as a result of present or future offsite or onsite pumping. Offsite wells would only be influenced if there was a reversal in the gradient. The projected withdrawal from the unconfined aquifer by the year 2015 is 11,200 gallons per day (about 8 gpm) from 26 projected wells. The projections are based on the estimated population in the area west of the Chattahoochee River by the year 2015. The analysis of groundwater gradient is made by the following two procedures: (a) Utilizing a value of permeability obtained from field tests of 4×10^3 ft per year, the estimated amount of water available in the unconfined aquifer along the 5000 ft. western plant boundary is 88,000 gallons per day or about 61 gpm. If all of the projected offsite wells were pumping along this boundary, there would be a surplus of 76,800 gallons per day, or 53 gpm, remaining. (b) Based on drawdown curves determined from observation wells monitoring the aquifer during site dewatering operations, there is a calculated underflow of 308,000 gallons per day (214 gpm) along the western site boundary. This is a surplus of 296,000 gallons per day (206 gpm) over the projected offsite requirement. The surplus values for groundwater availability indicate that no reversal in the eastward gradient will occur.

For an analysis of the rate of movement of the radioactive contaminants toward the river, it is assumed that the spill will occur in the immediate plant area. Inasmuch as the exact location and elevation of the spill are unknown, it is conservatively assumed that there will be a rapid downward infiltration of the contaminants into the unconfined groundwater system, and that the movement of contaminants will not be retarded by absorption or ion exchange. Once into the eastward flowing unconfined system, the shortest flow path to the river would be about 3500 feet. The average hydraulic gradient along this path is approximately 0.011 based on 1969 predewatering contours. The average permeability of the soil deposits along the flow path, obtained from laboratory tests, is conservatively estimated to be 3×10^{-2} cm/sec, or approximately 3×10^{4} ft per year, which is about ten times higher than the permeability obtained from the field tests. This indicates a conservative rate of movement of approximately 325 ft. per year. It is therefore conservatively estimated that at least ten years would be required for migration of the contaminants to the Chattahoochee River. 2



WATER USE (GPM)

	NORMAL	MAXIMUM
GROUNDWATER	380	1,000
SURFACE	61,200	90,000

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

PLANT WATER USE

FIGURE 3.3 – 1

Amend. No. 2

TABLE 3.3-1

WATER USE PER UNIT - FARLEY NUCLEAR PLANT

System	Normal Operation	Cold Shutdown	Hot Shutdown	
Circulating Water Makeup	17,800 gpm	-	-	
Service Water	30,585 "	38,085 gpm	30,585 gpm	
Potable Water Supply	86,400 gpd	86,400 gpd	86,400 gpd	2
Fire Protection	-	-	-	
Demineralizer Water	460,800 gpd	460,800 gpd	460,800 gpd	2

3.4 HEAT DISSIPATION SYSTEM

The circulating water system and service water system will serve as heat transfer mediums for the Farley Nuclear Plant. A quantitative schematic of this system for normal one-unit operation is found in Figure 3.4-1. This system will dissipate approximately 6.5 $x(10^9)$ BTU/hr. Approximately 6.3 $x(10^9)$ BTU/hr. will be dissipated to the atmosphere through the cooling tower circuit. The remaining 0.2 $x(10^9)$ BTU/hr. will be dissipated in the river. The heat discharged to the river will result in a negligible impact as discussed in Section 5.1 of this report.

3.4.1 WATER SOURCE AND WITHDRAWAL SCHEME

The river intake system of the Farley Nuclear Plant consists of a canal approximately 200 feet long, extending from the Chattahoochee River to the mouth of the intake structure. The intake consists of three bays equipped with vertical traveling screens. The screens will have a stainless steel mesh opening of 3/8 of an inch. The intake system is designed so that the maximum velocity in the canal is less than 0.5 feet per second and the maximum 2 velocity across the traveling screens is less than 1.0 feet per second at the mean water elevation of 77 feet. Trash and debris will be washed from the vertical screens into a trough at the top of the intake structure. The trough will flow into a steel mesh basket to trap the trash for disposal.

The river intake structure will house ten pumps with a total capacity of 97,500 gpm. Normal two unit withdrawal rate will be approximately 62,000 gpm. The river water will be pumped to a 108 acre storage pond. The pond intake structure will house ten pumps with a total capacity of 90,000 gpm to serve the service water and circulating water make-up systems. 2

3.4.2 SERVICE WATER SYSTEM

The service water system will provide cooling for the components shown in Table 3.4-1. The heat rejection rate for this system under normal operation will be 129 x(10^6) BTU/hr. for each unit. The flow requirement for the service water system will be 30,585 gpm per unit under normal operating conditions. This will produce an expected temperature rise of 8.5°F. in the service water system. Chlorine will be added to the service water at a point behind the screens at the storage pond intake structure. Chlorination will be required for the prevention of organic fouling which could degrade the performance of the components served. Chlorination will be performed on a one-unit-at-a-time basis at a rate of 0.5 ppm.

The service water system can also provide by-pass water for discharge dilution purposes. The dilution flow available will be approximately 14,400 gpm per unit, or the excess pumping capacity above the 30,585 gpm service water flow requirements. No heat will be added to this water in the system.

3.4.3 CIRCULATING WATER SYSTEM

The circulating water system is a closed circuit which includes the condensers and cooling towers. The system will circulate 635,000 gpm. Makeup water for this system will be provided from the discharge of the service water system. The makeup will be required to replace system losses due to evaporation and drift from the cooling towers and system blowdown.

Evaporation and drift are estimated to be approximately 12,700 gpm. Drift rate is estimated by the manufacturer to be less than 0.005% of the circulating water flow. Evaporation is estimated to be 2%. The blowdown rate will be approximately 5,100 gpm to maintain a dissolved solids concentration factor of approximately 3.5.

Chlorine will be added to the circulating water system at a point on Figure 3.4-1. Chlorination will be performed for 30 to 60 minutes each day to control biological growths in the cooling towers. The quantity of chlorine used will be sufficient to attain a concentration of 1 ppm at the top of the cooling tower cells. No other chemical additions are expected to be required for the control of scaling or corrosion. Taps will be provided for using other chemicals should they prove necessary. However, by operating with a concentration factor of 3.5 cycles, scaling and corrosion are expected to be controlled. Three cooling towers containing 14 cells each will be installed for each unit. The tower design conditions are as follows:

1. Approach to wet bulb, 11°F.
2. Design wet bulb, 78°F.
3. Water temperature to towers, 109°F.
4. Circulating water temperature, 89°F.

Each cooling tower utilizes 2100 H.P. which, according to the manufacturer, produces a sound power level of 138 dB (re 10^{-13} watts).

3.4.3 DISCHARGE SCHEME

The discharge structure is shown on Figure 3.4-2. It is located 1740 feet downstream from the intake structure. The discharges from Units 1 and 2 will be combined and carried to the discharge structure through a single 60" diameter pipe. The discharge is directed downstream by the discharge structure being constructed at an angle of approximately 30° from the bank. The structure will be designed so as to obtain the maximum mixing of the discharge with the waters of the Chattahoochee River. The concrete pad on the base of the discharge structure will prevent scouring.

Under normal operation, the discharge from the service water system and cooling towers will be 17,900 gpm per unit. The velocity of the discharge under normal one-unit operation will be approximately two feet per second. With two units operating under normal conditions, the velocity of the discharge will be approximately 4 feet per second.

Controlled quantities of radwaste, demineralizer regeneration waste, and sanitary waste will be added intermittently to the discharge. 2

During any period of low river flow, dilution water may be added to the discharge should it be needed to prevent river water temperature from exceeding permissible limits. Under the extreme conditions which might necessitate the use of dilution, the velocities of the discharge would increase. For one-unit operation with full dilution flow, the velocity of the discharge would be approximately 3.7 feet per second. The velocity of the discharge would be approximately 7.3 feet per second, with two-unit operation and full dilution flow.

3.4.4 DIFFERENTIAL BETWEEN INTAKE AND DISCHARGE WATER TEMPERATURES

During normal operation, the temperature rise across the auxiliary heat exchangers will be approximately 9.1°F. The temperature of the cooling towers' blowdown will be 89°F. under maximum design conditions. For example, if the storage pond water is 86°F., the resulting temperature of the mixed service water and tower blowdown will be 93.4°F., representing a rise of 7.4°F. The rise in temperature between water withdrawn and discharged under the above conditions can be limited to 5°F. with the addition of 9000 gpm of dilution water (Fig. 3.4-1). Available dilution flow of 14,400 gpm could be used to reduce the discharge temperature to 90°F. under these conditions. The above conditions are based on the design wet bulb temperature of 78°F. Since the wet bulb temperature is normally lower than this, the temperature of the blowdown will usually be less than 89°F. A detailed discussion of the impact of the operation of the heat dissipation system is found in Section 5.1 of this report. 1

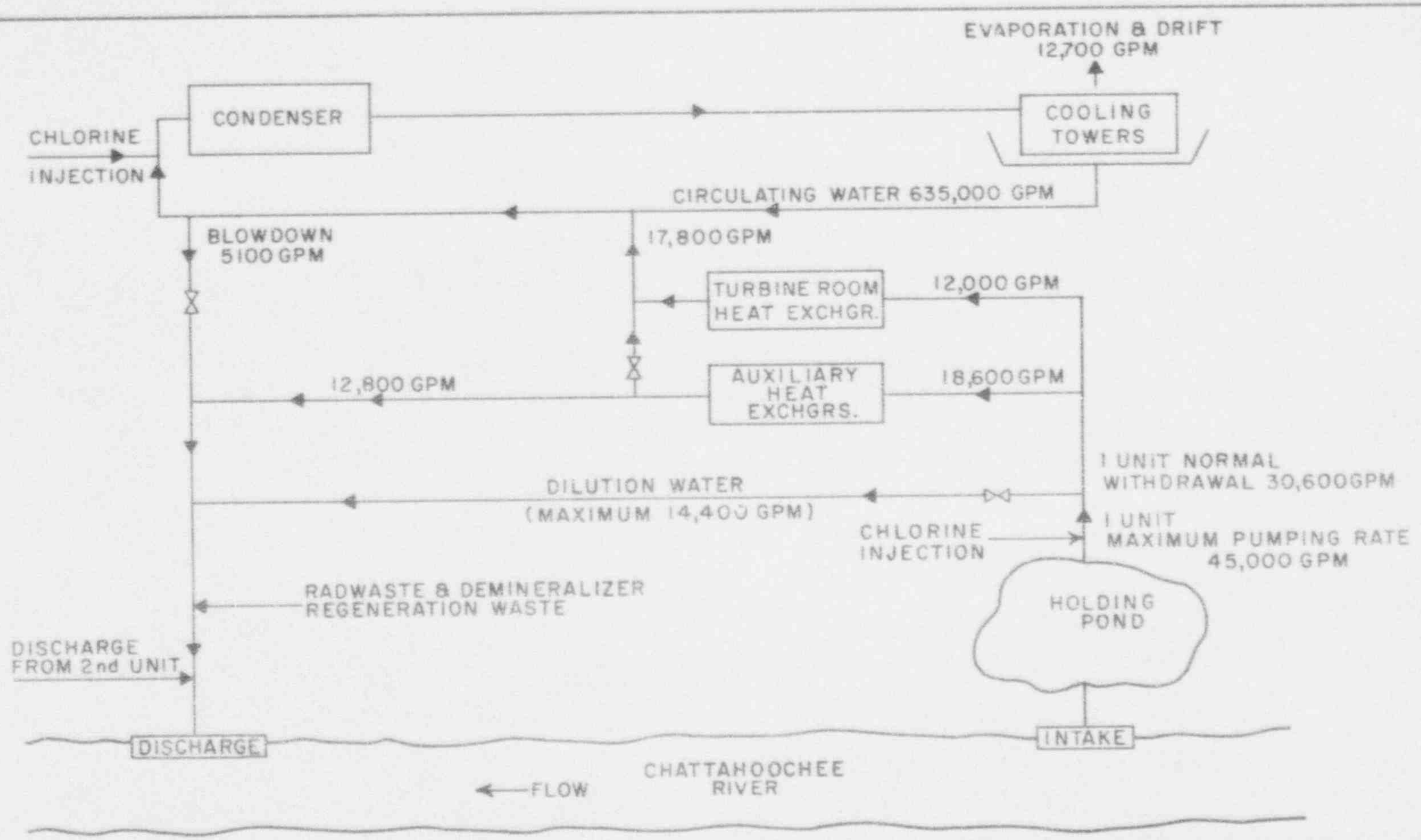
A diffuser system for the Farley discharge is not considered practical. The quantity of discharge is small compared to river flow and dredging operations are performed by the Corps of Engineers to maintain navigation on the Chattahoochee River. 1

TABLE 3.4-1

SERVICE WATER SYSTEM DESIGN FLOWS

	Flow - gpm Normal Operation
Component cooling heat exchangers	10,000
Containment coolers	3,200
Control room ac	240
Pump room coolers:	
RHR (LHSI)	80
Charging (HHSI)	315
Containment spray	210
Auxiliary feedwater	210
Component cooling	210
Letdown chiller	500
Blowdown heat exchanger	2,000
RC pump motor air cooler	500
Turbine building heat exchangers	12,000
Diesel generators	1,120
Total	30,585

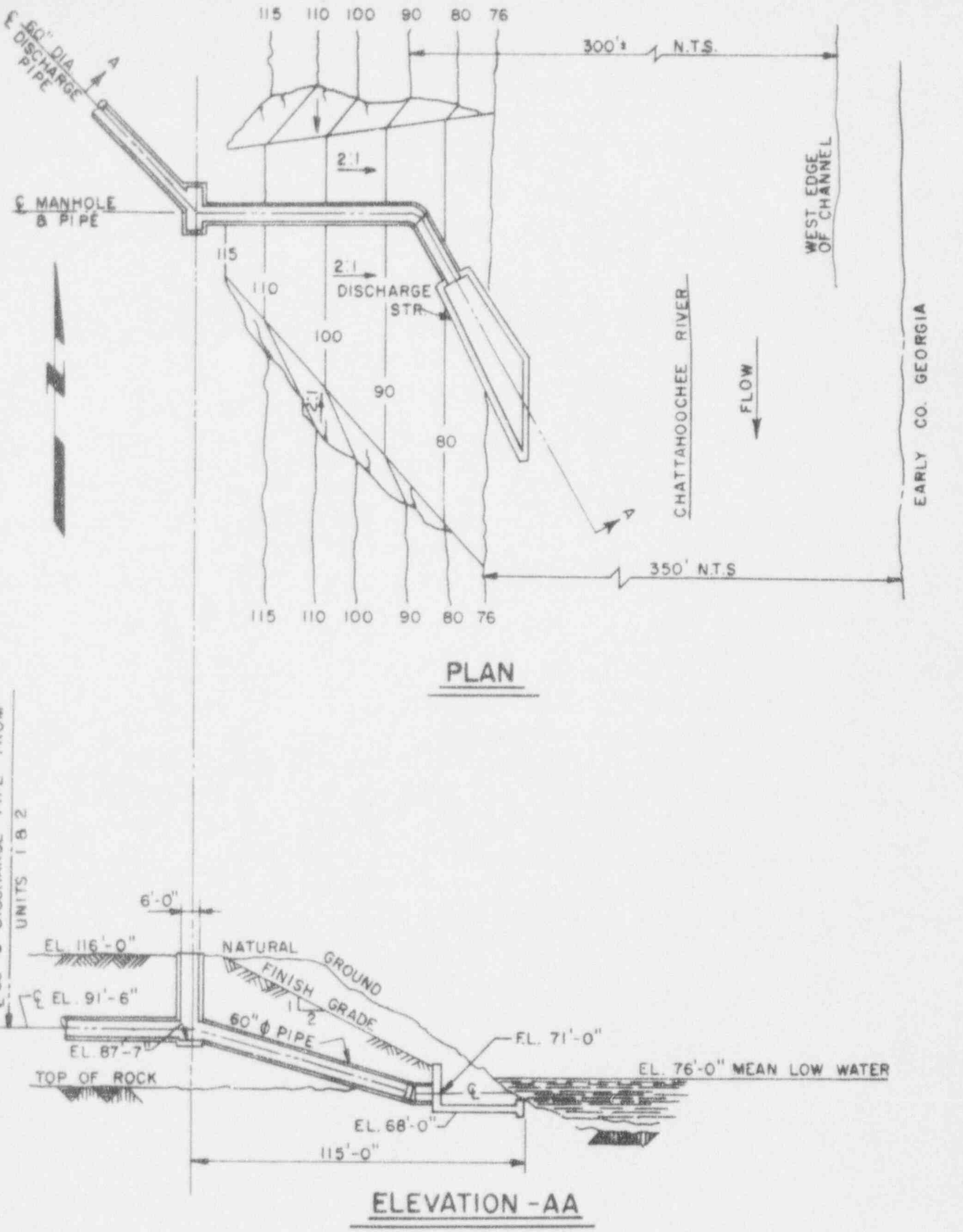
Figures given are for one unit.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

HEAT DISSIPATION SYSTEM

FIGURE 3.4-1



10 0 10 20 30 40

SCALE IN FEET

VERTICAL & HORIZONAL

AMENDMENT 2 4-19-74

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

DISCHARGE STRUCTURE

FIGURE 3.4-2

3.5 RADWASTE SYSTEMS

3.5.1 DESIGN OF WASTE PROCESSING SYSTEMS

Alabama Power Company will install the latest Westinghouse design concepts including the Gaseous Waste Processing System and Steam Generator Blowdown Treatment System in both of the Farley Units. These systems will provide means to limit the radioactive releases from the plant to the environment to levels as low as practicable consistent with 10 CFR 50. The term "as low as practicable" as used in 10 CFR 50 means "as low as is practicably achievable taking into account the state of technology and the economics of improvement in relation to benefits to the public health and safety and in relation to the utilization of atomic energy in the public interest."(1) A summary description of the systems for liquid, gaseous and solids waste processing as well as the expected radioactive release rates with isotopic breakdown is given in the following sections.

3.5.1.1 Liquid Waste System

3.5.1.1.1 Liquid Waste Processing System

Overall radioactive release limits are established as a basis for controlling plant discharges during operation with the occurrence of a combination of equipment faults of moderate frequency include operation with fuel cladding defects in combination with such occurrences as:

1. Steam generator tube leaks.
2. Malfunction in Liquid Waste Processing System
3. Excessive leakage in Reactor Coolant System equipment.
4. Excessive leakage in auxiliary system equipment.

---

(1) Draft Environmental Statement Concerning Proposed Rule Making Action: Nomerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "as low as practicable" for Radioactive Material in Light Water Cooled Nuclear Power Reactor Effluents, USAEC, January 1973.

The radioactive releases from the plant resulting from equipment faults of moderate frequency are within the 10 CFR 20 limits on a short term basis and will be "as low as practicable" for normal operation on an annual average basis over the forty year life of the plant. The Technical Specifications governing effluent releases will assure that the releases of radioactivity from the J. M. Farley site will be "as low as practicable".

3.5.1.1.1.1 Design Objectives

The Liquid Waste Processing System (LWPS) is designed to receive, segregate, process, recycle and discharge liquid wastes. The system design considers potential personnel exposure and assures that quantities of radioactive releases to the environment are as low as practicable. Under normal plant operation, the total activity from radionuclides leaving the LWPS does not exceed a small fraction of the discharge limits as defined in 10 CFR 20.

3.5.1.1.1.2 Systems Descriptions

The Liquid Waste Processing System collects and processes potentially radioactive wastes for recycle or for discharge. Provisions are made to sample and analyze fluids before they are recycled or discharged. Based on the laboratory analysis, these wastes are either released under controlled conditions via the cooling water system or retained for further processing. A permanent record of liquid releases is provided by analysis of known volumes of waste.

The bulk of the radioactive liquids discharged from the Reactor Coolant System are processed by the Boron Recycle System. This limits input to the Liquid Waste Processing System and results in processing of relatively small quantities of generally low-activity wastes.

The Liquid Waste Processing System is arranged to recycle as much reactor grade water as possible. This is implemented by the segregation of equipment drains and waste streams which prevents the intermixing of liquid wastes. The Liquid Waste Processing System consists of two main sub-systems designated as Drain Channel A and Drain Channel B. Drain Channel A normally processes all water which can be recycled and Drain Channel B normally processes all water which is to be discharged. A drain system is also provided inside the containment to collect drains and leaks, and transfer them to the recycle holdup tank. Capability for handling and storage of spent demineralizer resins is also provided.

Instrumentation and controls necessary for the operation of the Liquid Waste Processing System are located on a control panel in the auxiliary building. Any alarm on this control board is relayed to one common annuciator on the main control board in the control room.

A simplified Process Flow Diagram is shown on Figure 3.5-1. All lines in the Liquid Waste System, including field run, are considered as potential carriers of radioactivity.

Table 3.5-1 and Figure 3.5-1 gives process parameters for key locations in the system. Expected volumes to be processed by the Waste Processing System are given in Table 3.5-1. Assuming the volumes presented in Table 3.5-1 are processed at a uniform rate the input to the waste evaporator will be approximately 0.2 gpm while the evaporator is designed to handle 15 gpm. Hence, excess capacity is available to handle off-normal operating conditions. This will only change the load on the system, otherwise the operating features will not change. Component failures in the Waste Processing System are taken care of during system shut down. The system is designed so that interchange of components is possible.

3.5.1.1.1.2.1 Recycle Portion (Drain Channel A - Tritiated and Aerated Water Sources)

Drain Channel A is provided to process reactor grade water which enters the Liquid Waste Processing System via equipment leaks and drains, valve leakoffs, pump seal leakoffs, tank overflows, and other tritiated and aerated water sources.

Deaerated tritiated water inside the reactor containment from sources such as valve leakoffs, which is collected in the reactor coolant drain tank, need not enter Drain Channel A. These may be routed directly to the boron recycle holdup tanks for processing and/or reuse.

Administratively controlled equipment drains are the major contributor of water which can be recycled. Valve and pump leakoffs outside the reactor containment are also collected in the waste holdup tank for processing and recycle. Abnormal liquid sources include leaks which may develop in the reactor coolant and auxiliary systems. Considerable surge and processing capacity is incorporated in the recycle portion of the Liquid Waste Processing System to accommodate abnormal operations.

The basic composition of the liquid collected in the waste holdup tank is boric acid and water with some radioactivity. Liquid collected in this tank is evaporated to remove radioisotopes, boron, and air from the water so that it may be reused in the Reactor Coolant System. Evaporator bottoms are normally drummed unless found acceptable for boric acid recycle. The condensate leaving the waste evaporator may pass through the waste condensate demineralizer and then enter the condensate tank. When a sufficient quantity of water has collected in the waste condensate tank, it is normally transferred to the reactor makeup water storage tank for reuse. Samples are taken at sufficiently frequent intervals to assure proper operation of the system to minimize the need for reprocessing. If a sample indicates that further processing is required, the condensate may be passed through the waste condensate demineralizer or if necessary returned to the waste holdup tank for additional evaporation.

3.5.1.1.1.2.2 Waste Portion (Drain Channel B - Non-Reactor Grade Water Sources)

Drain Channel B is provided to collect and process non-reactor grade liquid wastes. These include floor drains, equipment drains containing non-reactor grade water, laundry and hot shower drains, and other non-reactor grade sources. Drain Channel B equipment includes a floor drain tank and filter, laundry and hot shower tank and filter, chemical drain tank, waste monitor tank demineralizer and filter, and two waste monitor tanks.

Non-recyclable reactor coolant leakage enter the floor drain tank from system leaks inside the containment via the containment sump and from system leaks in the auxiliary building via the floor drains. Unless an extremely large leak develops this liquid would not be recycled because it is diluted and contaminated by water entering the floor drain tank from other sources; i.e., laboratory equipment rinses, hose water, component cooling water leaks, etc. Non-reactor grade leakage which enters the floor drain tank from the containment sump and auxiliary floor drains are fan cooler leaks, secondary side steam and feedwater leaks, component cooling water and hose water. This leakage is assumed to not contribute significantly to activity release. The activity level is normally much less than 10^{-7} uCi/gm. ?

Normally the activity of the floor drain tank contents is well below permissible levels. Hence, the contents may be transferred directly to the Waste Monitor Tank. Following analysis to confirm the acceptable low level, the tank contents are discharged without further treatment. However, should spills, leaks or equipment failures cause radioactive water to enter the floor drain tank, this water is processed in the waste evaporator.

In general, if the activity in the floor drain tank is greater than 10^{-5} uCi/gm the liquids should be processed. If such a case should occur, the waste evaporator concentrate is drummed and the condensate returned to Drain Channel B for ultimate discharge.

Laundry and hot shower drains are the largest source of liquid wastes and normally need no treatment for removal of radioactivity. This water is transferred to one of the waste monitor tanks via the laundry and hot shower filter. A sample is taken and, after analysis, the results logged and the water discharged if the activity level is below acceptable limits.

The basic criteria for the laboratory drain subsystem is that strict segregation of radioactive and non-radioactive liquid wastes be maintained. Two separate drain sinks are to be provided for this control. One is used to dispose of spent and excess radioactive samples directly to the chemical drain tank for later disposal by drumming. The second sink is provided for normal laboratory equipment decontamination and rinsing. This liquid waste is directed to the floor drain tank. The sampling room contains two sinks. Excess sample purges of reactor grade coolant is drained from one sink to the waste holdup tank for recycle. The other sink is used for draining non-reactor grade excess samples to the floor drain tank.

Liquid wastes are released from the waste monitor tanks to the discharge canal. The discharge valve is interlocked with a process radiation monitor and closes automatically if the radioactivity concentration in the liquid discharge exceeds a preset limit. Liquid waste discharge flow volume is recorded.

3.5.1.1.1.2.3 Waste From Spent Resin

The spent resin sluice portion of the Liquid Waste Processing System consists of a spent resin storage tank, a spent resin sluice pump, and a spent resin sluice filter. The equipment is arranged such that the resin sluice water after entering a demineralizer vessel returns to the spent resin storage tank for reuse. The basic criteria for the system is to transport spent resin to the spent resin storage tank without generating large volumes of waste liquid. This is accomplished by reusing the sluice water for subsequent resin sluicing operations.

3.5.1.1.2 Steam Generator Blowdown Processing System

As part of the comprehensive steam side chemistry control program employed in this plant, the steam generator blowdown system functions to eliminate harmful concentrations of chemical deposits from accumulating in the steam generator.

The effluents from the secondary side of the steam generator are normally dispersed to the environment following dilution with cooling tower blowdown water.

In the event the secondary side does become contaminated with primary side coolant, the blowdown fluid will be radioactive. Under these conditions the blowdown processing system conditions the water such that it can be reused on the secondary side, and collects the radioactive contaminants and other solids for off-site disposal.

Multiple forms of instrumentation used to detect primary-secondary leakage are provided to assure that the public health and safety is not compromised by use of the steam generator blowdown processing system.

3.5.1.1.2.1 Design Basis

Secondary side water chemistry control specifications require 5 gpm continuous blowdown from each steam generator to achieve optimum effectiveness from the steam generator chemistry control program.

The steam generator blowdown processing system is designed to accommodate blowdown under a wide range of conditions.

Under conditions of steam generator tube leakage and/or condenser leakage, a continuous blowdown rate of 12.5 gpm maximum per generator may be required to maintain proper chemistry control in the generator. The design basis of the processing portion of the blowdown processing system is 50 gpm. This permits 12.5 gpm continuous blowdown for each generator plus some additional capacity as margin. However, the normal blowdown rate is expected to be 25 gpm on a continuous basis.

To facilitate the removal of any accumulated solids from the tube sheet when no tube leaks exist, the system is designed to accommodate, through the bypass portion of the system, an intermittent blowdown rate of 50 gpm per generator or 150 gpm total. If solids removal is required coincident with steam generator tube leakage, the processing system can accommodate only one steam generator blowing down at the maximum rate.

Although processed system effluent will ordinarily be recycled to the main condenser, the system is also designed to permit continuous release of processed steam generator blowdown without exceeding an average discharge concentration of 2×10^{-8} uc/cc.

3.5.1.1.2.2 System Description and Operation

Each reactor unit has three steam generators and each generator has its own blowdown and sample lines.

The flow of blowdown fluid from each of the three steam generators is individually controlled before reaching the blowdown line manifold outside of the containment barrier. Fluid from the steam generator manifold enters under pressure into a shell-and-tube heat exchanger, where the fluid temperature is reduced by plant service cooling water. The pressure is then reduced, and the blowdown is directed through the inlet filter. A simplified system flow diagram is shown in Figure 3.5-2.

Normally, when the radioactivity of the blowdown fluid is below required limits, the fluid flows through a radiation monitor into the surge tank. From this surge tank, the fluid is normally pumped to discharge through a process-controlled isolation valve. Instrumentation is provided in the discharge line to record the instantaneous activity concentration of the blowdown fluid. This alarm in the discharge section of the system, plus the radiation alarm located upstream of the surge tank that closes the process isolation valve downstream of the blowdown heat exchanger, provides automatic isolation of the blowdown fluid.

Should the radioactivity level of the blowdown fluid be such that its untreated discharge would exceed release limits, the flow would be diverted through a pair of series-connected cation demineralizers, a pair of series-connected mixed bed demineralizers, another filter, and then through the radiation monitor into the surge tank. From this surge tank, the fluid would normally be recycled to the main condenser but may be discharged through the discharge line when required. Batchwise cleanup of blowdown fluid in the surge tank can be accommodated by pumping fluid through the demineralizers via the recirculation line at the pump discharge downstream of the flow control valve.

The Steam Generator Blowdown Processing System is designed to operate continuously. After the proper flow path is made available, a discharge-recycle pump is started, and the blowdown isolation valves are opened, the blowdown rate (from each steam generator) is manually controlled from the main control board. Once established, the blowdown rates are maintained as desired by automatic control of the pressure differential across the high pressure portion of the system. In this manner, any flow fluctuations due to steam generator pressure variations are avoided. Low pressure instrumentation downstream of the pressure control valve automatically modulates service water flow to maintain a constant heat exchanger outlet temperature and automatically controls the discharge of the recycle flow rate to maintain a constant level in the surge tank. A process controlled isolation valve just downstream of the heat exchanger is interlocked to close on abnormally high pressure, temperature, flow rate, radiation level, or surge tank water level. Low level pump shut-offs protect the discharge recycle pumps and the spent resin sluice pump. A high radiation signal from the discharge-recycle radiation monitor closes the discharge valve. All automatic closures require system analysis and manual reopening from the local control panel. Other instrumentation including pH meters for establishing resin saturation and pressure indicators for determining component pressure drops provide additional process related information so that system performance can be reviewed.

3.5.1.1.3 Turbine Building Floor Drains

Liquid from turbine building leaks is collected alternately into one of two sumps, each with a capacity of approximately 32,000 gallons. Based on established high liquid levels in each sump the pump, in the sump being used, is automatically started and discharges about 800 gpm from the sump to the dilution pipe. After approximately 2000 to 3000 gallons are discharged, a low sump liquid level signal automatically turns the pump off.

3.5.1.2 Gaseous Waste Systems

The radioactive gaseous waste treatment systems at Farley consist of (1) a gaseous waste processing system for removal and storage of radioactive gases from the reactor coolant system, (2) a filter system for processing the potentially radioactive condenser air ejector discharge and (3) ventilation filter systems for those areas that contain radioactive systems. Of these systems only the gaseous waste processing system is shared by the two units. Figure 3.5-3 presents a simplified process flow diagram showing gaseous release paths from the Plant.

Although plant operating procedures, equipment inspection, and preventive maintenance are performed during plant operations to minimize equipment malfunction, overall radioactive release limits have been established as a basis for controlling plant discharges during operation with the occurrence of a combination of equipment faults of moderate frequency. A combination of equipment faults which could occur with moderate frequency include operation with fuel defects in combination with such occurrences as:

1. Steam generator tube leaks.
2. Malfunction in Liquid Waste Processing System.
3. Malfunction of Gaseous Waste Processing System.
4. Excessive leakage in Reactor Coolant System equipment.
5. Excessive leakage in auxiliary system equipment.

The radioactive releases from the plant resulting from equipment faults of moderate frequency are within 10 CFR 20 limits on the short term basis and will be "as low as practicable" for normal operation on an annual average basis over the forty year life of the plant.

3.5.1.2.1 Gaseous Waste Processing System

3.5.1.2.1.1 Design Objectives

The Gaseous Waste Processing System (GWPS) is designed to remove fission product gases from the reactor coolant and have the capacity to contain these throughout the forty year plant life. This is based on continuous operation with reactor coolant system activities associated with operation with cladding defects in the fuel rods generating one percent of the rated core thermal power. The system is also designed to collect and store expected fission gases from the boron recycle evaporator and reactor coolant drain tank throughout the plant life. This eliminates the need for scheduled discharge of radioactive gases from these sources. Thus, the gaseous waste processing system reduces the reactor coolant equilibrium activities thereby reducing the gaseous releases from the plant due to primary coolant leakage.

Gaseous activity released due to equipment leakage in the GWPS during normal operation of the plant is mixed with ventilation exhaust and is further diluted by atmospheric dispersion. Table 3.5-9 and 3.5-10 gives estimated leakages from the Gaseous Waste Processing System with corresponding activity discharges from the plant vent stack.

3.5.1.2.1.2 System Description

The Gaseous Waste Processing System consists mainly of a closed loop comprised of two waste gas compressors, two catalytic hydrogen recombiners, and gas decay tanks to accumulate the fission product gases.

The major input to the Gaseous Waste Processing System during normal operation is taken from the gas space in the volume control tank. The volume control tank gas space is purged at a rate of 0.7 scfm. There are no liquid seals in the system. The system is designed to preclude explosions by keeping the concentration of hydrogen and oxygen below the explosive limits.

A simplified Process Flow Diagram is shown on Figure 3.5-3. All lines in the Gaseous Waste System, including field run, are considered as potential carriers of radioactivity. Table 3.5-2 gives process parameters for the system. The radioactivity inventory in the system is given in Table 3.5-3 and Figure 3.5-5.

3.5.1.2.2 Condenser Air Ejector Filter System

Radioactive gases will be released with the condenser air ejector discharge when the combination of failed fuel and primary-to-secondary steam generator leakage exists. A filter system consisting of a humidity control device, a high efficiency particulate filter and a charcoal adsorber will be installed to process this release. The system will be utilized in accordance with the Technical Specifications to assure that releases from the plant will be "as low as practicable". The charcoal adsorber will have a minimum gas residence time of 0.25 sec and will be impregnated with an agent for the removal of organic iodines. A simplified process flow diagram is given in Figure 3.5-4.

3.5.1.2.3 Ventilation Filter Systems

Those areas in the station that have the potential for leaking hot reactor coolant have filter systems on the ventilation exhaust. These filter systems contain high efficiency particulate filters and charcoal adsorbers. The charcoal adsorber will have a minimum gas residence time of 0.25 sec and will be impregnated with an agent for the removal of organic iodines. The containment and the primary auxiliary building contain filter systems of this type. (A description of the systems is presented in Chapter 12.2 of the FSAR and a schematic process flow diagram is given in Figure 3.5-4.)

The containment purge filter system is utilized when required in accordance with the Technical Specifications.

The primary auxiliary building ventilation exhaust from those areas containing hot reactor coolant (chemical and volume control system) is routinely filtered.

The waste disposal building, which serves both units, has high efficiency particulate filters and charcoal filters on the ventilation exhaust. Releases from this building are described above under the GWPS.

3.5.1.3 Solid Waste System

3.5.1.3.1 Design Objectives

The solid waste system is designed to encapsulate spent resins, evaporator concentrates and chemical tank effluents and filter cartridges.

A separate system is available to bale low-radiation level, solid, compressible wastes such as paper, disposable clothing, rags, towels, floor coverings, shoe covers, plastics, cloth smears and respirator filters. In addition, two separate systems are utilized to process primary and secondary system spent resins. It is estimated that 1000 to 2000 cubic feet of waste are produced each year.

The systems are used to package radioactive wastes within the limitations specified by 10 CFR 71 and 49 CFR 170-178.

Shielding is designed to limit the radiation levels in the work areas to 10 mr/hr.

3.5.1.3.2 Equipment Description

3.5.1.3.2.1 Processing System Design

The solid waste system is designed to package all solid wastes in standard 55 gallon drums for removal to disposal facilities. In addition, a system has been designed to permit bulk shipment of spent resins. (The process flow diagram for the solid waste system is shown in Figure 11.5-1 of the FSAR.)

Spent resin, evaporator concentrates, and chemical drain tank effluents are encapsulated in the drums (or transferred to bulk shipment containers) while solid wastes such as paper, clothing, rags, towels, etc., are compressed directly into the drums.

1. Encapsulation Process - The evaporator bottoms, spent resins, and chemical drain tank effluent are transported in pipes to the drumming area.

   The evaporator bottoms and spent resins are dispensed from a common manifold using six separate valves, while the chemical drain tank effluent is dispensed from a single and separate valve. These valves are failsafe, air-operated diaphragm valves.

Waste evaporator bottoms and chemical drain tank effluent are encapsulated in 55 gallon drums that are prepared in a nonradiation area, separate from the drumming room

The drums are positioned upright and an injector assembly is suspended within the drum. A vibrator, which is strapped to the vertical surface of the drum, is energized and four bags of vermiculite-cement are gradually poured into the drum. This mixture completely surrounds the liquid injector assembly. The drum lid is installed, and the clamping ring is secured in position. The drum is now ready for use.

Spent resin slurries are encapsulated in 55 gallon drums that are prepared in a nonradiation area, separate from the drumming room.

The drums are positioned upright, and a mixture of water and cement is poured into the drum until the bottom surface is covered with a one-inch thick layer. This operation is followed by placing a 16 gauge thick carbon steel casting sleeve in the drum, and filling the annulus between the casting sleeve and the inside diameter of the drum with the water-cement mixture to a height of twenty-nine inches. After the cement liner has become compact, the drum vibrator is strapped to the outside surface of the drum and then energized. A one-inch layer of dry vermiculite-cement is then poured into the bottom of the casting sleeve. A resin cage assembly, which is fabricated of 12 gauge thick carbon steel, and resembling a DOT-2R container, is suspended inside the casting sleeve. The void between the cage and sleeve, and the area above the cage, extending to the top of the drum, is filled with the dry vermiculite-cement. The drum lid is then installed, and the clamping ring is secured in position. The drum is now ready for use.

2. Baling Process - The baling process involves the use of 55 gallon drums. The baler is equipped with a dust shroud to prevent the escape of radioactive particulate matter during the compaction process. This shroud is connected to the building exhaust system. After the drum has been filled with compacted wastes, it is sealed and transferred to the storage area.

3.5.2 ESTIMATES OF RADIOACTIVE DISCHARGE QUANTITIES

The following documents have been issued by the AEC to provide regulations and guidelines for radioactive releases:

1. 10 CFR 20, Standards for Protection Against Radiation
2. 10 CFR 50, Licensing of Production and Utilization Facilities

The total plant liquid and gaseous releases meet these regulations by providing assurance that the exposures to individuals in unrestricted areas are as low as practicable during normal plant operation. Normal operation, as used in conjunction with radioactivity treatment and effluents in this report, includes expected operational occurences which deviate from steady state operation. The parameters used in the calculation of normal operation radioactive effluents, as presented in Table 3.5-4, are realistic average values expected over forty years of operation. The extent and duration of operational occurrences will be governed by the plant technical specifications for effluent releases which are formulated on the "as low as practicable" criterion. As stated previously, "as low as practicable" is defined as "as low as is practicably achievable taking into account the state of technology and the economics of improvement in relation to benefits to the public health and safety...".

3.5.2.1 Liquid Wastes

3.5.2.1.1 Expected Liquid Waste Processing System Release

The quantities and isotopic concentration in liquids discharged to the Liquid Waste Processing System, and hence the releases to the environment, are highly dependent upon the operation of the plant. The analysis for Farley is based on engineering judgement with respect to the operation of the plant and the Liquid Waste Processing System and realistic estimation of the potential input sources. Hence, the results are representative of typical releases from one Farley Unit.

The input sources assumed in the study are summarized in Table 3.5-1. (The isotopic concentrations at key locations in the Liquid Waste Processing System are given in Table 11.2-2 of the FSAR with the locations indicated on the Process Flow Diagram, Figure 11.2-1 of the FSAR.) The associated releases in curies per year per nuclide are given in Table 3.5-5.

It is assumed that the waste entering the floor drain tank is twenty gallons per day of reactor coolant and forty gallons per day of non-reactor grade water and 40 gpd of decontaminated water without detergent. The isotopic composition of reactor grade water is based on 0.25% fuel defects.

The Liquid Waste Processing System is assumed to operate as described in Section 11.2.4 of the FSAR.

3.5.2.1.2 Expected Liquid Releases from the Steam Generator Blowdown System (SGBS)

Ordinarily, when operating without steam generator leakage or when the system effluent is being recycled back to the main condenser, there will be essentially zero release of radioactivity from this system. However, in the event system effluent is discharged to the environment when operating with concurrent fuel defects and steam generator leakage, radioactivity discharge rates will depend on the combinations of these parameters which are assumed.

The system is designed to limit average discharge concentrations under these conditions to 2 x 10^{-8} uc/cc or less. This average has been taken as being the average quarterly and the average annual discharge concentration for release to the environment. For the conditions of 20 gpd steam generator leakage and 0.25% fuel defects, the average discharge concentration will be considerably below the above limits ($\sim$1.1 x 10^{-9}). If conditions of higher tube leakage are postulated, the system could meet the average quarterly release limits assuming two months operation at 20 gpd steam generator leakage at 1 percent fuel defects and one month operation at 144 gpd steam generator leakage at 1 percent fuel defects. Following this period, the plant would require shutdown for steam generator tube repair if such is the case.

(The secondary side activity, assuming 0.25% fuel defects and 20 gal/day primary to secondary side leakage is given in Table 11.2-8 of the FSAR.)

The blowdown from the secondary side is normally recycled to the condenser, however, the liquid may be discharged if required. The activity released to the environment from such discharges is estimated in Table 3.5-6.

3.5.2.1.3 Expected Liquid Releases from Turbine Building Drains

The concentration of isotopes in steam or liquid leaked to the turbine building is considered to be a factor of 100 lower than secondary side concentrations for all isotopes except tritium. Tritium concentration in leakage is assumed to be the same as in the secondary side. The factor of 100 accounts for limited carry-over in steam. Steam leakage of 5 gpm (condensed) and liquid leakage of 12 gpm is assumed to be discharged through turbine building drains. Discharge rates for each isotope are given in Table 3.5-7.

3.5.2.1.4 Estimated Total Releases

The potential releases from each source have been evaluated as indicated in above sections. As shown in Table 3.5-8 the total expected releases from the plant is a fraction of the regulations as outlined in Section 3.5.1.1.1.1. (It is further shown that the expected liquid releases from Farley are well below releases in presently operating plants as shown in Table 11.2-6 of the FSAR. Hence, the releases from the plant are in accordance with the design objectives as outlined in Section 11.2.1 of the FSAR and the Technical Specifications, Chapter 16 of the FSAR.)

3.5.2.1.5 Release Points

The Liquid Waste Processing System is designed to minimize the total radioactive fluid released to the environment by processing and recycling as much water as possible. The plant is designed with only one release point for potentially radioactive liquid waste.

3.5.2.2 Gaseous Wastes

3.5.2.2.1 Expected Gaseous Waste Processing System Releases

The Gaseous Waste Processing System removes fission product gases from the volume control tank and recycle evaporator and has the capacity to contain them through the lifetime of the plant, eliminating the need for regularly scheduled discharge of these radioactive gases to the environment. Since the system reduces fission product gas concentrations in the reactor coolant during unit operation, it significantly reduces the escape of radioactive gases arising from reactor coolant leakage. Design is based on continuous operation with reactor coolant system activities associated with operation with cladding defects in fuel rods generating one percent of the rated core thermal power. Table 3.5-3 shows the maximum fission product inventory in the Gaseous Waste Processing Systems over the forty year plant life based on 0.25% fuel defect level.

Figure 3.5-5 shows that for a given power rating the quantity of fission gas activity accumulated in the gas system after forty continuous years of operation is only twice the activity accumulated after thirty days operation with the same fuel defect level. This is because most of the accumulated activity arises from short lived isotopes reaching equilibrium in one month or less.

The difference between the thirty day and forty year accumulations is essentially all Krypton-85. This accumulation of Krypton-85 is not a hazard to the plant operator because:

1. Radiation background levels in the plant are not noticeably affected by the accumulation of Krypton-85 which is a beta emitter, for which the tanks themselves provide adequate shielding.
2. The system activity inventory is distributed in several tanks so that the maximum permissible inventory in any single tank is actually less than that of earlier Gaseous Waste Disposal System designs.
3. Since this system permits fission gas removal from the reactor coolant during normal operation, it will reduce plant activity levels caused by a leakage of reactor coolant.

With operation of this system, it is possible to collect virtually all of the Kr-85 released to the reactor coolant and to achieve a reduction in the fission product gas inventory in the Reactor Coolant System. Provisions are also made to collect any residual gases stripped out of solution by the boron recycle evaporators and gases from the reactor coolant drain tank.

Table 3.5-9 and 3.5-10 gives calculated activity discharges from the plant vent stack due to Gaseous Waste Processing System leaks.

(To further ensure design basis releases in accordance with the "as low as practicable" philosophy the Technical Specifications, Chapter 16 of the FSAR establish limits for the releases.)

3.5.2.2.2 Expected Gaseous Radioactive Releases from Ventilation Systems and Condenser Air Ejector

A detailed review of the entire plant has been made to ascertain those items that could possibly contribute to airborne radioactive releases. Separate analyses were made for noble gases and iodines.

During normal plant operations, airborne noble gases and/or iodines can originate from reactor coolant leakage, equipment drains, venting and sampling, secondary side leakage, condenser air ejector and gland seal condenser exhausts, Gaseous Waste Processing System leakage, refueling operations and evaporations from the spent fuel pool.

The assumptions used for this study are given in Table 3.5-4. The noble gases and iodines discharged from the various sources are entered in Table 3.5-9, 3.5-10 and 3.5-11.

3.5.2.2.2.1 Sources of Radioactive Noble Gas Emission

During normal plant operations, airborne noble gases from the J. M. Farley Plant can originate from the following sources:

Reactor coolant leakage to the auxiliary building.

Equipment drains and sampling in the auxiliary building.

Waste gas processing system leakage.

Steam generator tube leakage and resultant secondary system releases.

Reactor coolant leakage to the containment building.

Refueling operations.

The quantities of waste liquids in the various systems during plant operation are administratively controlled. However, conservative estimates of these quantities were used for purposes of this study.

3.5.2.2.2.1.1 Auxiliary Building

Reactor Coolant Leakage to the Auxiliary Building (Entering Floor Drain Tank)

This effluent is non-recycleable reactor coolant from system leaks in the auxiliary building. These wastes enter the floor drain tank via the floor drains. It is assumed that the total amount of equivalent reactor coolant leakage is 20 gal/day per unit(2). The total volume of reactor coolant liquid from this source is ~7000 gal/year.

Equipment Drains and Sampling (Entering Waste Holdup Tank)

The source is a result of equipment drainage for maintenance and daily sampling to insure proper reactor coolant system operation. The specific contribution from each source is based on the following:

Tank Drains - 5% of the volume of all tanks that contain recycleable water and could have dissolved noble gases are drained on a once per year cycle.

Filter Drains - Each filter is drained and flushed once per month at an assumed rate of 50 gallons per filter. Only those that may have dissolved noble gases are included.

Demineralizer Drains - 1 drain per year of each demineralizer at an average rate of 250 gallons per drain. The following demineralizers could have dissolved radioactive gases:

Cation Demineralizer
Mixed Bed Demineralizers (2)
Thermal Regeneration Demineralizers (4)
Recycle Evaporator Feed Demineralizers (2)

Heat Exchanger Drains - The water equivalent of 100% of the heat exchanger volume based on its overall dimensions is assumed to be drained and flushed once a year from each heat exchanger. All inplant heat exchangers except

---

(2) Whenever gallons of liquid are referred to in this section, it should be assumed that it is a 1 atm and 70°F.

for the Spent Fuel Pit Heat Exchanger could have dissolved noble gases. These include the following components:

- Excess Letdown Heat Exchanger
- Letdown Chiller Exchanger
- Letdown Heat Exchanger
- Letdown Reheat Exchanger
- Moderating Heat Exchanger
- Reactor Coolant Drain Tank Heat Exchanger
- Regenerative Heat Exchanger
- Seal Water Heat Exchanger

Sample Sink Drains - 3000 samples per year of reactor grade water at a volume of 1 gallon per sample was assumed, based on recommended sampling procedures.

All of the above liquids are assumed to be at ambient conditions. Total volume of reactor coolant liquid which may contain dissolved noble gases from equipment drains and sampling is 19,000 gal/yr.

Waste Gas Processing Leakage

During continuous operation of the plant, releases from the gaseous waste processing system are not planned. However, as with all pressurized systems some leakage should be anticipated. The estimated leakage from this system is 100 standard cubic feet per year. This leak rate is based on every potential leakage point in the system leaking at just below the detectable limit. In addition, it assumes that as soon as activity reaches the detectable limit, corrective action is taken.

3.5.2.2.2.1.2 Turbine Building

Steam Generator Tube Leaks

Radioactive emissions from the secondary side are minimized by the physical separation of the reactor coolant cycle and the steam cycle. However, small leaks in the steam generator may occur. These leaks will result in release to the steam cycle of radioactive liquids and gases.

3.5.2.2.2.1.3 Containment Building

Reactor Coolant Leakage to the Containment Building

Exhausting the air in the containment prior to entrance for maintenance or refueling can be a normal, but intermittent, source of radioactivity in airborne effluents. The airborne activity will come from the evaporation of refueling water during refueling and leakage through valves, pumps and flanges while at power. During continuous operation of the plant, it is assumed that the equilibrium containment airborne activity results from a reactor coolant leak rate of 40 lbs. per day into the containment. No credit is taken for plateout of any isotope. For refueling operations, the noble gas activity in the refueling canal will go directly into the environment.

3.5.2.2.2.2 Sources of Radioactive Airborne Iodines

Liquids containing radioactive iodines are present in the various systems of a PWR. Components containing these liquids are located in the auxiliary building, turbine area and containment building. The quantities that become airborne from the solution will depend upon various factors. A brief discussion of each source follows.

3.5.2.2.2.2.1 Auxiliary Building

Chemical Drain Tank

A 600 gallon atmospheric tank is available to collect the chemically contaminated water from the laboratories. These spent and excess samples may contain radioactive iodine. It has been estimated that 1000 gallons per year are placed in this tank of which the equivalent of 150 gallons will be reactor grade water.

Spent Resin Storage Tank

The primary purpose of this tank is to provide a collection point for spent resin to allow for the decay of short lived radio-nuclides before drumming. It has been assumed that 6000 ft.^{3} of air (mostly N_2) is released from the tank per year.

Waste Holdup Tank

One 10,000 gallon atmospheric tank is provided to collect equipment drains, equipment leakoffs, sample room sink drains and other water from aerated tritiated sources. The expected drains into the tank are estimated to be 60,000 gallons per year. Of this quantity, 1600 gallons enter the tank having iodine concentration equivalent to reactor coolant, and another 10,000 gallons of liquids containing iodines will have passed through the mixed bed demineralizer before entering the tank. The remaining quantities should contain negligible iodine concentrations.

Reactor Coolant Leakage to the Auxiliary Building

This source is the same as that used for noble gases. However, for analysis of iodine releases, 1 gal/day is estimated to be from sources containing primary coolant at greater than 212°F. The remainder, or 19 gal/day, is assumed to be from lines containing primary coolant at less than 212°F.

Waste Evaporator Vent Condenser

This component condenses the dissolved gases stripped from the process feed flow. Dissolved air will come out of solution bringing with it entrained iodines. These iodines are in equilibrium with the iodine packing in the gas stripper column.

3.5.2.2.2.2.2 Turbine Building

Air Ejector

Activity release from the air ejector is dependent upon having concurrent fuel defects and steam generator tube leaks. Iodine transport from the steam generator has been assumed to be caused by both liquid entrainment in the steam and volatility. The steam is then carried over to the condenser from which iodines are assumed to be released.

Gland Seal Condenser Exhaust

The mechanisms used to determine the iodines released from the air ejector are similar for the gland seal condenser. The exhaust rate is 2000 lbs/hr of insoluble gas.

Secondary Side Steam Leakage

This source of activity is miscellaneous component leakage from the secondary systems that are operating above 212°F. No credit for any plateout in the secondary system is taken.

Secondary Side Liquid Leakage

Liquid leakage is defined as component leakage from systems operating below 212°F. This leakage was assumed to be at a rate of 12 gal/min.

3.5.2.2.2.2.3 Containment Building

Containment Purge Releases

Purge releases are based upon reactor coolant fission products released to the containment at a rate of 40 lbs/day. These releases are allowed to build up to an equilibrium state. From this starting point, the preaccess filter system is operated for 16 hours with an iodine efficiency of 90%. The purge flow rate for the system analyzed is 25,000 scfm, and the preaccess filter system flow rate is 20,000 scfm.

3.5.2.2.2.2.4 Miscellaneous Sources

In addition to the above, the following additional components were reviewed and found to release negligible iodines during normal operation:

Laundry and Hot Shower Tank
Waste Monitor Tanks
Component Cooling Surge Tank
Refueling Water Storage Tank
Spent Fuel Pit Pool

3.5.2.2.2.2.5 Estimated Total Releases of Gaseous Radioactivity

The potential release from each source has been evaluated as indicated in the above sections. The total releases of gaseous iodines and noble gases from the plant are given in Tables 3.5-10 and 3.5-11. These estimated releases have been used in calculating the site boundary doses as shown in Section 5.3 of the Environmental Report.

The dose calculations, based on the estimated total plant releases, show that the releases are in accordance with the design objectives in Section 3.5-1, and meet the regulations as outlined in the Section. (Further, the total plant releases are within the Technical Specifications as outlined in Chapter 16 of the FSAR.)

3.5.2.3 Solid Wastes

3.5.2.3.1 Expected Volumes

The volume of solid radioactive wastes is expected to total 100 drums of spent primary resins, 600 cubic feet of spent secondary resins and 100 drums of evaporator concentrates per year. However, if excessive equipment leakage occurs, the total volume of evaporator bottoms alone may be as much as 50 to 60 drums per month. Experience at plants presently in operation confirms this possibility. Chemical drain tank effluents are expected to total approximately 1000 gallons, or 33 drums, per year. The total volume of compressible waste, such as paper, disposable clothing, rags, towels, etc. is approximately 120 drums per year. Table 3.5-12 gives the anticipated total solid waste generated per year.

The expected curie content of the evaporator concentrates is approximately 3.2 microcuries per cubic centimeter. On the basis of about 30 gallons of evaporator concentrates per drum, the content of each drum is 0.34 curies. The curie content of the chemical drain tank effluents totals approximately 0.63 curies per year, or 0.02 curies per drum. In the case of primary spent resins, the curie content totals approximately 6400 curies per year, or 64 curies per drum. Secondary system spent resins are expected to account for 17 curies per year.

The principal nuclides shipped from the plant site include the following:

Iodine - 131
Cesium - 134
Cesium - 136
Cesium - 137
Cobalt - 58
Cobalt - 60
Iron - 55
Iron - 59
Manganese - 54
Manganese - 56
Molybdenum - 99
Strontium - 89
Strontium - 90
Chromium - 51

TABLE 3.5-1

PARAMETERS USED IN THE CALCULATION OF ESTIMATED ACTIVITY IN LIQUID WASTES

Collector Tank With Sources	Volume of Liquid Wastes	Basis	Collection Period Assumed Before Processing	Comments
Reactor Coolant Drain Tank	225 gal/day	0.05 gpm/R.C. pump #2 seal leak 0.002 gpm/R.C. pump #3 seal leak	Feed & bleed	Recycled to BRS
Waste Hold-up Tank				
1. Equipment Drains	57,000 gal/yr	Filter drains, heat exchanger drains, tank drains, demineralizer drains		
2. Excess Samples	3,000 gal/yr	3000 samples/yr at 1 gal/sample		
Total	60,000 gal/yr		20 days	Recycled to RMW
Floor Drain Tank				
1. Decontamination Water	15,000 gal/yr	40,000 ft^2 section once per week with 20 gallons of water per 5000 ft^2 with remainder for fuel cask, vessel head, etc.		
2. Laboratory Equipment	16,000 gal/yr	~60 gallons/day for 5 days/week		
3. Non-Recycleable Reactor Coolant	7,000 gal/yr	~20 gallons/day		
4. Non-Reactor Grade Leaks	13,000 gal/yr	~40 gallons/day		
Total	51,000 gal/yr		30 days	Discharged
Chemical Drain Tank	1,000 gal/yr	3000 samples/yr at 1/8 gal/sample plus rinse water	90 days	Drummed
Laundry & Hot Shower Tank	120,000 gal/yr	300 gallons/day with remainder for abnormal and refueling operations.	5 days	Discharged

TABLE 3.5-2

PROCESSING PARAMETERS FOR GWPS

Power Level	2766 MWt
Number of Units	2
Purification Flow Rate from RCS	60 gpm
Volume Control Tank Volumes	
Vapor	175 ft^3
Liquid	125 ft^3

Volume Control Tank Noble Gas Stripping Fractions and Iodine Partition Coefficients

Isotope	Stripping Fraction	Isotope	Partition Coefficient
Kr 85	2.5×10^{-1}	I 131	100
Kr 85m	2.9×10^{-1}	I 132	100
Kr 87	6.0×10^{-1}	I 133	100
Kr 88	4.3×10^{-1}	I 134	100
Xe 131m	2.5×10^{-1}	I 135	100
Xe 133	2.5×10^{-1}		
Xe 133m	2.6×10^{-1}		
Xe 135	2.8×10^{-1}		
Xe 138	8.0×10^{-1}		

Volume Control Tank Stripping Efficiency	40%
Hydrogen Purge Rate in Volume Control Tank	0.7 scfm
Number of Gas Decay Tanks	
- Normal Operation	6
- Shutdown	2
Volume of Each Gas Decay Tank	600 ft^3

TABLE 3.5-3

ACCUMULATED RADIOACTIVITY IN THE GASEOUS WASTE PROCESSING SYSTEM AFTER FORTY YEARS OPERATION*

Activity Following Plant Shutdown (Curies)

Isotope	Zero Decay	30 Days	50 Days
Kr-85	11,890	11,820	11,780
Kr-85m	5.5	~0	~0
Kr-87	0.75	~0	~0
Kr-88	7.0	~0	~0
Xe-131m	197	19	5.8
Xe-133	12,000	232	17
Xe-133m	96	0.01	~0
Xe-135	45	~0	~0
I-131	.166	.0126	.00226
I-132	.000684	0	0
I-133	.0259	0	0
I-134	.000144	0	0
I-135	.00504	0	0

* The table is based on forty years continuous operation with 0.25% defects.

TABLE 3.5-4

J. M. FARLEY - ASSUMPTIONS USED IN SOURCE TERM CALCULATIONS

(For One Reactor)

Reactor Power	2766 MW(t)
Capacity Factor	80%
Number of Steam Generators	3
Number Cold Shutdowns per Year	2
Reactor Containment Volume	2.05×10^6 ft^3
Number of Containment Purges per Year	4
Weight of Water in Primary System	4.0×10^5 lb
Weight of Water in Secondary System	4.1×10^5 lb
Weight of Steam in Each Steam Generator	6.3×10^3 lb
Weight of Liquid in Each Steam Generator	9.1×10^4 lb
Clean-up Demineralizer Flow	2.98×10^4 lb/hr
Total Steam Flow in Secondary System	1.22×10^7 lb/hr
Reactor Coolant Flow Rate	1.0×10^8 lb/hr
Blowdown Rate (Per Loop)	5 gpm
Fraction of Power from Failed Fuel	0.25%
Equipment Drainage & Sampling of Reactor Grade Fluid	19,000 gal/yr
Waste Gas Processing System Leakage	100 scf/yr
Air Ejector Flow Rate	60 scfm
Preaccess Filter System Flow Rate	20,000 scfm
Purge System Flow Rate	25,000 scfm
Halogen Filter Efficiency in Containment	90%
Liquid Leak Rate into the Turbine Building	12.0 gpm
Escape Rate Coefficients (Sec^{-1})	
Xe and Kr	6.5×10^{-8}
I, Br, Rb, Cs	1.3×10^{-8}
Mo	2.0×10^{-9}
Te	1.0×10^{-9}
Sr, Ba	1.0×10^{-11}
Others	1.6×10^{-12}

TABLE 3.5-4
(Contd.)

J. M. FARLEY - ASSUMPTIONS USED IN SOURCE TERM CALCULATIONS

(For One Reactor)

Fraction of fission products passing through primary coolant demineralizer (except ^3H, Y, Mo, Cs, Rb)	0.1
^3H, Y, Mo, Cs, Rb	1.0
Fraction of iodine passing through	
Containment building filter (charcoal)	0.1
Auxiliary building filter (charcoal)	0.1
Air Ejector Cleanup System	0.1
Leak rate of primary coolant:*	
Reactor containment building (hot water)	40 lb/day
Auxiliary building (hot water)	1 gal/day
Auxiliary building (cold water)	19 gal/day
Steam generator	20 gal/day
Leak rate of turbine steam (condensed)	5 gal/min
Gland seal steam flow (condensed)	2000 lb/hr

* Gallons in this section of the table refer to gallons at 1 atmosphere and 70°F.

TABLE 3.5-4
(Contd.)

J. M. FARLEY - ASSUMPTIONS USED IN SOURCE TERM CALCULATIONS

(For One Reactor)

	Decontamination Factor				
	I	Cs, Rb	Y	Mo	Others
Demineralizers					
Mixed-bed (Li_3-BO_3 form, CVCS)	10	1	1	1	10
Mixed-bed (H^+-OH^- form, clean waste)	10	10	1	1	10
Mixed-bed in waste evaporator condensate	10	10	1	1	10
Cation bed	1	10	10	10	1
Anion bed	10	1	1	1	10
Evaporators					
Waste	10^3	10^3	10^3	10^3	10^3
Boron recovery	10^3	10^3	10^3	10^3	10^3

IODINE SEPARATION FACTORS

Source	Separation Factor
Chemical Drain Tank (1)	10^4
Spent Resin Storage Tank (1)	10^4
Waste Holdup Tank (1)	10^4
Floor Drain Tank (1)	10^4
Waste Evaporator Vent Condenser (1)	10^4
Liquids on Auxiliary Building Floor (2)	10^2
Volume Control Tank (1)	10^2
Air Ejector Condenser Vent (3)	10^4
Gland Seal Condenser Vent (3)	10^4
Steam Leakage (4)	10^2
Steam Generator (4)	10^2
Steam Plant Liquid Leakage (2)	10^2

TABLE 3.5-4
(Contd.)

J. M. FARLEY - ASSUMPTIONS USED IN SOURCE TERM CALCULATIONS

(For One Reactor)

IODINE SEPARATION FACTORS
(Contd.)

(1) This factor is the ratio of the activity concentration in the Liquid (μci/cc) to the activity concentration in the vapor (μci/cc).

(2) This factor is the ratio of the total activity in the spill (μci) to the activity lost to the air (μci).

(3) This factor is the ratio of the activity concentration in the steam generator liquid (μci/cc) to the activity concentration in the vapor leaving the component (μci/cc).

(4) This factor is the ratio of the steam generator liquid activity (μci/gm) to the activity in the steam leaving the steam generator (μci/gm).

TABLE 3.5-5

EXPECTED ANNUAL DISCHARGES FROM LIQUID WASTE PROCESSING SYSTEM

(0.25% Fuel Defects)

(80% Plant Capacity Factor)

Isotope	Total Annual Discharge (ci/yr/unit)	Isotope	Total Annual Discharge (ci/yr/unit)
Rb 88	1.7×10^{-7}	Cs 134	1.3×10^{-2}
Sr 89	2.8×10^{-6}	Cs 136	5.8×10^{-5}
Sr 90	1.2×10^{-7}	Cs 137	4.2×10^{-2}
Sr 91	3.2×10^{-8}	Ba 140	1.7×10^{-6}
Y 90	1.2×10^{-7}	La 140	1.7×10^{-6}
Y 91	4.2×10^{-6}	Ce 144	1.3×10^{-3}
Zr 95	6.9×10^{-4}	Pr 144	1.3×10^{-3}
Nb 95	1.8×10^{-3}	Cr 51	2.2×10^{-6}
Mo 99	3.2×10^{-3}	Mn 54	2.3×10^{-6}
I 131	6.9×10^{-4}	Fe 59	2.8×10^{-6}
I 132	4.2×10^{-5}	Co 58	2.1×10^{-3}
I 133	1.5×10^{-4}	Co 60	6.3×10^{-4}
I 135	2.3×10^{-5}	Total Excluding Tritium	.067
		Tritium	96.0

TABLE 3.5-6

J. M. FARLEY

FISSION AND CORROSION PRODUCT RELEASES IN TREATED BLOWDOWN WATER FROM ONE UNIT

Basis:
- a) Leakage of 20 gal/day from primary to secondary side.
- b) Total steam generator blowdown rate of 15 gpm.
- c) Percent of fuel cladding defects = 0.25%
- d) Blowdown Process System Decontamination Factor - 100
- e) 80% plant capacity.

Isotope	(Millicuries/ year/unit)	Isotope	(Millicuries/ year/unit)
Br-84	4.88×10^{-2}	Te-132	1.24×10^{1}
Rb-88	7.36×10^{0}	Te-134	4.33×10^{-2}
Rb-89	5.38×10^{-2}	Cs-134	1.43×10^{1}
Sr-89	2.22×10^{-1}	Cs-136	7.62×10^{0}
Sr-90	7.71×10^{-3}	Cs-137	7.21×10^{1}
Sr-91	3.00×10^{-2}	Cs-138	1.07×10^{0}
Y-90	8.88×10^{-3}	Ba-140	2.13×10^{-1}
Y-91	3.31×10^{-1}	La-140	1.31×10^{-1}
Y-92	8.19×10^{-3}	Ce-144	1.81×10^{-2}
Zr-95	3.78×10^{-2}	Pr-144	1.81×10^{-2}
Nb-95	3.81×10^{-2}	Cr-51	5.05×10^{-2}
Mo-99	2.18×10^{2}	Mn-54	4.28×10^{-2}
I-131	1.21×10^{2}	Mn-56	1.44×10^{-1}
I-132	1.54×10^{1}	Co-58	1.36×10^{0}
I-133	9.78×10^{1}	Co-60	4.14×10^{-2}
I-134	1.12×10^{0}	Fe-59	5.38×10^{-2}
I-135	2.48×10^{1}	Total Excluding Tritium	590.9 millicuries/ year
		Total Tritium	76.4 Ci/yr

TABLE 3.5-7

EXPECTED TURBINE BUILDING DRAIN EFFLUENT

Isotope	Discharge (Ci/yr/unit)	Isotope	Discharge (Ci/yr/unit)
Br-84	5.7×10^{-5}	Te-132	1.4×10^{-2}
Rb-88	2.7×10^{-3}	Te-134	4.9×10^{-5}
Rb-89	6.2×10^{-5}	Cs-134	1.6×10^{-2}
Sr-89	2.5×10^{-4}	Cs-136	8.6×10^{-3}
Sr-90	8.6×10^{-6}	Cs-137	8.2×10^{-2}
Sr-91	3.5×10^{-5}	Cs-138	1.2×10^{-3}
Sr-92	4.3×10^{-6}	Ba-140	2.4×10^{-4}
Y-90	9.9×10^{-6}	La-140	1.5×10^{-4}
Y-91	3.8×10^{-4}	Ce-144	2.1×10^{-5}
Y-92	9.2×10^{-6}	Pr-144	2.1×10^{-5}
Zr-95	4.3×10^{-5}	Cr-51	5.7×10^{-5}
Nb-95	4.3×10^{-5}	Mn-54	4.9×10^{-5}
Mo-99	2.5×10^{-1}	Mn-56	1.6×10^{-4}
I-131	1.4×10^{-1}	Co-58	1.5×10^{-3}
I-132	1.7×10^{-2}	Co-60	4.6×10^{-5}
I-133	1.1×10^{-1}	Fe-59	6.2×10^{-5}
I-134	1.3×10^{-3}	H-3	8.6×10^{1}
I-135	2.8×10^{-2}	Total Excluding Tritium	0.67
		Tritium	86.0

TABLE 3.5-8

TOTAL LIQUID EFFLUENT PER UNIT

Isotope	Discharge (Ci/yr/unit)	Isotope	Discharge (Ci/yr/unit)
Br-84	1.1×10^{-4}	Te-132	2.6×10^{-2}
Rb-88	1.0×10^{-2}	Te-134	9.2×10^{-5}
Rb-89	1.2×10^{-4}	Cs-134	4.6×10^{-2}
Sr-89	4.7×10^{-4}	Cs-136	1.6×10^{-2}
Sr-90	1.6×10^{-5}	Cs-137	2.1×10^{-1}
Sr-91	6.5×10^{-5}	Cs-138	1.2×10^{-3}
Sr-92	4.3×10^{-6}	Ba-140	4.5×10^{-4}
Y-90	1.9×10^{-5}	La-140	2.8×10^{-4}
Y-91	7.1×10^{-4}	Ce-144	1.6×10^{-3}
Y-92	1.7×10^{-5}	Pr-144	1.3×10^{-3}
Zr-95	9.0×10^{-4}	Cr-51	1.1×10^{-4}
Nb-95	2.2×10^{-3}	Mn-54	9.5×10^{-5}
Mo-99	4.7×10^{-1}	Mn-56	3.0×10^{-4}
I-131	2.6×10^{-1}	Co-58	5.4×10^{-3}
I-132	3.2×10^{-2}	Co-60	8.5×10^{-4}
I-133	2.1×10^{-1}	Fe-59	1.2×10^{-4}
I-134	2.4×10^{-3}	H-3	2.6×10^{2}
I-135	5.3×10^{-2}	Total Excluding Tritium	1.33
		Tritium	260.0

TABLE 3.5-9

AIRBORNE IODINE DISCHARGES TO AUXILIARY BUILDING*

(curies/year/unit)

	Chemical Drain Tank	Spent Resin Storage Tank	Waste Holdup Tank	Floor Drain Tank	Liquid Leakage	Waste Evaporator Vent Condenser	Waste Gas System Leakage	Total
I-131	0.000035	0.0048	0.0062	0.0013	0.0069	0.000036	0.0046	0.018
I-132	0.000013	0.00022	0.00022	0.00047	0.0025	0.000013	0.000019	0.0035
I-133	0.000057	0.0008	0.00098	0.0021	0.011	0.000058	0.00072	0.016
I-134	0.0000085	0.0000013	0.00015	0.00031	0.0017	0.0000087	0.000004	0.0022
I-135	0.000031	0.000014	0.00054	0.0012	0.0061	0.000032	0.00014	0.0081

* Represents releases from auxiliary building services to the auxiliary building ventilation system.

Does not include filtration by the auxiliary building ventilation system.

TABLE 3.5-10

NOBLE GAS RELEASES

(curies/year/unit)

Isotope	Aux. Bldg. Leakage	Component Drains & Samples	GWPS Leakage	Spent Fuel Pool	Secondary Side Releases	Refueling Operations	Containment Purging	Total Releases
Kr-85	0.77	2.5	170	0.46	0.77	0.034	0.19	174.7
Kr-85m	11	36	2.6	0	11	0	0	60.6
Kr-87	7.1	23	0.24	0	7.1	0	0	37.4
Kr-88	21	68	2.6	0	21	0	0	112.6
Xe-133	440	1440	760	0.61	440	20	12	3312.6
Xe-133m	8.4	27	8.8	0.029	8.4	0	0	52.6
Xe-135	31	100	22	0	31	0	0	184.0
Xe-135m	1.1	3.6	0	0	1.1	0	0	5.8
Xe-138	3.8	12	0	0	3.8	0	0	19.6

TABLE 3.5-11

IODINE RELEASES

(curies/year/unit)

	Air Ejector	Gland Seal Condenser	Steam Leakages	Liquid Leakage Secondary Side	Contain. Purging	Aux. Building	Total
I-131	.0036	.0002	.04	.001	.0015	.0018	0.0481
I-132	.00046	.000026	.0052	.00013	0	.00035	0.00616
I-133	.0029	.00016	.033	.00082	.0019	.0016	0.0404
I-134	.00003	.0000019	.00037	.0000094	0	.00022	0.00063
I-135	.00074	.000041	.0083	.00021	0	.00081	0.010

TABLE 3.5-12

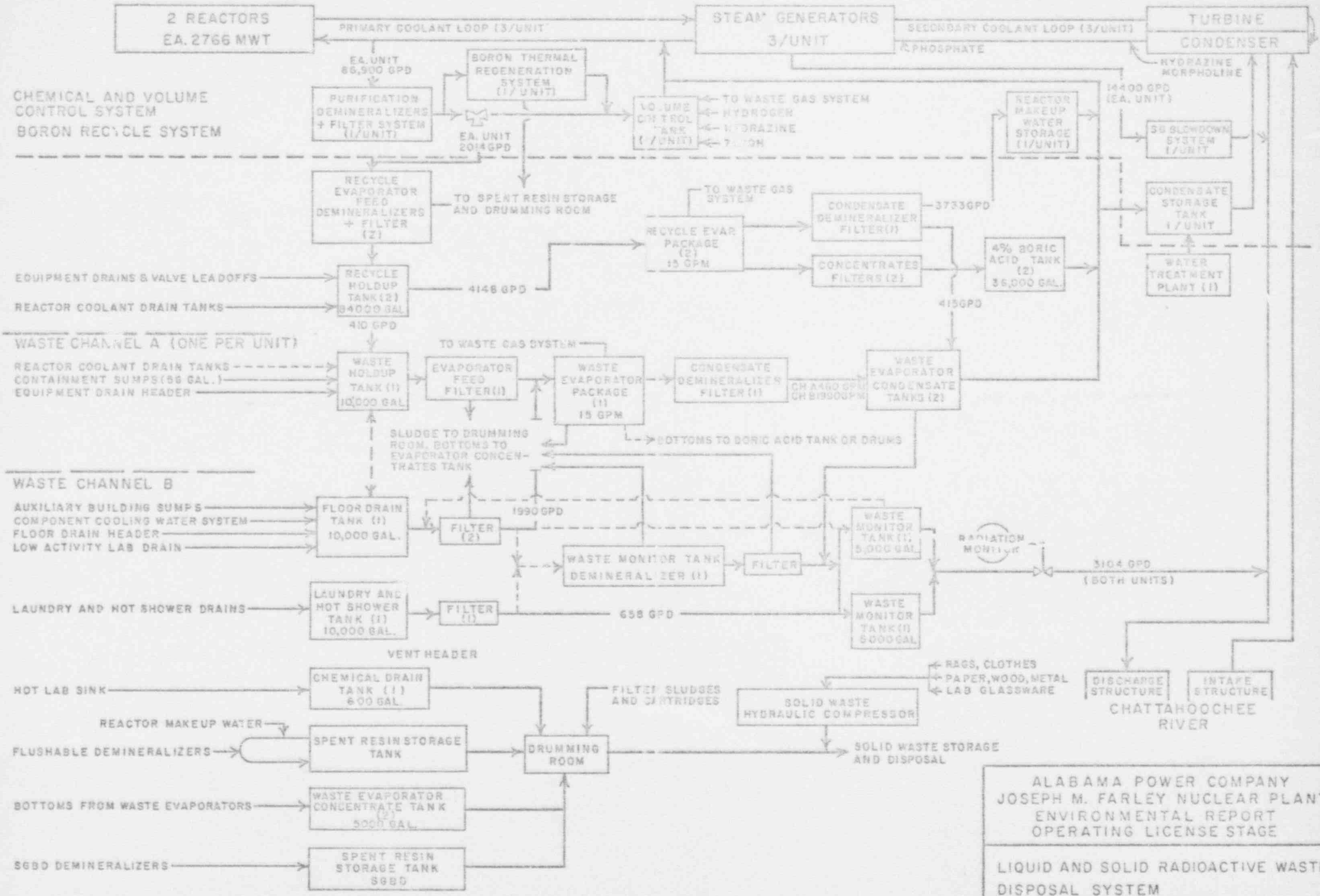
ANTICIPATED TOTAL SOLID WASTE GENERATED PER YEAR PER UNIT

	Total Volume (Ft^3)	Total Curies
Spent Primary Resins	200	6400
Evaporator Bottoms	370(1)	34
Chemical Drain Tank Effluents	134(2)	0.63
Dry Waste	-	4.0
Spent Filter Cartridges	-	-
SGBS Spent Resins	600(3)	17

(1) 2775 gallons

(2) 1000 gallons

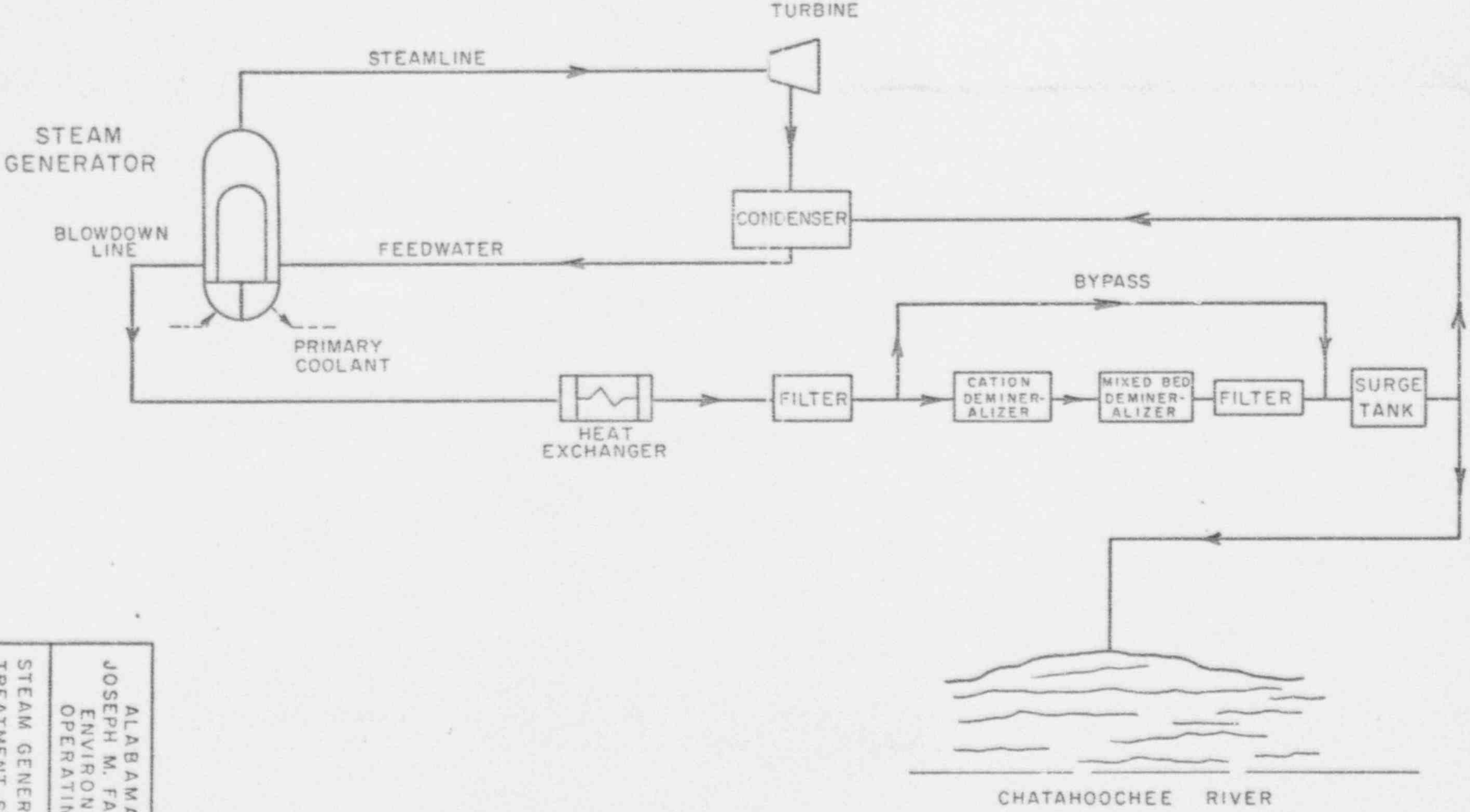
(3) 20 gpd primary to secondary leak
5 gpm per steam generator blowdown rate



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

LIQUID AND SOLID RADIOACTIVE WASTE DISPOSAL SYSTEM

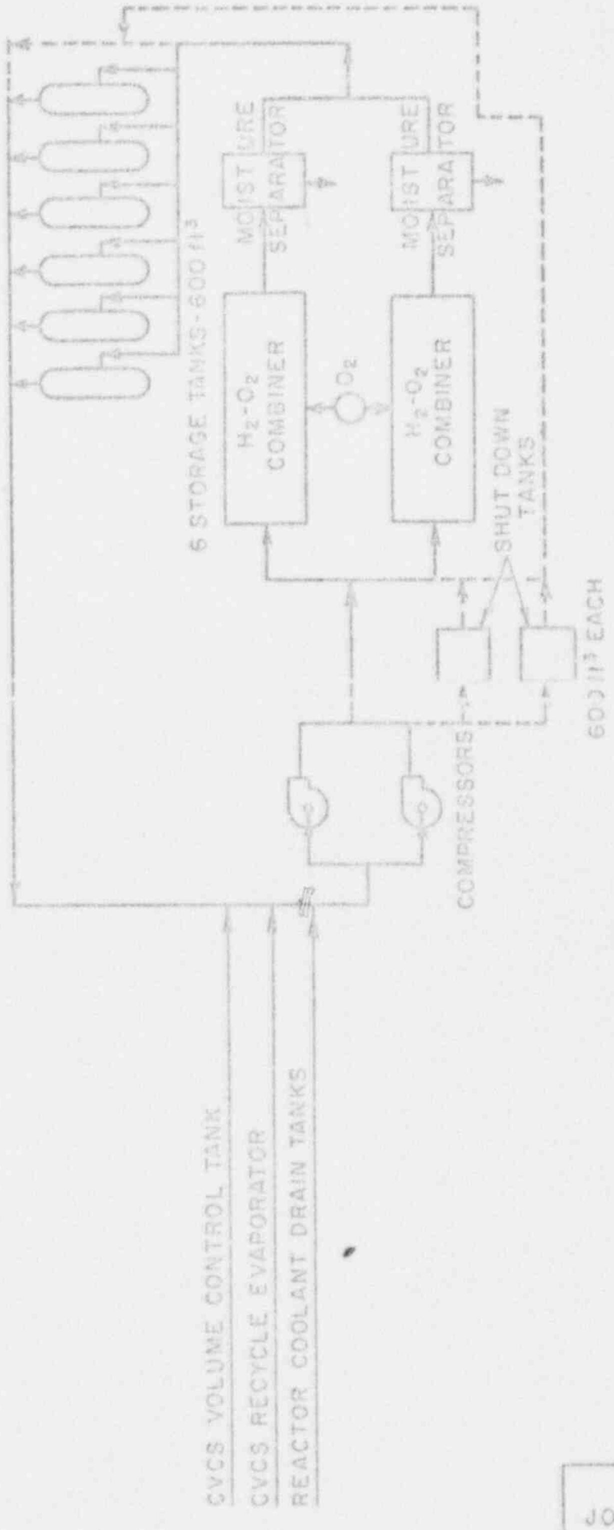
FIGURE 3.5-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

STEAM GENERATOR BLOWDOWN TREATMENT SYSTEM

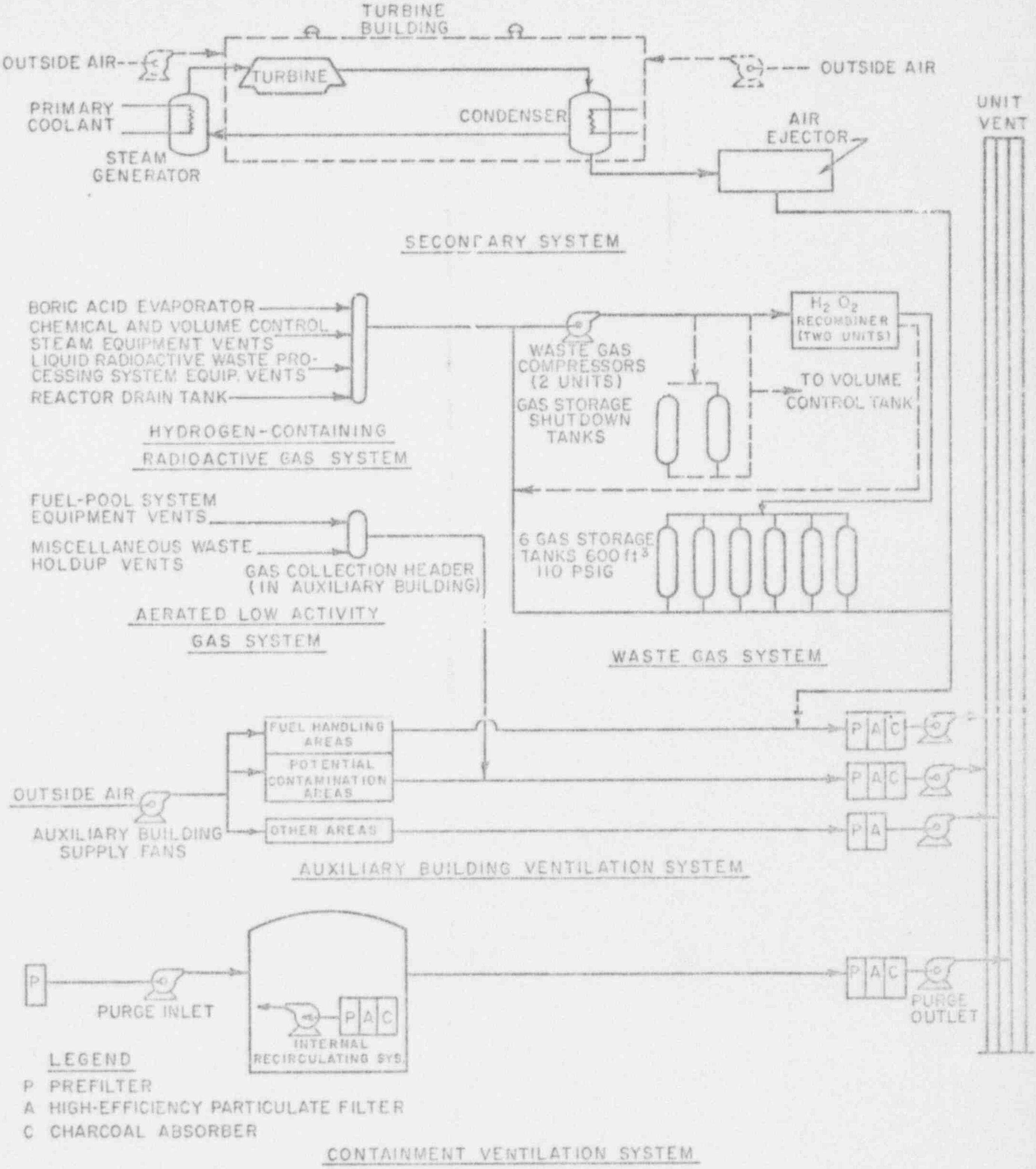
FIGURE 3.5-2



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

GASEOUS WASTE PROCESSING SYSTEM
FOR ONE UNIT

FIGURE 3.5-3

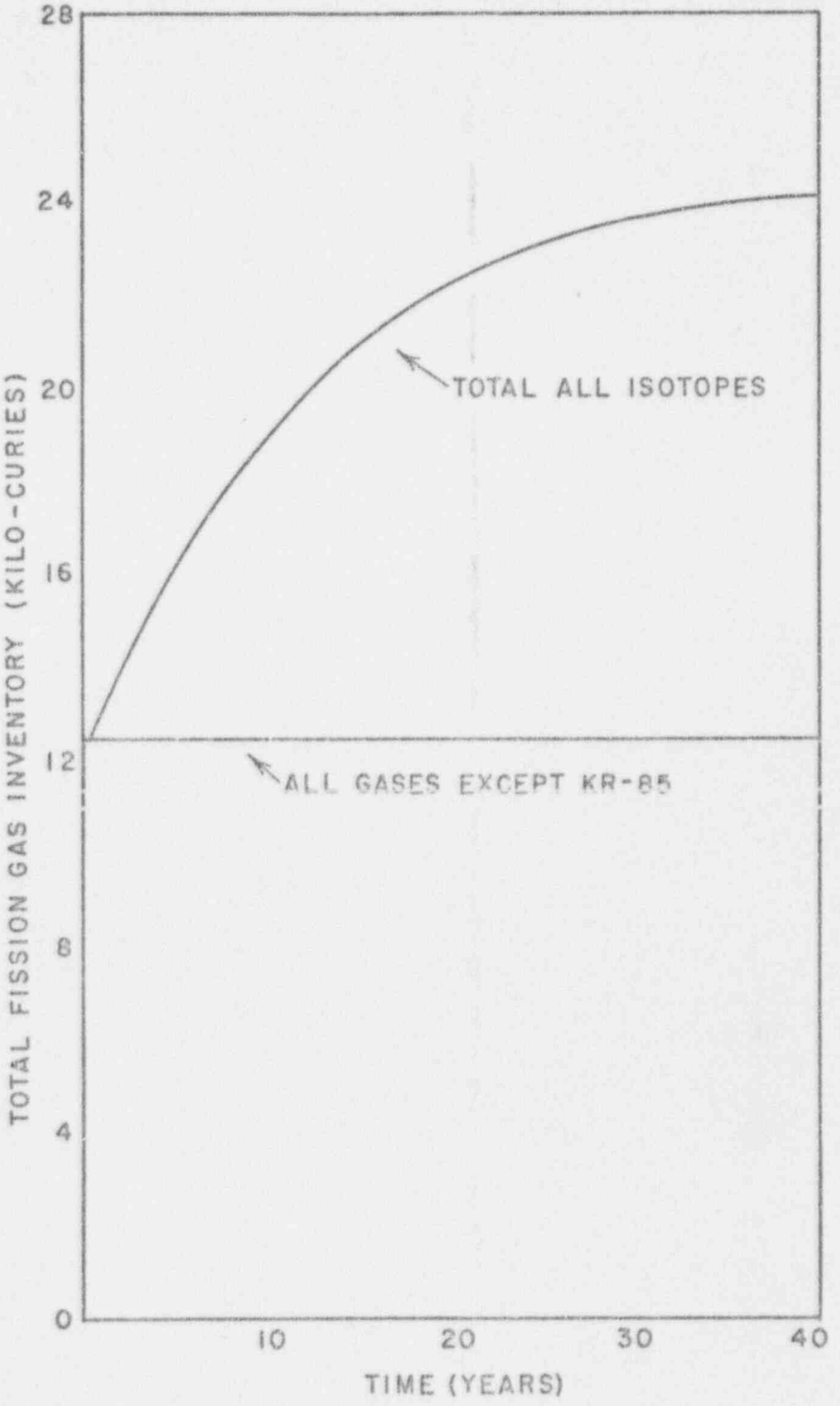


ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

GASEOUS WASTE DISPOSAL AND VENTILATION SYSTEM

J. M. FARLEY NUCLEAR PLANT

FIGURE 3.5-4



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ESTIMATED WASTE GAS PROCESSING SYSTE
FISSION GAS ACCUMULATION BASED ON
CONTINUOUS CORE OPERATION WITH
0.25 % FUEL DEFECTS
FIGURE 3.5-5

3.6 CHEMICAL AND BIOCIDE WASTES

Chemical and biocide wastes will be generated by chlorination, demineralizer regenerations, and reactor coolant makeup water treatment. Cooling tower blowdown and drift will contain solids at 3.5 concentrations of the solids level of the Chattahoochee River.

3.6.1 CHLORINATION OF SERVICE WATER SYSTEM AND COOLING TOWERS

Chlorine will be added to the service water system at the pond intake structure to a level of 0.5 ppm for 30 minutes to 1½ hours during each operating shift. The cooling tower circuit will be chlorinated from 30 to 60 minutes each day to a concentration of 1 ppm at the top of the cooling tower cells. 1

The residual chlorine content of the discharge is expected to be negligible. The water of the Chattahoochee River has a chlorine demand of 0.5 to 1 ppm. The travel time through the service water system from the intake at the pond to the discharge at the river will be sufficient for the chlorine to react completely with the demand in the water. Only one unit will be chlorinated at a time, which will allow dilution with unchlorinated water from the other unit prior to discharge. Also, the service water system and cooling tower circuits will not be chlorinated at the same time. The chlorination point for the cooling tower system will be downstream of the blowdown take-off (Fig. 3.4-1). The chlorinated water will pass through the condensers and the cooling towers before reaching the blowdown discharge. The cooling tower blowdown and the discharge from the service water system will be mixed prior to discharge to the river. Assuming that the residual chlorine content of the blowdown is virtually zero and the service water discharge contains a maximum of 0.5 ppm free residual, the discharge to the river would contain a maximum concentration of 0.18 ppm of free chlorine even if no demand was present in the service water. 1 1

However, the content is expected to be negligible since the chlorine demand has been determined to be 0.6 to 1.0 ppm for waters of the Chattahoochee River. 1

Figure 3.6-1 illustrates the relationship between chlorine dosage and a chlorine demand of 0.5 ppm Ammonia Nitrogen. Figure 3.6-2 illustrates the relationship between chlorine dosage and a 0.6 ppm chlorine demand composed of both Ammonia Nitrogen and organic Nitrogen. From these two figures, the following concentrations of chlorine residuals for the Farley Plant can be estimated:

Cooling Tower Circuit

Dosage - 1 ppm

Residual with 0.5 ppm Ammonia Nitrogen demand - 0.5 ppm

Residual with 0.6 ppm Ammonia and organic Nitrogen demand - 0.4 ppm

Service Water System

Dosage - 0.5 ppm

Residual with 0.5 ppm Ammonia Nitrogen demand - 0.2 ppm

Residual with 0.6 ppm Ammonia Nitrogen and organic Nitrogen demand - 0.2 ppm 1

For the stated conditions, the residual would be predominately monochloramine.

The concentration of monochloramine in the discharge under the operating conditions cited above would then be as follows:

Concentration in Discharge During Cooling Tower Chlorination

Blowdown - 5100 gpm @ 0.4 to 0.5 ppm Monochloramine

Service water - 12,800 gpm

Discharge from 2nd Unit - 17,900 gpm

Concentration - $\frac{5100\ (0.5)}{35,800}$ = 0.07 Monochloramine

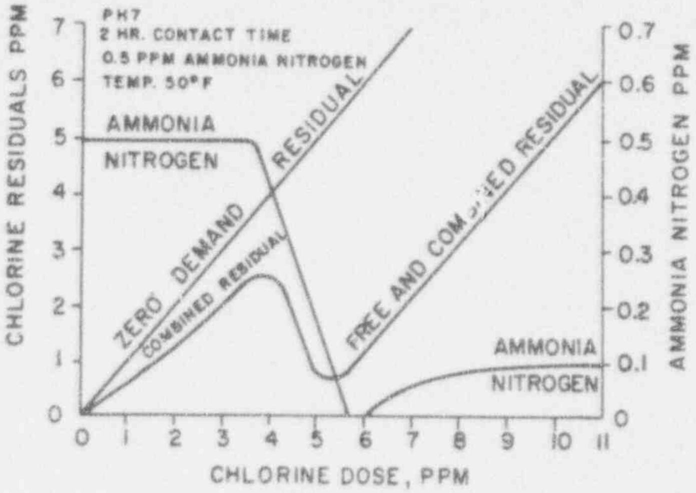


FIG. 3.6-1 RELATIONSHIP BETWEEN AMMONIA NITROGEN AND CHLORINE

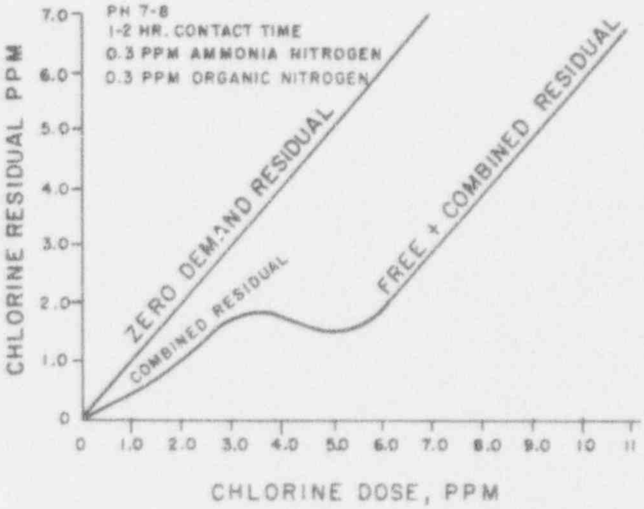


FIG. 3.6-2 RELATIONSHIP BETWEEN AMMONIA NITROGEN AND ORGANIC NITROGEN AND CHLORINE

ADOPTED FROM WHITE, G.C. 1972 HANDBOOK OF CHLORINATION, VAN NOSTRAND REINHOLD CO. NEW YORK.

Amendment # 1, Nov. 30, 1973

Concentration in Discharge During Service Water Chlorination

Blowdown - 5100 gpm 1

Service Water - 12,800 gpm @ 0.2 ppm Monochloramine

Discharge from 2nd Unit - 17,900 gpm

Concentration - $\frac{12,800\ (0.2)}{35,800}$ = 0.07 ppm Monochloramine

3.6.2 SOLIDS CONCENTRATION

The cooling towers will be operated to maintain approximately 3.5 cycles of concentration. The average concentration of solids in the Chattahoochee River is 63 ppm. The cooling tower blowdown and drift will therefore contain 220 ppm of total dissolved solids.

The cooling tower blowdown (5100 gpm) will be mixed with the service water discharge (12,800 gpm) prior to discharge to the river. The resultant concentration of solids in the discharge will be 108 ppm.

The cooling tower drift has been estimated by the manufacturer to be 0.005% of the circulating water rate, or 32 gpm. The total solids concentration in the drift will be 220 ppm.

3.6.3 OTHER CHEMICAL DISCHARGES

The quantities of chemical and biocide waste from other plant operations will be the same as set forth in Alabama Power Company's Environmental Report - Construction Stage - and the AEC Final Environmental Statement.

3.8 Radioactive Materials Inventory

During the course of normal plant operation, radioactive materials will, from time to time, be transported to and from the site. These materials will include new fuel, spent or irradiated fuel, and processed radioactive wastes.

3.8.1 New Fuel

New fuel shipped to the site consists of bundles of fuel rods called fuel assemblies. The fuel rods are made up of zircaloy tubing containing slightly enriched uranium dioxide pellets and sealed at each end. The average enrichment of the initial core is approximately 2.7%. Each fuel assembly contains approximately 460 kilograms of uranium.

The initial fuel loading for each of the two units will consist of 157 fuel assemblies. About 56 new assemblies are expected to be loaded every year into each of the units after they begin commercial operation. These fuel assemblies will have been fabricated at a fuel fabrication plant and shipped to the plant site shortly before they are required. It is anticipated that these shipments will be made by truck. Each container can accommodate two fuel assemblies and six or seven containers would constitute a truckload. Thus, for each unit about twelve to fourteen shipments will be required for the initial loading with only about four or five shipments every year thereafter.

3.8.2 Spent Fuel

The fuel for the Joseph M. Farley Nuclear Plant is designed for a peak pellet burnup of approximately 50,000 Megawatt Days per Metric Ton of Uranium (MWD/MTU), and on average discharge burnup of 33,000 MWD/MTU. At the end of design cycle life, the irradiated fuel will be stored at the plant for at least 100 days while the short half-life isotopes decay. The fuel will then be transported to a reprocessing plant for the necessary reprocessing services. It is anticipated that these shipments will be made by rail.

The railroad car will carry no other cargo and there will be no intermediate handling of the container system between the Farley Plant and the reprocessing plant. The container will be able to accomodate from about six to about sixteen fuel assemblies, depending upon its size. It is anticipated that approximately 56 spent fuel assemblies will be discharged from each unit annually. Thus, for each unit the shipment of from four to ten containers will be required each year.

3.8.3 Processed Radioactive Wastes

Radioactive wastes processed for shipment to off-site burial facilities are prepared by the solid waste handling system. The Farley Plant will have a solid waste handling facility for each unit.

Liquid wastes to be processed will come from the primary and secondary spent resin storage tanks, the waste evaporator concentrate tank, and the chemical drain tank. These spent resin slurries, waste evaporator bottoms and chemical drain tank effluent are piped to the drumming area where they are encapsulated in 55 gallon drums. The drums will have been prepared in a non-radiation area, separate from the drumming room. The drums for the evaporator bottoms and chemical drain tank effluent will be partially filled with a mixture of vermiculite and cement, while the drums for the resin slurries will have an inside coating of cement as well as the vermiculite-cement mixture. The liquid wastes are solidified in the vermiculite-cement mixture and the drums are sealed and if necessary, shielded. They may be shipped offsite immediately or stored at the plant in the drum storage area.

Solid, compressible wastes will be products of the plant operation and maintenance. They will be comprised of low-radiation level material such as paper, disposable clothing, rags, towels, floor coverings, shoe covers, plastics, cloth smears, and respirator filters. These materials are compressed directly into 55 gallon drums by a baler, which is equipped with a dust shroud to prevent the escape of dust or particles that may be emitted from the drum during compression of the wastes. When a drum is full, the lid is installed and secured by a clamping ring, and the drum is stored pending shipment.

The volume of radioactive wastes is expected to total 100 drums of spent primary resins, 600 cubic feet of spent secondary resins from the steam generator blowdown processing system, and 100 drums of evaporator concentrates per year for each unit. Chemical drain tank effluents are expected to total approximately 1000 gallons, or 33 drums, per year. The total volume of compressible wastes will be about 120 drums per year.

The expected curie content of the evaporator concentrates is approximately 3.2 microcuries per cubic centimeter. On the basis of about 30 gallons of evaporator concentrates per drum, the content of each drum is 0.34 curies. The curie content of the chemical drain tank effluents totals approximately 0.63 curies per year, or 0.02 curies per drum. In the case of primary spent resins, the curie content totals approximately 6400 curies per year, or 64 curies per drum. Secondary system spent resins are expected to account for approximately 17 curies per year.

Table 3.8-1 gives the anticipated total solid waste generated per year, and the associated curie content, for each unit.

TABLE 3.8-1

ANTICIPATED TOTAL SOLID WASTE PER UNIT GENERATED PER YEAR

(0.25% Fuel Defects)

	Total Volume (ft^3)	Total Drums	Total Curies
Spert Primary Resins	200	100	6400
Evaporator Bottoms	370[1]	100	34
Chemical Drain Tank Effluents	134[2]	33	0.63
SGBS Spent Resins	600[3]	200	17
Dry Waste	2500	120	<1

---

[1] 2775 gal.

[2] 1000 gal.

[3] 20 gpd primary to secondary leak, 5 gpm/SG Blowdown

3.9 Transmission Facilities

The electrical power generated at the Joseph M. Farley Plant will be delivered to the interconnected transmission system over 230 kV and 500 kV transmission lines. The size, voltage levels, and routings of these lines were determined primarily on the basis of reliability of electrical service.

Initial studies for these transmission facilities began in 1968. Load flow and transient stability studies simulated peak hour conditions in the period 1975-1977 with the initial operation of the two Farley units in 1975 and 1977. Three basic plans involving different combinations of lines and different voltage levels were studied. Alternatives of different line conductor sizes were also considered.

The plan selected is:

(a) One 230 kV line directly to Alabama Power Company substation at Pinckard. One 230 kV line to the substation at Pinckard by way of Webb.

(b) One 230 kV line to Georgia Power Company.

(c) One 500 kV line to Georgia Power Company (Initial operation at 230 kV).

(d) One 500 kV line to Alabama Power Company substation near Montgomery, Alabama.

Georgia Power Company will be responsible for the transmission connections from the Farley substations to the Georgia system which is adjacent to the Farley Plant on the east side of the Chattahoochee River.

The first 230 kV line to Webb will be energized by mid-1973 to supply plant testing power. The other 230 kV lines, including the 500 kV line to be operated initially at 230 kV, will be completed between 1973 and 1975. The additional 500 kV line will be required for service with Unit No. 2 by 1977, along with conversion of the initial 500 kV line from 230 kV operation to 500 kV operation.

Underground transmission lines to deliver the amount of power to be produced at the Farley Plant are not considered technically feasible or economically justifiable. Transmission of such blocks of power at 230 kV underground is estimated to cost in the order of 10 to 40 times more than conventional overhead construction.[1]

Projection work was begun on the Farley transmission line routes early in 1970. Aerial maps and other geographical data were obtained. Detailed field investigations including aerial survelliance, local land research and on the ground inspections were conducted. Consultations were conducted with local county and city officials with respect to local land planning. Alternate routes were developed and final routes selected from these as shown in Figure 3.9-1, sheets 1,2 & 3. The four routes selected are discussed below:

(a) Farley-Webb Section of the Farley-Webb-Pinckard 230,000 Volt Line

This line is approximately 10.5 miles long and runs in a westerly direction from the Farley Plant Substation to the Webb Transmission Substation. The right-of-way will be 125 feet wide. The present land use along the right-of-way route is primarily agricultural. There are no towns along this route; therefore, the route runs in an almost straight line with only slight deviations for churches, homes and road crossings. There are no places in this area listed in "The National Register of Historic Places, 1969", published by the National Park Service, U. S. Department of the Interior. There is no public use land along this route, except for roads and highways, and the route is located in an area which is not subject to floods from the Chattahoochee River. The area traversed by the route is served by a network of roads which will provide a means for easy access for construction and maintenance of the transmission line. It is anticipated that land in this area will continue to serve agricultural needs and the area will remain essentially rural. This line will therefore have little or no impact on land use. A straight line route is desirable because it requires the least amount of land and is the least costly to build. The major adverse environmental impact resulting from construction of this line will be its effect on agricultural use of the land, and this will be minimal. It will not appreciably affect production of trees, shrubs, grass or other plants, and will have little effect on birds, animals, fish or other fauna. Cultural factors, such as land use and recreation will not be affected to any extent by the selection of this route.

Route selection was also evaluated on the basis of the Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities. The route selected complies with applicable items of this document. This line is currently scheduled for service in July, 1973.

(b) Pinckard-Webb Section of the Farley-Webb-Pinckard 230,000 Volt Line

This line is approximately 18.0 miles long. It begins at Pinckard Transmission Substation and runs 0.8 mile east and then parallels an existing 115,000 volt line 8.2 miles, then northeasterly 0.9 mile to a point north of Dothan, and then southeasterly 8.1 miles to the Webb Transmission Substation. The land along this route is now used primarily for agriculture. There are no places in this area listed in "The National Register of Historic Places, 1969". There is no public use land along the route, except for roads and highways, and the route is located in an area which is not subject to floods from the Choctawhatchee River. The area traversed by the route has a network of roads providing easy access for construction and maintenance of transmission lines. It is anticipated that land in this area will remain essentially rural except for the land between Highway 231 and Highway 431.

Construction of this line should have little impact on the environment of this area. The major adverse environmental impact resulting from construction of this line will be from its effect on agricultural use of the land, and this will be minimal. It will not appreciably affect production of shrubs, trees, grass or other plants, and will have little effect on birds, animals or fish. Cultural factors, such as land use and recreation will not be affected to any extent by the route choice.

Route selection was also evaluated on the basis of the Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities. The route selected complies with applicable items of this document. This line is currently scheduled for service December 1, 1973.

(c) Farley-Pinckard (South Route) 230,000 Volt Line

This line is approximately 34.0 miles long. The line begins at the Farley Plant substation and runs southeasterly 6.7 miles to a point southeast of Ashford, then west 14.5 miles south of Dothan, and then 13.8 miles northwesterly to the Pinckard substation. The right-of-way is 125 feet wide. This line was routed around the City of Dothan. There are no places in this area listed in "The Register of Historic Places, 1969". There is no public use land along this route, except for roads and highways, and the route is located in an area which is not subject to floods from the Chattahoochee River. The area has a network of roads which provide a means for easy access for construction and maintenance of the transmission line. Currently there are no major transmission lines in the area south of Dothan. Additional power requirements for this area could be served from this line.

The environmental impact of this line will be limited to the effects of the line on agricultural development in the area, and this will be minimal. The route selected is expected to remain out of heavily populated areas of Dothan for many years. Construction of this line will not appreciably affect production of trees, grass or other plants, and will have little effect on birds, animals or fish. Cultural factors such as land use and recreation will not be affected by the selection of this route.

Route selection was also evaluated on the basis of the Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities. The route selected complies with applicable items of this document. This line is currently (June, 1973) being surveyed. Right-of-way acquisition is scheduled for completion by early 1974. The line is scheduled for service by January 1, 1975.

(d) Farley-Snowdoun 500,000 Volt Line

This line is approximately 96 miles long. It runs in a northwesterly direction from Farley Plant substation to the Snowdoun Transmission Substation. The right-of-way is 200 feet wide and the line is almost a straight line passing northeast of Headland, Newville, Ozark, Brundidge, and Troy. The line runs through farmlands across Houston, Henry and Dale Counties, through mostly timberland in Barbour and Pike Counties and through pasturelands in Montgomery County. The line crosses the Choctawhatchee, Pea and Conecuh Rivers. There are no places in this area listed in "The National Register of Historical Places, 1969", published by the National Park Service, U. S. Department of the Interior. There is no public use land along this route except for roads and highways. The area traversed by the route is served by a network of roads which will provide a means of easy access for construction and maintenance of the transmission line. It is anticipated that land in this area will continue to serve agricultural, timber and pasture needs and the area will remain essentially rural. This line will therefore have little or no impact on land use. A straight line route is desirable because it requires the least amount of land and is the least costly to build. The major adverse environmental impact will be its effect on agricultural use of the land, and this will be minimal. It will not appreciably affect production of trees, shrubs, grass or other plants, and will have little effect on birds, animals or fish. Cultural factors, such as land use and recreation will not be affected to any extent by the selection of this route.

Route selection was also evaluated on the basis of Federal Power Commission's Guidelines for the Protection of Natural, Historic, Scenic and Recreational Values in the Design and Location of Rights-of-Way and Transmission Facilities. The route selected complies with applicable items of this document. The right-of-way for this line is currently under survey. The scheduled completion date for acquisition is September 1, 1974. Line clearing and construction is scheduled to start in September, 1974 and be completed by September, 1976.

The economic effects of these transmission rights-of-way can be evaluated on the basis of estimated loss of income to the owner.

In Figure 3.9-2, the four transmission line routes selected are divided into use and revenue evaluation by county. Land use classifications are wood product areas, farm crop or cultivated areas and pasture areas. Acreages devoted to such uses were determined from maps made from aerial photographs. The revenue derived per acre from these land uses is based on data supplied by the Annual Report of the respective county agents. In Table 3.9-1, Sheets 1 through 12, the total farm income for each county is shown on a crop-acre-income basis.

Gross figures supplied in the data have been modified to represent a net income figure by the application of a 30 percent factor as an averaged multiplier to reduce gross to net. This factor is an estimated amount and was suggested by some of the county agents.

Annual average income from cultivated areas was combined with that from wood products. To determine the reduction of annual income from the property caused by the construction of the transmission line, a devaluation factor was applied which represents the estimated reduction in productivity. Wood products will be eliminated on the transmission line right-of-way and, therefore, a devaluation factor of one was used. Cultivated land is not affected to any great extent since less than one percent of the land will be removed from productivity. However, a devaluation factor of one-tenth was assumed for this type of property use, based on considerations of inconvenience to the owner. Pasture land is only slightly affected by transmission lines and therefore a devaluation factor of zero was applied to pasture areas. Figure 3.9-2 shows these reduction factors and the total annual loss of revenue in dollars per acre by county for land used for right-of-way. This is compared with the estimated annual tax payment which is expected to be made to each county for the transmission lines. It is recognized that only a small portion of the tax payment will benefit the landowner. Therefore, the initial price paid for the right-of-way is treated as a direct purchase from the landowner.

The economic effect on the area of construction of these transmission lines will be small and will be compensated for by tax payments to the counties as well as by purchase of the rights-of-way.

During construction, rights-of-way will be cleared and smoothed. Stumps will be sheared and high banks and other obstructions leveled to facilitate future maintenance with mowing equipment. Culvert pipes will be installed wherever necessary to maintain the natural flow of water. Natural screens composed of native shrubs and trees will be utilized at road crossings where practical to avoid long views of transmission line corridors.

Reclearing of the rights-of-way will be done every three or four years by bush-hogs and the use of herbicides in such a way that the ground cover of native shrubs and grasses will not be disturbed. Only herbicides approved by the Environmental Protection Agency will be used under controlled conditions predominately by helicopter application according to label instructions. All transmission lines are patrolled on a monthly basis by fixed wing aircraft. 1

Alabama Power Company encourages property owners to convert their rights-of-way brush acreage to permanent pasture, row crops, wildlife food plots, or some other useful crop by providing technical assistance and sharing in the initial cost of establishing such areas.

TABLE 3.9-1

1970 - HOUSTON COUNTY FARM INCOME
TOTAL RURAL ACREAGE - 350,000

1. FARM CROPS, FRUITS AND NUTS

130,000 Acres Available - 106,725 Acres Harvested

Crop	Acres Harvested	Gross Income	Gross Income Per Acre
Cotton	7,300	1,586,462	217
Peanuts	31,215	8,615,340	276
Soy Beans	1,500	66,000	44
Corn	40,000	1,600,000	40
Sorghum	6,000	270,000	45
Grains	9,200	196,000	21
Pecans	500	128,000	256
Vegetables	9,000	1,500,000	167
Watermelons Canteloupes	2,000	240,000	120
Fruits	10	10,000	1,000
TOTALS	106,725	14,211,802	133

Estimated net income at 30% of gross income = $40/acre harvested

2. TIMBER LANDS

Total Acreage - 130,000

1970 Harvest - 6,000 Acres

1970 Income - $650,000

1970 - $108 Stumpage

Based on cutting each 20 years, annual value of wood products/acre = 108/20 = $5.40

TABLE 3.9-1 (Continued)

3. LIVESTOCK AND PASTURE (55,000 Acres)

Cattle and Calves	$ 2,000,000
Hogs and Pigs	$ 2,344,000
Dairying	$ 365,000
Broilers	$ 100,000
Eggs	$ 905,000
Total	$ 6,714,000

Gross income equals 6,714,000/55,000 = $122 per acre.

Net income @ 30% of gross equals $37 per acre.

4. Remaining acreage not in use or rented to Federal Government = 58,275

23,275 Acres Idle Crop Land

15,000 Acres Govt. Programs

20,000 Acres Non-Productive Land

Government payments plus hunting rights = 221,060 and assuming this is averaged over above land = $3.79 per acre.

TABLE 3.9-1 (Continued)

1972 - BARBOUR COUNTY FARM INCOME
TOTAL RURAL ACREAGE - 575,400

1. FARM CROPS, FRUITS AND NUTS

79,620 Acres Available - 66,620 Acres Harvested

Crop	Acres Harvested	Gross Income	Gross Income Per Acre
Cotton	2,270	401,973	177
Peanuts	20,000	4,862,100	243
Soy Beans	950	52,725	56
Corn	30,000	1,090,214	36
Sorghum	200	6,500	33
Grains	200	5,200	26
Pecans	13,000	337,500	26
Vegetables	0	0	0
Watermelons Cantaloupes	0	0	0
Fruits	0	0	0
TOTALS	66,620	6,756,212	101

Estimated net income at 30% of gross income = $30/acre harvested

TABLE 3.9-1 (Continued)
(Barbour County)

2. TIMBERLANDS

Total Acreage Used	382,500
1972 Harvest	18,000
1972 Income	$ 2,756,000
1972 Income/Acre Harvested	$ 153 Stumpage

Based on cutting each 20 years, annual value of wood products/acre = 153/ 20 = $7.65

3. LIVESTOCK AND PASTURE (66,249 Acres)

Cattle and Calves	$ 613,100
Hogs and Pigs	$ 1,872,800
Dairying	$ 221,000
Broilers	$ 425,250
Eggs	$ 606,000
TOTAL	$ 3,738,150

Gross income equals 3,738,150/66,249 - $56 per acre

Net income @ 30% of gross equals $17 per acre

4. Remaining acreage not in use or rented to Federal Government = 60,031

13,000 Acres Idle Crop Land

30,031 Acres Government Programs

17,000 Acres Non-Productive Land

Government payments plus hunting rights = 755,911 and assuming this is averaged over above land = $12.59 acre

TABLE 3.9-1 (Continued)

1972 - PIKE COUNTY FARM INCOME
TOTAL RURAL ACREAGE - 317,904

1. FARM CROPS, FRUITS AND NUTS

110,876 Acres Available - 46,473 Acres Harvested

Crop	Acres Harvested	Gross Income	Gross Income Per Acre
Cotton	60	6,540	109
Peanuts	14,500	4,045,000	210
Soy Beans	350	21,420	61
Corn	18,000	210,600	12
Sorghum	3,000	12,540	4
Grains	2,650	25,400	10
Pecans	2,500	225,000	90
Vegetables	373	78,850	211
Watermelons Canteloupes	8	1,200	150
Fruits	32	9,000	281
TOTALS	46,473	4,685,550	101

Estimated net income at 30% of gross income = $30/acre harvested.

TABLE 3.9-1 (Continued)
(Pike County)

2. TIMBER LANDS

Total Acreage	- 143,190
1972 Harvest	- 5,000 Acres
1972 Income	- $899,512
1972 Income/Acre Harvested	- $180 Stumpage

Based on cutting each 20 years, annual value of wood products/acre = 180/20 = $9.00

3. LIVESTOCK AND PASTURE (102,005 Acres)

Cattle and Calves	$ 3,542,000
Hogs and Pigs	$ 2,372,500
Dairying	$ 451,635
Broilers	$ 1,396,395
Eggs	$ 2,091,500
Total	$ 9,854,030

Gross income equals 9,854,030/102,005 = $97 per acre.

Net income @ 30% of gross equals $29 per acre.

4. Remaining acreage not in use or rented to Federal Government = 26,236

11,236 Acres Idle Crop Land

10,000 Acres Govt. Programs

5,000 Acres Non-Productive Land

Government payments plus hunting rights = 801,800 and assuming this is averaged over above land = $30.56 per acre.

TABLE 3.9-1 (Continued)

1972 - MONTGOMERY COUNTY FARM INCOME
TOTAL RURAL ACREAGE - 454,562

1. FARM CROPS, FRUITS AND NUTS

75,000 Acres Available - 66,063 Acres Harvested

Crop	Acres Harvested	Gross Income	Gross Income Per Acre
Cotton	4,600	773,325	168
Peanuts	0	0	0
Soy Beans	18,000	1,512,000	84
Corn	3,000	98,250	33
Sorghum	1,200	48,000	40
Grains	2,400	90,000	38
Pecans	1,733	288,000	166
Vegetables	125	35,500	284
Watermelons Canteloupes	5	1,200	240
Fruits	0	0	0
Hay	35,000	150,000	4
TOTALS	66,063	2,996,275	45

Estimated net income at 30% of gross income = $14/acre harvested.

TABLE 3.9-1 (Continued)
(Montgomery County)

2. TIMBER LANDS

Total Acreage	- 206,200
1972 Harvest	- 7,000
1972 Income	- $750,000
1972 Income/Acre Harvested	- $107 Stumpage

Based on cutting each 20 years, annual value of wood products/acre = 107/20 = $5.35

3. LIVESTOCK AND PASTURE (162,000 Acres)

Cattle and Calves	$ 7,614,000
Hogs and Pigs	$ 553,925
Dairying	$ 4,460,400
Broilers	$ 81,400
Eggs	$ 310,000
Total	$13,019,725

Gross income equals 13,019,725/162,000 = $80 per acre.

Net income @ 30% of gross equals $24 per acre.

4. Remaining acreage not in use or rented to Federal Government = 20,299.

4,532 Acres Idle Crop Land

8,137 Acres Govt. Programs

7,630 Acres Non-Productive Land

Government payments plus hunting rights = 499,265 and assuming this is averaged over above land = $24.59 per acre.

TABLE 3.9-1 (Continued)

1972 - DALE COUNTY FARM INCOME
TOTAL RURAL ACREAGE - 300,000

1. FARM CROPS, FRUITS AND NUTS

70,246 Acres Available - 36,288 Acres Harvested

Crop	Acres Harvested	Gross Income	Gross Income Per Acre
Cotton	0	0	0
Peanuts	16,438	3,496,197	213
Soy Beans	150	11,850	79
Corn	14,000	71,500	5
Sorghum	1,000	40,000	40
Grains	3,500	175,000	50
Pecans	500	100,000	200
Vegetables	500	150,000	300
Watermelons	200	45,000	225
Fruits	0	0	0
TOTALS	36,288	4,089,547	113

Estimited net income at 30 % of gross income = $34/acre harvested

TABLE 3.9-1 (Continued)

2. TIMBER LANDS

Total Acreage	- 220,000
1972 Harvest	- 9,000
1972 Income	- $1,150,000
1972 Income/Acre Harvested	- $ 128 Stumpage

Based on cutting each 20 years, annual value of wood products/acre = 128/20 = $6.40

3. LIVESTOCK AND PASUTRE (20,000 Acres)

Cattle and Calves	$ 690,000
Hogs and Pigs	$ 995,000
Dairying	$ 0
Broilers	$ 500,000
Eggs	$ 100,000
Total	$ 2,285,000

Gross income equals 2,285,000/20,000 = $114 per acre

Net income @ 30% of gross equals $34 per acre

4. Remaining acreage not in use or rented to Federal Government = 23,712

13,184	Acres Idle Crop Land
2,528	Acres Government Programs
8,000	Acres Non-Productive Land

Government payments plus hunting rights = 450,431 and

assuming this is averaged over above land = $18.99/acre

TABLE 3.9-1 (Continued)

1972 - HENRY COUNTY FARM INCOME
TOTAL RURAL ACREAGE - 341,000

1. FARM CROPS, FRUITS AND NUTS

75,000 Acres Available - 73,300 Acres Harvested

Crop	Acres Harvested	Gross Income	Gross Income Per Acre
Cotton	1,050	160,000	152
Peanuts	31,434	9,500,000	302
Soy Beans	1,000	65,000	65
Corn	25,000	350,000	14
Sorghum	756	7,800	10
Grains	9,000	75,000	8
Pecans	5,000	30,000	6
Vegetables	50	5,000	100
Watermelons	10	2,000	200
Fruits	0	0	0
TOTALS	73,300	10,194,800	139

Estimated net income at 30% of gross income = $42/acre harvested

TABLE 3.9-1 (Continued)

2. TIMBER LANDS

Total Acreage - 186,900

1972 Harvest - 6,500 Acres

1972 Income - $ 750,000

1972 Income/Acre Harvested - $ 115 Stumpage

Based on cutting each 20 years, annual value of wood products/acre = 115/20 = $5.75

3. LIVESTOCK AND PASTURE (35,000 Acres)

Cattle and Calves	$ 2,500,000
Hogs and Pigs	$ 1,600,000
Dairying	$ 500,000
Broilers	$ 0
Eggs	$ 250,000
Total	$ 4,850,000

Gross income equals 4,850,000/35,000 = $139

Net income @ 30% of gross equals $42 per acre

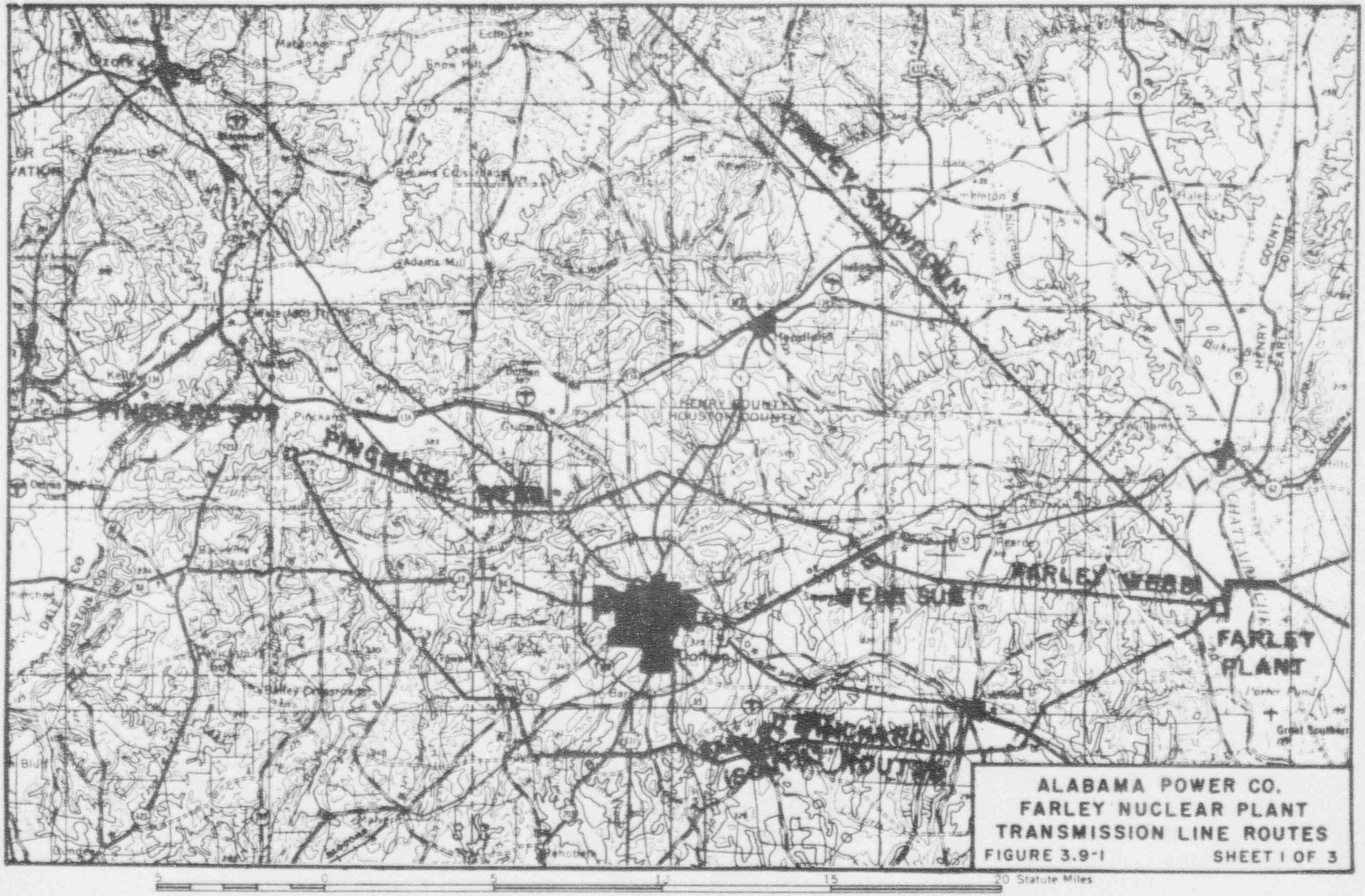
4. Remaining acreage not in use or rented to Federal Government = 45,800

35,000 Acres Idle Crop Land

5,800 Acres Government Programs

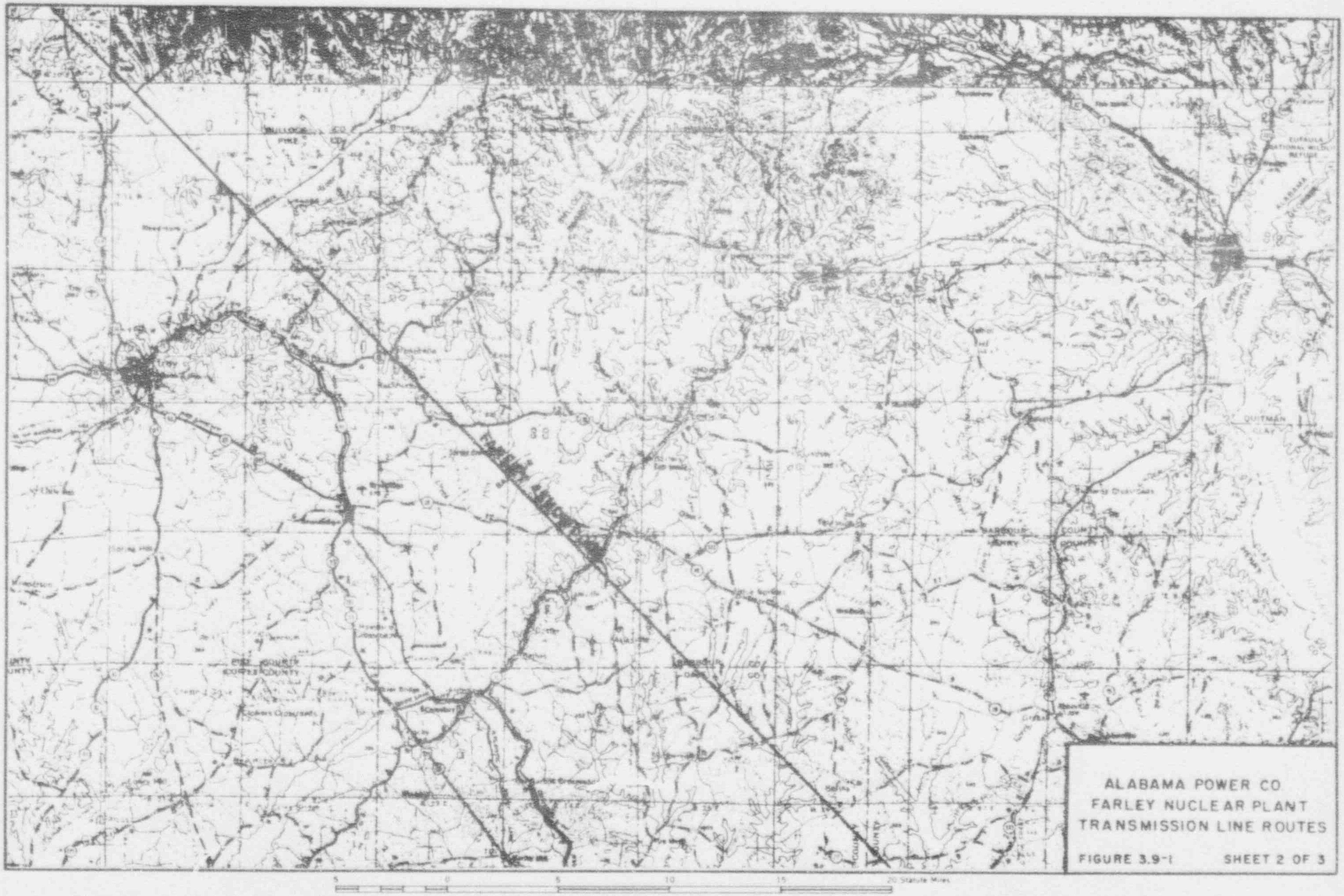
5,000 Acres Non-Productive Land

Government payments plus hunting rights = 804,927 and assuming this is averaged over above land = $17.57 per acre.



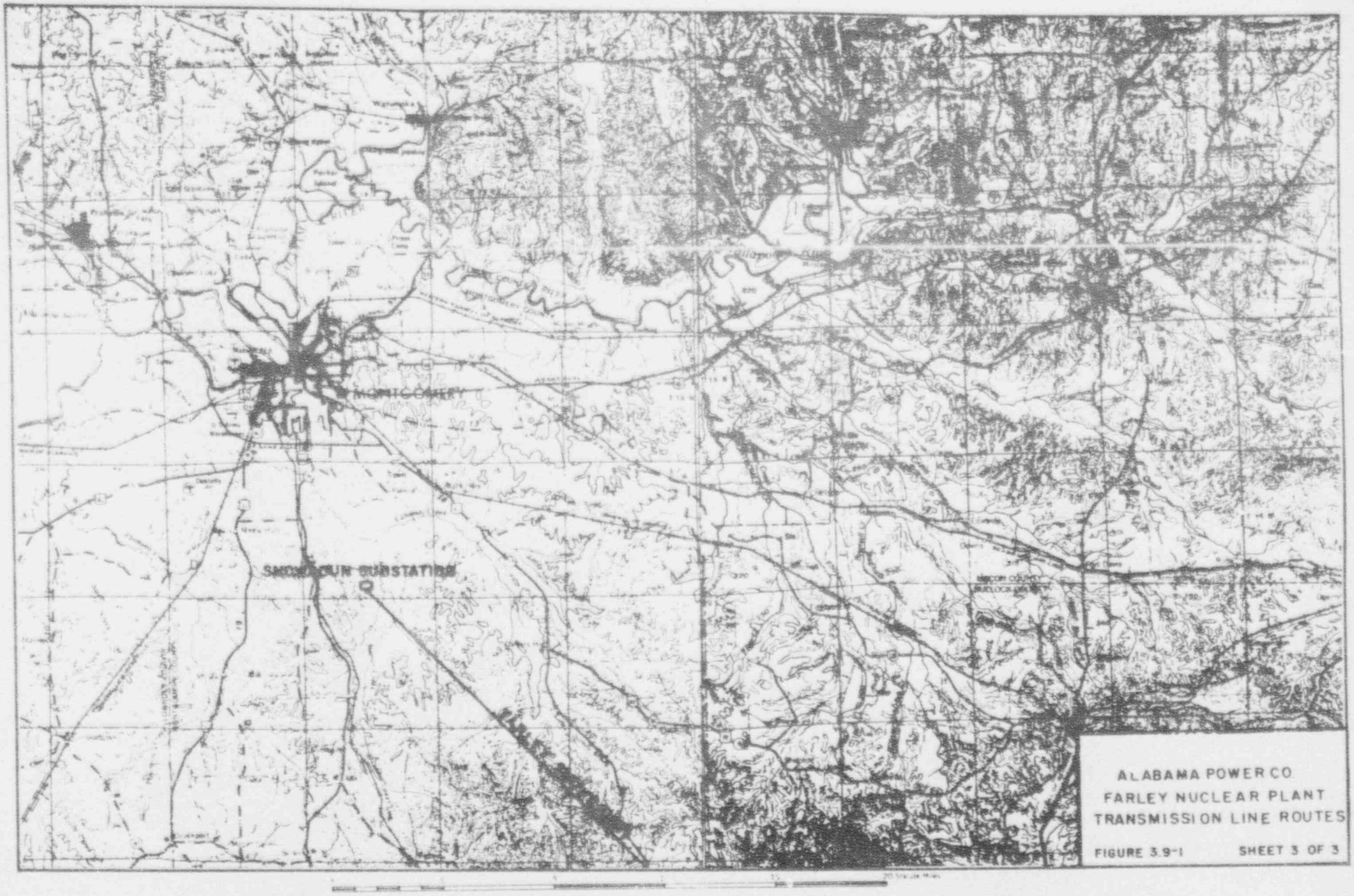
ALABAMA POWER CO.
FARLEY NUCLEAR PLANT
TRANSMISSION LINE ROUTES

FIGURE 3.9-1 SHEET 1 OF 3



ALABAMA POWER CO
FARLEY NUCLEAR PLANT
TRANSMISSION LINE ROUTES

FIGURE 3.9-1 SHEET 2 OF 3



ALABAMA POWER CO.
FARLEY NUCLEAR PLANT
TRANSMISSION LINE ROUTES

FIGURE 3.9-1 SHEET 3 OF 3

TOTAL ANNUAL LOSS OF REVENUE PER ACRE

	Length in Miles	Acres in R/W	Acres R/W in Woods	Acres R/W in Farm	Annual Tax Paid To County For Lines	Annual Tax Per Acre	Estimated Total Annual Rev. From Present Use		Devaluation Factors Due to Line			Annual Loss of Revenue Due to Trans. Line			Total Annual Loss of Revenue Per Acre
							Timber	Farm	Timber	Farm	Past.	Timber	Farm	Past.	
I FARLEY-WEBB															
10.5 Miles					*		**	**							
1. Houston Co.	10.5	159	51.5	107.5	$1,060	$6.67	$278	$4,300	1	.1	0	$278	$430	0	$4.45
2. Dale Co.	0	0	0	0	-	-	0	0	1	.1	0	0	0	0	0
II WEBB-PINCKARD															
18.5 Miles					*		**	**							
1. Houston Co.	12	181	49.5	131.5	1,210	6.67	267	5,260	1	.1	0	267	526	0	4.38
2. Dale Co.	6.5	98	27	71	630	6.41	146	2,840	1	.1	0	146	284	0	4.39
III FARLEY-PINCKARD South															
31 Miles					*		**	**							
1. Houston Co.	27	408	126	282	2,721	6.67	680	11,280	1	.1	0	680	1,128	0	4.43
2. Dale Co.	4	60.5	19	41.5	386	6.41	103	1,660	1	.1	0	103	166	0	4.45
IV FARLEY-SNOWDOUN 500 kV															
96 Miles					*		**	**							
1. Houston Co.	8	194	85.3	108.7	1,408	7.26	461	4,348	1	.1	0	461	435	-	4.61
2. Henry Co.	18	436.4	192	244.4	3,168	7.26	1,110	10,130	1	.1	0	1,110	1,013		4.95
3. Dale Co.	11.5	278.8	214.7	64.1	1,943	6.97	1,370	2,180	1	.1	0	1,370	218	-	5.70
4. Barbour Co.	12	290.9	180.4	110.5	2,112	7.26	1,380	3,320	1	.1	0	1,380	332		5.88
5. Pike Co.	23.5	569.7	364.6	205.1	3,474	6.10	3,280	6,153	1	.1	0	3,280	615	-	6.83
6. Montgomery Co.	23	551.6	278.8	278.8	3,400	6.10	1,492	6,690	1	.1	0	1,492	669		3.91

*Based on current method of tax payment and estimated value of $80,000 per mile for 230 kV and $125,000 per mile for 500 kV

**See individual county reports for revenue per acre for timber products and farm values

NOTE: For purposes of annual land income, all open land assumed as crop lands with devaluation factor of .1

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

TOTAL ANNUAL LOSS OF
REVENUE PER ACRE

FIGURE 3.9-2

4.2 Transmission Facilities Construction

Section VII B of the AEC Final Environmental Statement - Construction Stage - addressed specific rare and endangered species which might reside in the area of the Farley Nuclear site and along the transmission corridors. In response to this question, Alabama Power engaged as a consultant Dr. Julian L. Dusi, vertebrate ecologist, Professor at Auburn University's Department of Zoology and recognized authority on Alabama birds to investigate these concerns. The proposal made to us by Dr. Dusi specifically included provisions for on the ground reconnaissance for areas which he considered questionable from the air. Dr. Dusi's report which is included as Section 4.2 of the Environmental Report - Operation Stage - indicates that he was fully able to make the conclusions in regard to rare and endangered species from the aerial reconnaissance work and from his extensive knowledge of the endangered species in question. His report which addresses this particular aspect follows: 1

AERIAL RECONNAISSANCE
OF THE PROPOSED TRANSMISSION LINES
FROM FARLEY STATION TO ALABAMA

by Julian L. Dusi

Procedure

In preparation for the flights, it was necessary to transfer the transmission line routes to county road maps so that accurate check points to road intersections, towns, etc., would be present so that we could exactly keep on course and also be able to plot exactly any eagle nests or special habitat that would require exact location from the ground. To do this, it was necessary to xerox the portions of county maps needed, fit them together, plot in the transmission line routes, cut this into 8½ x 11 inch size pages, copy these master pages and attach them together so that they could be referred to while piloting the aircraft. 1

On Friday, April 27, Rosemary Dusi and I drove to Dothan and the airport there and arranged rental of a Cessna-150 from Napier Air Services, then we flew the Farley Station to Pinckard substation transmission line routes, to the north and south of Dothan. We also flew part of the Farley Station to Montgomery line to a point north of the Dothan airport.

On Saturday, April 28, we flew the rest of the Montgomery line, in the morning.

On Friday May 11, we flew from the Auburn airport in a Cessna-150, rented from Auburn School of Aviation, to the end of the transmission line at the south Montgomery substation, rechecked part of the line to Farley Station and then checked the right-of-way from the south Montgomery substation to the 500KV switching station in Montgomery

The weather was excellent for the flights. Visability was at least 10 miles, few clouds were present and turbulence was light. This permitted excellent visibility and it was relatively easy to keep the aircraft on heading. We flew at 1,000 feet above ground level and with the excellent visibility, were able to observe accurately a path at least 1½ miles wide on each side of the aircraft, with our most accurate observations covering a path several hundred feet wide under the direct path of the plane. This permitted the recognition of any swamps, which might be habitat for the alligator, Bachman's Warbler, or wading birds. It also permitted recognition of any possible nests of the Bald Eagle and the upland habitat which might be used by Red-cockaded Woodpeckers or the Florida panther. Notations of observations were made and possible locations marked on the maps used.

Results of the Reconnaissance

Farley Station - Pinckard Substation Transmission Lines

There were no eagle nests, swamps that were alligator habitat or wading bird nesting sites, no swamps with suitable Bachman's Warbler nesting habitat, or open stands of large pine trees that were typical Red-cockaded Woodpecker habitat. The forested area along the Chattahoochee River and tributaries of the Choctawhatchee River, near Pinckard, are areas where the Florida panther or cougar might travel. The northern part of this line from Farley Station to Pinckard substation was already cut and the line partly constructed. This prevented our seeing any eagle nests that could have been present but since this was definitely not eagle nesting habitat, it is hardly likely that any were present.

The land-use is strongly agricultural. Almost 50% of the already-cut line was forested and it will probably be the same for the rest of the line.

Farley Station - Montgomery Substation Transmission Line 500K-

Along this line, there was no suitable habitat for eagles and no nests were found. No swamps suitable for alligators or wading bird colonies were seen. Suitable nesting habitat for Bachman's Warblers or Red-cockaded Woodpeckers was not present. The forested river bottoms of the Chattahoochee, Choctawhatchee and its tributaries and the Conecuh and its tributaries, appeared to be suitable habitat and travel ways for panthers.

At this stage of agricultural land preparation, it appeared that at least 50% of the land was cropland and plowed. The pasture land added to this would leave only about 30% in unpastured woods and river forests. The transmission line was probably laid out so that it was in forested land where possible, so that it did traverse 50% farm land and 50% forested land. Thus the much higher use of agricultural land would have adversely affected animal populations.

Montgomery 500kV Switching ation - South Montgomery Substation Transmission Line

This short line is completely out of habitat required by any of the species concerned and none were noted present.

Discussion and Conclusions

None of these transmission lines in Alabama will affect a highly important or sensitive enrivonmental area of great concern to naturalist. Most of it has already been modified by agriculture, so that relatively little of the right-of-ways could be considered to be traversing untouched natural habitat.

Well managed right-of-ways, kept in low herbaceous or shrubby vegetation, will actually improve the present habitats, providing edge effect and a stable habitat, so that more wild animals will be able to exist.

The effects of these transmission lines on the five endangered species follow:

1. The Southern Bald Eagle. No nests were seen or expected. There is no nesting habitat for these birds and only occasional migrants pass through the area.
2. Bachman's Warbler. None of the swampland observed seemed to be typical nesting habitat. These lines are still a number of miles south of the known nesting range in Alabama. Dr. Henry M. Stevenson, reporting on the recent history of this warbler in the Wilson Bulletin of September 1972, said that only 30 Bachman's Warblers were seen between 1950 and 1966 and that none have been seen since 1966. This precludes any possible impact from the construction of these transmission lines.
3. Red-cockaded Woodpecker. No suitable habitat for these birds was noted. The nearest colony known to us is at Hurtsboro, over 50 miles away. It is always possible that some small colonies could have been overlooked. The chance of a narrow right-of-way being directed through a small colony is so slight that no impact is expected.
4. Florida Panther. This species exists in some of our big river swamps. It could be present along the Chattahoochee River, Pea River and its tributaries and the Conecuh River and its tributaries. It requires extensively forested river bottoms and this exists in the above. The transmission line right-of-ways are narrow and do little to interrupt this habitat. After the transmission lines are constructed they would have no impact on this species.
5. The American Alligator. This species could exist in swamps of suitable size throughout this area and also in large rivers and lakes. No suitable swamps were located by the aerial reconnaissance and since the disturbance at rivers will be slight, it is felt that the transmission lines would have no impact on this species.

No other species that aggregate or nest in large concentrations were seen along the proposed right-of-ways. Therefore, any other species would be only slightly affected by these lines and no more impact would occur than regularly occurs in agri-practices that are regularly practiced.

****

5.1 EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM

Approximately 3% of the total station waste heat is dissipated in the Chattahoochee River. The discharge volume equals about 6.6% of the river flow at minimum conditions and approximately 1% at most probable conditions. Under these circumstances,and particularly since the blowdown from the cooling towers and the service water discharge can be diluted before discharge by water taken directly from the storage pond, very little temperature elevation is likely when the water is returned to the river from the discharge structure.

There will be little other change in the quality of the water returning to the river, both because the quantity of discharge from the cooling system is small and because it is diluted with water of normal mineral content pumped from the storage pond. The operation of the plant will comply with water quality standards of both the States of Georgia and Alabama.

5.1.1 THERMAL IMPACT

No appreciable biological impact is expected from release of heated water effluents by the Farley station. The cooling towers are designed on the basis of a 78°F. wet bulb temperature, with an approach of 11°F. When the design wet bulb temperature prevails, the blowdown water temperature will be 89°F. However, the wet bulb temperature will be less than 78°F. most of the time and the blowdown water will usually be cooler than 89°F. The tower blowdown water (5100gpm) will be mixed with service water discharge (12,800gpm) and can be diluted with water at approximately river temperature before discharge.

Using an intake water temperature of 86°F. (a maximum summer river temperature), a maximum blowdown water temperature of 89°F., service water temperature of 94.5°F. with the lowest reported 1-day minimum flow in the Chattahoochee River since 1929 (1210 cfs), a simple thermal balance calculation indicates a discharge temperature of 93.4°F. and a resulting temperature increase in the river of 0.5°F. after mixing. This estimated maximum increase in river water temperature is well within requirements of water quality standards for the Chattahoochee River which allow a 5°F. rise after mixing and a maximum of 90°F. For the most probable river flow, 8000 cfs, the expected rise in river water temperature, following the assumptions made above, is 0.07°F. Sufficient dilution water is available (14,400 gpm) to limit the temperature of the discharge to 90°F. under the extreme conditions outlined above.

Estimates have been made of the temperature distribution along the centerline of the discharge plume and of the width of the plume at the point where the centerline temperature falls to within 5°F. of the initial river temperature. In January, assuming average ambient river and air temperature conditions, the temperature of the plume centerline falls to within 5°F. of ambient river temperature approximately 135 feet from the discharge point (measured along the plume centerline) where the plume has a width of 126 feet. In the summer months of July and August, the 5°F. temperature differential (Δt) between the discharge and the ambient river water should be reached within 65 feet of the discharge point (measured along the centerline, assuming average ambient conditions).

Table 5.1-1 is a tabulation of discharge temperatures and Δt values for average ambient conditions. The maximum Δt (13.3°F.) occurs in January. The maximum discharge temperature of 89.1°F. occurs in July and August. Also shown on Table 5.1-1 are the two worst case conditions of extreme wet bulb temperature for January and July. Under these conditions, the maximum Δt is 16.6°F. in January with a maximum discharge temperature of 90.5°F. occurring in July. The wet bulb temperature on which the worst case is based occurs approximately four hours during each year.

Table 5.1-2 and 5.1-3 show estimates of mixing distances and plume widths for the average ambient and worst case conditions mentioned above. The estimates of Table 5.1-2 assume a river flow of approximately 1200 cfs, while those of 5.1-3 assume no river flow. The maximum distance to obtain mixing to within 5°F. of ambient is 218 feet from the discharge point. This occurs under the worst case of a high wet bulb temperature in January, with no river flow.

The basis for these estimates is derived from curves (shown in Figures 5.1-1 and 5.1-2), extracted from published work by K. D. Stolzenbach and D. Harleman.[1,2] These curves model the centerline temperature, plume geometry (depth, width and centerline position) as a function of the following dimensionless parameters:

> Froude number, ratio of jet height to jet half-width (aspect
> ratio, bottom slope, ratio of centerline - ambient 2
> temperature difference to initial temperature difference, ratio
> of surface heat loss coefficient to jet velocity. Of these
> parameters the bottom slope (barring actual interference with
> the jet) and the heat loss parameter are not critical in the
> region of interest. The analysis by Stolzenbach and Harleman
> assumes large Reynolds numbers and fully developed turbulent
> flow in both the discharge jet and river. 1

Notes on tables and graphs:

1. <u>Symbols</u>:

IF_o = Froude number of jet at discharge
V/u_o = River velocity/jet discharge velocity
K/u_o = Surface heat transfer coefficient/jet discharge velocity
A = Aspect ratio - discharge jet height/discharge jet half-width
$\Delta Tc/\Delta T_o = (T_z-T_a)/(T_o-T_a)$ = Difference of centerline to ambient water temperature/Difference of discharge to ambient water temperature.
D_o = Diameter discharge jet.
$D_o \star \sqrt{\pi/2}$ = Scaling factor.
X = Distance along centerline of jet, measured from discharge point.
X_r = Deflection of jet downstream, measured from discharge point.
Y = Half width of discharge jet, measured along perpendicular from centerline.
Z = Depth of bottom of jet, measured from top of discharge pipe.

---

[1] <u>An Analytical and Experimental Investigation of Surface Discharges of Heated Water</u>, E.P.A. - Water Pollution Control Series #16130 - DJU - 02/71.

[2] <u>A User's Manual for Three-Dimensional Heated Surface Discharge Computations</u>, E.P.A. - R2 - 73 - 133.

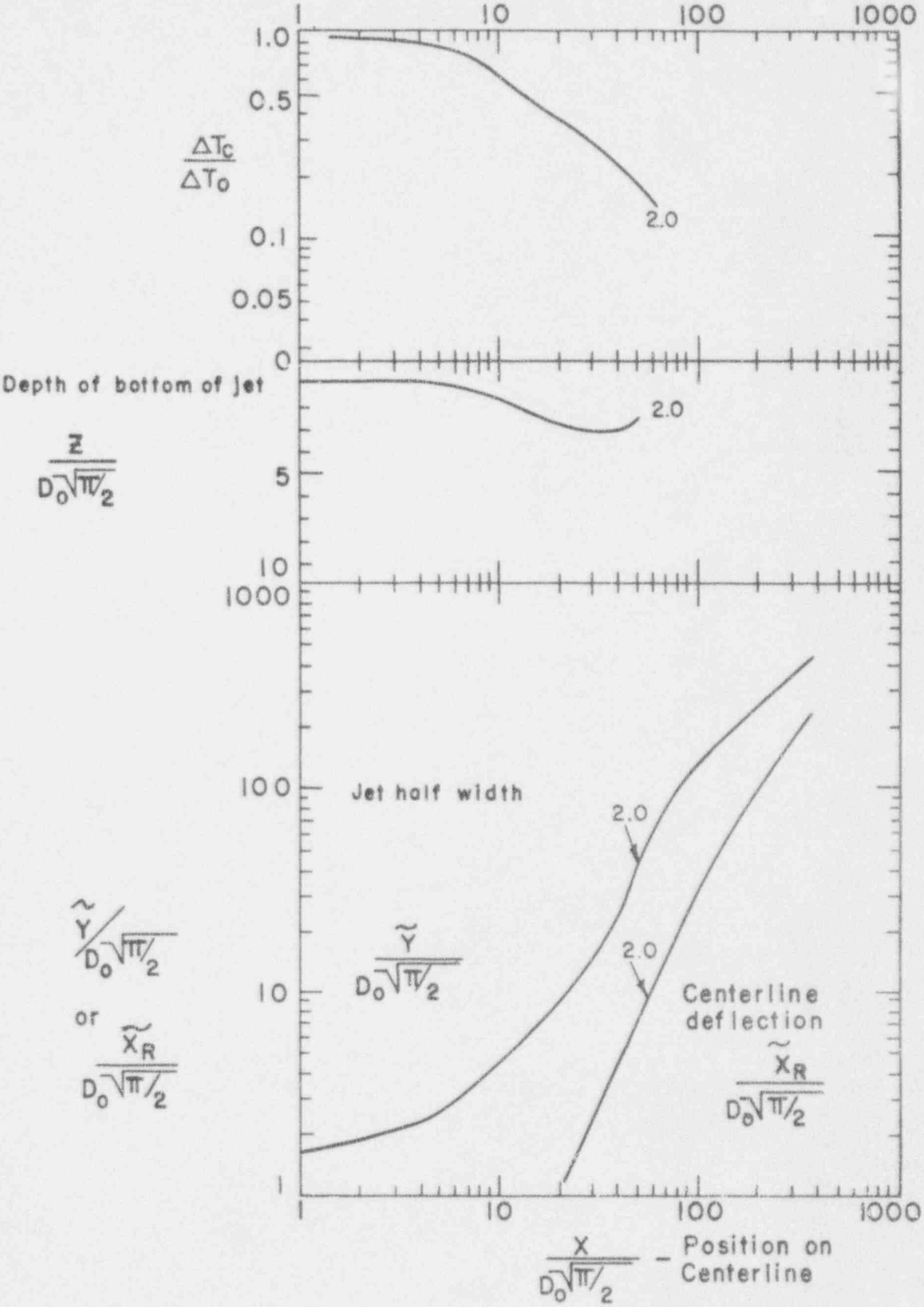


Fig. 5.1-1 Jet Parameters for $\mathbb{F}_0 = 10.0$, $V/u_0 = 0.05$, $k/u_0 = 0$, $A = 2.0$

Amendment # 1, Nov. 30, 1973

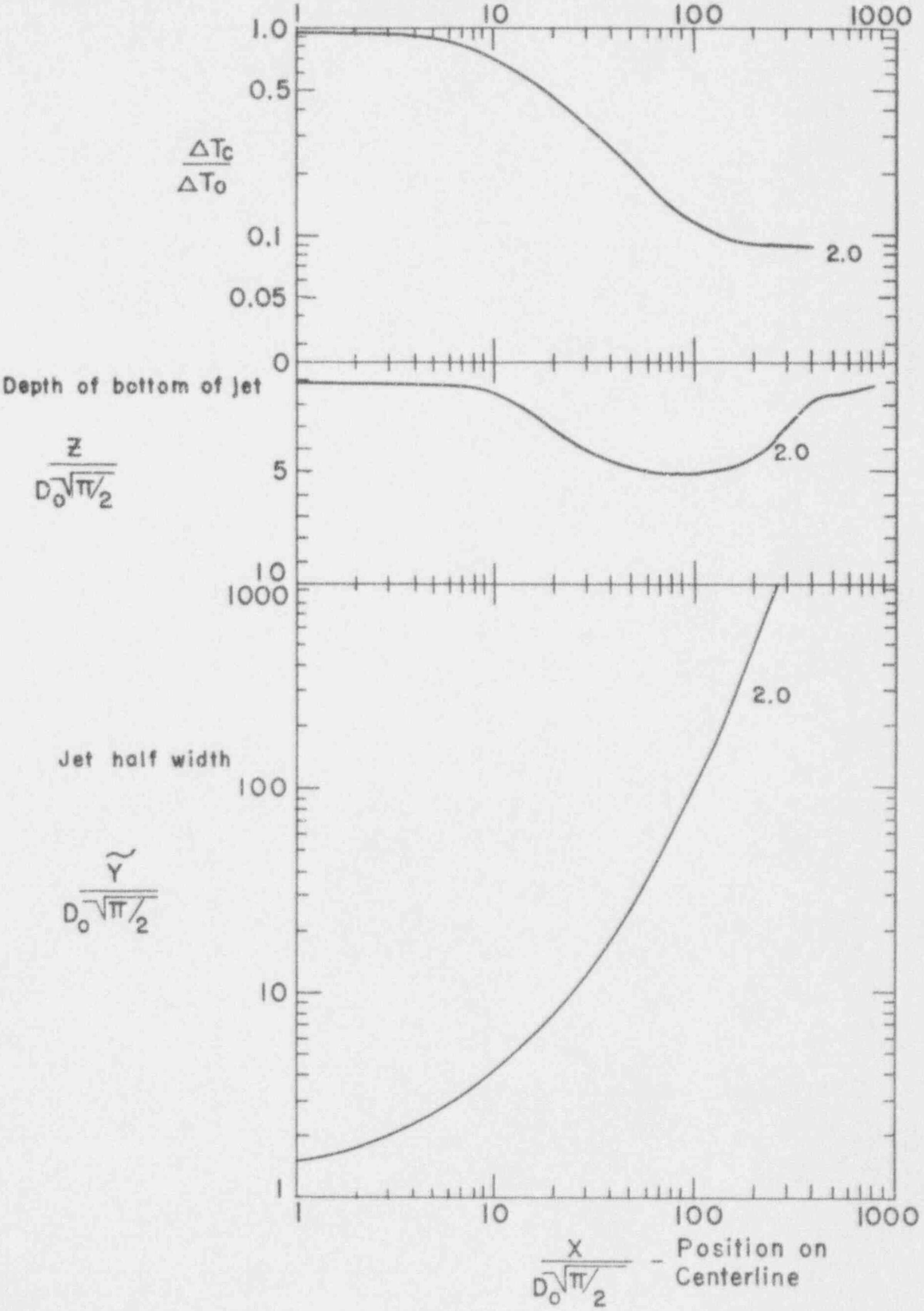


Fig. 5.1-2 Jet Parameters for $\mathbb{F}_o = 10.0$, $V/u_o = 0$, $k/u_o = 0$, $A = 2.0$

Amend. 1- 11/30/73

2. Undiluted Flow: No dilution water supplied from storage pond. Discharge rate - 35,800 gpm.

The major differences between the model used for the above estimates and the actual Farley discharge are:

1. There is a higher ratio (V/uo) for the Farley discharge than is assumed in the model studies, even at the minimum recorded river flow rate of 1200 cfs. 1

2. The discharge at Farley is submerged while the model assumes a surface discharge. The heat transfer across the air-water interface is negligible in the region of the jet and all computed temperature reduction is due to dilution of the plant discharge with entrained river water. Due to the submerged nature of the discharge at Farley, dilution should occur more rapidly than predicted in the model.

Both of the above differences are conservative and the actual centerline distance at a specific temperature differential should be less than that estimated.

The U. S. Geological Survey is in the process of rating the spillway and lock at Columbia Dam, approximately 3 miles upstream from the Farley site, for the purpose of measuring discharges, which constitute most of the streamflow in the Chattahoochee River at the site. This work is being done at the request of Alabama Power Company and information will be telemetered from Columbia Lock and Dam to the control room at Farley. The U.S.G.S. program is described in Section 6.3 of this report.

This information will be utilized to coordinate discharges from Farley with streamflow in the Chattahoochee River. Should the streamflow fall below that required to obtain suitable mixing, the plant operator will take steps to prevent the temperature of the discharge from exceeding 90°F.

As indicated previously, the ratio of river velocity to jet discharge velocity of the Farley discharge is greater than the ratio used for estimating the mixing distance. From Figure 5.1-1, the ratio from the model studies was 0.05. Under minimum recorded flow conditions of 1210 cfs, it is estimated that the velocity of water in the Chattahoochee River would be approximately 0.4 feet per second in the plant discharge area. This estimate is based on a velocity profile measured adjacent to the outfall site by the U. S. Geological Survey on May 31, 1972 for a measured discharge of 1,620 cfs. The average velocity on that day was 0.509 feet per second across the cross section. A proration of this discharge from 1620 to 1210 results in a calculated average of velocity of 0.4 feet per second. The ratio of river velocity to jet discharge velocity for normal two-unit operation under these conditions would be approximately 0.1. Therefore, the mixing conditions estimated by the model would be the same for a river flow of approximately 600 cfs. 2

The normal water elevation of Lake Seminole is 77 feet above msl. At this elevation the centerline of the Farley discharge will be approximately 6 feet under water. At a flow of 1210 cfs, it is estimated that the maximum depth of the river would be approximately 15 feet and that it would have a width of approximately 340 feet. The most probable flow at Farley Nuclear Plant is approximately 8,000 cfs. At this flow the discharge from the plant would be approximately 7.5 feet under the surface with the river having a depth of 16 feet and being approximately 340 feet wide. The average velocity at this flow would be approximately 2.1 feet per second.

Since the Farley discharge is submerged and since the estimates illustrated above indicate that suitable mixing could be obtained down to a river flow of approximately 600 cfs, the use of dilution water to limit the temperature of the discharge will only occur during very extreme conditions. Dilution water would only be required during those periods of high wet bulb temperature, coupled with an extremely low river flow. The gaging work being done by the U.S.G.S. will provide the necessary information to coordinate the use of dilution water at the Farley plant. 2

5.1.2 ENTRAINMENT

Water for the cooling towers' makeup and the service water system (approximately 62,000 gpm) will be drawn from the Chattahoochee River through a 200 foot long entrance canal and pumped approximately one mile into a 108 acre pond. Water from this storage pond, which will contain approximately 1000 acre-feet under normal conditions, will be pumped into the station. Organisms small enough to pass through the 3/8 inch mesh screens of the intake structure are likely to be drawn into the storage pond and then into the station. This passage will expose these organisms to mechanical shock, chemicals, and elevated temperatures. It is assumed that all entrained organisms will be killed. 2

The impact of entrainment depends upon the proportion of the total volume of river water that is diverted through the station. About 11% of the minimum recorded flow (approximately 1210 cfs) in the Chattahoochee will be affected by this process. In the case of the most probable river flow (8000 cfs), only 2.0% of the river flow will be drawn into the station. Under these conditions, a relatively small fraction of the river biota would be affected.

TABLE 5.1-1

DISCHARGE TEMPERATURE CALCULATIONS
(Based on One Unit)

	Avg. Water(1) Temp.	Avg. Hourly Wet Bulb	Blow-Down Temp.(2) (5100 gpm)	Service Water Temp. (12800 gpm)	Discharge Temp. (17900 gpm)	ΔT_o =
Jan.	48.0°F.	48.0°F.	71.7°F.	57.1°F.	61.3°F.	13.3°F.
Feb.	50.6	49.0	72.3	59.7	63.3	12.7
Mar.	52.2	56.0	75.9	61.3	65.5	13.3
Apr.	65.8	60.0	78.1	74.9	75.8	10.0
May	71.2	66.0	81.6	80.3	80.7	9.5
June	78.8	73.0	85.9	87.9	87.3	8.5
July	81.1	74.0	86.5	90.2	89.1	8.0
Aug.	81.0	74.0	86.5	90.1	89.1	8.1
Sept.	76.4	70.0	84.0	85.5	85.1	8.7
Oct.	66.0	61.0	78.7	75.1	76.1	10.1
Nov.	58.4	52.0	73.8	67.5	69.3	10.9
Dec.	51.0	48.0	71.7	60.1	63.4	12.4
Jan.(3)	48.0	69.0	83.4	57.1	64.6	16.6
July(3)	81.1	81.0	91.2	90.2	90.5	9.4

1

---

(1) Geological Survey of Alabama, <u>A Compilation of Surface Water Quality Data in Alabama</u>, Circular 36, University, Alabama, 1966

(2) Manufacturer's Cooling Tower Performance Curves

(3) Maximum Hourly Wet Bulb Temperature

TABLE 5.1-2

MIXING DISTANCES FROM POINT OF DISCHARGE
(At Minimum Recorded Flow of 1200 cfs)

Model Parameters: $IF_o = 9.6$; $V/u_o = .103$; $K/u_o = o$; $A = 2.0$

Month	ΔT_o	Approx. Centerline Distance $\Delta t = 5^oF$.	Plume Width @ Centerline where $\Delta t = 5^oF$
Jan.	13.3° F	132 ft.	126 ft.
Feb.	12.7	113	100
Mar.	13.3	132	126
Apr.	10.0	94	79
May	9.5	88	73
June	8.5	75	65
July	8.0	63	56
Aug.	8.1	63	56
Sept.	8.7	75	65
Oct.	10.1	100	83
Nov.	10.9	107	88
Dec.	12.4	113	100
Jan.*	16.6	178	188
July*	9.4	87	73

1

* Assumes maximum wet bulb temperatures for January and July of 69 and 81°F., respectively. Assumes average ambient river temperatures.

TABLE 5.1-3

MIXING DISTANCES FROM POINT OF DISCHARGE
(At Assumed Zero River Flow)

Model Parameters: $IF_o = 9.6$; $V/u_o = 0$; $K/u_o = 0$; $A = 2.0$

Month	ΔT_o	Approx. Centerline Distance $\Delta t = 5^oF$	Plume Width @ Centerline where $\Delta t = 5^oF$
Jan.	13.3°F	170 ft.	144 ft.
Apr.	10.0	116	88
Jul.	8.0	86	68
Dec.	12.4	152	113
Jan.	16.6 *	218	204
Jul.	9.4*	113	88

1

* Assumes maximum wet bulb temperatures for January and July of 69 and 81°F., respectively. Assumes average ambient river temperatures.

Section 6.2.5 outlines an operational monitoring program to quantify entrainment effects.

The benthic populations of animals in the Chattahoochee River are minimal since the bottom of the river is sandy, and the shifting bottom prevents case building and burrowing of the animals. Further, the scouring action of sand during periods of power generation by upstream dams exerts a destructive effect on the benthos and markedly reduces their density in this area. The physical situation in the river bottom created by operation of the upstream dam is catastrophic to both animal and plant benthos. Nevertheless, there are some benthic species which will be affected by the operation of the Farley plant. Some benthic species have weak-swimming or floating stages in their life cycle. For example, during the pupal stage of its life cycle, the Tendipedidae (midges) can be carried by the current and passed through the station's cooling-water system. All such organisms will be killed there. These organisms do not travel a great distance downstream; therefore, only the organisms developing in the vicinity of the station will be involved in entrainment. Depending upon the dilution of chemical discharges and heated water, a difference in abundance and species composition is likely to occur near the outfall of the water discharge. Typical species that occur in such areas are tubificids (segmented worms) and pollution-tolerant species of chironomids (midges).

Since only 2% of the river flow will be used by the station during normal flow conditions, the benthic species in the water withdrawn will be small in number. The resulting kill by heat and other mechanisms will have a small adverse impact.

It is estimated that approximately 3200 tons/year of small primary producers and consumers will be withdrawn from the river. This estimate is based on a density of 85,000 organisms per cubic foot of river water and a withdrawal rate of 138 cfs. In a closed-cycle system all of these entrained organisms will probably be killed. This represents organisms in only about 2.0% of the most probable river flow. Repopulation of these organisms should occur in downstream Lake Seminole, which supports a much richer biota. The estimate of loss of fish larvae through entrainment is 1.8 tons/year. The species composition of this loss by weight is bass, 3%; sunfish, 17%; catfish, 5%; carpsuckers, 19%; and forage (shad), 56%.

5.1.3 IMPINGEMENT

Excessive loss of fish due to impingement should not occur at Farley because the velocity of flow across the screen will not exceed 1.0 fps when the river is at its normal minimum pool level of 77 feet above msl, and 0.5 fps in the canal leading to the intake structure. Velocities at the screen and in the 200 foot long entrance canal will diminish as water level elevation increases, because of the increase in area across the flow section. 2

Because the discharge is located 1740 feet downstream from the intake, no recirculation of discharged cooling water is expected. Therefore, warm water from the discharge will not attract fish to the intake. If a fish does enter the intake canal, the relatively low velocity will not prevent escape. Section 6.2.5 outlines a monitoring program to quantify the magnitude of impingement effects. 2

The Farley intake structure has been designed to minimize the effects of impingement. The low intake velocities in the canal and across the screens and the location relative to the discharge structure are such that a fish would not be attracted to the intake. Therefore, that are no provisions included in the Farley intake structure to return any fish which might be impinged after it is washed from the traveling screens. 2

5.1.4 COOLING TOWER DRIFT

Approximately 61 acres of land have been allocated for the cooling towers. Nearly all the waste heat from both units will be dissipated to the environment through these towers. A small amount of water is entrained and carried by the saturated air leaving the towers. Since the water contains minerals, such as sodium, calcium, and magnesium, that will be concentrated by a factor of 3.5, there will be some increase in mineral content of the water leaving the towers in the form of drift. These minersls are essentially of the same composition as the natural water from which the station is fed. Consistent with the drift loss as guaranteed by the tower manufacturer and with the analysis of the minerals in the water being used as makeup for the circulating system, approximately 24 tons/year of river-water minerals will be distributed on the land in the vicinity of the tower. Since the particle-size distribution of this material is not known, it is not possible to predict how it actually will be deposited on the land. It will likely be deposited within the site boundary. If an even distribution were assumed, deposition would amount to 0.01 ton/(acre year) over the 1850-acre site. This value may be compared with reported quantities of cations that are leached from trees by rain. Depending upon the type of forest, 1 inch of rain may leach from 0.1 to 9.5 lb/acre of Ca, Mg, K, P, and Na from tree foliage.

Any significant accumulation of chemicals on adjacent land areas due to drift loss would be offset by leaching back into the river and to the soil as well as normal uptake by vegetation. The minerals being recycled to the river are essentially the same, in chemical composition, as in the river itself. Hence little change in the river water quality is expected. The chemicals being leached into the soil are to a great extent the same as found in commercial fertilizer, but in smaller concentrations. On the basis of the quantities of chemicals to be deposited on the soil and in the river and on experience with operations of similar capacity, marked changes are not expected in the river or soil, leading to an adverse environmental effect on the ecosystem.

5.1.5 Fogging Potential and Noise from Cooling Tower Operation

Construction Permit No's. CPPR-85 and CPPR-86, issued to Alabama Power Company on August 16, 1972, contain provisions for assessing natural fogging potential and noise at the Farley site. As part of the benefit-cost analysis for the construction permit stage environmental report, an estimate was made of natural fogging potential using the saturation deficit method.[1] The data utilized for this estimate were dry bulb temperature and relative humidity from the Dothan area during the winter months.

The AEC Final Impact Statement for the construction permit referenced this limited study and recommended that the analysis be extended to other seasons if climatological data were available to predict the total annual probability for increased fogging.[2]

According to reference (1), fogging potential has an extremely low probability as long as the "delta mass" is not less than 0.5 grams per cubic meter. For a "delta mass" less than 0.5 gram per cubic meter but greater than 0.1 gram per cubic meter there is a low probability of fogging potential. For a "delta mass" less than 0.1 grams per cubic meter, there is a high probability of fogging potential. 1

Analyses have been made utilizing the saturation deficit method for each month of the year with the Dothan area data.[3] One analysis utilized average hourly dry bulb temperature and average hourly relative humidity to obtain the saturation deficits for each hour. The results of this analysis indicated that fogging potential would have an extremely low probability for all hours of each month. During the months of January and December, the saturation deficit or "delta mass" fell below 1.0 grams per cubic meter but did not fall to 0.5 grams per cubic meter. A "delta mass" of less than 1.0 grams per cubic meter occurred from the hours 3 a.m. to 8 a.m. for January and December.

An additional analysis has been made utilizing the average hourly minimum temperature and maximum average hourly relative humidity from the Dothan area. This analysis indicated that a "delta mass" of 0.6 grams per cubic meter would occur in January and December. Under the conditions of average minimum temperature, a relative humidity of approximately 93% would produce a saturation deficit of 0.5 grams per cubic meter while a relative humidity of approximately 99% would be required to produce a saturation deficit of 0.1 grams per cubic meter for the months of January and December. During the period June through September, relative humidities of 97% and 100% would be required to produce saturation deficits of 0.5 and 0.1 grams per cubic meter respectively at the average minimum temperature.

The above discussion indicates the necessity for the accurate measurement of high relative humidity conditions in order to adequately assess fogging potential. Data is also needed for input to analytical plume dispersion models. It is for these reasons that thermoelectric dewpoint cells are being installed on the site meteorological tower. These cells will provide comprehensive site data for one year prior to facility operation, as required by Construction Permits No's. CPPR-85 and CPPR-86. As data become available, further studies are being planned in order to assess natural fogging frequencies and to be used in models to predict increases in ground fogging due to cooling tower operation. These studies are in accordance with the Construction Permit requirements as discussed in Section 6.2.4 of this report. 1

A preliminary analysis, based on manufacturers data, has been made to determine noise levels due to cooling tower operation at Highway 95.

This analysis indicates an expected level of 40 dBA. The analysis of noise sources, including cooling towers, turbo-generators and switch yard is found in Section 5.7 of this report.

---

[1] National Thermal RES. PROG., Pacific N.W. Water Lab and Great Lakes REgional Office. U. S. Department of Interior, Federal Water Quality Administration, Feasibility of Alternative Means for Cooling for Thermal Power Plants on Lake Michigan, 1970, pp. VI-9-11.

[2] U. S. Atomic Energy Commission. Final Impact Statement Related to the Construction of Joseph M. Farley Nuclear Plant, Units 1 and 2. June, 1972. pp. V-7.

[3] U. S. Department of Commerce, Weather Bureau, Climatological Summary, Dothan, Alabama, 1902-1954, Montgomery, Alabama, 1955.

5.2 RADIOLOGICAL IMPACT ON BIOTA OTHER THAN MAN

The small amounts of radioactive materials in gaseous and liquid effluents from the Farley plant will result in a slight increase above the annual background radiation dose received by organisms other than man. Naturally-occurring radiation sources will continue to contribute most of the total dose as they have in the past. This section outlines exposure pathways for organisms other than man ans presents dose estimates for several important organism types which have high potential for exposure to radiation from plant effluents.

5.2.1 Exposure Pathways

Figure 5.2-1 is a simplified illustration of exposure pathways in the aquatic environment. Figure 5.2-2 is the corresponding illustration of exposure pathways in the terrestrial environment. The irrigation pathway is shown as a broken line because essentially no irrigation takes place downstream from the site. The figures show organism groups of major importance. Organisms having higher than normal potential for radiation exposure from plant effluents include aquatic organisms such as fish, plants, and invertebrates which inhabit waters near the liquid effluent discharge point, and terrestrial organisms, such as the raccoon or muskrat, which may feed on the aquatic organisms.

Figures 5.2-1 and 5.2-2 illustrate in a general way, the complex relationships affecting distribution of radionuclides in the environment.

5.2.2 Radioactivity in the Environment

This section describes the distribution of effluent radioactive materials in the aquatic and terrestrial environment.

5.2.2.1 Concentration of Isotopes in Receiving Water

Liquid effluents are discharged into the Chattahoochee River. Annual average discharge rates for each isotope are listed in Table 5.2-1. In estimating concentrations in receiving water, instantaneous and complete dilution of liquid effluent by river water is assumed. For estimating concentration in river water near the plant, the average annual flow rate of the Chattachoochee River, 11,500 cfs, is used. For estimating concentrations in the Apalochicola Bay and in the Apalachicola River below Lake Seminole, the flow rate of the Apalachicola River below Lake Seminole, 21,900 cfs, is used. Estimates of receiving water concentrations are given in Table 5.2-1.

5.2.2.2 Concentration of Isotopes in Air

Ground level air concentrations of isotopes in gaseous effluent are calculated from the discharge rate Q(Ci/year), and the annual average dispersion coefficient values are tabulated by distance and direction from the plant in Section 7.1. Appendix 2 describes the calculation of ground-level air concentration. Noble gas discharge rates are listed in Table 5.2-2. Iodine isotope discharge rates and maximum off-site ground level air concentrations are shown in Table 5.2-3.

5.2.2.3 Deposition on Vegetation and Soil

Radioactive noble gases will not deposit to any appreciable extent on soil or vegetation because they are chemically inert and relatively insoluble in water. Since water receiving liquid effluents is not used for irrigation, there will be no deposition from irrigation. Thus, the only important effluents from the standpoint of deposition on soil and vegetation will be iodine isotopes in atmospheric effluents. The methods and assumptions used in the calculation of deposition on vegetation and soil are described in Appendix 2. Results of these calculations are presented in Table 5.2-3. The vegetation calculations assume a deposition velocity of 0.01 meter/second, an initial retention of 100%, a "field loss" half-time of 14 days, and radiological decay. The soil resutls assume a deposition velocity of 0.01 meter per second, an initial retention of 100%, and loss by radioactive decay only.

5.2.2.4 Cumulative Buildup

Although certain radioactive noble gases have fairly long half-lines, rapid dispersion in the atmosphere will prevent the accumulation of significant quantities or concentrations of these isotopes over the life of the plant. Iodine isotopes have short half-lives which will limit cumulative buildup of these isotopes in the environment. Calculations in the previous section estimate upper limit accumulation of iodine on soil. There will be no appreciable cumulative buildup from radioactive materials discharged to the atmosphere.

A stable element study described in Section 5.3.1 will help determine the potential for accumulation of effluent isotopes by local sediments and other environmental media.

5.2.3 Dose Rate Estimates

Isotope concentrations in river water near the plant and fresh water bioaccumulation factors from Table 5.2-4 are used to estimate the concentration in fresh water fish, invertebrates, and plants. Isotope concentrations in estuary water and salt water bioaccumulation factors in Table 5.2-5 are used to calculate concentrations in estuarine fish, invertebrates and plants. Isotope concentrations in aquatic organisms are given in Table 5.2-6. Annual internal doses are calculated from concentration of isotopes in an organism. The method is described in Appendix 2. External doses are derived from human swimming dose calculations in Section 5.3. Results of aquatic organism internal and external dose estimates are given in Table 5.2-7.

Terrestrial organisms which feed upon aquatic organisms are likely to receive a higher dose from plant effluents than animals which do not consume aquatic organisms. A generalized model, described in Appendix 2, is used to calculate the isotope concentration and resulting dose to a small mammal such as a raccoon or muskrat. The model assumes the animal weighs 1,000 grams and consumes 100 grams/day of aquatic organisms. Isotope concentrations in the terrestrial organism are given in Table 5.2-8. An estimate of external dose to the terrestrial organism assumes that the dose from the plume and soil is the same as the total body received by a man at the site boundary. Terrestrial organism dose results are given in Table 5.2-7.

Other portions of this report show that the operation of the Farley Plant poses no possible threat to the health of the people living in the vicinity. The radiation doses to the public anticipated from the plant are well below the limits recommended by the International Commission on Radiological Protection and the National Council on Radiation Protection. There is no question that the operation of this plant will be safe for humans.

It follows that the operation can have no possible effects on wild species living in the vicinity. This contention is supported by several observations. With a single exception, no effects of any kind have been observed at radiation levels up to, and considerably larger than, the public limits recommended by ICRP and NCRP. The single exception is the report of Polikarpov that drinking water concentration of strontium-90 produced injury to fish eggs. Several attempts have been made to repeat Polikarpov's experiment, but none has shown the effects which he reported. Perhaps the most recent such attempt is that of Trabalka (doctoral thesis, University of Michigan), who found no differences between any of a number of species, including spawning fish, in a pair of matched tanks, one of which was maintained at a concentration of cerium-144 well above the drinking water limit.

During the past 20 years much of the world's surface has experienced levels of radioactivity from fallout which at times were considerably larger than the levels that may be produced by the Farley Plant. In spite of widespread and intensive study, no ecological effects have been recorded.

Finally, it can be stated that the radiological monitoring program will detect the presence of radioactive materials from the Farley Plant in the environment at levels many orders of magnitude lower than those which can possibly produce effects on species in the area. This monitoring program will detect and give notice on unexpected concentrations so that if corrective action is necessary, it can be taken long before any ecological effect is produced.

TABLE 5.2-1

FARLEY NUCLEAR PLANT LIQUID EFFLUENT

ANNUAL AVERAGE DISCHARGE RATES AND RECEIVING WATER CONCENTRATIONS

(TWO UNITS)

Isotope	Discharge Rate (uCi/yr)	Concentration In Chattahoochee River (µCi/cm^3)	Concentration In Apalachicola Bay And River Below Lake Seminole (µCi/cm^3)
H-3	5.20E+08	4.92E-08	2.66E-08
CR-51	2.20E+02	2.08E-14	1.13E-14
MN-54	1.90E+02	1.80E-14	9.73E-15
MN-56	6.00E+02	5.68E-14	3.07E-14
FE-59	2.40E+02	2.27E-14	1.23E-14
CO-58	1.10E+04	1.04E-12	5.63E-13
CO-60	1.70E+03	1.61E-13	8.71E-14
BR-84	2.20E+04	2.08E-12	1.13E-12
RB-88	2.00E+04	1.89E-12	1.02E-12
RB-89	2.40E+02	2.26E-14	1.22E-14
SR-89	9.40E+02	8.90E-14	4.81E-14
SR-90	3.20E+01	3.03E-15	1.64E-15
SR-91	1.30E+02	1.23E-14	6.66E-15
SR-92	8.60E+00	8.14E-16	4.41E-16
Y-90	3.80E+01	3.60E-15	1.95E-15
Y-91	1.40E+03	1.33E-13	7.17E-14
Y-92	3.40E+01	3.22E-15	1.74E-15
ZR-95	1.80E+03	1.70E-13	9.22E-14
NB-95	4.40E+03	4.17E-13	2.25E-13
MO-99	9.40E+05	8.90E-11	4.81E-11
TE-132	5.20E+04	4.92E-12	2.66E-12
TE-134	1.80E+02	1.70E-14	9.22E-15
I-131	5.20E+05	4.92E-11	2.66E-11
I-132	6.40E+04	6.06E-12	3.28E-12
I-133	4.20E+05	3.98E-11	2.15E-11
I-134	4.80E+03	4.54E-13	2.46E-13
I-135	1.10E+05	1.04E-11	5.63E-12
CS-134	9.20E+04	8.71E-12	4.71E-12
CS-136	3.20E+04	3.03E-12	1.64E-12
CS-137	4.20E+05	3.98E-11	2.15E-11
CS-138	2.40E+03	2.27E-13	1.23E-13
BA-140	9.00E+02	8.52E-14	4.61E-14
LA-140	5.60E+02	5.30E-14	2.87E-14
CE-144	3.20E+03	3.03E-13	1.64E-13
PR-144	2.68E+03	2.54E-13	1.38E-13

TABLE 5.2-2

FARLEY NUCLEAR PLANT

NOBLE GAS EFFLUENT DISCHARGE RATES

(Ci/yr)

Isotope	Discharge Rate (two units)
Kr-83m	-
Kr-85m	1.21E+2
Kr-85m	3.50E+2
Kr-87	7.48E+1
Kr-88	2.26E+2
Kr-89	-
Xe-131m	-
Xe-133m	1.05E+2
Xe-133	6.62E+3
Xe-135m	1.16E+1
Xe-135	3.68E+2
Xe-137	-
Xe-138	3.92E+1

TABLE 5.2-3

FARLEY NUCLEAR PLANT

GASEOUS EFFLUENTS OTHER THAN NOBLE GASES

(TWO UNITS)

Isotope	Annual Discharge Rate (Ci/Yr)	Maximum Off-Site Ground Level Air Concentration (μCi/cm^3)	Maximum Off-Site Accumulation On Vegetation (μCi/m^2)	Maximum Off-Site Accumulation On Soil (μCi/m^2)
I-131	9.62×10^{-2}	1.71×10^{-14}	1.08×10^{-4}	1.74×10^{-4}
I-132	1.23×10^{-2}	2.18×10^{-15}	2.53×10^{-7}	2.55×10^{-7}
I-133	8.08×10^{-2}	1.43×10^{-14}	1.42×10^{-5}	1.51×10^{-5}
I-134	1.26×10^{-3}	2.24×10^{-16}	9.77×10^{-9}	9.80×10^{-9}
I-135	2.00×10^{-2}	3.54×10^{-15}	1.21×10^{-6}	1.23×10^{-6}

TABLE 5.2-4

CONCENTRATION FACTORS FOR ORGANISMS IN CHATTAHOOCHEE RIVER, LAKE SEMINOLE, AND APALACHICOLA RIVER

(μCi/gm per μCi/cm^3)

Isotope	Fish	Crustacea	Molluscs	Algae and Plants
H-3	1	1	1	1
CR-51	1	10	10	20
MN-54	1000	40000	40000	10000
MN-56	1000	40000	40000	10000
FE-59	5000	10000	10000	5000
CO-58	50	200	200	1000
CO-60	50	200	200	1000
BR-84	130	100	100	750
RB-88	2000	2000	2000	1000
RB-89	2000	2000	2000	1000
SR-89	1	20	20	500
SR-90	1	20	20	500
SR-91	1	20	20	500
SR-92	1	20	20	500
Y-90	100	1000	1000	10000
Y-91	100	1000	1000	10000
Y-92	100	1000	1000	10000
ZR-95	10	100	100	1000
NB-95	30000	100	100	1000
MO-99	100	100	100	100
TE-132	400	75	75	100
TE-134	400	75	75	100
I-131	1	25	25	100
I-132	1	25	25	100
I-133	1	25	25	100
I-134	1	25	25	100
I-135	1	25	25	100
CS-134	1000	1000	1000	200
CS-136	1000	1000	1000	200
CS-137	1000	1000	1000	200
CS-138	1000	1000	1000	200
BA-140	10	200	200	500
LA-140	50	500	500	10000
CE-144	50	500	500	10000
PR-144	50	500	500	10000

TABLE 5.2-5

CONCENTRATION FACTORS FOR ORGANISMS IN APALACHICOLA BAY

(μCi/gm per μCi/cm^3)

Isotope	Fish	Crustacea	Molluscs	Algae and Plants
H-3	1	1	1	1
CR-51	100	1000	1000	1000
MN-54	3000	10000	50000	10000
MN-56	3000	10000	50000	10000
FE-59	1000	4000	20000	6000
CO-58	100	10000	300	100
CO-60	100	10000	300	100
BR-84	3	10	10	100
RB-88	30	50	10	10
RB-89	30	50	10	10
SR-89	1	1	1	20
SR-90	1	1	1	20
SR-91	1	1	1	20
SR-92	1	1	1	20
Y-90	30	100	100	300
Y-91	30	100	100	300
Y-92	30	100	100	300
ZR-95	30	100	100	1000
NB-95	100	200	200	100
MO-99	10	100	100	100
TE-132	10	10	100	1000
TE-134	10	10	100	1000
I-131	20	100	100	10000
I-132	20	100	100	10000
I-133	20	100	100	10000
I-134	20	100	100	10000
I-135	20	100	100	10000
CS-134	30	50	10	10
CS-136	30	50	10	10
CS-137	30	50	10	10
CS-138	30	50	10	10
BA-140	3	3	3	100
LA-140	30	100	100	300
CE-144	30	100	100	300
PR-144	100	1000	1000	1000

TABLE 5.2-6

FARLEY NUCLEAR PLANT

CONCENTRATION OF ISOTOPES IN AQUATIC ORGANISMS

	Chattahoochee River				Apalachicola Bay			
Isotope	Fish	Crustacea	Molluscs	Plants	Fish	Crustacea	Molluscs	Plants
H-3	4.92E-08	4.92E-08	4.92E-08	4.92E-08	2.66E-08	2.66E-08	2.66E-08	2.66E-08
CR-51	2.08E-14	2.08E-13	2.08E-13	4.17E-13	1.13E-12	1.13E-11	1.13E-11	1.13E-11
MN-54	1.80E-11	7.19E-10	7.19E-10	1.80E-10	2.92E-11	9.73E-11	4.87E-10	9.73E-11
MN-56	5.68E-11	2.27E-09	2.27E-09	5.68E-10	9.22E-11	3.07E-10	1.54E-09	3.07E-10
FE-59	1.14E-10	2.27E-10	2.27E-10	1.14E-10	1.23E-11	4.92E-11	2.46E-10	7.38E-11
CO-58	5.21E-11	2.08E-10	2.08E-10	1.04E-09	5.63E-11	5.63E-09	1.69E-10	5.63E-11
CO-60	8.05E-12	3.22E-11	3.22E-11	1.61E-10	8.71E-12	8.71E-10	2.61E-11	8.71E-12
BR-84	2.71E-10	2.08E-10	2.08E-10	1.56E-09	3.38E-12	1.13E-11	1.13E-11	1.13E-10
RB-88	3.79E-09	3.79E-09	3.79E-09	1.89E-09	3.07E-11	5.12E-11	1.02E-11	1.02E-11
RB-89	4.51E-11	4.51E-11	4.51E-11	2.25E-11	3.65E-13	6.09E-13	1.21E-13	1.21E-13
SR-89	8.90E-14	1.78E-12	1.78E-12	4.45E-11	4.81E-14	4.81E-14	4.81E-14	9.63E-13
SR-90	3.03E-15	6.06E-14	6.06E-14	1.51E-12	1.64E-15	1.64E-15	1.64E-15	3.28E-14
SR-91	1.23E-14	2.46E-13	2.46E-13	6.15E-12	6.66E-15	6.66E-15	6.66E-15	1.33E-13
SR-92	8.14E-16	1.63E-14	1.63E-14	4.07E-13	4.41E-16	4.41E-16	4.41E-16	8.81E-15
Y-90	3.60E-13	3.60E-12	3.60E-12	3.60E-11	5.84E-14	1.95E-13	1.95E-13	5.84E-13
Y-91	1.33E-11	1.33E-10	1.33E-10	1.33E-09	2.15E-12	7.17E-12	7.17E-12	2.15E-11
Y-92	3.22E-13	3.22E-12	3.22E-12	3.22E-11	5.22E-14	1.74E-13	1.74E-13	5.22E-13
ZR-95	1.70E-12	1.70E-11	1.70E-11	1.70E-10	2.77E-12	9.22E-12	9.22E-12	9.22E-11
NB-95	1.25E-08	4.17E-11	4.17E-11	4.17E-10	2.25E-11	4.51E-11	4.51E-11	2.25E-11
MO-99	8.90E-09	8.90E-09	8.90E-09	8.90E-09	4.81E-10	4.81E-09	4.81E-09	4.81E-09
TE-132	1.97E-09	3.69E-10	3.69E-10	4.92E-10	2.66E-11	2.66E-11	2.66E-10	2.66E-09
TE-134	6.79E-12	1.27E-12	1.27E-12	1.70E-12	9.18E-14	9.18E-14	9.18E-13	9.18E-12
I-131	4.92E-11	1.23E-09	1.23E-09	4.92E-09	5.33E-10	2.66E-09	2.66E-09	2.66E-07
I-132	6.06E-12	1.51E-10	1.51E-10	6.06E-10	6.56E-11	3.28E-10	3.28E-10	3.28E-08
I-133	3.98E-11	9.94E-10	9.94E-10	3.98E-09	4.30E-10	2.15E-09	2.15E-09	2.15E-07
I-134	4.54E-13	1.14E-11	1.14E-11	4.54E-11	4.92E-12	2.46E-11	2.46E-11	2.46E-09
I-135	1.04E-11	2.60E-10	2.60E-10	1.04E-09	1.13E-10	5.63E-10	5.63E-10	5.63E-08
CS-134	8.71E-09	8.71E-09	8.71E-09	1.74E-09	1.41E-10	2.36E-10	4.71E-11	4.71E-11
CS-136	3.03E-09	3.03E-09	3.03E-09	6.06E-10	4.92E-11	8.20E-11	1.64E-11	1.64E-11
CS-137	3.98E-08	3.98E-08	3.98E-08	7.95E-09	6.45E-10	1.08E-09	2.15E-10	2.15E-10
CS-138	2.27E-10	2.27E-10	2.27E-10	4.54E-11	3.69E-12	6.15E-12	1.23E-12	1.23E-12
BA-140	8.52E-13	1.70E-11	1.70E-11	4.26E-11	1.38E-13	1.38E-13	1.38E-13	4.61E-12
LA-140	2.65E-12	2.65E-11	2.65E-11	5.30E-10	8.61E-13	2.87E-12	2.87E-12	8.61E-12
CE-144	1.51E-11	1.51E-10	1.51E-10	3.03E-09	4.92E-12	1.64E-11	1.64E-11	4.92E-11
PR-144	1.27E-11	1.27E-11	1.27E-11	2.54E-09	1.38E-11	1.38E-10	1.38E-10	1.38E-10

TABLE 5.2-7

FARLEY NUCLEAR PLANT

ANNUAL DOSES TO ORGANISMS

(rads/yr)

Organism	Internal Dose	External Dose	Total
Fish near Farley Site	9.2×10^{-4}	2.7×10^{-6}	9.2×10^{-4}
Molluscs near Farley Site	9.1×10^{-4}	2.7×10^{-6}	9.1×10^{-4}
Crustacea near Farley Site	9.1×10^{-4}	2.7×10^{-6}	9.1×10^{-4}
Aquatic Plants near Farley Site	6.9×10^{-4}	2.7×10^{-6}	6.9×10^{-4}
Fish in Apalachicola Bay	3.2×10^{-5}	1.5×10^{-6}	3.3×10^{-5}
Molluscs in Apalachicola Bay	1.7×10^{-4}	1.5×10^{-6}	1.7×10^{-4}
Crustacea in Apalachicola Bay	1.6×10^{-4}	1.5×10^{-6}	1.6×10^{-4}
Plants in Apalachicola Bay	5.7×10^{-3}	1.5×10^{-6}	5.7×10^{-3}
Terrestrial Animal near Farley Site	5.9×10^{-3}	1.7×10^{-3}	7.6×10^{-3}

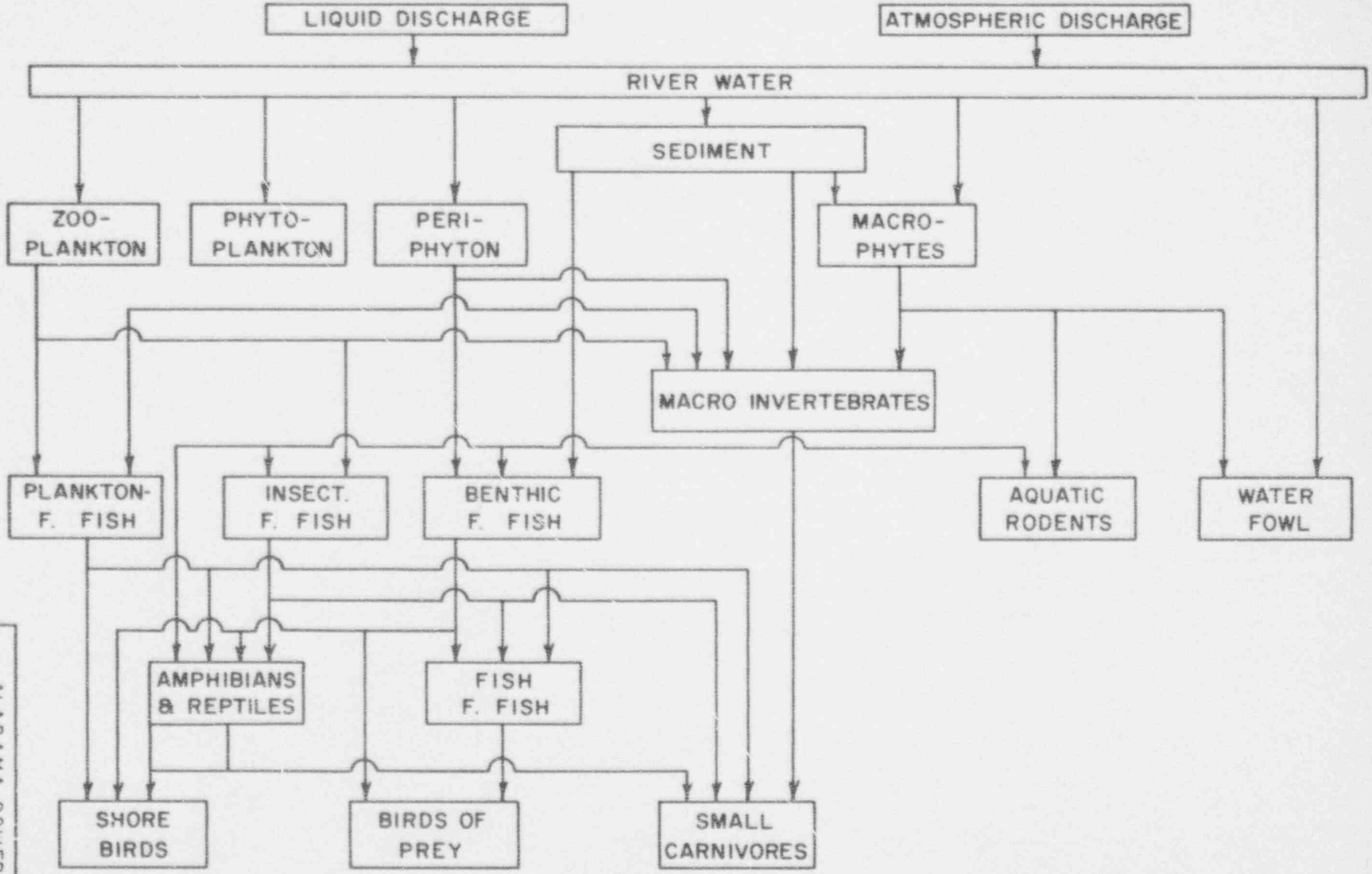
TABLE 5.2-8

FARLEY NUCLEAR PLANT

CONCENTRATION OF ISOTOPES IN TERRESTRIAL ORGANISM NEAR FARLEY SITE

(μCi/gm wet weight)

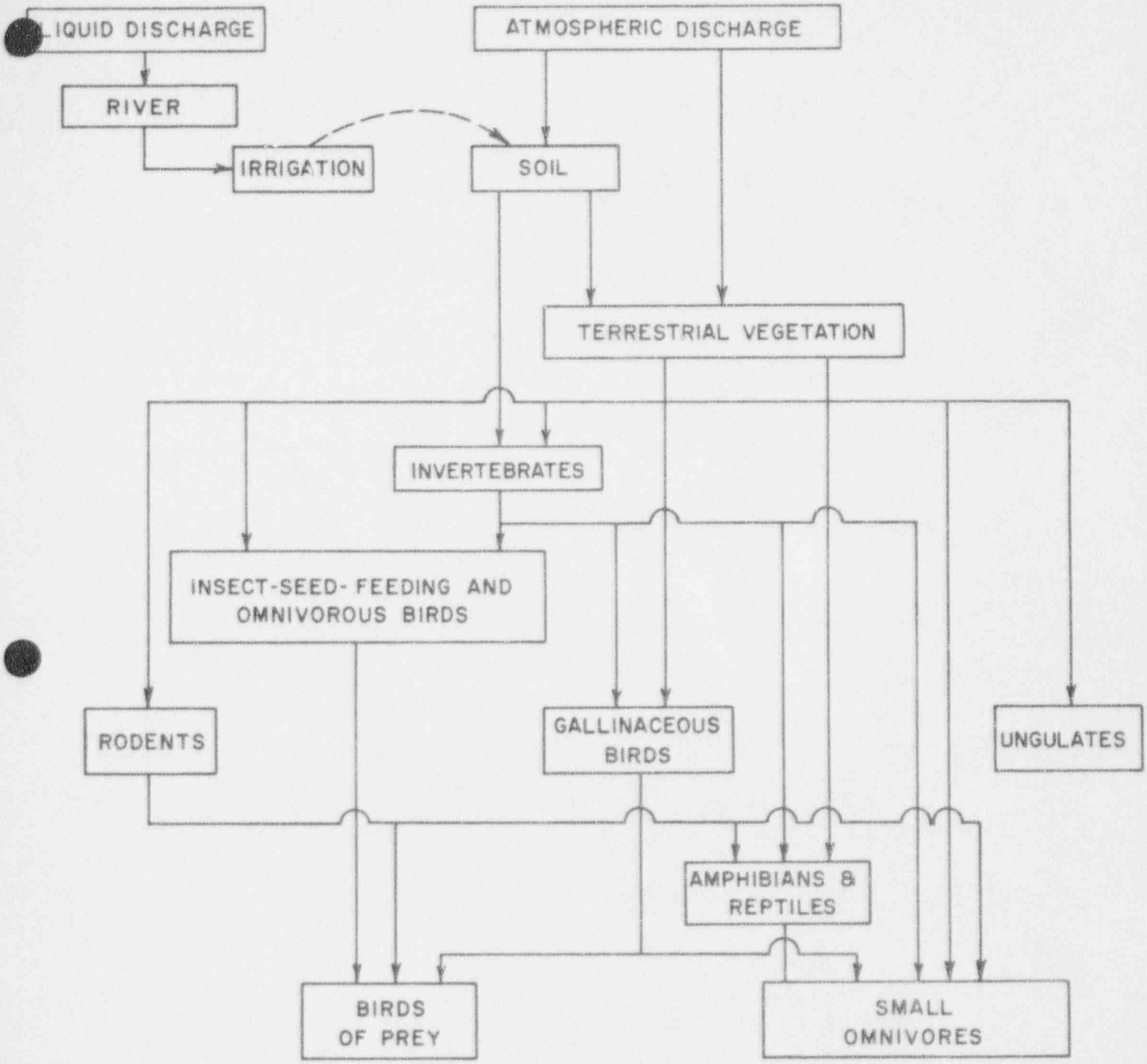
Isotope	Concentration
H-3	3.11E-05
CR-51	1.67E-14
MN-54	3.93E-09
MN-56	4.19E-12
FE-59	3.59E-10
CO-58	5.48E-09
CO-60	2.25E-08
BR-84	4.94E-12
RB-88	2.89E-12
RB-89	3.47E-14
SR-89	1.64E-10
SR-90	1.12E-09
SR-91	1.78E-13
SR-92	3.32E-15
Y-90	1.38E-13
Y-91	1.12E-10
Y-92	6.61E-15
ZR-95	1.62E-11
NB-95	2.11E-11
MO-99	3.56E-09
TE-132	1.11E-10
TE-134	3.80E-13
I-131	5.70E-09
I-132	8.30E-12
I-133	4.82E-10
I-134	2.37E-13
I-135	4.17E-11
CS-134	3.01E-10
CS-136	1.21E-09
CS-137	2.07E-08
CS-138	1.46E-13
BA-140	3.93E-11
LA-140	1.28E-12
CE-144	6.22E-08
PR-144	2.22E-12



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

PRINCIPAL FOOD PATHWAYS IN THE AQUATIC ENVIRONMENT

FIGURE 5.2-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

PRINCIPAL FOOD PATHWAYS IN THE TERRESTRIAL ENVIRONMENT

FIGURE 5.2-2

5.3 RADIOLOGICAL IMPACT ON MAN

The small quantities of radioactive materials in gaseous and liquid effluents from the Farley plant will add a small increment to the annual background radiation dose received by man. Naturally-occurring radiation sources will continue to contribute the largest part of the total dose to man. This section outlines exposure pathways for man and presents dose estimates for the regional population and for individuals having the maximum exposure potential.

5.3.1 Exposure Pathways

Radioactive releases in the liquid and gaseous effluent from the facility result in a small external and internal exposure to man in the vicinity of the Farley plant. Figure 5.3-1 depicts the routes by which man is exposed both externally and internally to radioactivity in the aquatic environment at the Farley site. Swimming, boating and fishing are in general responsible for external exposure to radioactivity in the water and sediment. The ingestion of fish, molluscs and crustacea are responsible for internal exposure.

Figure 5.3-2 depicts routes by which man is exposed, both externally and internally, to radioactivity in the terrestrial environment in the vicinity of the Farley site. External exposure arises from radioactivity in the air and on the ground, and internal exposure arises predominantly from inhalation and the ingestion of contaminated milk and vegetables.

5.3.1.1 Other Exposure Pathways

It is unlikely that pathways not discussed in this report will result in radiation doses significant relative to those estimated herein. However, a stable analysis program is being conducted to identify any site-specific anomalies in the environmental distribution of effluent isotopes.

5.3.2 Liquid Effluents

The expected annual average concentrations of radionuclides in the Farley receiving waters and down stream in the estuary are obtained from Table 5.2-1. The pathways by which man will be exposed to this activity have been described in Section 5.3.1.

Receiving waters below the Farley site are not used as a source of irrigation or drinking water. Accordingly, the only source of internal radiation from aquatic radioactive releases is the ingestion of fish and invertebrates. Table 5.3-1 presents the annual commercial fish catch from Farley receiving waters. Invertebrates are of little economic importance near the Farley site, but are important in the Apalachicola Bay. Table 5.3-1 shows the annual catch of crustacea and molluscs harvested from the Apalachicola Bay.

The main sources of external radiation exposure from liquid effluents are swimming, boating, and shoreline activities such as fishing and picnicking. The expected radionuclide concentrations in aquatic organisms which inhabit waters near the plant are presented in Table 5.2-6. These concentraitons were calculated using concentration in the Chattahoochee River and fresh water bioaccumulation factors. Concentrations in estuarine organisms are also shown in Table 5.2-6. The Apalochicola Bay concentrations are used with salt watet bioaccumulation factors from Table 5.2-5 to calculate concentrations in estuarine organisms.

Table 5.3-2 gives assumed consumption rates and occupation times used to compute the maximum probable organ doses received by an individual. Table 5.3-3 is a table which summarizes results of these dose calculations for liquid effluent pathways. Methods used for dose calculations are described in Appendix 2.

5.3.3 Gaseous Effluents

Table 5.3-4 is a summary of maximum probable organ doses received by an adult and an infant through gaseous effluent pathways. These dose estimates are based upon effluent discharge rates from Tables 5.2-2 and 5.2-3, and consumption rates and occupation times from Table 5.3-2. The thyroid is the only organ for which dose to an infant is calculated. Doses to other infant organs are assumed to be the same as doses to adult organs. External plume dose is calculated for an individual at the site boundary where the X/Q for noble gases is 5.6×10^{-6} sec/m^3. Doses due to ingestion of milk are calculated for the nearest farm west southwest of the site where the X/Q is 5.5×10^{-8} sec/m^3. Doses for all other pathways are determined for the site boundary. Methods for calculating doses are described in Appendix 2. It should be noted that doses expected to be received by people near the Farley site do not exceed existing or proposed federal standards.

5.3.5 Summary of Annual Radiation Doses

Tables 5.3-5 and 5.3-6 summarize the total body radiation dose to the regional population from all plant-related sources. Dose estimates use a projected 1995 regoinal population of 393,000. Average consumption rates for aquatic organisms are estimated by assuming the locally consumed fraction of the edible portion of the catch is evenly distributed among the regional population. In these calculations, the edible fraction is taken as one-third for fish and one for other organisms. The fraction consumed by the regional population is assumed to be one-half for fish, one-quarter for crustacea, and one-tenth for molluscs. Tables 5.3-5 and 5.3-6 also list assumed numbers of persons, occupation times, and other data used to estimate population total body doses.

TABLE 5.3-1

Estimated Annual Quantity of Fish and Shellfish Taken From the River System and Apalachicola Bay

Category	Quantity
Fish	
Chattahoochee River and Lake Seminole (including the Flint River portion of the lake)	1,025,000 lbs.
Apalachicola River (north of the bay)	900,400 lbs.
Apalachicola Bay	264,000 lbs.
Oysters	
Apalachicola Bay	2,000,000 lbs. (meat)
Shrimp	
Apalachicola Bay	265,000 lbs.

TABLE 5.3-2

FARLEY NUCLEAR PLANT

CONSUMPTION RATES AND OCCUPATION TIMES USED TO ESTIMATE MAXIMUM PROBABLE DOSES TO INDIVIDUALS

Pathway	Adult	Infant
External Dose from Plume	8,760 hr/yr	8,760 hr/yr
External Dose from Soil Deposition	8,760 hr/yr	8,760 hr/yr
Inhalation	20 m^3/day	3 m^3/day
Ingestion of Milk	1,000 cm^3/day	1,000 cm^3/day
Ingestion of Vegetation (3 mo./yr)	100 gm/day	50 gm/day
External Dose from Swimming	88 hr/yr	0 hr/yr
External Dose from Boating	500 hr/yr	0 hr/yr
Ingestion of Fish	200 gm/day	50 gm/day
Ingestion of Molluscs	10 gm/day	5 gm/day
Ingestion of Crustacea	10 gm/day	5 gm/day
External Dose from River Bank Fishing and Picnicking	500 hr/yr	500 hr/yr

TABLE 5.3-3

FARLEY NUCLEAR PLANT (2 UNITS)

ANNUAL DOSE TO MOST EXPOSED INDIVIDUAL

LIQUID EFFLUENTS

(rem/yr)

Pathway	Total Body	Skin	Adult Thyroid	Infant Thyroid	Bone	GI Tract
Ingestion of fish caught near Plant	2.0×10^{-4}	2.0×10^{-4}	5.2×10^{-4}	5.4×10^{-4}	6.9×10^{-4}	4.3×10^{-4}
Ingestion of fish caught in Bay	3.2×10^{-6}	3.2×10^{-6}	9.8×10^{-5}	2.3×10^{-4}	1.4×10^{-5}	1.1×10^{-5}
Ingestion of molluscs from Bay	1.3×10^{-7}	1.3×10^{-7}	2.3×10^{-5}	5.7×10^{-5}	2.3×10^{-6}	2.0×10^{-6}
Ingestion of crustacea from Bay	3.5×10^{-7}	3.5×10^{-7}	2.4×10^{-5}	5.8×10^{-5}	3.7×10^{-6}	2.7×10^{-6}
External dose from swimming near Plant	2.7×10^{-8}	6.5×10^{-8}	2.7×10^{-8}	0	2.7×10^{-8}	2.7×10^{-8}
External dose from boating near Plant	7.7×10^{-8}	7.7×10^{-8}	7.7×10^{-8}	0	7.7×10^{-8}	7.7×10^{-8}
Fishing and picnicking on River Bank	1.2×10^{-4}	1.2×10^{-4}	1.2×10^{-4}	1.2×10^{-4}	1.2×10^{-4}	1.2×10^{-4}

TABLE 5.3-4

FARLEY NUCLEAR PLANT (2 UNITS)

ANNUAL DOSE TO MOST EXPOSED INDIVIDUAL

GASEOUS EFFLUENTS

(rem/yr)

Pathway	Total Body	Skin	Adult Thyroid	Infant Thyroid	Bone	GI Tract
External Dose from Plume*	1.7×10^{-3}	3.3×10^{-3}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-3}
Inhalation*	3.6×10^{-7}	3.6×10^{-7}	2.3×10^{-4}	2.0×10^{-4}	4.9×10^{-7}	6.4×10^{-6}
External dose from Soil deposition*	4.5×10^{-6}	4.5×10^{-6}	4.5×10^{-6}	4.5×10^{-6}	4.5×10^{-6}	4.5×10^{-6}
Milk ingestion**	1.1×10^{-7}	1.1×10^{-7}	6.9×10^{-6}	6.9×10^{-5}	1.4×10^{-7}	1.3×10^{-6}
Vegetation ingestion*	9.6×10^{-7}	9.6×10^{-7}	6.1×10^{-4}	3.0×10^{-3}	1.3×10^{-6}	1.1×10^{-5}

* Site boundary: $X/Q = 5.6 \times 10^{-6}$ sec/m^3

** Milk farm: $X/Q = 5.5 \times 10^{-8}$ sec/m^3 assumed. See 5.3.3 for explanation.

TABLE 5.3-5

FARLEY NUCLEAR PLANT (2 UNITS)

POPULATION TOTAL BODY DOSES

LIQUID EFFLUENTS

Pathway	People Exposed	Average Consumption Rate	Average Occupation Time (hr/yr)	Population Total Body Dose (man-rem/yr)
Ingestion of fish from Chattahoochee River and Lake Seminole	3.93×10^5	0.54 gm/day	-	2.1×10^{-1}
Ingestion of fish from Apalachicola River	3.93×10^5	0.47 gm/day	-	1.0×10^{-1}
Ingestion of fish from Apalachicola Bay	3.93×10^5	0.14 gm/day	-	8.8×10^{-4}
Ingestion of molluscs from Bay	3.93×10^5	0.63 gm/day	-	3.2×10^{-3}
Ingestion of crustacea from Bay	3.93×10^5	0.21 gm/day	-	2.9×10^{-3}
External dose from swimming near Plant	1.0×10^3	-	88	2.7×10^{-5}
External dose from boating near Plant	1.0×10^3	-	500	7.7×10^{-5}
Swimming and picnicking on River Bank	1.0×10^3	-	500	1.2×10^{-1}

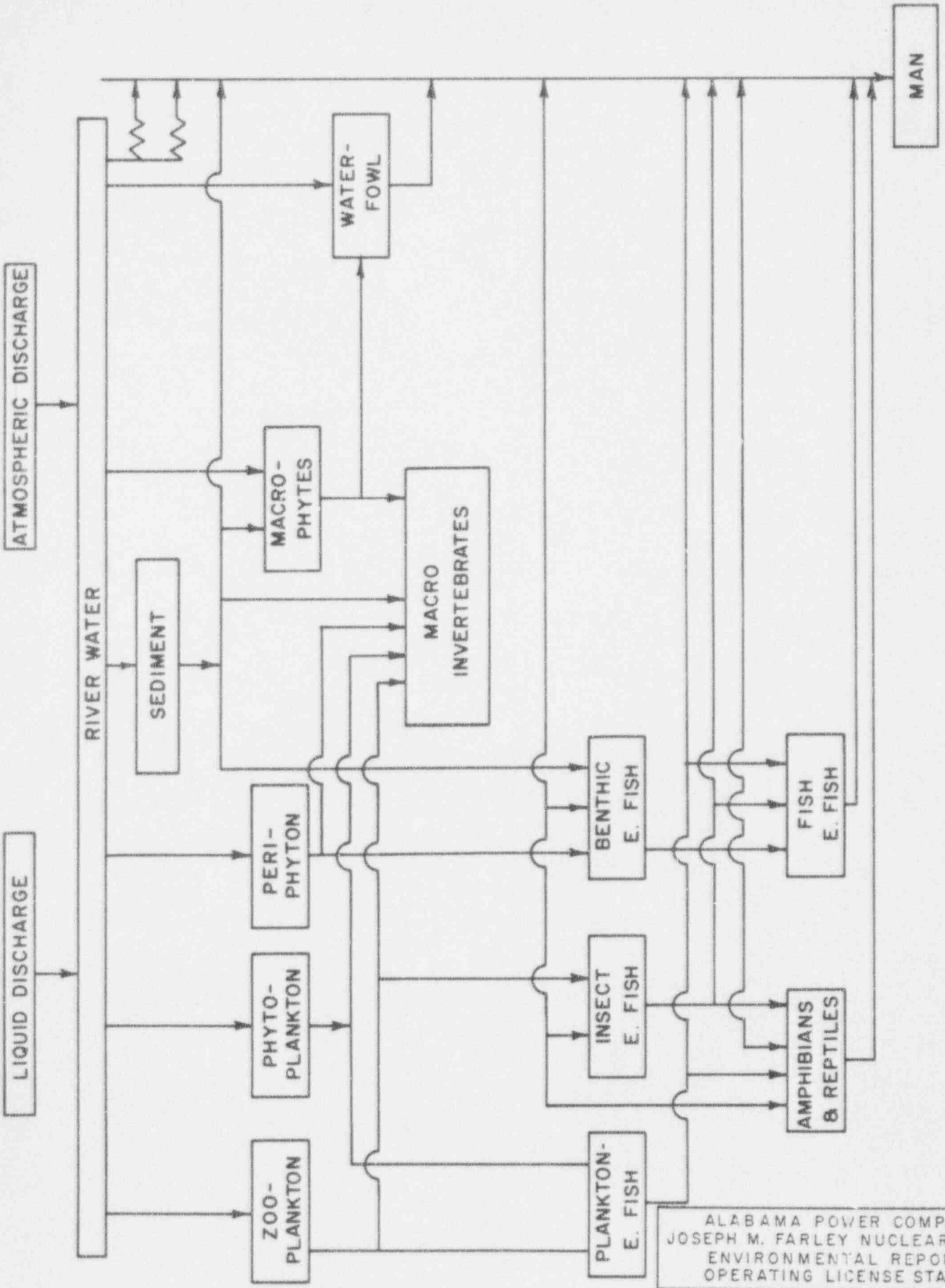
TABLE 5.3-6

FARLEY NUCLEAR PLANT

POPULATION TOTAL BODY DOSES

GASEOUS EFFLUENTS

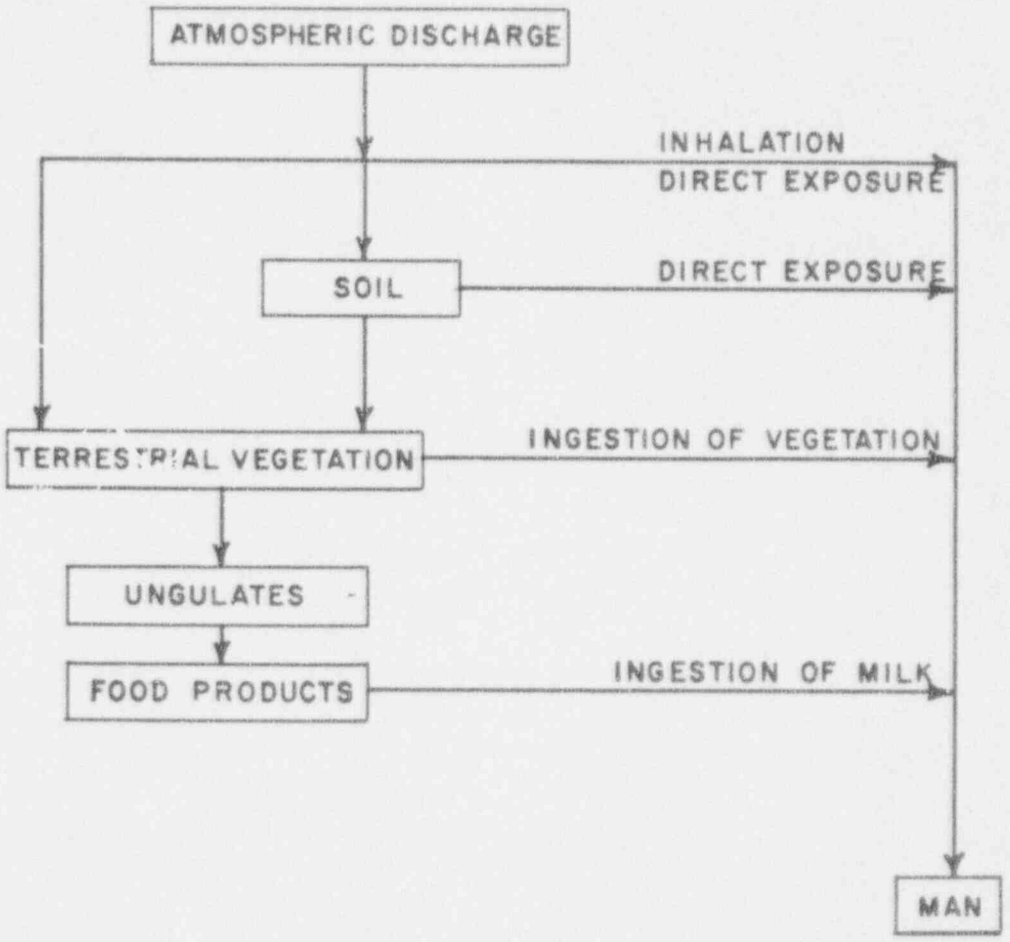
Pathway	People Exposed	Average Consumption Rate	Average Occupation Time (hr/yr)	Population Total Body Dose (man-rem/yr)
External dose from Plume	3.93×10^5	-	8,760	2.92×10^0
Inhalation	3.93×10^5	$20\ m^3$/day	-	5.99×10^{-4}
External dose from Soil deposition	3.93×10^5	-	8,760	5.76×10^{-2}



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

PRINCIPAL FOOD PATHWAYS TO MAN IN THE AQUATIC ENVIRONMENT

FIGURE 5.3-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

PRINCIPAL RADIATION EXPOSURE PATHWAYS FOR MAN IN THE TERRESTRIAL ENVIRONMENT

FIGURE 5.3-2

5.4 EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES

The maximum amounts of chemicals in the discharge to the Chattahoochee River are given in Table 5.4-1. After the blowdown water is diluted with bypass water, the discharged water contains about 107 ppm of dissolved solids at a pH of about 7.8. Even before dilution and mixing in the river, concentrations of sodium (23 ppm), chloride (10 ppm), sulfate (31 ppm), and boron (0.05 ppm) in the discharge are below reported harmful concentrations.

Free residual chlorine is the most potentially toxic chemical released in the discharge. The application of chlorine to cooling water will be intermittent and only one unit will be chlorinated at a time. Gaseous chlorine will be added, depending upon the need for biocidal treatment of cooling water. Chlorination of the cooling tower circuit will occur for a period of 30 to 60 minutes during the day. Chlorination of the service water will be for a period of 30 to 90 minutes during each operating shift. Dilution before discharge, the chlorine demand of the Chattahoochee River water (0.5-1.0 ppm), and further dilution in the river will reduce the residual chlorine level to undetectable limits.

A residual chlorine monitor will be placed on the Farley discharge line to detect concentrations in excess of 0.2 ppm. This monitor will alarm in the control room should the level rise above 0.2 ppm. 1

The chemical effluent monitoring program (Section 6.2.2) will be conducted for one year after plant operation begins. Should this program indicate significant adverse impacts due to the chemical discharges, the applicant will take steps to mitigate those effects.

TABLE 5.4-1

ESTIMATED MAXIMUM CONCENTRATIONS OF CHEMICALS IN COOLING WATER DISCHARGE TO THE CHATTAHOOCHEE RIVER

	Concentration (ppm)				
	In River Water[a]	From Cooling-Tower Blowdown[b] and Service Water	From Steam Generator Blowdown[c]	From Makeup Demineralizer Regeneration[d]	Total in Discharge
Sodium (Na)	8.0	14	0.2	9	23
Potassium (k)	1.8	3			3
Magnesium (Mg)	1.25	2		1	3
Calcium (Ca)	5.8	10		1	11
Manganese (Mn)	0.11	0.2		0	0.2
Iron (total)(Fe)	0.3	0.4		0	0.4
Silica (SiO_2)	7.5	13		2	15
Nitrate (N)	0.09	0.1			0.1
Ammonia	<0.1	<0.1			<0.1
Phosphorus (P)	0.15	0.2	0.3		0.5
Sulfate (SO_4)	5.0	9		22	31
Chloride (Cl)	5.0	9		1	10
Chlorine (Cl_2)		<0.1			0.1
Boron (B)			0.05		< 0.05
Lithium (Li)			0.01		< 0.01

6

[a] Analysis of samples collected near site at U. S. Highway 84 bridge at Alaga on September 3, 1968. Also determined: pH, 7.42.

[b] Estimate assumes a concentration of minerals in blowdown stream 3.5 times that of the river analysis diluted by a service water flow of 12,800 gpm.

[c] Estimate assumes a steam generator leak of 1 gpm, 890 ppm B and 2.2 ppm Li in primary loop, and sodium phosphate concentration 10 times that based on an annual requirement of 3600 lb. per unit.

[d] Based on the batch discharge of 19,000 gal. of neutralized waste into 35,800 gpm of circulating water over a period of 2.5 hr. (127 gpm).

5.6 EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEM

Staff members of the U. S. Atomic Energy Commission during a visit to the site on March 11-13, 1974 asked the following questions concerning transmission lines:

1. Discuss the potential for induced or conducted ground currents associated with the operation of 500 KV lines. Describe the permanent structures such as residences and farm buildings that would be within 100 yards of the 500 KV rights-of-way.
2. Discuss the use of herbicides in maintaining the transmission system (i.e., types, volumes, concentrations, frequency of use, methods of application, conditional controls of helicopter broadcasts on inaccessible sites, and wind conditions, etc.).

An estimate of the number of permanent structures within 100 yards of the Farley to Montgomery 500 KV rights-of-way has been made from aerial photographs and U.S.G.S. maps. It has been determined that there are approximately 50 structures within 100 yards of this 500 KV right-of-way and that approximately 50% of these are residences. The majority of these structures are found in the vicinity of road crossings. A listing of the number of structures along the rights-of-way by county is as follows: 2

Houston	- 5	Barbour	- 5
Henry	- 7	Pike	- 6
Dale	- 5	Montgomery	- 22

Attention has been given to the matter of hazard, or lack of it, of electrostatic induction associated with EHV transmission lines. Recent information indicates that currents from parallel fences up to 1000 feet in length, trucks, and structures in or near EHV transmission line rights-of-way do not present a hazard, even if well insulated.(1) They may, however, particularly under dry conditions, provide an unpleasant steady stimulation or a momentary shock, which may vary from very slight up to a considerable jolt. For this reason structures such as fences are grounded. Fences which cross rights-of-way in a direction generally transverse to the line do not exhibit perceptible voltages and current, but it is considered good practice to ground these fences also, particularly when a gate is involved or when the fence attaches to a portion of fence which runs parallel to the line.

Although electrostatic induction in fences, vehicles or roofs of moderate size may be annoying but not lethal, a much more serious problem with induction occurs between parallel transmission lines. For this reason, in maintenance work or wire stringing, proper grounding procedures are followed, and all crews are well instructed in proper procedures.

Attention has also been directed to the matter of electromagnetically induced voltages and currents. Studies based on field tests have shown that magnetically induced voltages along a fence strand due to overhead currents are only approximately 1/13 MV in a 1000 foot long test fence. Concern has been expressed over the possibility that injury could be sustained by contact with a fence within the right-of-way running roughly parallel to a transmission line. For this reason fences on rights-of-way are grounded. 2

The following practices are employed in connection with the construction of EHV transmission lines for Alabama Power Company: (a) Construction of 500 KV lines will be based on use of three (3) 1033 mcm conductors per phase, arranged in a triangular pattern of 18 inches per side. The phases will be

---

(1) F. A. Jenkins, L. W. Long, "EHV Transmission Lines - Fences and Things". Paper presented to Southeastern Electric Exchange Meeting on Sept. 20-22, 1972.

oriented in a flat configuration, with a spacing of 31 feet in a "delta" arrangement. The ground clearance is based on a minimum of 33 feet at 100°C. (b) Grounding provisions are specified so that all towers will be grounded with driven-rod groundfields with a design objective of a maximum resistance of 15 ohms per tower. Standard counterpoise will be installed on the fence line. Fences, both across and immediately parallel to Alabama Power Company rights-of-way, will be grounded. There is no anticipation of any problem with induced voltages off the Company rights-of-way. (c) In selecting routes for the transmission lines, every effort will be made to avoid or minimize conflicts with residences and to minimize curtilage problems.

It is the practice of Alabama Power Company to utilize the following herbicides in connection with maintenance of its transmission line rights-of-way: 2

1. 2,4,5-T LVE
2. 2,4,5-TP
3. Tordon 101
4. Tordon 10 K Pellets
5. Amchem's 170 (2,4-D and 2,4-DP)
6. Banvel (Dicamba)

Although the above herbicides are now used by Alabama Power Company, newer, more effective herbicides may be developed in the future, and there may be future additions to this list. Only herbicides which have been approved by the U. S. Environmental Protection Agency and the U. S. Department of Agriculture are considered for use by Alabama Power Company, and all herbicides are applied in strict accordance with instructions contained on the labels.

The predominant means of application is by helicopter. Some locations may require ground application.

Generally, the first spraying is done in the second or third growing season after initial clearing. The next spraying is usually done again in about three years to give the windrow (if present) and other debris more time to decay and break down before mechanical mowing equipment is again used on the right-of-way. After the first mechanical clearing, the density of the growth, the rate of growth and the accessibility to the area will all be factors in determining exactly when the next spraying is necessary. 2

The following controls are utilized in the application of herbicides: (a) Spraying is done only when the wind velocity is such that the herbicides can be applied on the target plants. This involves restricting applications to times when wind velocity is less than about three miles per hour. (c) Care is exercised in the selection of herbicides; those used are characterized by low toxicity and low volatility and are applied according to label instructions. (c) Only professional pilots with a demonstrated level of competence and mature judgment are employed.

5.7 OTHER EFFECTS OF PLANT OPERATION

5.7.1 COOLING TOWER NOISE

The Farley Construction permit issued on August 16, 1972 contained the following provision:

"The applicant will obtain necessary specifications from the manufacturers of the cooling towers and the turbine generators and make a detailed calculation of the noise level at the site boundary paralleling Highway 95"

In accordance with the above directive, the following information has been developed:

From extensive measured data, Ecodyne Cooling Products Company has developed a sound power level versus total horsepower chart. Each cooling tower at Plant Farley represents 2100 horsepower, which from the chart, produces a sound power level of

$$L_W = 138 \text{ dB re } 10^{-13} \text{ watts.}$$

Although numerous factors such as humidity, temperature and frequency enter the evaluation of sound attenuation as a function of distance the attached Figure 5.7-1 gives reasonable values (attenuations are based on a 10^{-13} watt reference for sound power level). A typical calculation for the dBA sound level of a tower assumed to be 4800 feet from the Highway 95 follows:

Center Frequency, Hz

	63	125	250	500	1000	2000	4000	8000
L_w	138	138	138	138	138	138	138	138
Attenuation	-84	-89	-103	-107	-118	----	----	----
L_p	54	49	35	31	20	--	--	--
dBA correction	-25	-16	-9	-3	0			
L_p (dBA)	29	33	26	28	20			

34 30

35dBA TOTAL

Therefore, one would expect a 35 dBA sound level 4800 feet from a tower. Summing up the contributions from all of the towers indicates an approximate sound level of 40 dBA and 60 dB overall at the site boundary along Highway 95.

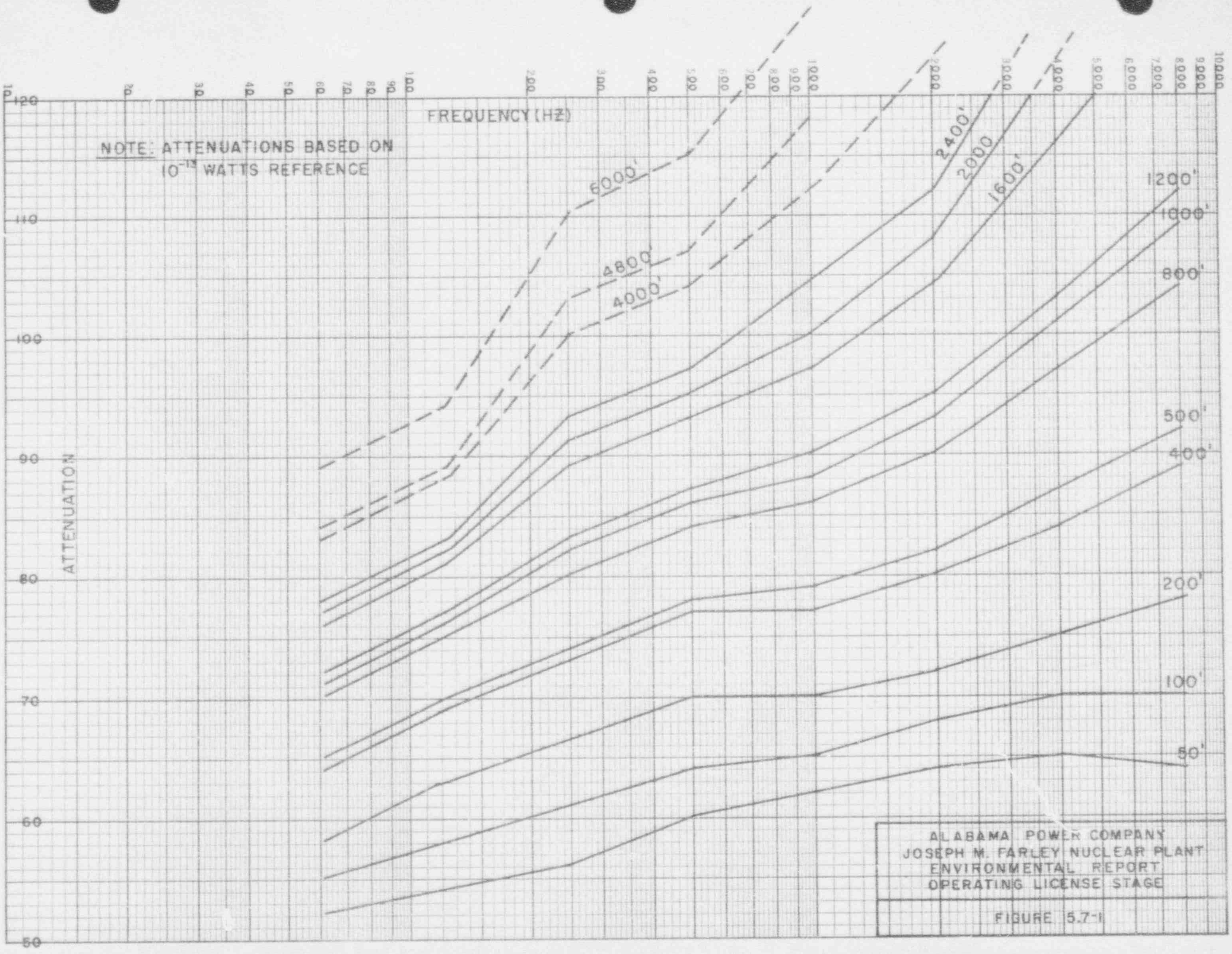
5.7.2 Turbogenerators

Although the sound level inside the turbine room may be in the mid-90 dBA range, the exterior walls should reduce this by 20 dBA. As a comparison, the sound level at the base of the cooling towers will be approximately 85 dBA, whereas outside the turbine enclosure the sound level will be approximately 75 dBA. Therefore, the additional sound level contribution due to the turbogenerators as measured at the site boundary should be small.

5.7.3 Switchyard

Large transformers produce sound levels in the order of 80-90 dBA but the sound spectrum is predominated by low frequencies (500 Hz). These low frequencies may produce a hum slightly above the background noise level during very quiet periods. Properly muffled circuit breakers should not cause any noise problems at the site boundary.

In summary, the sound level at the site boundary near Alabama Highway 95 should be in the order of 40-50 dBA during operation of the plant.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

FIGURE 5.7-1

6.1 PRE-OPERATIONAL ENVIRONMENTAL PROGRAMS

The pre-operational environmental monitoring program for the Farley Nuclear Plant includes both radiological and non-radiological aspects. This program is designed to provide one years data prior to fuel loading. Comparison of the data collected during the pre-operational phase with that collected during the operational phase will form the basis for determining the environmental impact associated with the operation of the Farley Nuclear Plant.

Certain phases of the pre-operational program began November 1, 1974. This was based on the previously scheduled fuel loading date of November 1, 1975. 6

The operational and pre-operational programs are described fully in Section 6.2 of this report. The sampling locations and frequencies for both the operational and pre-operational programs are delineated as well as the methodology to be used in conducting the programs.

6.2.1 RADIOLOGICAL MONITORING

6.2.1.1 PLANT EFFLUENT MONITORING SYSTEM

The following instruments monitor the liquid and gaseous effluents from the Farley Plant. A brief description of each monitor is also provided.

Plant Vent Gas Monitor 6

The plant vent gas monitor detects radioactivity passing through the vent to the atmosphere. It consists of four thin-walled, self-quenching-type Geiger--Mueller tubes (high sensitivity beta-gamma detectors) operated in aprallel. Remote indication and annunciation are provided on the Waste Processing System control board.

Condenser Air Ejector Gas Monitor

This channel monitors the discharge from the air ejector exhaust header of the condenser for gaseous radioactivity which is indicative of a primary to secondary system leak. The gas discharge is routed to the plant vent. A beta-gamma sensitive Geiger-Mueller tube is used to monitor the gaseous radioactivity level. The detector is inserted into an in-line fixed volume container which includes adequate lead shielding to reduce the effect of background radiation so that it does not interfere with the detectors' maximum sensitivity.

Waste Processing System Liquid Effluent Monitor

This channel monitors Waste Processing System liquid releases from each unit. Automatic valve closure action is initiated by this monitor to prevent further release after a specified radiation level is indicated and alarmed. 6 A scintillation counter in an in-line sampler assembly monitors these effluent discharges. Remote indication and annunciation are provided on the Waste Processing System control board.

Plant Vent Air Particulate Monitor

An air sample is taken from the plant vent and monitored by a scintillation counter filter paper detector assembly. The filter paper collects 99 percent of all particulate matter greater than 1 micron in size on its constantly moving surface, and is viewed by a photomultiplier-scintillation crystal combination.

The detector assembly is in a completely enclosed housing. The detector is an hermetically sealed photomultiplier-tube scintillation-crystal (NaI) combination. The pulse signal is transmitted to the Radiation Monitoring System cabinets in the control room. The filter paper has a 25-day minimum supply at normal speed. Lead shielding is provided to reduce the effect of background radiation to a level that does not interfere with the detector's sensitivity. The filter paper mechanism, an electromechanical assembly which controls the filter paper movement, is provided as an integral part of the detector unit.

Plant Vent Gas Sample Monitor

This monitor is provided to measure continuously the gaseous beta-gamma radioactivity in the plant vent. This channel takes the continuous air sample after it passes through the air particulate monitor, R-21, and draws the sample through a closed system to the gas monitor assembly. The sample is monitored by a Geiger-Mueller tube located in a fixed shielded volume. The detector assembly is in a completely enclosed housing containing a beta-gamma sensitive Geiger-Mueller tube mounted in a constant gas volume container. Lead shielding is provided to reduce the effect of background radiation to a point where it does not interfere with the detector's sensitivity.

Steam Generator Blowdown Processing System Monitors

The Steam Generator Blowdown Process Radiation Monitor is provided to monitor the liquid activity level of the blowdown fluid entering the surge tank. This full flow, in-line monitor detects large fluctuations in activity concentration due to variations in steam generator inleakage conditions or to radioactive breakthrough of the system demineralizer train. A high signal from this instrument sounds an alarm and stops blowdown by closing the system's process controlled isolation valve.

The Steam Generator Blowdown Discharge Radiation Monitor is provided to monitor the liquid activity level of the discharged fluid. This full flow, in-line monitor provides the radioactive control of the system's effluent. A high signal from this instrument sounds an alarm and closes the discharge valve if it should be open.

A tabulation of the effluent radiation monitoring channels is found in Table 6.2.1.1-1. The minimum sensitivity listed in the table is based on a CO_{60} background level of 2 mr/hr. The alarm setpoints for the process radiation are listed in Table 6.2.1.1-2.

Liquid effluents from the turbine building will be sampled and analyzed periodically when the steam generator blowdown processing system monitors and the air ejector monitors indicate significant radioactivity in the secondary system.

TABLE 6.2.1.1-1

PROCESS RADIATION MONITORING SYSTEM CHANNEL SENSITIVITIES AND ENERGY BY ISOTOPE

Monitor	Monitor Type	Indicating Devices and Alarms	Detector Type	Sensitivity Range* μCi/cc
Plant vent monitor	Radioactive gases	Log rate meter and alarms on control room monitoring panel	Geiger-Mueller	5.0×10^{-7} to 1.0×10^{-4}
Condenser air ejector gas monitor	Radioactive gases	Log rate meter and alarms on control room monitoring panel	Geiger-Mueller	1.0×10^{-6} to 1.0×10^{-3} (5×10^{-7} for Kr^{85})
Liquid waste processing monitor	Liquid	Log rate meter and alarms on control room monitoring panel	NaI scintillation detector	1.0×10^{-5} to 1.0×10^{-2}
Plant vent air particulate monitor	Air Particulate	Log rate meter and alarms on control room radiation monitoring panel	NaI scintillation detector	1.0×10^{-9} to 1.0×10^{-6}
Plant vent gas sample monitor	Radioactive gases	Log rate meter and alarms on control room radiation monitoring panel	NaI scintillation detector	5.0×10^{-7} to 1.0×10^{-4}
Steam generator blowdown processing system	Liquid	Log rate meter and alarms on control room radiation monitoring panel	NaI scintillation detector	1.0×10^{-6} to 1.0×10^{-3}

6

*Range not for all isotopes.

TABLE 6.2.1.1-1 (Continued)

Monitor	Principal Isotopes Monitored	Detector Energy Response	Effluent Steam Flowrate	Sample Flowrate and Velocity	Expected Service
Plant vent monitor	Kr^{85} A^{41} Xe^{133} Xe^{135}	100 kev to 3.0 mev-γ 200 mev to 3.0 mev B			Continuous
Condenser air ejector gas monitor	Kr^{85} A^{41} Xe^{133} Xe^{135}	100 kev to 3.0 mev-γ (Kr^{85}) 200 kev to 3.0 mev B (A^{41})			Continuous
Liquid waste processing monitor	I^{131} I^{133} Cs^{134} Cs^{137} Co^{58} Co^{60}	100 kev to 3.0 mev-γ			Continuous
Plant vent air particulate monitor	I^{131} I^{133} Cs^{134} Cs^{137} Co^{58} Co^{60} Rb^{88}	100 kev to 3.0 mev-γ			Continuous
Plant vent gas sample monitor	Kr^{85} Ar^{41}	100 kev to 3.0 mev-γ (Kr^{85}) 200 kev to 3.0 mev B (A^{41})			Continuous
Steam generator blowdown processing system monitors	I^{131} I^{133} Cs^{134} Co^{58} Co^{60} Cs^{137}	100 kev to 3.0 mev-γ	15 to 37.5 gpm 2" and 3" Sched. 40		Continuous

TABLE 6.2.1.1-1 (Continued)

Monitor	Background mR/hr	Normal Activity	Maximum Activity	Alarms and Their Basis	Monitor Control Function
Plant vent monitor	2.0	Normal operational auxiliary building vent exhaust activity levels	Post fuel handling accident activity level	1. Circuit failure 2. High radiation level 3. Test mode	
Condenser air ejector gas monitor	2.0	Normal condenser exhaust activity levels	Post steam generator tube rupture accident activity levels	1. Circuit failure 2. High radiation level 3. Test mode	
Liquid waste processing monitor	2.0	Normal radioactive waste activity level	Anticipated operational occurrences radioactive waste activity level	1. Circuit failure 2. High radiation level 3. Test mode	
Plant vent air particulate monitor	2.0			1. Circuit failure 2. High radiation level 3. Test mode	
Plant vent gas sample monitor	2.0			1. Circuit failure 2. High radiation level 3. Test mode	
Steam generator blowdown processing system monitors	1.0	Normal steam generator activity <1.0x10 μc/cc	Post steam generator tube rupture accident activity level	1. Circuit failure 2. High radiation alarm $1\text{x}10^{-5}$ μCi/cc meeting low as practicable 10CFR50 for continuous discharge 3. Test mode	Isolates steam generator blowdown process system and discharge line on high alarm

TABLE 6.2.1.1-2

PROCESS MONITOR ALARM SETPOINTS

Monitor	Alarm Level
Plant Vent Gas	7.6×10^{-5} uCi/cc
Condenser Air Ejector	1.0×10^{-3} uCi/cc
Waste Processing Liquid Effluent	1×10^{-3} uCi/g
Vent Air Particulate	2.5×10^{-8} uCi/cc
Vent Gas Sample	7.6×10^{-5} uCi/cc
Steam Generator Blowdown Processing System Liquid	5.3×10^{-5} uCi/g

6

6.2.1.2 ENVIRONMENTAL RADIOLOGICAL MONITORING

6.2.1.2.1 EXPECTED BACKGROUND

As discussed in Section 2.8, external dose rate from natural causes is expected to be about 110 mrem/year.

Recent data on radioactivity concentrations in the State of Alabama are summarized in Tables 2.8-1 through 2.8-4.

Table 2.8-5 summarizes the preliminary measurements of concentrations of radioactive materials on and around the Farley site. The measurements of radiation and radioactivity planned for the pre-operational and operational phases of the program are described in Section 6.2.1.2.3.

6.2.1.2.2 CRITICAL PATHWAYS

6.2.1.2.2.1 Expected Liquid and Gaseous Releases

In Table 6.2.1.2-1 the quantities of radioisotopes anticipated in the liquid effluents from Farley Units 1 and 2 are evaluated for relative importance with respect to radiation doses. Column 1 gives the isotope; column 2, the anticipated quantity discharged from both units in curies per year; column 3, the half-life of each isotope in years; column 4, the equilibrium quantity of each isotope which will be present in the environment at the end of plant life; column 5, the maximum permissible concentration of each isotope in public drinking water, soluble or insoluble form, whichever is lower; column 6, the volume of water (V x 10^6 cc per year) necessary to dilute the annual discharged quantity to the MPC; column 7, the concentration factor of each element in fresh-water fish given in a generally accepted reference; column 8 gives the value of relative importance, W = VxC.F.; and column 9 gives the rank of each radioisotope according to its importance, i.e., the largest value of W is rank 1, etc.

In Table 6.2.1.2-2, the 20 most important radioisotopes are listed in the order of decreasing importance. It is noteworthy that a number of isotopes of tellurium appear among these 20 radioisotopes. The reason is the very large concentration factor (C.F. = $1x10^5$) assigned to tellurium by Chapman, et al, in view of the absence of published data on this element. Measurements made by the applicant in Chattahoochee River water and in fish give concentration factors for tellurium in fish of 6,000 and less. It is proper to conclude that for this river, at least, the W values for tellurium in Tables 6.2.1.2-1 and 6.2.1.2-2 are high by a factor of 10 or more, and that the importance of the tellurium isotopes is somewhat less than the values of W suggest. The arrows in Table 6.2.1.2-2 indicate the positions of the tellurium isotopes called for by field measurements.

Examination of Table 6.2.1.2-2 shows that the important elements in the river water-fish-human pathway are: cesium, hydrogen, cobalt, tellurium, iron, strontium, yttrium and iodine, and that isotopes of the 8 elements will account for more than 99.9% of the dose.

With regard to atmospheric discharges, only noble gases and iodine-131 (1.5 curies per year from both units) are anticipated. The critical pathway for noble gas is direct, external exposure, and that for iodine-131 is the pasture-cow-milk-infant route.

6.2.1.2.2.2 Pathways of Human Exposure

In Figure 6.2.1.2-1 are shown the principal food pathways in the aquatic environment of the Farley site. Table 6.2.1.2-3 gives the types of organisms represented by the blocks in Figure 6.2.1.2-1.

Figure 6.2.1.2-2 gives the principal food pathways in the terrestrial environment of the Farley site, and Table 6.2.1.2-4 gives the types of mechanisms represented by the blocks in the figure. The possibility that river water might be used to irrigate agricultural land is indicated by the dashed link in Figure 6.2.1.2-2. No evidence of this practice has been found.

The exposure pathways from the aquatic environment to man shown in Figure 6.2.1.2-1 are drinking water from the river, eating waterfowl and the four classes of fish. In addition to these, there is direct exposure to the radiations from radioactive materials in the river water and in the sediment.

Of the five exposure pathways from the terrestrial environment to man shown in Figure 6.2.1.2-2, only two are of any significance under conditions of normal plant operation. Under these conditions only noble radioactive gases and iodine-131 will be discharged to the atmosphere. The only pathway open to the noble gases is from the atmosphere itself by direct exposure and, to a smaller extent, by inhalation. The dominant pathway by which airborne iodine-131 reaches humans is that of vegetation to cow and then to milk.

6.2.1.2.2.3 Food Pathways in Accidents

In the event of an accidental release of radioactive material to the river, the only qualitative difference from the normal situation would be the presence of short-lived activities. Half-lives shorter than a day or two will not be able to travel far along a food pathway before radioactive decay has reduced them to insignificant levels. Thus, it seems that the pathways indicated in Figure 6.2.1.2-1 will apply to the accident situation as well as to normal operation.

Accidental release of radioactive material to the atmosphere will change conditions in the terrestrial pathways qualitatively as well as quantitatively. Radioactive isotopes other than the noble gases and iodine-131 may be present in physiologically significant quantities. In such circumstances it is possible that all the pathways shown in Figure 6.2.1.2-2 leading to man will account for some exposure, rather than only the two which need be considered for normal operation.

6.2.1.2.2.4 Mathematical Models Used to Estimate Exposures

The purpose of this section is to describe the mathematical models used to estimate the human exposures which will result from the several pathways discussed in Section 6.2.1.2.2.2.

Figure 6.2.1.2-3 is a schematic drawing of the means for calculating human doses which result from the discharge of radicactive materials to the atmosphere. Figure 6.2.1.2-4 is a schematic drawing of the means for calculating the human doses which result from the discharge of radioactive materials to the river.

6.2.1.2.2.5 Effluent and Environmental Monitoring Data Used to Confirm the Critical Pathways

Measurements of the types and quantities of radioactive isotopes discharged to the atmosphere and to the river will be made to confirm or modify the estimates which have been given. These measurements will be made by taking samples from the gaseous and liquid waste tanks before these tanks are discharged. The samples will be analyzed in the laboratory with a gamma spectrometer and with appropriate radiochemical methods as required. In addition, on-line effluent monitors will be used to measure the actual rates of release.

The results of these measurements on effluent quantities and types will be examined in terms of exposure pathways to determine whether pathways other than those anticipated have the possibility of being critical. If such cases develop, the environmental monitoring program described in Section 6.2.1.2.3 will be modified accordingly.

6.2.1.2.2.6 Concentration Factors

The concentration factors used in Table 6.2.1.2-1 are taken from the published literature and are not, therefore, necessarily applicable to the Farley site. Recognizing this limitation, a study was made of stable element concentrations in the area for the purpose of estimating concentration factors specific to the site.

The principle behind this stable element study is the converse of the well-established use of radioactive isotopes as tracers in biological and environmental investigations. The principle may be expressed as follows:

$$\frac{CRO}{CRW} \leq \frac{CSO}{CSW}$$

where

CRO = the concentration of a particular radioisotope in an aquatic organism, say a fish,

CRW = the concentration of the same radioisotope in the water in which the organism lives,

CSO = the concentration of the corresponding stable isotope in the same organism,

CSW = the concentration of the same stable isotope in a filtered sample of the water in which the organism lives.

The relation above is valid provided that (1) the concentration in moles, or ppm of the radioisotope in water, is a small fraction of the existing concentration of the stable isotope in water (i.e. $CRW \ll CSW$), in which case the addition of the radioisotope does not change the chemistry of that element in the river, and (2) the chemical form of the radioisotope is no more available, biologically, than is the chemical form of the stable element. The use of filtered water for the determination of CSW assures that the second condition applies.

Table 6.2.1.2-5 summarizes the concentration factors which have resulted from the stable element studies of the Farley environment. The values for concentration factors in the table are, in most cases, rounded averages of a number of measurements. For comparison to the values measured at the Farley site, published values for freshwater fish and aquatic plants are also given in the table. The concentration factors measured for crops, pork, milk and game animals and birds presume that these organisms obtain their water from the river, i.e. by irrigation with river water and by drinking at the river's edge.

6.2.1.2.2.7 Food Consumption Rates

Table 6.2.1.2-6 gives provisional values for consumption rates and occupancy times. The typical values are similar to those used by the International Commission on Radiological Protection for the standard man (Report of Committee 2, Pergamon Press, 1959 and by Fletcher and Dotson for the infant (U. S. AEC Report HEDI-TME-71-168, 1971). Other values have been estimated from national averages.

6.2.1.3 SAMPLING MEDIA, LOCATIONS AND FREQUENCY

The preoperational and operational environmental radiological monitoring program at the Farley Nuclear Plant has been designed to meet requirements called for in Table 2 of the NRC "Working Paper", Regulatory Guide 4.X Environmental Technical Specifications, Vol. 1, Guide for the Preparation of Environmental Technical Specifications for Nuclear Power Plants, August, 1974 and the EPA Report ORP/SID 72-2, Environmental Radioactivity Surveillance Program, June, 1972. 6

Outlines of the preoperational and operational programs are shown in Tables 6.2.1.2-7 and 6.2.1.2-7a respectively. The programs are divided into two phases, airborne and waterborne. The media sampled, number of sampling stations, collection frequency and types of analysis performed are shown in Tables 6.2.1.2-7 and 6.2.1.2-7a.

The sampling stations are divided into three general categories; indicator, community, and background. The indicator stations are those most likely to be influenced by the release of radioactive effluents to unrestricted areas around the plant. The community stations sample certain media in the nearest population centers to the plant and should normally not be affected appreciably by routine releases of radioactive effluents. The background stations are located so as not to be influenced by normal releases of radioactive effluents from the plant. The locations of the three types of sampling stations are shown in Figures 6.2.1.2-5, 6.2.1.2-6 and 6.2.1.2-6a and are expected to remain the same for both the preoperational and operational programs. 6

The frequencies of sampling shown in Table 6.2.1.2-7 and 6.2.1.2-7a have been selected considering a number of factors. The frequency of sampling for airborne particulates is set by the fact that filters clog after about one week so that the flow of air is markedly reduced. The two sample periods for the TLD's used to measure external radiation are a compromise between the limit of detection and the occasional need to determine as soon as possible when an above normal exposure occurred. Other sampling frequencies are set in consideration of environmental time constants (where these are known) and the lower limit of detection for the methods used to analyze the samples.

1. Airborne Phase

The airborne sampling phase includes particulates, iodine, external radiation, milk, vegetation, and soil. Airborne particulates are sampled at four indicator stations, (along the plant boundary in sectors having the highest offsite concentration and at the nearest residence) three community and three background stations. Airborne iodine is sampled at two indicator stations along the plant boundary having the highest offsite concentration, at the nearest residence, at one community station, and at one background station. External radiation and soil are measured at each of the 10 particulate sampling stations and in five additional sectors along the plant boundary. Also, external radiation measurements are made at two additional background stations. Each external radiation station contains two (2) thermoluminescent dosimeters one of which is changed and read quarterly and the other annually.

As Tables 6.2.1.2-7 and 6.2.1.2-7a indicate there will be one background milk sampling station and one or more indicator milk sampling stations in accordance with the availability of milk cows or goats. A semi-annual survey is used to locate indicator milk cows in the area around the plant to a distance of five miles and for milk goats to a distance of 15 miles. According to the June, 1975 survey, the nearest milk cow is in the East sector on a family farm about five miles from the plant, and thus is used as an indicator station. The Brooks-Silcox Dairy in the west southwest sector about 10 miles from the plant is used as a background station.

The vegetation shown in Tables 6.2.1.2-7 and 6.2.1.2-7a is of two types; forage consumed by animals, and vegetables and fruits consumed by humans. Forage is sampled along the plant boundary in two sectors of highest offsite concentration and from one background station in the Dothan area. Vegetables and fruits grown in the plant vicinity with the exception of green leafy vegetables are sampled at harvest. Background samples of the same varieties are sampled in the Dothan area. Likewise, during the growing season from October to March, green leafy vegetables are collected monthly in the plant vicinity and from the Dothan area for indicator and background samples, respectively.

2. Waterborne

The background sampling station for all samples from the Chattahoochee River is above Andrews Lock and Dam. The indicator sampling station for surface water, fish and sediment is in the vicinity of Smith's Bend at a distance of between one and two miles downstream of the plant discharge. This is the first downstream point at which complete mixing of the plant discharge with the river is expected to be attained. River vegetation and benthos (clams) 6 are collected at the nearest downstream point at which they can be found. Figure 6.2.1.2-6a shows the river sampling locations.

Well water samples in the path of ground water flow are normally taken to monitor the inadvertent discharge of radioactive liquid effluents into the ground. In the Farley Nuclear Plant area, the shallow ground water aquifer flows towards the river in generally a southeast direction. No wells are between the plant and the river tapping this aquifer. There is an artesian well in the south southeast sector about 0.2 mile south of the plant boundary. This well and the well supplying water for the nearest residence will be sampled.

6.2.1.4 ANALYTICAL SENSITIVITY

6.2.1.4.1 Measuring Equipment

The equipment used to analyze the samples collected in the environmental monitoring program will have, at a minimum, sensitivities as shown in Table 6.2.1.2-8. These sentivities may be lowered due to improvements in detection equipment and techniques.

Parameter	Liquid Scintillation Counter	Low Background Beta Counter
LLD	3.3 cpm	0.5 cpm
Efficiency	60%	50%
Sample Sensitivity	2.5 pCi/sample	0.5 pCi/sample

The LLD and sample sensitivity for the gamma spectrometer are complex because they depend on the isotope to be measured and the geometrical relations between the sample and the spectrometer crystal. A typical limit of detection for a 2.2 liter Marinelli beaker and a 3x3 inch crystal is 20 pCi per sample, or 10 pCi/liter. Higher than normal backbround levels and the presence of other gamma-emitting isotopes may in some circumstances raise the LLD from 20 to 80 pCi/sample. Use of a larger Marinelli beaker (3.5 liter) will offset the LLD to some extent and give sample sensitivity of about 20 pCi/liter. Aquatic organisms will not generally be available in large quantities and will be counted in a container like a one-pint freezer jar placed on top of the crystal. The overall LLD will remain about the same, but because the sample size has been reduced (to say 500g) the sample sensitivity will be increased (to 0.15 pCi/gram).

For iodine-131 on charcoal through which 400 m^3 of air has been drawn, the considerations above give a sample sensitivity of 0.05 pCi/m^3, provided the collection efficiency of charcoal for iodine is 100% (see below). The LLD could probably be reduced if smaller quantities of charcoal could be used.

6.2.1.4.4 Collection Efficiency

The collection efficiency of the filter for airborne dust has been taken to be 100% because filters of the membrane and glass-fiber types have been shown in practice to attain this efficiency (Air Sampling Instruments, Amer. Conf. of Gov. Ind. Hyg., 3rd ed, 1966, p B-2-3).

The collection efficiency of charcoal for iodine is a matter on which agreement is hard to reach. Two experiments illustrate this difficulty.

1) Craig, et al (Effect of Iodine Concentration on the Efficiency of Activated Charcoal Absorbers, Health Physics 19: 223-233, 1970) found that both activated charcoal and charcoal impregnated with iodine had efficiencies of about 90% for removing methyl iodide (CH_3I) at 22° C., 75% relative humidity and air concentrations from 2.3×10^{-6} to 2.7×10^{-10} μg/cc. However, for molecular iodine (I_2) they found that the collection efficiency began to fall off at a concentration of 1×10^{-5} g/cc and reached 50% at 5×10^{-8} μg/cc, the lowest concentration used.

   The maximum permissible concentration of iodine-131 in public air corresponds to 1×10^{-15} μg/cc.

2) Keller, et al (An Evaluation of Materials and Techniques Used for Monitoring Airborne Radioiodine Species, Twelfth USAEC Air Cleaning Conf. 1972) found that the efficiencies of both charcoal and iodine-impregnated charcoal were greater than 99% for elemental iodine at concentrations from 10^{-8} to 10^{-12} μg/cc. They observed collection efficiencies for methyl iodide of 20 to 35% at 200 linear feet per minute and 50 to 70% at 50 linear feet per minute for both charcoal and iodine-impregnated charcoal.

The iodine collection efficiencies are based on the work of Keller, et al. because they used materials and devices planned as samplers (Craig, et al were testing large air-cleaning devices) and because they worked at lower concentrations than did Craig, et al. The iodine collection device which will probably be used has a linear flow velocity of about 120 feet per minute, at which velocity Keller, et al observed the collection efficiency of charcoal to be about 100% for molecular iodine and about 25% for methyl iodide.

6.2.1.5 DATA ANALYSIS AND PRESENTATION

In cases where the background samples give measurable values, statistical analyses will be required to determine whether the indicator samples are significantly higher than the background samples. The student "t" test for the difference between two normally distributed means will be used for this purpose. A flow chart which shows how this test will be applied is given in Figure 6.2.1.2-7. The terms used in the figure have the following definitions: 4

X_i = measurements at the indicator stations

X_b = measurements at the background stations

N_i = number of indicator stations

N_b = number of background stations

$$X = \text{mean value} = \frac{1}{N} \sum_{j=1}^{N} X_j$$

$$S = \text{Standard deviation} = \left[\frac{\sum_{j=1}^{N} (X_j - \bar{X})^2}{N-1} \right]^{1/2}$$

Subscripts "i" and "b" are not used in Figure 6.2.1.2-7 because of the requirement that $S_1^2 > S_2^2$. The necessary values, F_{table} and t_{table}, are given in A. Goldstein, <u>Biostatistics, and Introductory Text</u>, McMillan Co., New York, 1964, page 244 and 242, respectively. Note that in this t-test, values for "both tails" are used for t_{table}. 4

The minimum detectable difference is calculated by the method of Pelletier (Environmental Surveillance in the Vicinity of Nuclear Facilities, W.C. Reinig, ed., Chas. C. Thomas, Inc., Springfield, 1970):

$$M = t_{table}\ Sp\left(\frac{1}{N_1} + \frac{1}{N_2}\right)$$

where

M = minimum detectable difference in the same units as the sample sensitivity

t_{table} = the one-tailed value for t for DF = $N_1 + N_2 - 2$, and for P = 0.01

S_{p1}, N_1, N_2 are the values used or derived in the t-test

Data will be presented in a form similar to that shown in Table 6.2.1.2-9.

6.2.1.6 PROGRAM STATISTICAL SENSITIVITY

The two most important exposure pathways that appear are ingestion of iodine-131 in milk and external exposure to noble gases. The effectiveness of the environmental monitoring program will be limited by the sensitivities of the measurements along these pathways.

The limit of sensitivity for thermoluminescent dosimeters is about 10 mrem. If the year is covered by 4 quarterly dosimeters, the minimum detectable difference between indicator and background sets may be as low as 10 mrem per year.

The sensitivity for the detection of iodine-131 in milk was given as 0.5 pCi per liter in Section 6.2.1.2.4.

TABLE 6.2.1.2-1

ANNUAL RELEASE OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENT
FARLEY UNITS 1 & 2

Isotope	Qw(1) Ci/yr	T½ Years	A∞ (2)	MPC_W (3) µCi/cc	V (4)	C.F. (5)	W (6)	Rank
Rb-86	9.6(-4)	5.1 (-2)	7.06(-5)	2 (-5)	3.5 (0)	2(+3)	7.0(+3)	15
Sr-89	9. (-4)	1.44(-1)	1.87(-4)	3 (-6)	6.2(+1)	4(+1)	2.5(+3)	18
Sr-90	3. (-5)	2.77(+1)	1.20(-3)	3 (-7)	4.0(+3)	4(+1)	1.6(+5)	10
Y -90	4. (-5)	7.31(-3)	4.22(-7)	2 (-5)	2.1(-2)	1(+2)	2.1 (0)	
Zr-95	1.5(-4)	1.79(-1)	3.87(-5)	6 (-5)	6.5(-1)	1(+2)	6.5(+1)	
Nb-95	1.5(-4)	9.6 (-2)	2.08(-5)	1 (-4)	2.1(-1)	3(+4)	6.3(+3)	17
Ru-103	1.0(-4)	1.08(-1)	1.56(-5)	8 (-5)	2.0(-1)	1(+2)	2.0(+1)	
Rh-103m	1.0(-4)	1.09(-4)	1.57(-8)	1 (-2)	1.6(-6)	1(+2)	1.6(-4)	
Rh-105	1.7(-4)	4.10(-3)	1.01(-6)	1 (-4)	1.0(-2)	1(+2)	1.0 (0)	
Ru-106	9. (-5)	1.01 (0)	1.31(-4)	1 (-5)	1.3(+1)	1(+2)	1.3(+3)	21
Sn-125	1. (-6)	2.58(-2)	3.72(-8)	2 (-5)	1.9(-3)	1(+3)	1.9 (0)	
Tc-125m	2.9(-5)	1.60(-1)	6.70(-6)	1 (-4)	6.7(-2)	[1(+5)]	[6.7(+3)]	16
Sb-127	5.5(-6)	1.06(-2)	8.41(-8)	-	-	4(+1)		
Te-127m	7.0(-4)	2.99(-1)	3.02(-4)	5 (-5)	6.0 (0)	[1(+5)]	[6.0(+5)]	7
Te-127	7.0(-4)	1.07(-3)	1.08(-6)	2 (-4)	5.4(-3)	[1(+5)]	[5.4(+2)]	
Te-131m	1.0(-3)	3.42(-3)	4.94(-6)	4 (-5)	1.2(-1)	[1(+5)]	[1.2(+4)]	14
Te-131	1.9(-4)	4.71(-5)	1.29(-8)	-	-	[1(+5)]		
Ba-140	9.6(-4)	3.51(-2)	4.86(-5)	2 (-5)	2.4 (0)	1(+1)	2.4(+1)	
La-140	8.1(-4)	4.59(-3)	5.36(-6)	2 (-5)	2.7(-1)	1(+2)	2.7(+1)	
Ce-141	1.6(-4)	8.90(-2)	2.05(-5)	9 (-5)	2.3(-1)	1(+2)	2.3(+1)	
Ce-143	2.3(-5)	3.77(-3)	1.25(-7)	4 (-5)	3.1(-3)	1(+2)	3.1(-1)	
Pr-143	1.3(-4)	3.72(-2)	6.98(-6)	5 (-5)	1.4(-1)	1(+2)	1.4(+1)	

TABLE 6.2.1.2-1 (Contd.)

ANNUAL RELEASE OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENT FARLEY UNITS 1 & 2

Isotope	Q_w(1) Ci/yr	$T_{1/2}$ Years	A_{∞}(2)	MPC_w(3) µCi/cc	V (4)	C.F.(5)	W (6)	Rank
Ce-144	8.9(-5)	7.78(-1)	9.99(-5)	1 (-5)	1.0(+1)	1(+2)	1.0(+3)	22
Nd-145	5.0(-5)	3.03(-2)	2.19(-6)	6 (-5)	3.7(-2)	1(+2)	3.7 (0)	
Pm-147	9.6(-6)	2.62(0)	3.63(-5)	2 (-4)	1.8(-1)	1(+2)	1.8(+1)	
Pm-149	3.7(-5)	6.06(-3)	3.24(-7)	4 (-5)	8.1(-3)	1(+2)	8.1(-1)	
Y -91	1.8(-1)	1.61(-1)	4.18(-2)	3 (-5)	1.4(+3)	1(+2)	1.4(+5)	11
Mo-99	7.4(-2)	1.61(-3)	8.11(-4)	4 (-5)	2.0(+1)	1(+2)	2.0(+3)	19
Te-129m	7.5(-2)	9.34(-2)	1.01(-2)	2 (-5)	5.1(+2)	[1(+5)]	[5.1(+7)]	3
Te-129	7.5(-2)	1.31(-4)	1.42(-5)	8 (-4)	1.8(-2)	[1(+5)]	[1.8(+3)]	20
I -131	2.0(-1)	2.21(-2)	6.38(-3)	3 (-7)	2.1(+4)	1 (0)	2.1(+4)	13
Te-132	3.5(-2)	8.87(-3)	4.48(-4)	2 (-5)	2.2(+1)	[1(+5)]	[2.2(+6)]	6
Cs-134	8.1(-1)	2.05 (0)	2.40 (0)	9 (-6)	2.7(+5)	1(+3)	2.7(+8)	1
Cs-136	2.7(-1)	3.75(-2)	1.46(-2)	6 (-5)	2.4(+2)	1(+3)	2.4(+5)	8
Cs-137	4.4(-2)	3.00(+1)	1.90 (0)	2 (-5)	9.5(+4)	1(+3)	9.5(+7)	2
Ba-137m	5.2(-2)	4.86(-6)	3.65(-7)	-	-	1(+1)		
Cr-51	3. (-2)	7.62(-2)	3.30(-3)	2 (-3)	1.7 (0)	2(+2)	3.4(+2)	
Mn-54	4.4(-2)	8.30(-1)	5.27(-2)	1 (-4)	5.3(+2)	2.5(+1)	1.3(+4)	13
Fe-55	1.3(-1)	2.60 (0)	4.88(-1)	8 (-4)	6.1(+2)	3(+2)	1.8(+5)	9
Fe-59	3.7(-2)	1.25(-1)	6.67(-3)	5 (-5)	1.3(+2)	3(+2)	3.9(+4)	12
Co-58	1.55(0)	1.95(-1)	4.36(-1)	9 (-5)	4.8(+3)	5(+2)	2.4(+6)	5
Co-60	4.4(-2)	5.26 (0)	3.34(-2)	3 (-5)	1.1(+4)	5(+2)	5.5(+6)	4
H-3	~1.0(+3)	1.23(+1)	~1.8(+4)	3 (-3)	~6(+6)	9.31(-1)	~5.6(+6)	3

1. Estimate of annual release from both units, Environmental Statement, p. III-21.

TABLE 6.2.1.2-1 (Contd.)

ANNUAL RELEASE OF RADIOACTIVE MATERIALS IN LIQUID EFFLUENT FARLEY UNITS 1 & 2

2. $A_{\infty} = Qw\ T_{\frac{1}{2}}/0.693$

3. 10CFR20, App. B, Table II, Col. 2, soluble, or insoluble, whichever is smaller.

4. $V = A_{\infty}/MPCw$. If multiplied by 10^6, V is the volume of water necessary to dilute the equilibrium activity to public drinking water concentrations.

5. W. H. Chapman, et al, UCRL-50564, 1968.

6. $W = V \times C.F.$

TABLE 6.2.1.2-2

ISOTOPES IN LIQUID EFFLUENT RANKED BY IMPORTANCE

Rank	Isotope	W
1	Cs-134	2.7(+8)
2	Cs-137	9.5(+7)
3	H-3	~5.6(+6)
4	Co-60	5.5(+6)
5	Co-58	2.4(+6)
6	Te-132	[2.2(+6)]
7	Te-127	[6.0(+5)]
8	Cs-136	2.4(+5)
9	Fe-55	1.8(+5)
10	Sr-90	1.6(+5)
11	Y-91	1.4(+5)
12	Fe-59	3.9(+4)
13	I-131	2.1(+4)
14	Te-131m	[1.2(+4)]
15	Rb-86	7.0(+3)
16	Te-125m	[6.7(+3)]
17	Nb-95	6.3(+3)
18	Sr-89	2.5(+3)
19	Mo-99	2.0(+3)
20	Te-129	[1.8(+3)]

SEE TEXT FOR COMMENTS

ABOUT TELLURIUM

TABLE 6.2.1.2-3

TYPES OF ORGANISMS IN THE AQUATIC ENVIRONMENT CORRESPONDING TO THE BLOCKS

IN FIGURE 6.2.1.2-1

Block	Type of Organisms
Zooplankton	Free-floating microscopic animals
Phytoplankton	Free-floating microscopic plants
Periphyton	Diatoms and algae
Macrophytes	Rooted, marginal and floating aquatic plants, shrubs and trees
Macroinvertebrates	Insect larvae, crustaceans, molluscs, etc.
Waterfowl	Ducks and geese
Plankton-feeding fish	Shad and minnows
Insect-feeding fish	Sunfishes, crappies and minnows
Benthos-feeding fish	Suckers, carp, buffalo and catfish
Aquatic rodents	Muskrat and beaver
Amphibians and reptiles	Salamanders, frogs, turtles and alligators
Fish-feeding fish	Large catfish, large crappie, bass and gar
Wading and diving birds	Herons, anhingas, etc.
Birds of prey	Osprey and eagle
Small carnivores	Raccoons, otter and mink
Man	

TABLE 6.2.1.2-4

TYPES OF ORGANISMS IN THE TERRESTRIAL ENVIRONMENT
CORRESPONDING TO THE BLOCKS
IN FIGURE 6.2.1.2-2

Block	Types of Organisms
Terrestrial vegetation	Grasses, shrubs, trees, seeds, grain, nuts, wild fruit and crops
Invertebrates	Annelids, arthropods, etc.
Insect feeding, seed-feeding and omnivorous birds	Sparrows, blackbirds, meadowlarks, woodcock, etc.
Rodents and Lagomorphs	Mice, rats, squirrel, rabbits
Gallinaceous birds	Dove, quail and turkey
Undulates	Deer, cattle, pigs, goats
Amphibians and reptiles	Salamanders, toads, snakes, terrestrial turtles
Birds of prey	Owls, hawks and vultures
Small omnivores and carnivores	Oppossum, raccoon, skunk, fox and wild cat

TABLE 6.2.1.2-5

CONCENTRATION FACTORS IN THE FARLEY AREA

Element	River Fish	Freshwater Fish*	River Clams	River Plants	Aquatic Plants*
Antimony	300	40	320	300	-
Arsenic	220	330	210	150	330
Barium	40	10	390	400	500
Cadmium	50	3,000	40	30	1,000
Cerium	200	100	80	130	10,000
Cesium	200	1,000	420	290	200
Cobalt	100	500	200	240	1,000
Copper	150	200	340	160	1,000
Iodine	20	1	20	10	100
Iron	1,000	300		2,500	5,000
Manganese	20	25	320	2,600	10,000
Mercury	300	1,000	170	230	1,000
Molybdenum	100	100	380	400	100
Phosphorus	150,000	100,000	69,000	20,000	100,000
Strontium	30	40	150	120	500
Tellurium	2,000	100,000	1,300	70	100,000
Tin	150	1,000	74	70	33
Yttrium		100			10,000
Zinc	100	1,000	190	120	4,000

* W. H. Chapman, et al, UCRL-50564, 1968

TABLE 6.2.1.2-5
(Contd.)

CONCENTRATION FACTORS IN THE FARLEY AREA

Element	Estuary Crustacea & Mollusks	Estuary Snail	Estuary Plants	Estuary Fish
Antimony	20	20	20	20
Arsenic	100	170	80	90
Barium	10	~900	20	3
Cadmium	150	200	150	400
Cerium	10	60	15	5
Cesium	3,000	1,000	1,200	400
Cobalt	20	220	50	10
Copper	70	~400	10	13
Iodine	30	~ 5	10	5
Iron	-	-	-	-
Manganese	100	1,100	500	6
Mercury	200	220	200	210
Molybdenum	10	60	6	6
Phosphorus	40,000	40,000	5,000	30,000
Strontium	10	~200	3	3
Tellurium	5,000	90	-	2,000
Tin	50	40	10	30
Yttrium	-	-	-	-
Zinc	500	60	120	80

TABLE 6.2.1.2-5
(Contd.)

CONCENTRATION FACTORS IN THE FARLEY AREA

Element	Crops	Pork	Milk
Antimony	250	160	14
Arsenic	250	80	4
Barium	60	6	4
Cadmium	30	200	0.1
Cerium	30	12	0.3
Cesium	500	600	-
Cobalt	50	50	2
Copper	300	120	13
Iodine	10	3	3
Iron	-	-	-
Manganese	200	4	20
Mercury	200	60	3
Molybdenum	500	50	40
Phosphorus	100,000	80,000	80,000
Strontium	50	3	7
Tellurium	300	100	2
Tin	100	110	3
Yttrium	-	-	-
Zinc	150	200	80

TABLE 6.2.1.2-5
(Contd.)

CONCENTRATION FACTORS IN THE FARLEY AREA

Element	Opossum	Raccoon	Squirrel	Deer	Dove	Quail	Wild Turkey
Antimony	–	–	–	220	–	–	300
Arsenic	–	–	–	240	–	–	240
Barium	8	16	8	30	10	16	6
Cadmium	–	–	–	90	–	–	100
Cerium	2	2	2	30	1	1	30
Cesium	1,200	1,700	1,400	1,300	700	1,000	600
Cobalt	50	70	60	90	20	40	40
Copper	–	–	–	250	–	–	120
Iodine	5	9	9	25	10	10	2
Iron	–	–	–	–	–	–	–
Manganese	8	6	7	4	6	10	4
Mercury	200	200	100	1,600	90	90	170
Molybdenum	–	–	–	40	–	–	240
Phosphorus	110,000	90,000	110,000	110,000	60,000	110,000	90,000
Strontium	2	3	2	20	3	2	5
Tellurium	60	90	80	120	90	80	130
Tin	–	–	–	150	–	–	100
Yttrium	–	–	–	–	–	–	–
Zinc	500	500	160	300	140	140	120

TABLE 6.2.1.2-6

CONSUMPTION RATES AND OCCUPANCY TIMES

Factor	Units	Adult		Infant	
		Typical	Maximum	Typical	Maximum
Shine	Hrs/Yr	8760	8760	8760	8760
Immersion in Air	Hrs/Yr	8760	8760	8760	8760
Inhalation	cm^3/day	$2x10^7$	$2x10^7$	$3x10^6$	$3x10^6$
Swimming	Hrs/Yr	88	88	0	0
Boating	Hrs/Yr	88	8760	88	8760
River Bank Exposure	Hrs/Yr	88	530	88	88
Ingestion of:					
Marine Invertebrates	g/day	60	100	0	0
Fish	g/day	0.8	100	0	0
Water	cm^3/day	2,200	2,200	2,200	2,200
Milk	cm^3/day	370	1,100	1,000	1,000
Vegetables	g/day	40	100	0	0

TABLE 6.2.1.2-7

PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Phase	Sample Medium	Number of Stations[1]			Collection Frequency	Analysis
		Ind	Comm	Bkgnd.		
AIRBORNE	Airborne Particulates	4	3	3	C-W	B, N-Q[7], Sr-Q[7]
	Airborne Iodine[2]	3	1	1	C-W	I
	External Radiation	9	3	5	C-Q, C-Y	R
	Milk[3]	1 to 4	-	1	G-M	I, N, Sr
	Vegetation					
	Forage	2	-	1	G-M	N
	Vegetables & Fruits	1	-	1	H	N, I[5]
	Soil[6]	9	3	3	G	N, Sr(90)
					(S)	(N)
WATERBORNE	River Water	1	-	1	G-M	N-M, T-Q[7], Y-Q[7]
	River Vegetation	1	-	1	G-S	N, Sr
	River Benthos (Clams)	1	-	1	G-S	N, Sr
	River Fish	1	-	1	G-S	N
	River Sediment	1	-	1	G-S	N, Sr(90)
	Groundwater	-	-	2	G-Q	N, T

Amend. 6 - 7/28/75

(See Attached Sheet for Notes)

Notes for Table 6.2.1.2-7

(1) Future operational sampling stations.

(2) One weekly sample collected each month.

(3) Number of indicator milk sampling stations may vary with availability of cows or goats as determined by semi-annual surveys.

(4) One sampling location for each type of vegetable or fruit consumed by humans in the plant vicinity.

(5) For green leafy vegetables.

(6) Semi-annual <u>in situ</u> gamma measurements only, after initial samples.

(7) Composite sample analysis.

Symbols:

C - Sampled continuously
G - Grab sample
W - Weekly
M - Monthly
Q - Quarterly
S - Semi-annually
Y - Yearly
H - Harvest

B - Gross beta analysis
N - Gamma Nuclide Analysis
I - Iodine-131 analysis
Sr - Strontium-89, 90 analysis
Sr(90) - Strontium-90 analysis only
T - Tritium analysis
R - Read radiation dose

TABLE 6.2.1.2-7a

OPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

Phase	Sample Medium	Number of Stations			Collection Frequency	Analysis
		Ind.	Comm.	Bkgnd.		
AIRBORNE	Airborne Particulates	4	3	3	C-W	B, N-Q[5], Sr-Q[5]
	Airborne Iodine	3	1	1	C-W	I
	External Radiation	9	3	5	C-Q, C-Y	R
	Milk[1]	1 to 4	-	1	G-M	I, N, Sr
	Vegetation					
	Forage	2	-	1	G-M	N
	Vegetables & Fruits[2]	1	-	1	H	N, I[4]
	Soil(3)	9	3	3	S	N
WATERBORNE	River Water	1	-	1	C-M	N, T-Q[5], Sr-Q[5]
	River Vegetation	1	-	1	G-S	N, Sr
	River Benthos (Clams)	1	-	1	G-S	N, Sr
	River fish	1	-	1	G-S	N
	River sediment	1	-	1	G-S	N, Sr(90)
	Groundwater	-	-	2	G-Q	T, N

6

Amend. 6 - 7/28/75

(See Attached sheet for notes)

Notes for Table 6.2.1.2-7a

(1) Number of indicator milk sampling stations may vary with availability of cows or goats as determined by semi-annual surveys.

(2) One sampling location for each type of vegetable or fruit consumed by humans in the plant vicinity.

(3) Semi-annual *in situ* gamma analysis is used for soil sampling.

(4) For green leafy vegetables.

(5) Composite sample analysis.

Symbols:

C - Sampled continuously
G - Grab sample
W - Weekly
M - Monthly
Q - Quarterly
S - Semi-annually
Y - Yearly
H - Harvest

B - Gross beta analysis
N - Gamma Nuclide analysis
I - Iodine-131 analysis
Sr - Strontium-89, 90 analysis
Sr(90) - Strontium-90 analysis only
T - Tritium analysis
R - Read radiation dose

TABLE 6.2.1.2-8

SIZES AND SENSITIVITIES OF ENVIRONMENTAL SAMPLES

	Sample Size	Analysis	Sample Sensitivity
Airborne Particulates	400 m^3	B	3×10^{-3} pCi/m^3
	400 m^3	γ Spec.	0.0/pCi/m^3
		Sr-89,90	10^{-3} pCi/m^3
Airborne Iodine	400 m^3	I-131	0.1 pCi/m^3
External Radiation	3 months	Read	10 mrem
	12 months	Read	10 mrem
Milk	6 L	I-131	0.5 pCi/l
Milk	1 L	γ Spec.	25 pCi/l/Isotope
	2 L	Sr-89,90	1 pCi/l
River Benthos, Fish Plants	0.5 Kg	γ Spec.	100 pCi/kg
Vegetation I	1 Kg	γ Spec.	100 pCi/Kg/Isotope
Vegetation II	1 Kg	γ Spec.	100 pCi/Kg/Isotope
Soil		γ Spec.	200 pCi/Kg/Isotope
WATERBORNE			
River Water	4 l	γ Spec.	25 pCi/l
River Water	1 l	Sr-89,90	5 pCi/l
River Water	1 l	H-3	200 pCi/l

6

TABLE 6.2.1.2-8 (cont.)

	Sample Size	Analysis	Sample Sensitivity
Aquatic Vegetation	1 Kg	γSpec. Sr-89,90	100 pCi/Kg/Isotope 5 pCi/Kg
Benthos	.5 Kg	γSpec. Sr-89,90	100 pCi/Kg/Isotope 5 pCi/Kg
Fish	1 Kg(tissue)	γSpec.	100 pCi/Kg/Isotope
River Sediment	1 Kg	γSpec. Sr90	100 pCi/Kg/Isotope 50 pCi/Kg
Groundwater	4 1	γSpec. H-3	25 pCi/1/Isotope 100 pCi/1

6

TABLE 6.2.1.2-9

FORM OF DATA PRESENTATION

For each sample:

Medium (Material) ______________________

Type of Analysis ______________________

Date Sampling Began ______________________

Date Sampling Ended ______________________

Date Counted, or Measured ______________________

Value ______________________

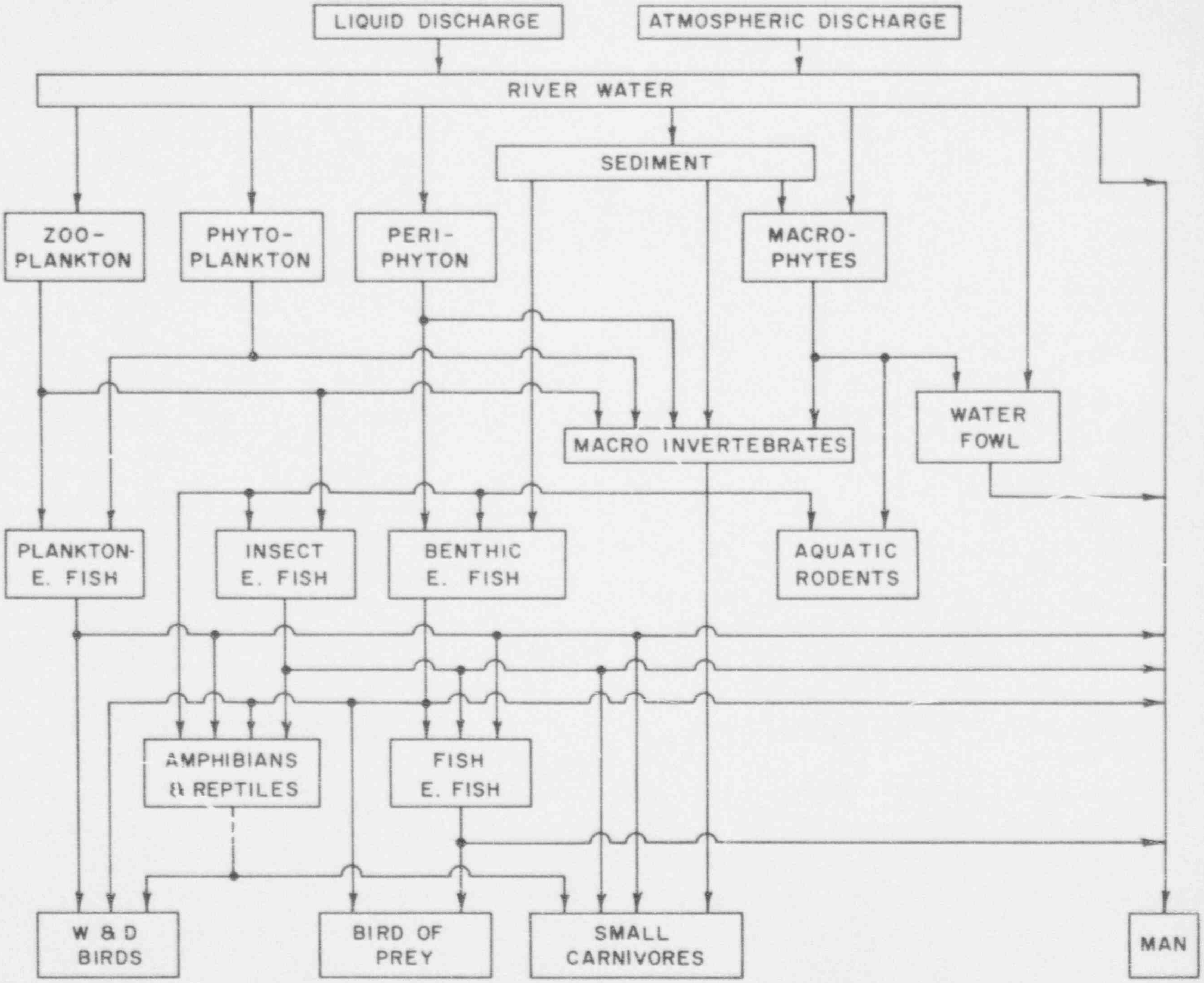
For each set of samples:

	Indicator Stations	Background Stations
$\overline{X}$		
S		
N		
F_{cal}		
F_{table}		
t_{cal}		
t_{table}		

If $t_{cal} < t_{table}$, the difference =

If $t_{cal} > t_{table}$, the minimum detectable difference =

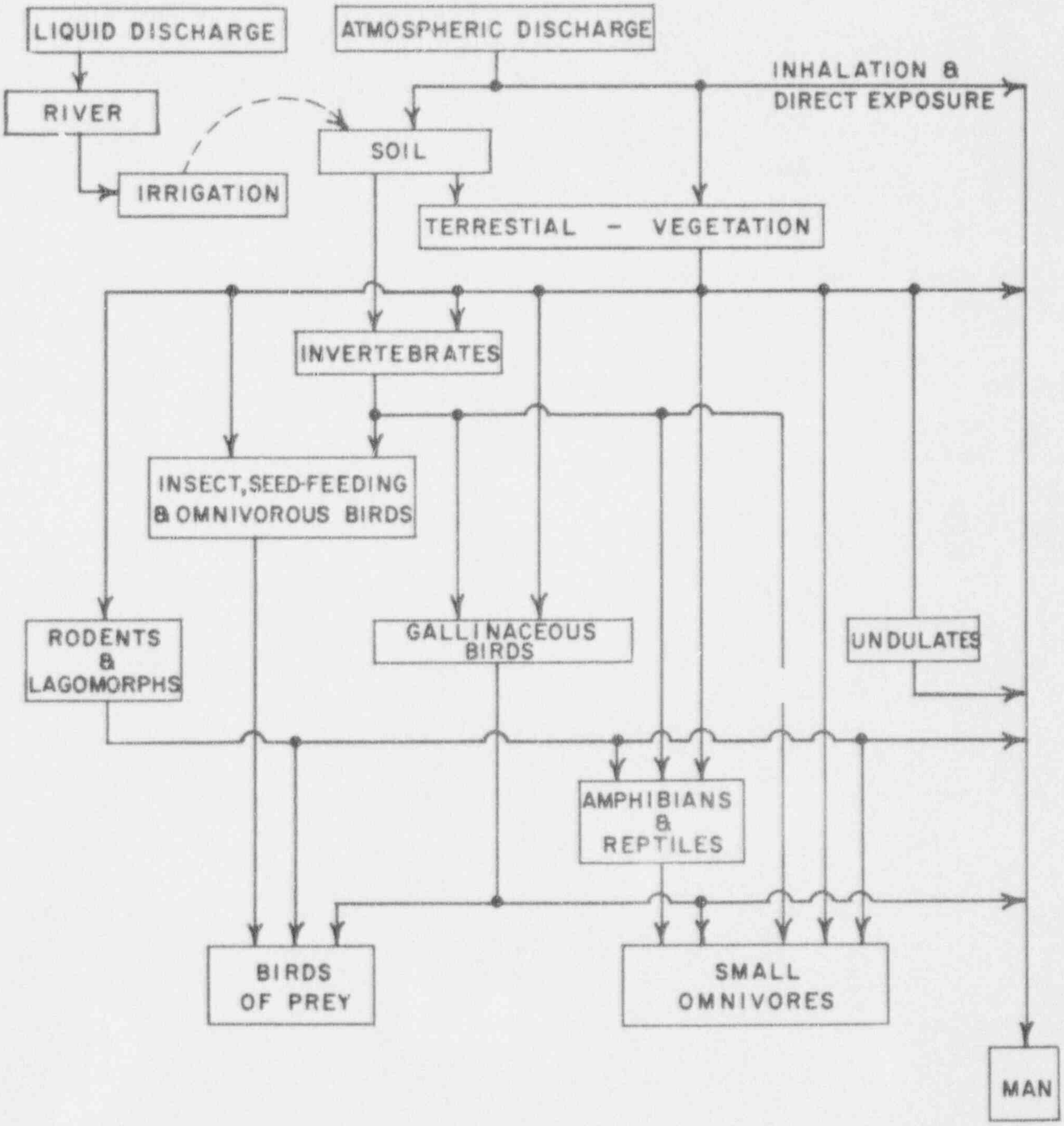
The corresponding dose =



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

PRINCIPAL FOOD PATHWAYS IN THE AQUATIC ENVIRONMENT OF THE FARLEY SITE

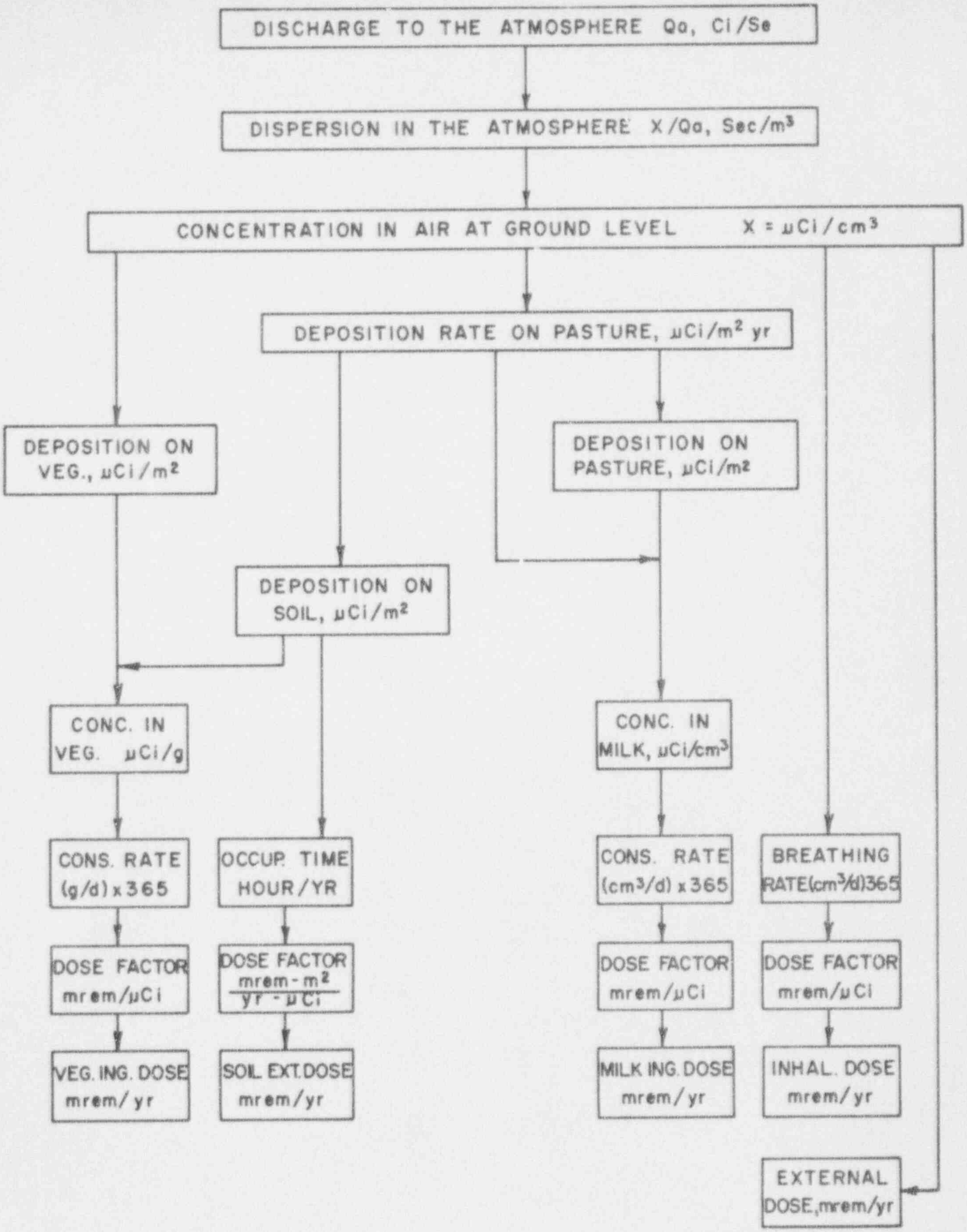
FIGURE 6.2.1.2-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

PRINCIPAL FOOD PATHWAYS IN THE TERRESTRIAL ENVIRONMENT OF THE FARLEY SITE

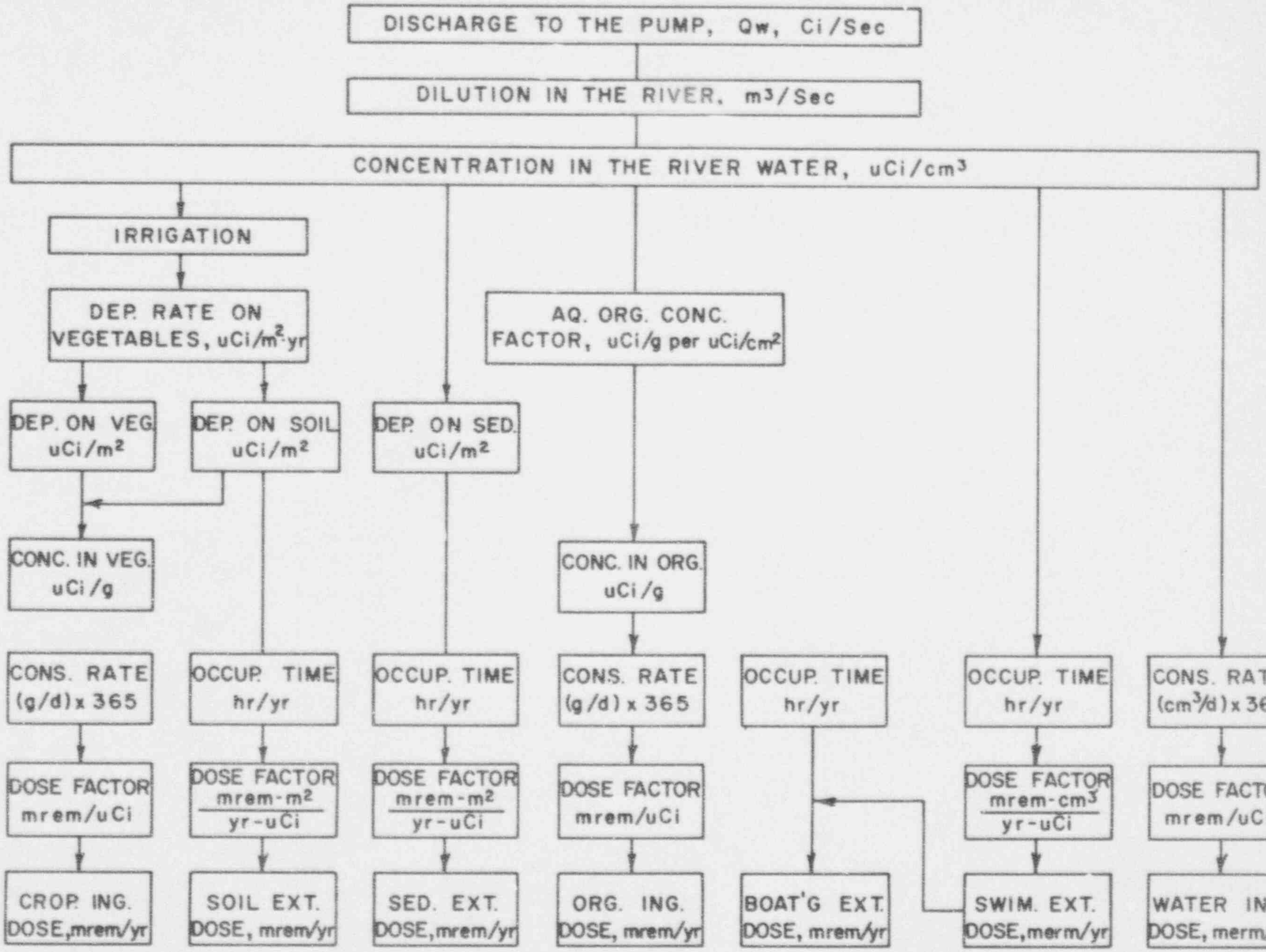
FIGURE 6.2.1.2-2



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

CALCULATIONS OF HUMAN DOSES RESULTING FROM DISCHARGES TO THE ATMOSPHERE

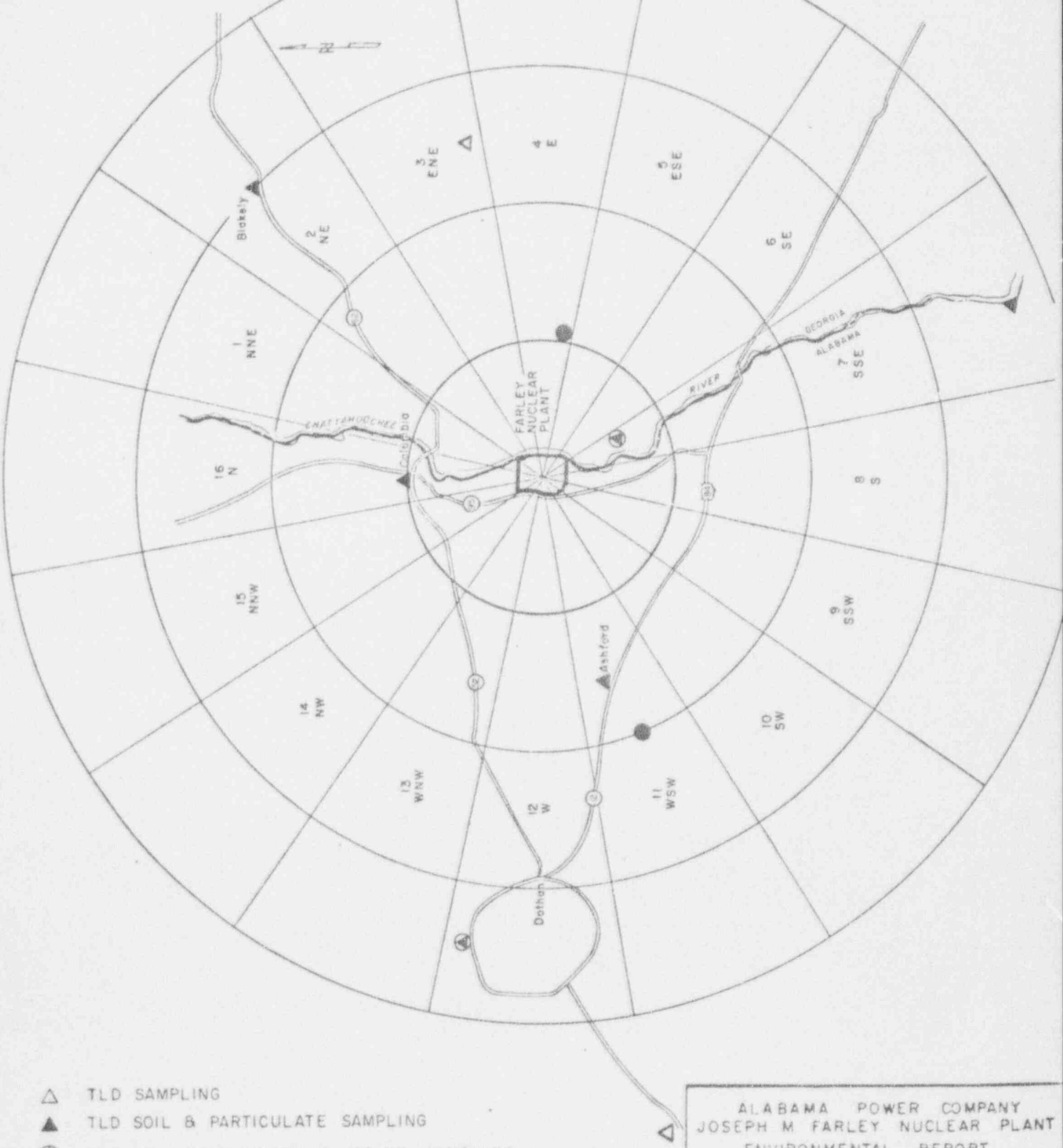
FIGURE 6.2.1.2-3



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

CALCULATIONS OF HUMAN DOSES RESULTING FROM DISCHARGES TO THE RIVER

FIGURE 6.2.1.2-4

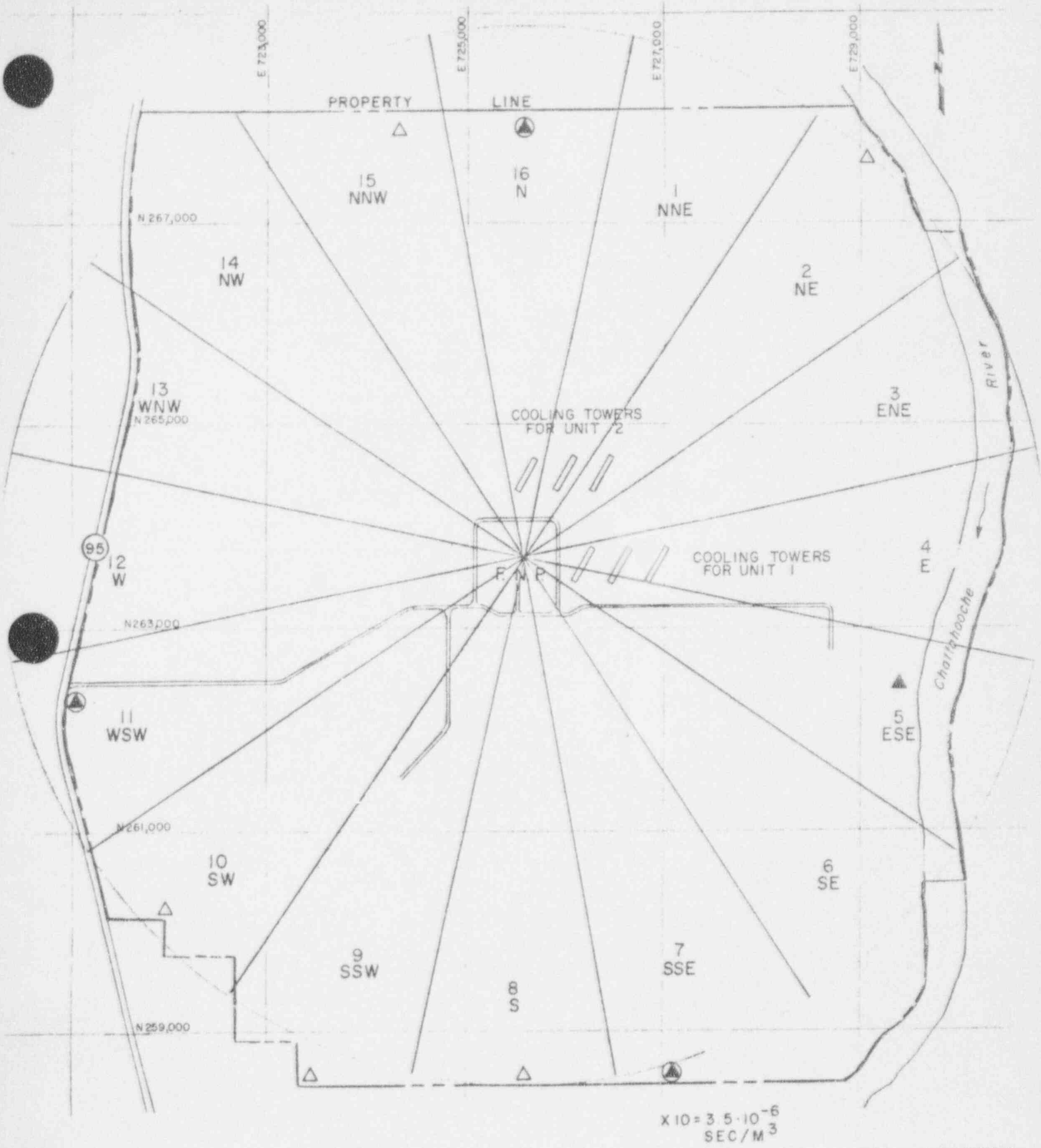


△ TLD SAMPLING
▲ TLD SOIL & PARTICULATE SAMPLING
◬ TLD SOIL, PARTICULATE & IODINE SAMPLING
● MILK SAMPLING

Amend. 6 - 7/28/75

ALABAMA POWER COMPANY
JOSEPH M FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

LOCATION OF THE OFF-SITE AIRBORNE RADIOLOGICAL SAMPLING STATIONS
Figure 6.2.1.2-5



△ TLD and Soil Sampling

▲ TLD, Soil and Particulate Sampling

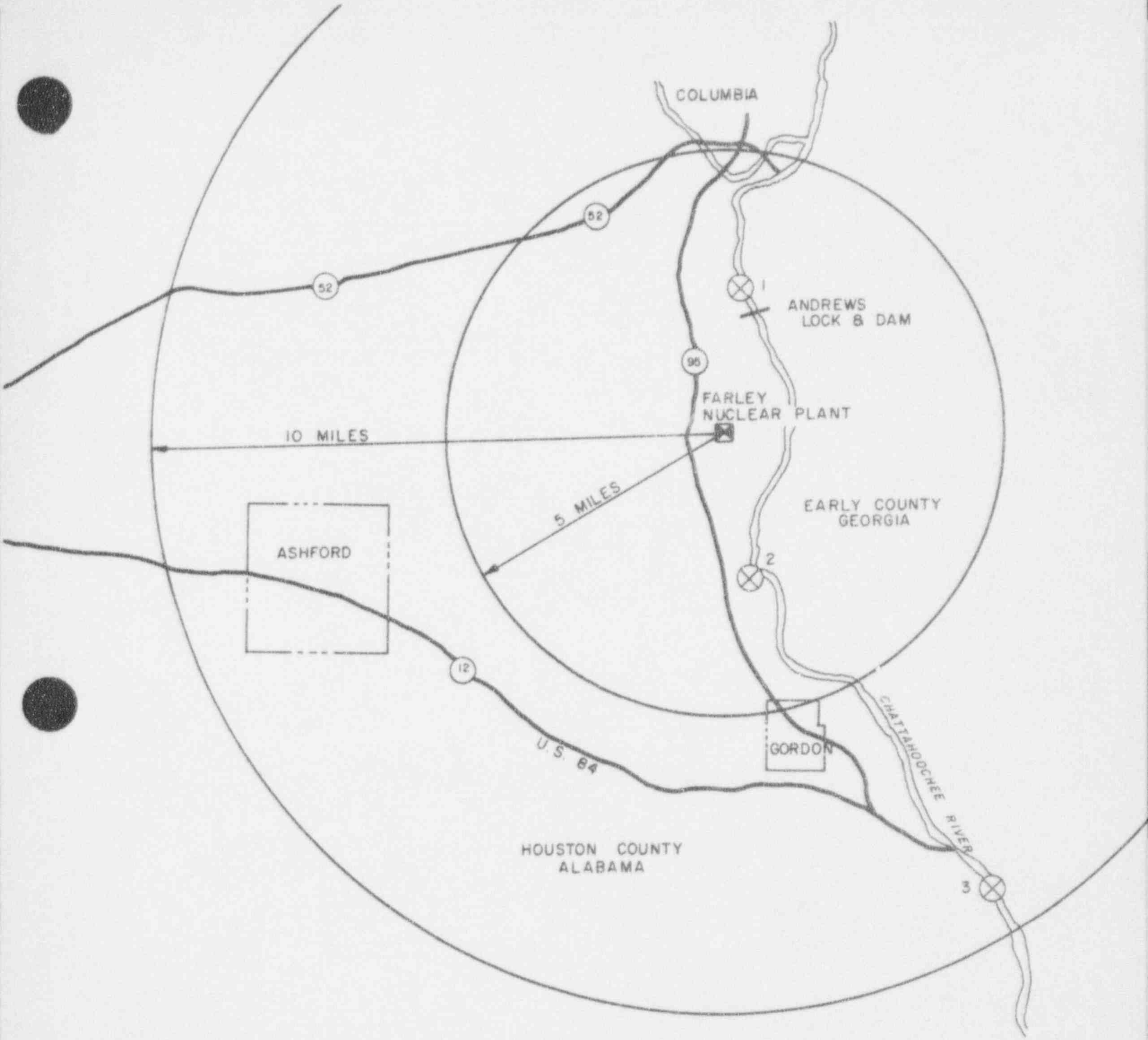
◬ TLD, Soil, Particulate and Iodine Sampling

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

LOCATION OF THE PLANT PERIMETER AIRBORNE RADIOLOGICAL SAMPLING STATIONS

Figure 6.2.1.2-6

Amend. 6 - 7/28/75



1. WATER, FISH, SEDIMENT, BENTHOS AND VEGETATION
   a) BENTHOS AND VEGETATION WILL BE COLLECTED AT THE FIRST LOCATION WHERE THEY OCCUR, ABOVE ANDREWS LOCK AND DAM.
2. WATER, FISH, AND SEDIMENT
3. BENTHOS AND VEGETATION
   b) BENTHOS AND VEGETATION WILL BE COLLECTED AT THEIR FIRST LOCATION OF OCCURANCE, BELOW SAMPLE SITE # 3.

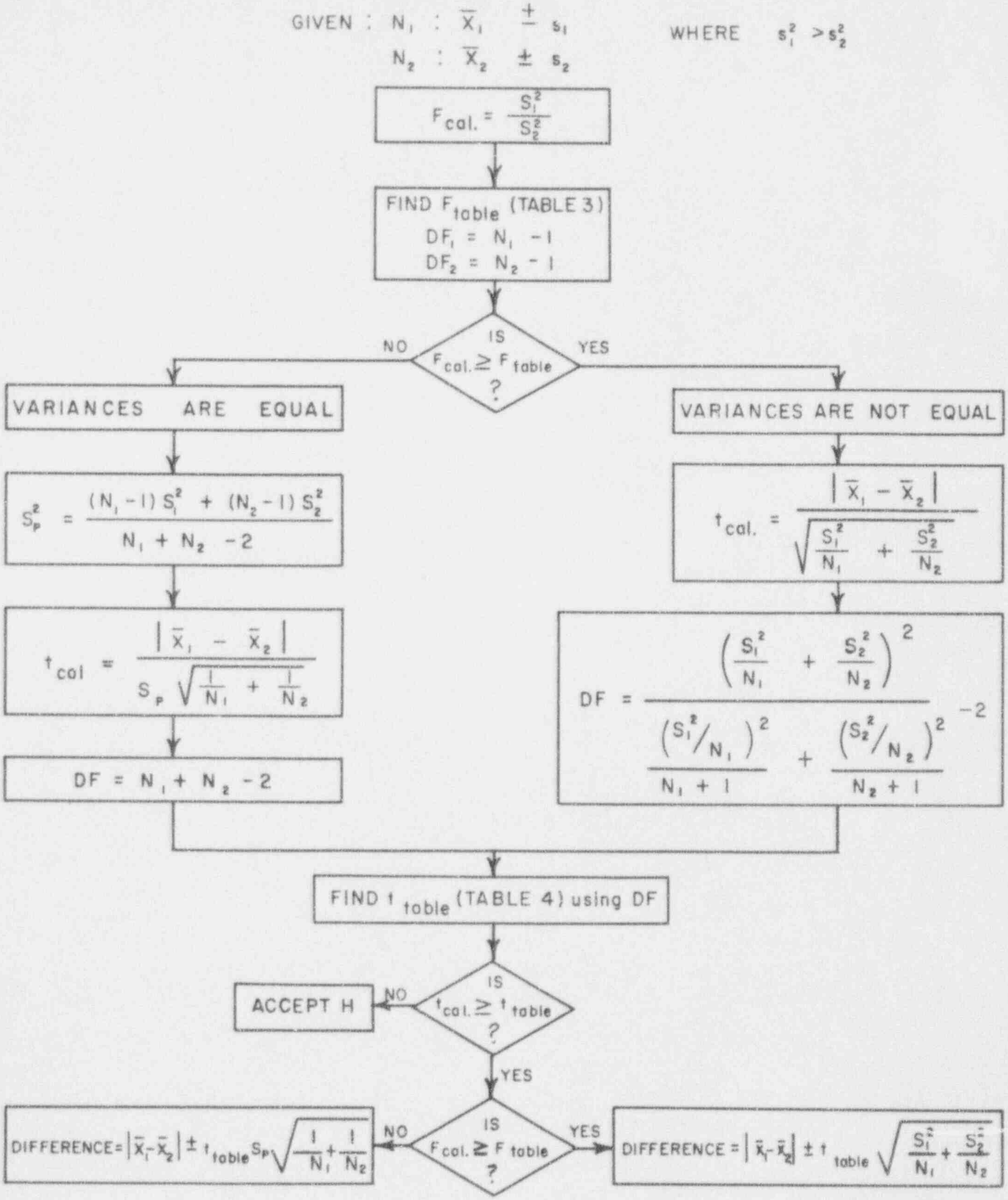
Amend. 6 - 7/28/75

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT

LOCATION OF OFF-SITE WATERBORNE
RADIOLOGICAL SAMPLING STATIONS

FIGURE 6.2.1.2-6a

TEST THE HYPOTHESIS (H): There is no difference between $\overline{X}_1$ and $\overline{X}_2$ at the 99% confidence level.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

FLOW CHART OF THE F-TEST (ANALYSIS OF VARIANCE) AND THE t-TEST

FIGURE 6.2.1.2-7

6.2.2 CHEMICAL EFFLUENT MONITORING

Table 5.4-1 is a listing of chemicals in the discharge from the Farley Nuclear Plant. This list gives the basic parameters to be included in the chemical effluent monitoring program for the pre-operational and operational stage. In addition, the following parameters will be analyzed: 6 pH, temperature, dissolved oxygen, BODs, and conductivity.

The pre-operational chemical monitoring program began on March 1, 1975 which is more than one year prior to Unit No. 1 operation. The operational program will be conducted for 1 year after unit #1 goes critical and for one year after Unit No. 2 goes critical. Under the present schedule, the total program will last about four years. Table 6.2-1 shows the sampling station locations and sampling frequency for the chemical effluent monitoring program.

In addition to the above sampling program, the discharge line will have a continuous chlorine monitor as discussed in Section 5.4.

6.2.2.1 METHODOLOGY

Grab samples for chemical analysis will be collected in midstream at a depth of 5 feet using best field practice. Field measurements for pH, 6 dissolved oxygen, temperature, chlorine and conductivity will be made at the time of sample collection.

Chemical analyses will be performed by Alabama Power Company personnel. All analyses will be performed in accordance with standard testing procedures.

6.2.2.2 MODIFICATIONS DURING OPERATIONAL PHASE

The sampling locations and frequency shown in Table 6.2-1 may be modified during the operation phase if necessary to obtain more meaningful results.

TABLE 6.2-1

SAMPLING STATIONS ON THE CHATTAHOOCHEE RIVER

Stations and Nearest River Mile	Sample and Frequency
River Mile 46 (Between the intake and Andrews Lock and Dam)	1a, 1b, 2a, 3, 4a, 4c, 5a, 5b
River Mile 43.7 (Intake area)	1b, 2b, 4b, 4c, 5b
River Mile 43.5 (Discharge area)	1b, 2b, 3, 4a, 4c, 5b
River Mile 41 (Smith's Bend)	1a, 1b, 2a, 3, 4a, 4c, 5a, 5b

Sample and Frequency Code

1. Thermal - a. Monitoring during pre-operational phase
   b. Monitoring during operational phase 6
2. Plankton - a. Quarterly
   b. Monthly for entrainment during plant operation
3. Benthos and Macroinvertebrates - Quarterly
4. Fish - a. Quarterly for thermal effects
   b. One 24-hour period weekly for impingement during plant operation
   c. Larval fishes will be collected at two week intervals during mid-March through June
5. Chemical and Water Quality
   a. All parameters monthly during pre-operational phase
   b. All parameters monthly during plant operation

6.2.3 THERMAL EFFLUENT MONITORING

Recording thermographs (temperature range of 50° F to 110° F and accurate to the nearest 2° F) will be used to obtain river temperature data, including that in the vicinity of both the intake and discharge. These instruments consist of self-contained, encapsulated, clock-driven mechanisms which draw pressure sensitive tapes under pen arms and wind the tapes around spools. The tapes must be changed every 30 to 45 days and the clock mechanisms rewound.

Table 6.2-1 shows the locations of the sampling stations on the Chattahoochee River. The monitoring program began on March 1, 1975, which is more than one year prior to Unit No. 1 operation, and will be conducted for one year after Unit No. 1 goes critical and for one year after Unit No. 2 goes critical. During the preoperational period, thermographs will be maintained near River Mile 46 and River Mile 41. A thermograph will be suspended at a depth of five feet at each of these stations. 6

Adjustments will be made in the thermal monitoring program when the plant becomes operational. Additional thermographs will be installed and maintained near River Mile 43.7 (intake) and near River Mile 43.5 (discharge). 6 The mixing zone will be defined by thermal mapping surveys made during summer flow periods. Stations near River Mile 43.5 will be located to monitor the mixing zone. Thermographs will also be used to provide a means of relating water temperature to the biota collected for ecological monitoring (See Section 6.2.5).

The thermal and ecological data collected will be analyzed for any possible significant effects associated with plant operations. If adverse effects are noted, the applicant will analyze the effects and determine a course of action to alleviate those attributed to plant operation.

6.2.4 Meteorological Monitoring

The meteorological monitoring program presently being conducted
at the Farley Nuclear Plant is described in Section 2.6. This monitoring
program will be continued after plant start-up. This program will provide
the data required complying with condition 2 of the Farley Construction Permit.
In addition to the present monitoring program, in order to better define the 6
natural moisture conditions at the site, the applicant has installed thermo-
electric dewpoint cells at two elevations on the site meteorological tower.
The dewpoint and dewpoint gradient data will be used as input to analytical
plume dispersion models as they become available. The data will also be
used to compare site moisture conditions with those at the Dothan Airport.
Also a program for the observation of fogging conditions in the vicinity
of the plant site shall provide supplementary input to the dew point data 6
for assessing fogging conditions. This program shall consist of daily
visibility observations during the hours of the day for which fogging
conditions are most likely to develop.

6.2.5 ECOLOGICAL MONITORING

6.2.5.1 Aquatic

Table 6.2-1 outlines the combined thermal-aquatic ecological sampling program on the Chattahoochee River. The sampling program is divided into two phases: preoperational and operational. During the preoperational phase (at least 12 months prior to operation of Unit No. 1) biota will be sampled quarterly near River Mile 46 (approximately 0.8 mile below Andrews Lock and Dam), 43.6 (intake and discharge area), and 41 (Smith's Bend) for background data and seasonal variability.

Operational monitoring will be conducted for one year after Unit No. 1 becomes operational and for one year after Unit No. 2 becomes operational. Biota will be sampled near River Miles 46, 43.5 (discharge), 43.7 (intake) and 41 (Smith's Bend). Sampling stations downstream of the discharge may be adjusted in accordance with the findings of the thermal profile studies and the determination of the mixing zone. The stations downstream from the nuclear power plant will be monitored on both sides of the river to determine the effect of temperature in the mixing zone on biota. 6

Plankton

Both zooplankton and phytoplankton will be collected using a pump sampling technique. Periodic diurnal sampling will be carried out to account for possible plankton pulses. Pump samples will be taken for specific time intervals at each station to standardize the sampling procedures and provide uniform data for analyses. The preserved samples will be processed in the laboratory. Organisms will be identified with the proper references and keys to the appropriate taxon and will be enumerated under a microscope using a standard type counting cell. Species diversity will be determined and related to the temperature at each station. Data will be evaluated, and analyzed to assess possible effects on biota.

Macroinvertebrates

A total of six multiple-plate samples will be set at each location to collect aquatic macroinvertebrates on a quarterly regime. Six samplers will be set to provide enough data for analyses and allow for sampler attrition. The samplers will be suspended at a depth of five feet near shore where these organisms are found. During the preoperational and operational phases samples will be obtained along both the east and west banks. 6

Upon retrieval, the samplers will be placed in individual plastic bags and labeled. After being sorted and processed, organisms will be preserved in labeled jars. Organisms will be identified to the proper taxon and enumerated. Species diversity will be calculated for each station. The data will be evaluated and analyzed to assess any possible impact on these organisms.

Larval Fish

There are no specific data on fish eggs or larvae concentrations in the Chattahoochee River near the Farley Nuclear Plant. The preoperational monitoring program will provide data to substantiate estimates of losses due to entrainment given in the Construction Permit Stage Environmental Report.

Larval fish will be collected at two week intervals during the major spawning season (mid-March through June). Collections will be made during both the preoperational and operational sample periods. Preoperational monitoring will include sampling during at least one spawning season 12 months prior to plant start-up.

Larval fish will be sampled utilizing a plankton net with attached flowmeter. Samples will be taken at depths of 1.5, 3, and 4.6 meters in the vicinity of Chattahoochee River Miles 46 (approximately 0.8 mile below

Andrews Lock and Dam), 43.5 (discharge area), and 41 (Smith's Bend). An additional sample point will be located in the intake canal during the operational monitoring period. Larval fish collected shall be identified to the appropriate taxon, and the results expressed quantitatively as number of fish per cubic meter of water sampled. Data obtained from this study will be used to assess the impact of entrainment on larval fish populations.

Adult Fish

Fish populations will be sampled quarterly during both the preoperational and operational sample periods. Fish will be collected primarily by electrofishing, however, gill nets and hoop nets may be used if conditions are suitable. Sample areas for fish will be in the vicinity of Chattahoochee River Miles 46 (approximately 0.8 mile below Andrews Lock and Dam), 43.5 (discharge area) and 41 (Smith's Bend). Fish will be collected on both the east and west banks of the river at each sample area. Upon collection, fish will be identified, counted, weighed, and total length measured. Condition factors and catch per unit effort will be tabulated by species. These computations will be analyzed to assess the impact of plant operation on fish populations. 6

The impingement of fishes on intake screens will be assessed beginning with the operation of Unit No. 1. Impingement studies will be conducted for one year after Unit No. 1 becomes operational, and for one year of two unit operation. Organisms impinged on intake screens will be collected during one 24-hour sample period each week. The collection of impinged organisms will be made by passing the screen wash water through a wire basket. Fish impinged on intake screens will be identified, counted, weighed, and total length measured. Data obtained from this study will be used to assess the impact of impingement on populations of aquatic organisms.

Water velocities in the intake canal and across the traveling screens will be measured during a special study. Velocities will be measured during both one and two unit operation. Data obtained in this study will provide field measurements of the design velocities, as stated in Section 5.1.3. 6

6.2.5.2 Terrestrial Monitoring

Construction of the Joseph M. Farley Nuclear Plant began in 1968 prior to the enactment of NEPA and promulgation of Environmental Report Guidelines by the NRC. Therefore, no preconstruction baseline data exists for the plant site on which to base any assessment of impact.

Alabama Power Company is currently developing plans for the utilization of portions of the site as a wildlife refuge. This program will include reforestation and the planting of vegetation to encourage the development of wildlife on the site.

Under these conditions, any attempt to obtain data on the impact due to plant construction and operation would be meaningless. There would be bias due to the lack of baseline data and due to the development of an environment conducive to wildlife habitation.

A surveillance program will be performed which will include infra-red photography of the area once every two years. The photography shall be performed during the period May to June and under similar conditions (light, scale). An initial infra-red surveillance shall be conducted prior to the beginning of Unit 1 operation to serve as a baseline for comparison of future infra-red surveillance. 6

6.3 Related Environmental Measurement and Monitoring Programs

6.3.1 River Flow Monitoring

The Farley Construction permit issued August 16, 1972 included the following requirement:

"The applicant will install gaging equipment in the Chattahoochee River in the vicinity of the facility so that continuous flow conditions of the river can be recorded."

In compliance with the above requirement Alabama Power Company has entered into an arrangement with the U.S. Geological Survey which in turn is working closely with the Georgia Environmental Protection Division to design a water flow measurement system which will satisfy the above construction permit condition.

A letter from Mr. John R. George, District Chief, USGS in Atlanta, Georgia dated December 15, 1972 contained the following summary of the status of the gaging work:

"Since May, 1972, we have accomplished the following:

1. Visited Coffeeville Lock and Dam, Tombigee River, near Coffeeville, Alabama, and observed the USGS instrumentation used to obtain flow through the structure.
2. Visited USGS deflection-gage installations at several sites in Florida.
3. Collected and analyzed 4 discharge measurements at the Farley Nuclear Plant outfall site to determine the stability of the cross-section and velocity distribution.
4. Made 1 discharge measurement at Columbia Lock and Dam, 3 miles upstream from the Farley Nuclear Plant outfall. There is essentially no tributary inflow in the reach. The measured discharge was within 6 percent of the discharge computed with the coefficients determined for the gate ratings at Coffeeville Lock and Dam.
5. Obtained and reviewed records of the dredging of the Chattahoochee River by the Corps of Engineers.

We have investigated methods of gaging the Chattahoochee River at Plant Farley as Follows:

1. Instrumentation and rating of Columbia Lock and Dam (about 3 miles upstream from Plant Farley.)
2. Slope gages
3. Deflection gages (3 types)
4. Acoustic velocity system

The most accurate and reliable method of abtaining low-flow discharge records of the Chattahoochee River in the vicinity of Plant Farley is Method 1, instrumentation and rating of Columbia Lock and Dam. Method 2 is unsatisfactory, due to lack of fall and unsteady flow conditions in the river. Method 3, while providing flow record at the plantsite, would not be as accurate or reliable as Method 1 due to effects of dredging operations, natural shifts in the stream channel geometry, debris buildup on the vanes, and possible damage from flood and river traffic. Annual station operation cost for Method 3 will be much higher than for Method 1. Method 4 is quite expensive and is considered in the experimental phase. By copy of this letter, we are informing the Environmental Protection Division, Georgia Department of Natural Resources of our recommendation. We have informally contacted the U.S. Army Corps of Engineers, regarding the installation of the recording equipment at their Columbia Lock and Dam facility and they have indicated their full cooperation."

Another letter from the USGS (attached) gives the status of the project and data recoding-telemetering interface as of May 4, 1973. Alabama Power Company is continuing to work with the USGS to assure that the data acquisition system is available for real time determination of river flow prior to plant startup.

6.3.2 Great Southern Paper Company Monitoring

At the present time, Great Southern Paper Company located downstream of the Farley Nuclear Plant on the east bank of the river near Cedar Springs, Georgia, is carrying out a water quality sampling program. Turbidity, pH, temperature, dissolved oxygen and BOD are being measured at selected stations on the Chattahoochee River on a weekly sampling interval basis. 6

Also, the state of Florida and EPA have a joint station for water quality monitoring at Neal's Landing public use area, owned by the U. S. Corps of Engineers near Highway 2 bridge in the state of Florida. 6

Amend. 6 - 7/28/75

COPY

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
900 Peachtree Street, N.E., Room 301
Atlanta, Georgia 30309

May 4, 1973

Mr. Terry G. Arnold
Alabama Power Company
600 North 18th Street, Room 635
Birmingham, Alabama 35203

Dear Mr. Arnold:

On May 2, 1973, you requested that we furnish information regarding the general plan of streamflow data acquisition and details of the interface equipment requirements for real-time communication of data at George W. Andrews Lock and Dam, Chattahoochee River near Columbia, Alabama.

The U. S. Geological Survey was requested by the Alabama Power Company through EPD (Environmental Protection Division), Georgia Department of Natural Resources, to develop a plan to obtain low-flow (discharges less than 4,000 cfs) data of the Chattahoochee River at the A.P.Co. Farley Nuclear Plant Site, near Columbia, Ala. Gaging low flow in this reach of the Chattahoochee River is complicated by: (1) backwater from Lake Seminole, (2) power releases from Walter F. George Reservoir, and (3) lockages at Andrews Lock and Dam. After investigating various techniques, it became apparent that streamflow instrumentation at George W. Andrews Lock and Dam, which is about 3-½ miles upstream from the plant site, would provide the most reliable data. We received further support for this approach from the Mobile District, Corps of Engineers, who indicate that their Alaga gaging station (at U.S. Highway 84), which has a very poor low-water rating, could be discontinued should we establish a full-range gaging station at Andrews. The Alabama Power Company through the Georgia EPD has agreed to fund the instrumentation and operation of automatic recording equipment at Andrews Lock and Dam. The Corps of Engineers has given USGS permission to install this equipment at their facility.

The equipment is briefly described as follows:

(1) Digitizer to record gage openings at each of the four tainter gates and wiring to the control house. At each gate, the gate hoist drum is mechanically coupled to a potentiometer which is

electrically connected to a programmer located in the control house.

(2) Lockage digitizer to be installed in the bulkhead recess to record number of lockages. The digitizer, which can be easily removed when stop logs are required to be placed in the recess, will be wired to the control house.

(3) Bubble gages, housed in 4' x 4' x 7' concrete block shelters, will be needed about 600 feet upstream and downstream from the dam to record pool and tailwater elevations. These gages may be attached to the lock wall or placed on the left (east) bank, or a combination of both, and electrically connected to the programmer in the control house. The floor of the gage shelters should be above an elevation of 120 feet, msl. For bank installations, plastic tubing from the shelter to the orifice, which is to be located in the river below minimum water level, will be placed in a buried conduit for protection.

(4) Programmer and digital recorder to be located in control house to record sequentially on paper tape the individual gate openings, number of lockages, and pool and tailwater elevations.

The USGS will obtain sufficient current meter measurements of river discharge to determine discharge coefficients for the tainter gates and the open spillway. A computer program is available that will compute discharge utilizing the input data acquired on the digital tape and the discharge coefficients.

You have indicated an eventual need for real-time river flow data at the Farley plant site. Attached is a letter from our equipment specialist, Mr. H. O. Wires, which describes the interface equipment requirements between our central console (programmer) to a telephone line. If your equipment personnel require additional information in this regard, please have them contact Mr. Wires directly at the address shown on the head of the attached letter, or at telephone number (601) 688-4180.

As we have previously indicated, the USGS program for converting the gate opening, lockage, and water-level data to river flow data will be made available to Alabama Power Company for conversion to your computer system. Thus, by interfacing the recording equipment at Andrews to a telephone line to Plant Farley and Converting the USGS program to your system, real-time river discharge data can be made available at the nuclear plant.

If you need clarification or additional data, in this regard, please let me know.

Sincerely,

For the District Chief

Harold G. Golden
Hydrologist

attachment

COPY

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
GULF COAST HYDROSCIENCE CENTER
Mississippi Test Facility
Bay St. Louis, Mississippi, 39520

March 12, 1973

Memorandum

To: District Chief, WRD
Atlanta, Georgia

From: Chief, Instrument Development Laboratory

Subject: EQUIPMENT & SUPPLIES - Remote Interrogation of Instrumentation at George Andrews Lock and Dam, Chattahoochee River

Reference Mr. Golden's telephone inquiry of March 9 concerning the need for remote interrogation of the discharge instrumentation we proposed by memo of January 24, 1973, for the George Andrews Lock and Dam on the Chattahoochee River.

We can provide an output from the parameters of headwater, tailwater, four gate openings and lockages to a Cannon subminiature connector on the central console chassis. The data would be presented at this connector in a serial mode, that is, serial groups of 16 parallel bits for each parameter in sequence. The sequence of parameters can be controlled by the interrogation equipment. The values read would be the actual parameter value at the time of interrogation and not the last punched values.

From this connector on, it would be best for the cooperator to arrange for the interfacing as necessary, depending upon the form in which it is needed at the terminal end and phone facilities in the locality in which it is to be used. The interface between our connector and the phone line is fairly expensive as it would have a multiplexer and coding (probably ASC11). The phone company can likely provide assistance to your cooperator in deciding the proper direction for them to take.

Several companies specialize in this type of interface equipment and we could work with them on details. For instance, a signal from our recording system would be present at the output connector whenever the recording cycle is in process, and this signal would inhibit the start of the interrogative cycle until the complection of the record cycle. Conversely, a signal should be available from the interface telemetry unit to inhibit the start of a record cycle whenever an interrogation cycle is in process.

In summary, our interface to the telemetry connector will be binary coded decimal (BCD) values of gate openings, headwater, tailwater, and lock count. Voltage and current levels are transistor-to-transistor logic (TTL) compatible and the connector a Cannon "D" subminiature DDM-50S.

In all probability, your cooperator has had occasion to interface other remote interrogation equipment and has a file of possible contractors in that area. Our project schedule is so heavy that we would be extremely reluctant to assume more than a consulting position on the interfacing.

H. O. Wires

7.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

7.1 GENERAL BASIS FOR ANALYSIS OF POSTULATED ACCIDENTS

This section evaluates the environmental impact of postulated accidents and occurrences which could occur, however remote the possibility, during the operating life of the Joseph M. Farley Nuclear Plant. The evaluation follows the guidelines given in the AEC Regulatory Guide 4.2 "Guide to the Preparation of Environmental Reports for Nuclear Power Plants", hereafter referred to as the AEC guide.(1) The results of this evaluation reveal that the consequences of the postulated accidents and occurrences have no significant adverse environmental effects.

The average natural background radiation exposure in Alabama is about 110 mrem/yr. The largest computed total body dose at the site boundary is 1.32 mrem for the large pipe break loss of coolant. The annual integrated exposure from natural background to the population within 50 miles of the plant is 43,000 man-rem. The largest computed incremental exposure to the same population from any postulated accident is 3.91 man-rem for the large pipe break loss of coolant. Thus, the exposure resulting from any accident is well within the increment of exposure to the general public from natural background.

The postulated accidents and occurrences are divided into the nine accident classes identified in the AEC guide and shown in Table 7.1-1. The environmental impact of the postulated incidents is evaluated using the assumptions contained in the AEC guide, as opposed to the conservative assumptions used in the Final Safety Analysis Report (FSAR). The radiological consequences of an accident are evaluated on the basis that average meteorological conditions and the population distribution at the midpoint of plant life exist at the time of an accident. This is considered realistic for random events.

7.1.1 EVENT CLASSIFICATION

In the following pages, typical accidents for each class are described and their consequences evaluated. Consideration of the 9 classes reveal that these classes can be conveniently grouped on the basis of their likelihood of occurrence as follows:

Class 1 through Class 5

This group deals with events which are likely to occur at one time or another during the life of the plant. The compilation of a complete list of postulated events which fall in this group, with their corresponding frequencies, is neither 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. This procedure gives timely identification of any possible cumulative effects or trends leading to unacceptable environmental effects. This also allows corrective actions (such as equipment repair, changes in procedure, frequent inspection, or temporary plant shutdown) to be taken before a significant adverse impact on the environment can occur.

Postulated occurrences as outlined in the AEC Guide for Classes 3 through 5 are considered in the following pages. Class 1 events, which are considered to consist of small spills or small leaks inside the containment, are a part of normal operation and are not considered in this accident evaluation.

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. Also, a low level of continuous leakage may be expected from components such as valve packing and stems, pump seals, flanges, etc. Infrequent increases in leakage from specific components might occur; however, these would be detected by operators and/or inplant monitoring and appropriately repaired to minimize any potential offsite effect. Liquid releases would not be released to the environment since they would be contained by the drain systems and processed by the Liquid Waste System. Gaseous releases, however, would be released to the building ventilation system and ultimately to the plant vent stack and the environment. These releases are evaluated under routine releases in Chapter 5 of this report, and are not considered in this accident evaluation.

Classes 6 and 7

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

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 FSAR. Accidents falling in this class have no significant adverse environmental effects because:

1. 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,
2. and, the expected environmental consequences if any one of the accidents were to occur are even below the limits considered safe for normal operation (10 CFR 20).

Class 9

This accident class involves hypothetical sequences of failure 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 other hand, would consider the initiation event, rupture of a Reactor Coolant System pipe, occurring simultaneously with hypothetically deteriorated performance of plant safeguards; i.e. failure of outside power supply, 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 FSAR 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 product of the occurrence frequency and the consequences of successive failures as presented in the FSAR is so minimal that the environmental risk is extremely low. Hence, it is not necessary to discuss these multiple barrier failures in this report.

7.1.2 EVENT ANALYSIS

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, manufacture, installation and operation to essentially eliminate the possibility of its occurrence, a list of the significant assumptions used in the analyses and the results of the dose calculation. 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 performed in this report are based on assessments of the performance of the nuclear plant safeguards. The values suggested by the AEC guide are used throughout. Where an additional assumption has been made, it has been clearly identified by an asterisk. Analysis of each accident requires some specific assumptions. Table 7.1-2 presents the general assumptions used in all the accident analyses.

The radionuclide concentrations in the primary and secondary coolants are required to compute the activity releases associated with coolant releases. Only the noble gases and iodine concentrations are given, since there are only gaseous releases associated with the accidents considered in this section. The filters provided in the plant are very effective in removing airborne particulates from the gaseous effluents.

The primary and secondary concentrations are based on the assumptions of the AEC guide, i.e. a fuel defect level of 0.5%, a steam generator leak rate of 20 gpd, and a steam generator blowdown rate of 10 gpm/generator. The assumptions on fuel defects and blowdown rate are not the same as those used in Section 3.5 Radwaste System. It is the intent to follow the AEC guide as closely as possible in this accident evaluation to facilitate regulatory review. This does not imply that the applicant considers the guide assumptions applicable to this plant.

The primary concentrations are given in Table 7.1-3, and the secondary concentrations in Table 7.1-4.

7.1.3 RADIOLOGICAL DOSE MODELS

Four radiological doses are calculated for each accident, the average thyroid dose at the site boundary, the average total body dose at the site boundary, the average skin dose at the site boundary, and a total dose to the population within a 50 mile radius of the site. The average site boundary total body dose includes only gamma contributions. The skin dose at the site boundary is computed from beta contributions due to the short range of beta particles. The population dose, which is a measure of the genetically significant and long-term somatic effects, is derived from the gamma contributions only.

Population data are shown in Figures 7.1-1 through 7.1-4 which were obtained from Chapter 2 of this report. It is assumed that the average off-site population that will be potentially affected by operation of the Farley Nuclear Plant can be approximated by the estimated population distribution that would exist at the midpoint of the plant's 40-year useful life. The data for 1995 were used in the figures.

Estimates of atmospheric dilution factors are shown in Figure 7.1-5 through 7.1-8. The values shown are weighted by the frequency the wind blows in each direction. These figures were used in the dose analyses and were based on on-site annual average meteorological data as discussed in Chapter 2.

The $(\frac{\chi}{Q})$ used in the site boundary doses is the average of the values at the site boundary for the sixteen directions. The average $(\frac{\chi}{Q})$ at the site boundary is 2.72×10^{-6} sec/m^3. The population dose uses the sum of the product of $\frac{\chi}{Q}$ and population for each sector in the 50 mile radius circle, which has a value of 8.07×10^{-3} man-sec/m^3. Radioactivity is assumed to be released at ground level and natural radioactive decay is not considered after the activity is released to the environment.

The models used to compute the thyroid, total body and population doses are presented below:

a. Thyroid Dose

The average thyroid dose at the site boundary is 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 released to the environment of isotope i (curies)

DCF_i = dose conversion factor of isotope i (rem/curie)

$\overline{B}$ = breathing rate of the average man (20 m^3/day)

$\overline{(X/Q)}_{S.B.}$ = weighted X/Q at the site boundary (sec/m^3)

b. Total Body Dose

The average total body dose at the site boundary is computed using the equation for a semi-infinite spherical cloud as given by:

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

where:

A_i = activity released to the environment of isotope i (curies)

$\overline{E}_{\gamma i}$ = gamma energy of isotope i (MEV/dis)

$\overline{(X/Q)}_{S.B.}$ = weighted X/Q at the site boundary (sec/m^3)

D = conversion factor = 0.25 m^3 rem/MEV

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

c. Skin Dose

The average skin dose at the site boundary is calculated from the equation below:

$$\text{Skin Dose} = D' \times \overline{\left(\frac{X}{Q}\right)}_{S.B.} \times \sum_i A_i \times \overline{E}_{\beta i}$$

where:

A_i, $(\frac{X}{Q})_{S.B.}$ are defined as above.

D' = conversion factor = 0.23 m^3 -rem/Mev

$\overline{E}_{\beta i}$ = Beta Energy of isotope i (Mev/dis)

d. Population Dose

The population dose is computed using the equation:

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

where:

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

$X/Q_{r,\phi}$ = the annual average X/Q for a given sector (ϕ) and distance (r) (sec/m^3)

$P_{r,\phi}$ = the population estimate for a given sector (ϕ) and distance (r) (men).

The values for the various parameters in the dose equations are given in Section 5.2.

7.1 REFERENCES

1. USAEC, "Regulatory Guide 4.2, Preparation of Environmental Reports for Nuclear Plants", March 2, 1973.

TABLE 7.1-1

Classification of Postulated Accidents and Occurrences

Class	Description	Accidents
1	Trivial Incidents	Small spills and leaks inside containment
2	Small Releases Outisde Containment	Small spills and leaks of radioactive materials outside containment
3	Radwaste System Failures	1. Equipment leakage or malfunction 2. Release of waste gas storage tank contents 3. Release of liquid waste storage tank contents
4	Fission Products to Primary System (BWR)	Not applicable to Farley Nuclear Plant
5	Fission Products to Primary and Secondary Systems (PWR)	1. Fuel cladding defects and steam generator leakage - considered under normal operation for expected range of variables 2. Off-design transients that induce fuel failure above those expected and steam generator leak 3. Steam generator tube rupture
6	Refueling Accidents	1. Fuel assembly drop in containment 2. Heavy object drop onto fuel in core
7	Spent Fuel Handling Accident	1. Fuel assembly drop in fuel storage pool 2. Heavy object drop onto fuel rack 3. Fuel cask drop
8	Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report	1. Loss of coolant accident - small break 2. Loss of coolant accident - large break 3. Break in instrument line from primary system that penetrates the containment 4. Rod ejection accident 5. Steamline break - small break 6. Steamline break - large break
9	Design Basis Accidents Assuming Multiple Failures	Discussion not required for this report, per the AEC guide.

TABLE 7.1-2

GENERAL ASSUMPTIONS USED FOR ALL ACCIDENT ANALYSES

1. Twenty (20) gpd primary to secondary leakage - equivalent to 167 lb/day
2. 10 gpm blowdown per steam generator
3. 0.5% Fuel defects
4. Power - 2766 Mwt
5. Primary side mass 414800 lb
6. Secondary side mass 281850 lb
7. Containment volume 2.03×10^6 ft^3
8. Containment purge rate 25000 cfm
9. Charcoal Filter efficiency (except as noted otherwise) 0.99 for all iodines
10. Condenser air ejector flow 60 SCFM

TABLE 7.1-3

AVERAGE PRIMARY COOLANT RADIOACTIVITY LEVELS**

Isotope	Concentration (μc/gm)
I-131	1.24
I-132	0.47
I-133	2.02
I-134	0.31
I-135	1.11
Kr-85	0.06
Kr-85m	1.05
Kr-87	0.59
Kr-88	1.83
Xe-133	39.00
Xe-133m	0.78
Xe-135	2.81
Xe-135m	0.11
Xe-138	0.38

**Caluclated for 0.5% fuel defects and 2766 MWt steady power operation.

TABLE 7.1-4

AVERAGE SECONDARY COOLANT RADIOACTIVITY LEVELS

Isotope	Concentration (μc/gm)**
I-131	5.42×10^{-4}
I-132	8.19×10^{-5}
I-133	5.7×10^{-4}
I-134	9.12×10^{-6}
I-135	1.73×10^{-4}

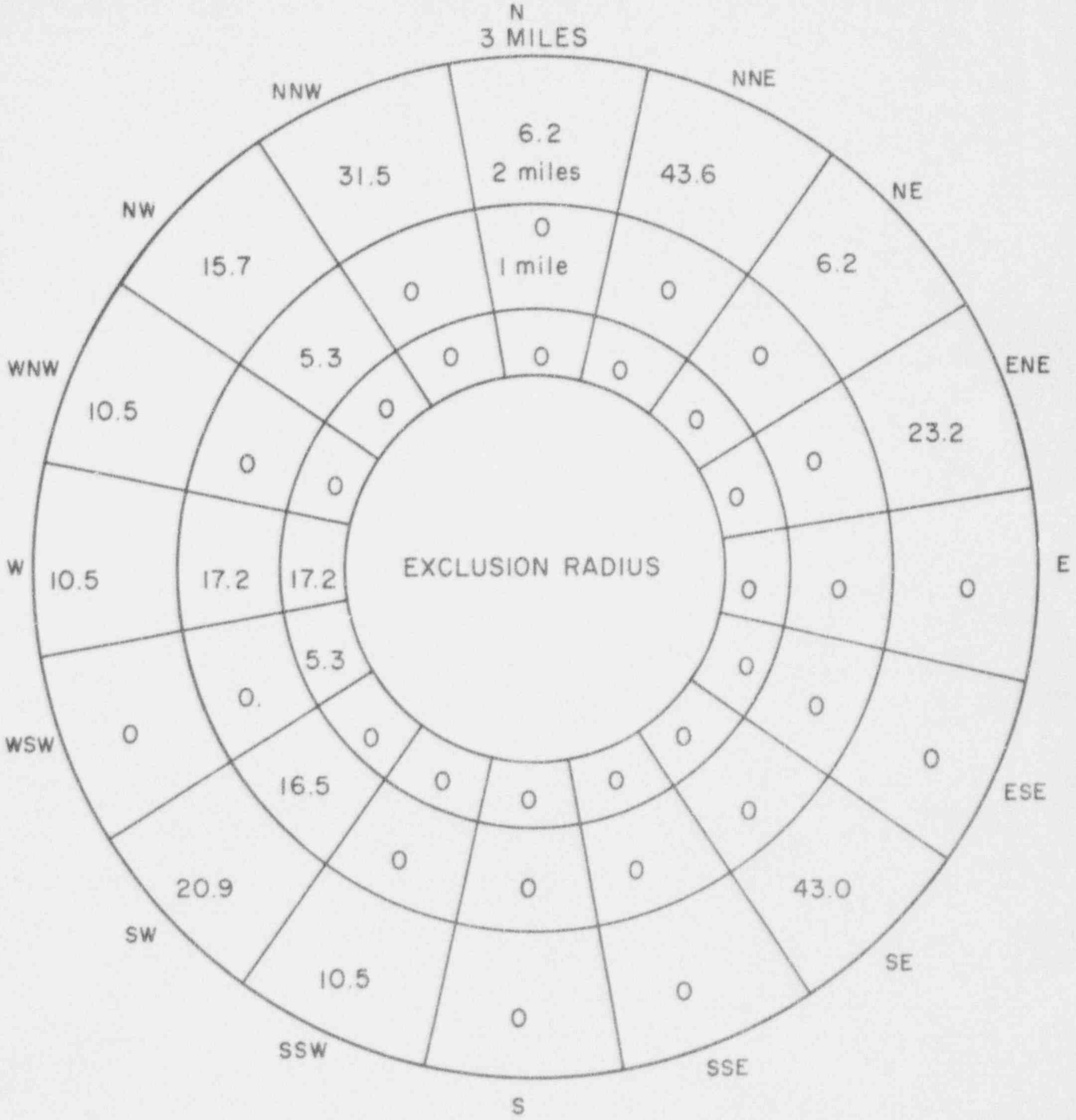
Isotope	Primary to Secondary Release Rate (μc/sec)
Kr-85	6.13×10^{-2}
Kr-85m	8.98×10^{-1}
Kr-87	5.70×10^{-1}
Kr-88	1.67×10^{0}
Xe-133	3.43×10^{1}
Xe-133m	6.62×10^{-1}
Xe-135	2.47×10^{0}
Xe-135m	8.76×10^{-2}
Xe-138	3.07×10^{-1}

**Calculated for 20 gpd primary-secondary leak rate.

10 gpm blowdown/steam generator.

Total secondary side mass of 281,850 lbs.

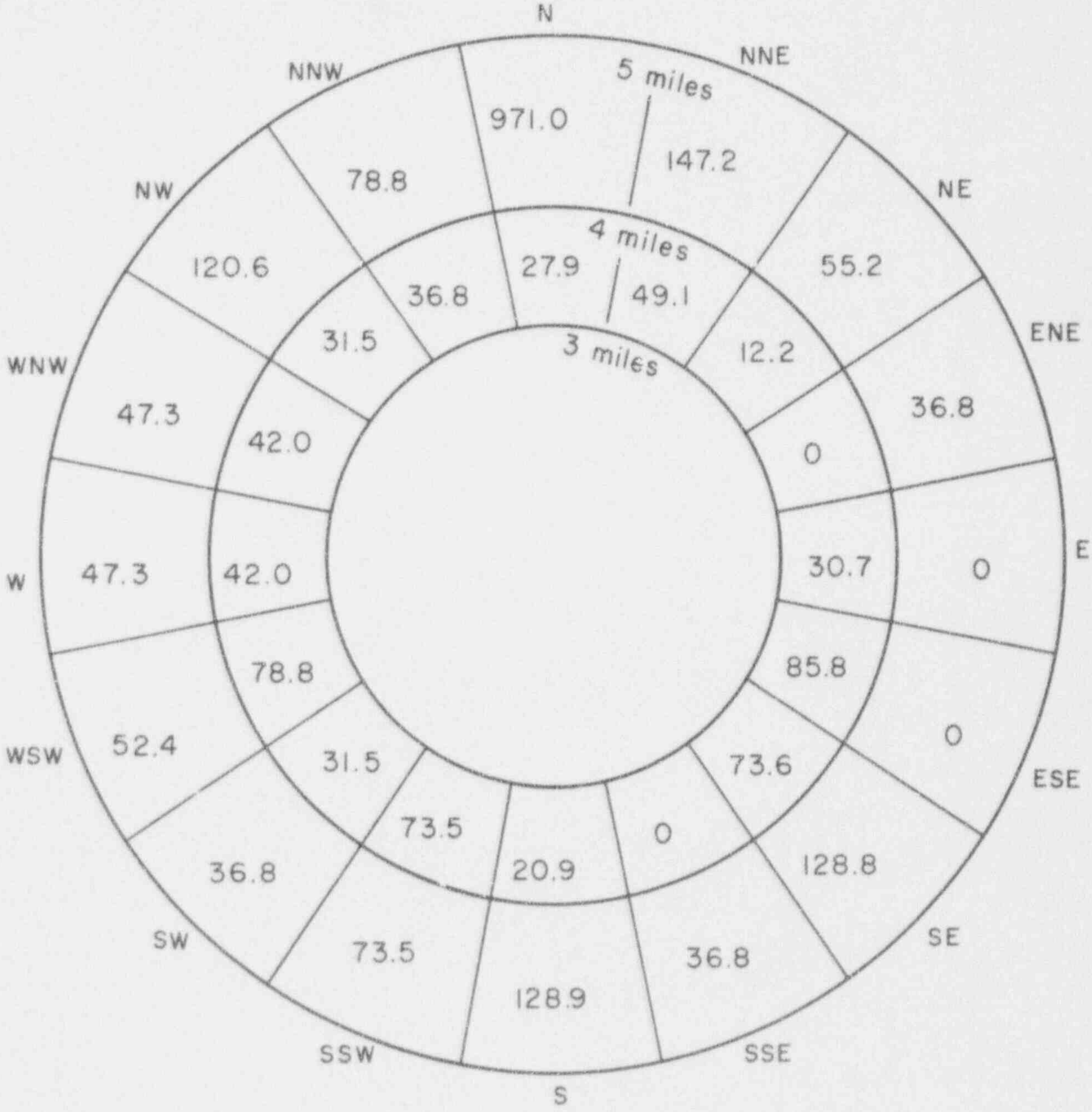
0.5% fuel defects and 2766 MWt steady power operation.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
0-3 MILES

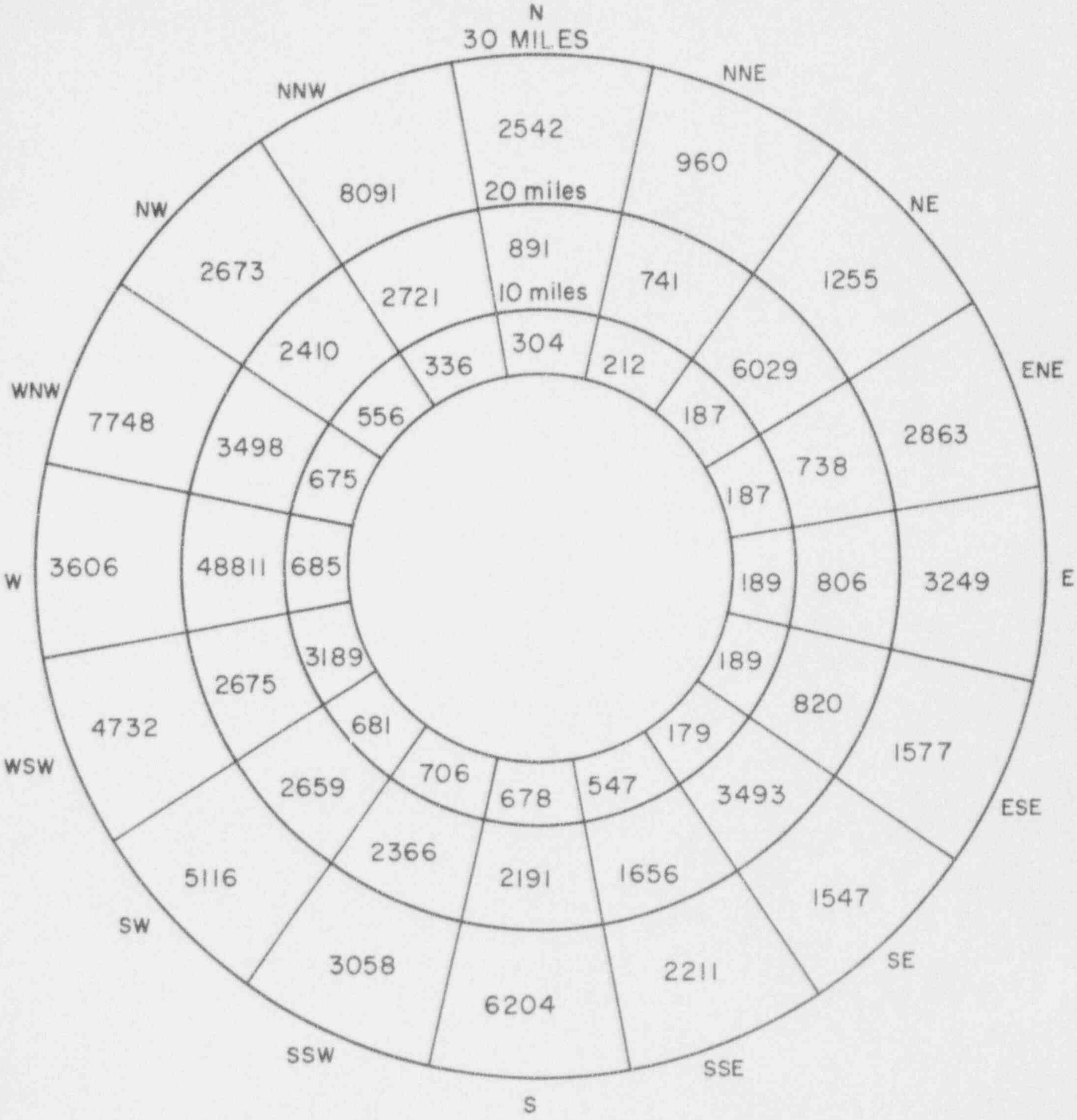
FIGURE 7.1-1



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
3-5 MILES

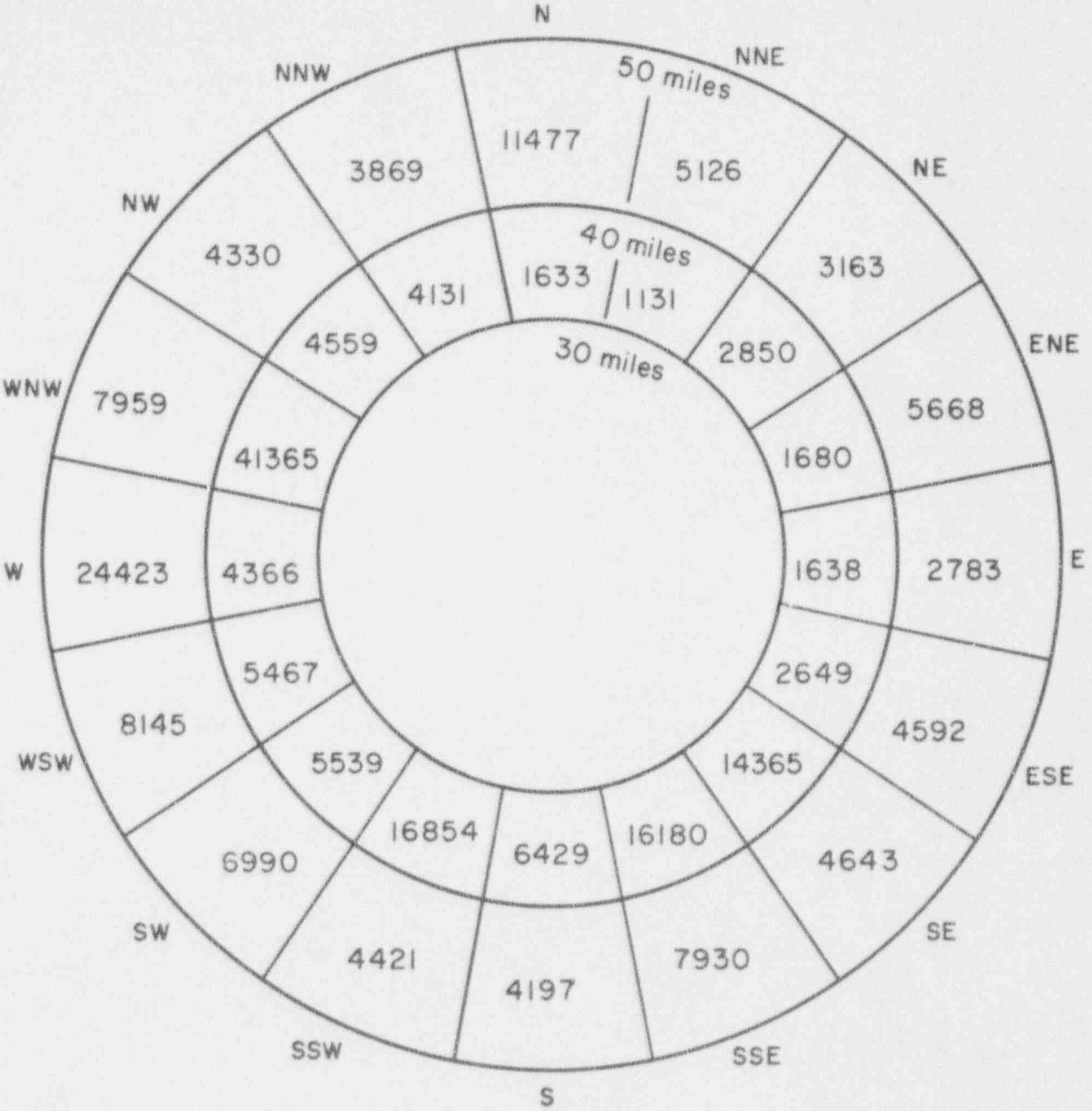
FIGURE 7.1-2



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
5-30 MILES

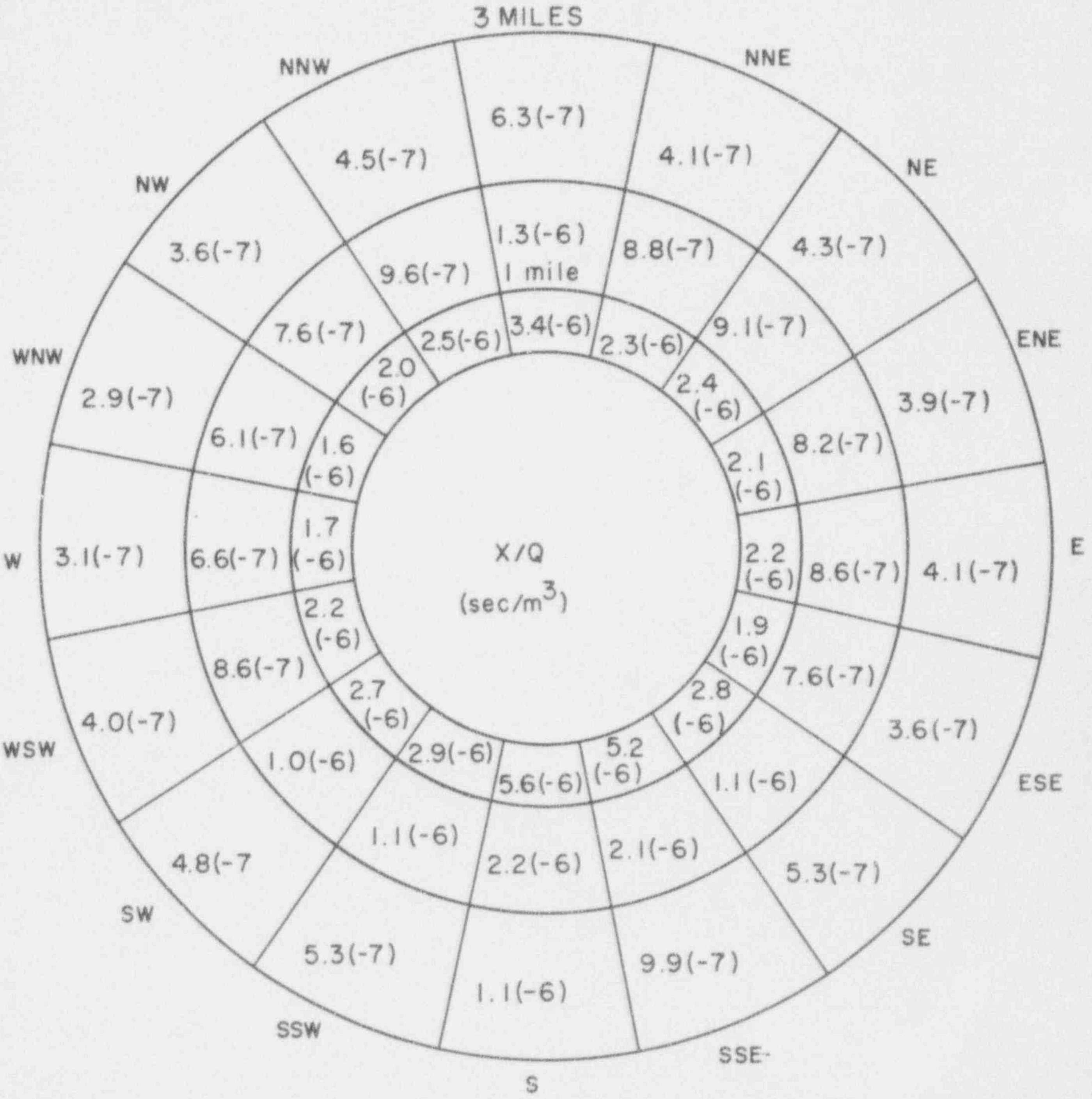
FIGURE 7.1-3



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

POPULATION DISTRIBUTION
30-50 MILES

FIGURE 7.1-4

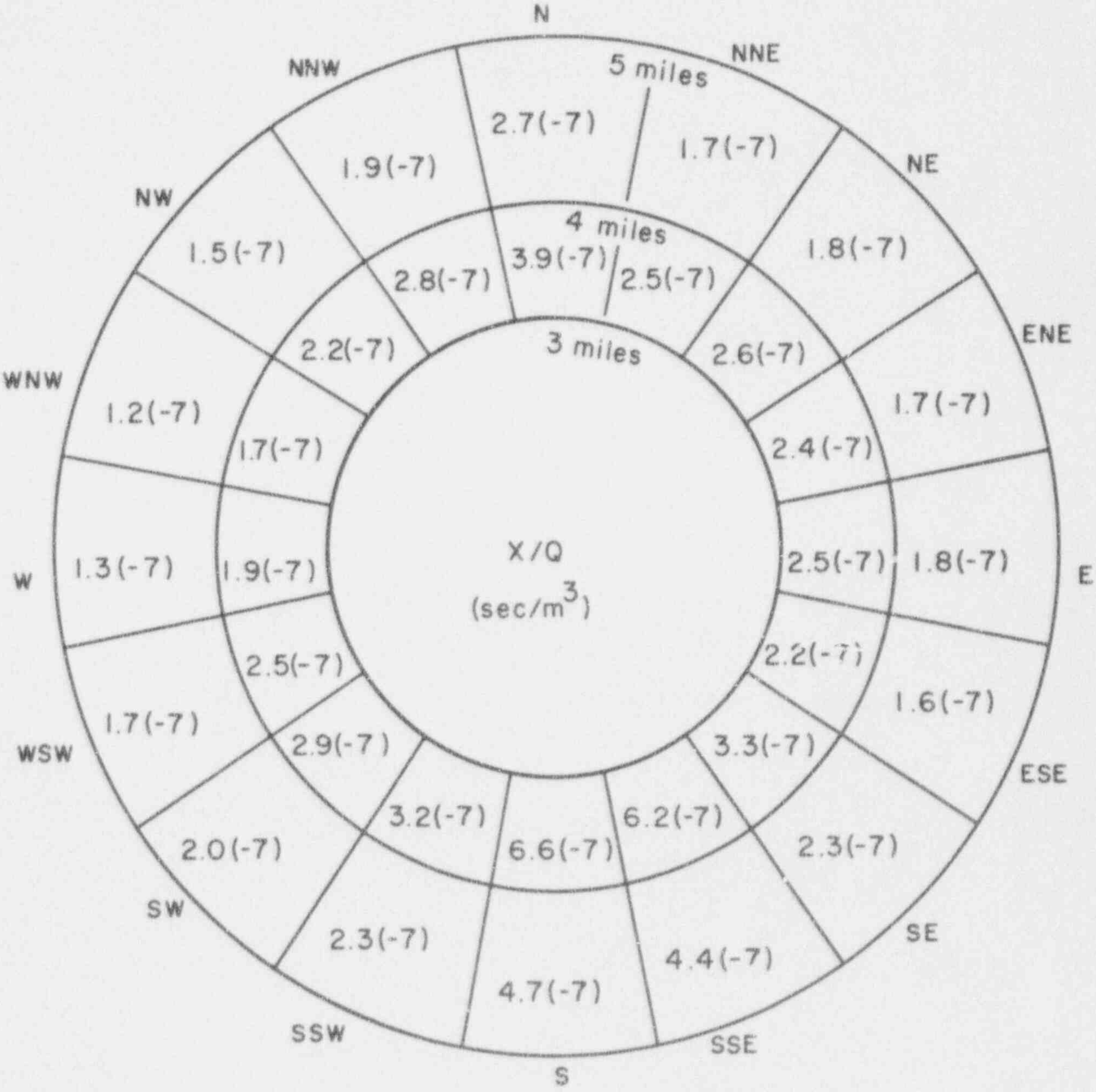


Average Annual X/Q
At Site Boundary
2.72×10^{-6} (sec/m^3)

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ATMOSPHERIC DILUTION FACTORS
0-3 MILES

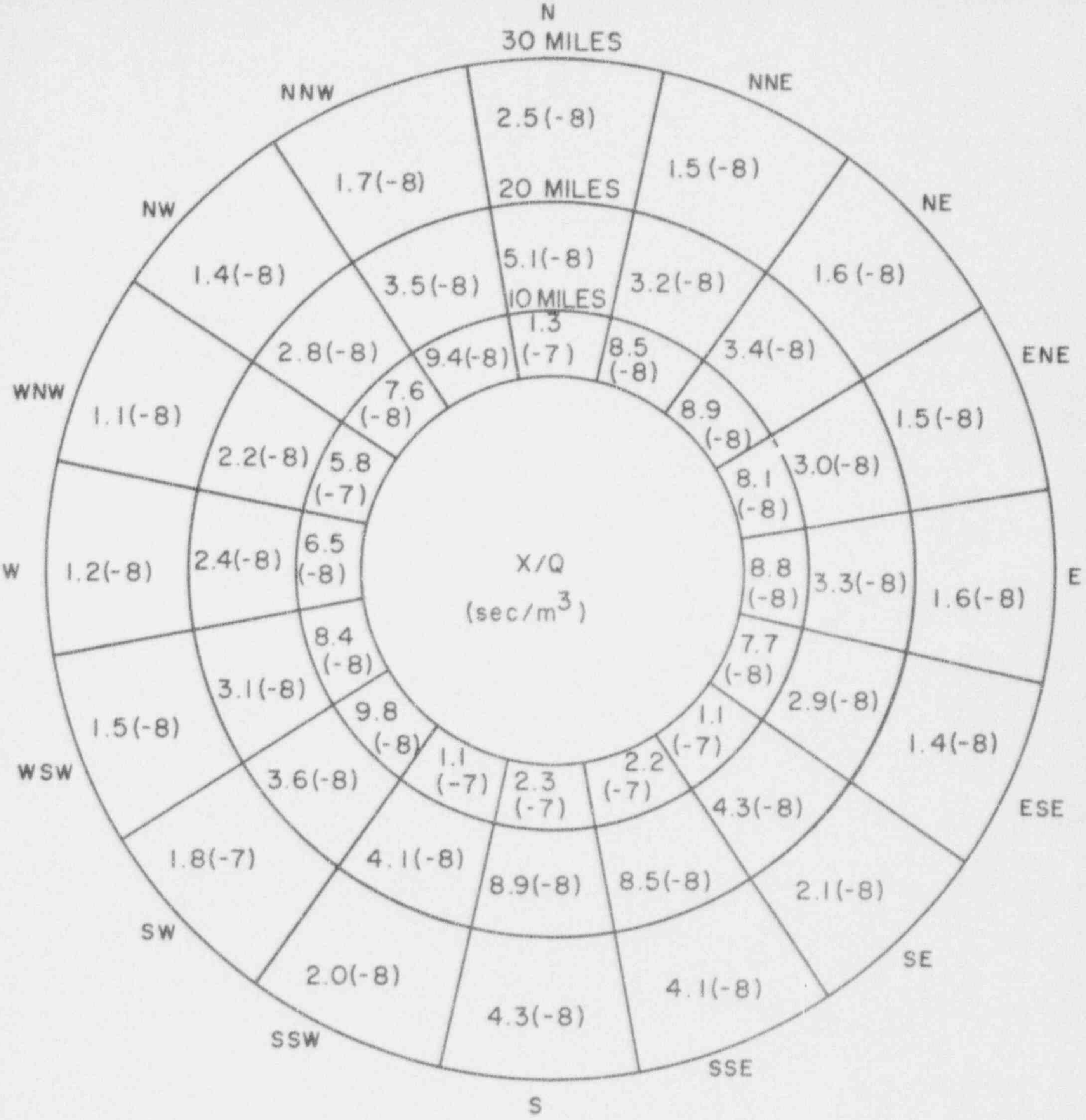
FIGURE 7.1-5



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ATMOSPHERIC DILUTION FACTORS
3-5 MILES

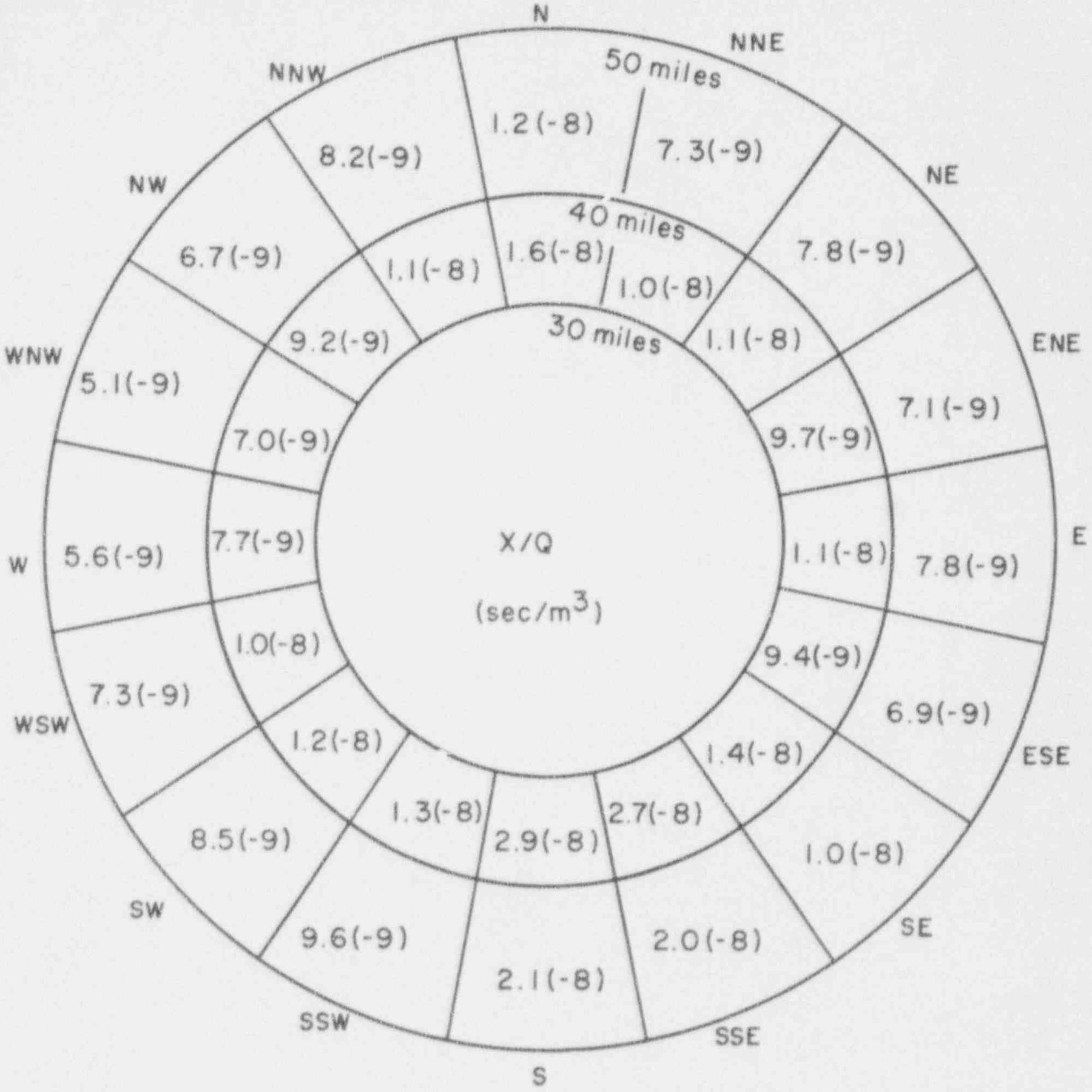
FIGURE 7.1-6



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ATMOSPHERIC DILUTION FACTORS
5-30 MILES

FIGURE 7.1-7



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

ATMOSPHERIC DILUTION FACTORS
30-50 MILES

FIGURE 7.1-8

7.2 CLASS 3 - RADWASTE SYSTEM FAILURES

7.2.1 DISCUSSION

Class 3 events cover equipment malfunction and human error which may result in the release of activity from the Waste Disposal System. A leaking 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.

7.2.2 EQUIPMENT LEAKAGE OR MALFUNCTION

This incident is defined as the release of 25 percent of the liquid and gaseous contents of the largest storage tank in the radwaste system due to equipment leakage or malfunction or operator error.

7.2.2.1 Discussion of Remoteness of Possibility

Activity release from the liquid radwaste treatment system is a highly unlikely event due to the following reasons: Primary grade radioactive liquids enter into the radwaste system and are collected in a separate channel from which there is no direct path of discharge to the environment. The channel which collects the non-primary grade liquid wastes and whose contents are discharged to the environment after treatment, is not expected to have significant activity to adversely affect the environment even if discharged without treatment. However, interlocks are provided to alarm and automatically terminate the discharges from the liquid radwaste system under these conditions.

In addition all tanks in the radwaste system that contain significant liquid radioactivity are below grade level in the auxiliary building. Therefore, all liquid release from this system would be contained in the building.

The major collection point for gaseous activity outside the containment is the gaseous waste section of the Radwaste Processing System. An equipment malfunction or error could allow initiation of activity release from a waste gas decay tank. This activity would leak into the auxiliary building atmosphere and pass through the plant vent to the outside atmosphere. The plant vent monitor would detect this radiation and transmit an alarm signal to the control room.

The six gas decay tanks used in normal operation contain the gases vented from the reactor coolant drain tank, recycle evaporator, and volume control tank.

The gaseous waste processing system is designed such that during normal operation a hydrogen recombiner will remove hydrogen from nitrogen-fission gas mixtures by oxidation to water vapor which is removed by condensation. This limits the amount of gas which is transferred to the gas decay tanks.

At beginning of life the gas decay tanks will operate under an initial pressure of 3 to 5 psig compared to a design pressure of 150 psig. The maximum anticipated pressure in any gas decay tank is not expected to exceed 50 psig.

The gas decay tanks are designed to Safety Class 3 requirements and are designed to ASME Section VIII requirements.

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 Safety Class 3 design, the possibility of an accidental release from any of the tanks is very remote.

7.2.2.2 Assumptions

The assumptions used in this accident are identical to those used in Sections 7.2.3 and 7.2.4 (Release of Waste Gas Storage Tank Contents and Release of Liquid Waste Storage Tank Contents). The only exception is that in this case only 25% of the contents of the tanks are released. In the case of the liquid waste holdup tank the doses are due to dissolved iodine released in gaseous form through the auxiliary building exhaust vent.

7.2.2.3 Doses at Site Boundary and Population Doses

The doses are one-fourth the doses calculated in 7.2.3 and 7.2.4. The values are given below:

	Gas Decay Tank Release	Liquid Waste Holdup Tank
Thyroid Dose at Site Boundary	1.41×10^{-2} mrem	1.70×10^{0} mrem
Total Body Dose at Site Boundary	2.13×10^{-2} mrem	3.22×10^{-3} mrem
Skin Dose at Site Coundary	1.99×10^{-1} mrem	1.05×10^{-3} mrem
Population Dose	6.30×10^{-2} man-rem	9.55×10^{-3} man-rem

7.2.3 RELEASE OF ALL GAS DECAY TANK CONTENTS

7.2.3.1 Event Description

The gas decay tanks are part of the gaseous waste processing system. The tanks are located outside of the containment in the auxiliary building and contain the gases vented from the reactor coolant system and volume control tank. Sufficient volume is provided to store the gases stripped during reactor shutdown. The incident evaluated is a malfunction or operator error which would allow the initiation of an activity release from the tanks. This activity would be exhausted to the plant vent by the ventilation fans. The radiation monitors would detect this release and transmit an alarm to the control room. In this event it is assumed that 100% of the contents of one gas decay tank are released.

7.2.3.2 Discussion of Remoteness of Possibility

Most of the gas received by the waste disposal system during normal operation is cover gas displaced from the chemical and volume control system. The gaseous waste processing system is designed such that during normal operation a hydrogen recombiner will remove hydrogen from nitrogen-fission gas mixtures by oxidation to water vapor which is removed by condensation. This limits the amount of gas which is transferred to the gas decay tanks.

At the beginning of life the gas decay tanks will operate under an initial pressure of 3 to 5 psig, compared to a design pressure of 150 psig. The maximum anticipated pressure in any gas decay tank is not expected to exceed 50 psig.

The gas decay tanks are designed to Safety Class 3 and ASME Section VIII requirements.

Because of the conservative design, extensive QA, the close monitoring and sampling throughout the system, and the fact that the system components are not subject to high pressure or stresses, the release of the entire contents of one of the gas decay tanks is considered highly improbable.

7.2.3.3 Assumptions

*a) Tank Volume = 600 ft^3

b) Inventory (Table 7.2-1) is based on 0.5% defective fuel

*c) Activity is released from a tank with average inventory

*d) Noble gas and halogen release.

*e) Volume control tank stripping efficiency = 0.4

*f) Twenty year operation of the plant prior to incident

g) All of tank contents are released.

TABLE 7.2-1

AVERAGE GAS DECAY TANK ACTIVITY

Isotope	Activity (curies/tank)
Kr-85	3116
Xe-133	3960
I-131	0.06

*Not specifically an assumption from the AEC guide.

7.2.3.4 Doses at the Site Boundary and Population Dose

The thyroid dose at the site boundary is 5.62×10^{-2} mrem. The total body dose at the site boundary is 8.52×10^{-2} mrem. The skin dose at the site boundary is 7.97×10^{-1} mrem. The calculated population dose is 2.52×10^{-1} man-rem.

7.2.4 RELEASE OF TOTAL CONTENTS OF LIQUID WASTE STORAGE TANK

7.2.4.1 Event Description

The waste holdup tank stores all contaminated liquids from the plant that are to be processed by the waste evaporator before discharge. The tank has a volume of 10,000 gallons and is normally filled to about 25% before processing. About 40% of the liquid in the tank is reactor coolant. The postulated incident is the release of the entire tank contents. The tank inventory is given in Table 7.2-2.

TABLE 7.2-2

WASTE HOLDUP TANK AVERAGE INVENTORY OF IODINES

Isotope	Activity (Curies)*
I-131	4.7
I-132	1.7
I-133	7.6
I-134	1.1
I-135	4.2

7.2.4.2 Discussion of Remoteness of Possibility

The waste holdup tank is located in the auxiliary building below ground level. Therefore, any liquid leakage will be contained within the building (the building is assumed to remain intact during the incident) and cannot contaminate the ground water. The piping and valving of the liquid waste processing system is such that inadvertent activation of the waste evaporator feed pump cannot result in direct discharge to the dilution line. Thus the possibility of liquid waste release is extremely remote. However dose calculations are presented for compliance with the AEC Guide.

7.2.4.3 Assumptions

a) Release of total contents of the tank

*b) Liquid volume 2500 gallons (1000 gallons is reactor coolant)

*c) Radioactive decay of contents is neglected

*d) Reduction of activity due to operation of demineralizer is not accounted for

*e) All iodines dissolved in the coolant are released in gaseous form through the auxiliary building exhaust vent

*Not specifically an assumption of the AEC guide.

f) Auxiliary building remains intact.

7.2.4.4 Doses at the Site Boundary and Population Dose

The thyroid dose, total body dose and skin dose to an individual at the site boundary are 6.70×10^{0} mrem, 1.30×10^{-2} mrem and 4.19×10^{-3} mrem, respectively. The calculated population dose is 3.85×10^{-2} man-rem.

7.3 CLASS 4 - FISSION PRODUCTS TO PRIMARY SYSTEM (BWR)

This class of incidents is not applicable to Farley, which utilizes pressurized water reactors.

7.4 CLASS 5 - FISSION PRODUCTS TO PRIMARY AND SECONDARY SYSTEMS (PWR)

7.4.1 DISCUSSION

The Class 5 events are defined as those events that transfer radioactivity from the reactor coolant into the secondary system through steam generator tube leakage, with a fraction of the transferred radioactivity in turn being released to the environment through the condenser air ejectors. Radioactivity releases to the environment resulting from the events in this class require a concurrent occurrence of the two independent events of fuel defects and steam generator tube leakage. This has occurred in some operating plants.

7.4.2 FUEL CLADDING DEFECTS AND STEAM GENERATOR LEAK

7.4.2.1 Event Description

Over the forty year life of the Farley plant, it is possible that concomitant fuel defects and steam generator tube leaks will occur. The values that would be considered in normal operation are 0.25 percent fuel defects with a steam generator leak rate of 20 gpd and a blowdown of 5 gpm/steam generator. The analyses are performed in Section 5.3 and are based on 0.25% fuel defects. However, Westinghouse PWR experience with zircaloy fuel indicates a fuel defect level less than 0.2%

If the plant is operated with fuel defects and 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. The radioactivity releases from the secondary system are proportional to the secondary system coolant activity. Since the condenser air ejector effluent is monitored with a radiation monitor, it would indicate the steam generator tube leakage and the resultant radioactivity releases. In addition, the steam generator blowdown liquid sampler monitor provides backup information to indicate primary-to-secondary leakage.

The operator must evaluate secondary system activity in terms of the plant technical specification. If the primary-to-secondary leak rate and the resultant releases were insignificant, the operator could continue to operate the plant until a convenient time is available to shut down and repair the leaking steam generator. If the releases became significant, the steam generator blowdown would be terminated and preparations made for shut down of the leaking unit.

Plant operation with up to 0.25 percent equivalent fuel defects and a 20 gpd steam generator leakage is considered routine and is not separately considered in this section on the environmental effects of accidents.

7.4.2.2 Discussion of Remoteness of Possibility

Primary to secondary leakage has occurred from time to time on operating PWR's. Operating experience has demonstrated that leakage, when it does occur, develops in a predictable fashion, and an orderly evaluation and repair is instituted in accordance with the requirements summarized in

Section 7.4.2.1. Steam generator leakage has been found to occur from two different causes; the first being due to a manufacturing technique which has been corrected, and another due to corrosive water chemistry conditions which has been eliminated by corrective operator action.

7.4.2.3 Doses at Site Boundary and Population Dose

No doses from this routine operation are presented in this accident evaluation section of the report. (See Section 5.3).

7.4.3 OFF-DESIGN TRANSIENTS THAT INDUCE FUEL FAILURE

7.4.3.1 Event Description

The Farley plant is designed so that all anticipated transients may be met with no damage to the fuel or to the plant. However, a transient is postulated which results in the release of 0.02 percent of the reactor core inventory of fission products (equivalent to 2 percent fuel defects) to the reactor coolant. A specific mechanism for this transient cannot be identified.

7.4.3.2 Discussion of Remoteness of Possibility

As discussed in Chapter 15 of the FSAR, the plant is designed to survive all Condition I and II transients with no fuel damage or loss of capability to return to full power. By definition, these transients do not propagate to a more serious fault and thus will not lead to the postulated fault. Condition III transients are faults which may occur infrequently during the life of the plant with at most the failure of a small fraction of the fuel rods.

Several of these transients are analyzed in the FSAR, including minor primary and secondary pipe breaks, inadvertent loading of a fuel assembly into an improper postion, and a complete loss of forced reactor coolant flow.

A specific transient leading to the postulated fault cannot be identified, therefore a discussion of possibilities is not possible.

7.4.3.3 Assumptions

a) Primary system equilibrium activity based on 0.5% fuel defects (Table 7.1-3).

b) Secondary system equilibrium activity based on 20 gpd leak rate and 10 gpm blowdown/steam generator (Tabel 7.1-4).

c) Additional fuel damage resulting in the release of 0.02% of the reactor core inventory of noble gases and halogens to the primary coolant.

*d) Blowdown terminated upon initiation of the transient

*e) Duration of transient is one day.

f) Steam generator halogen partition factor of $0.1 \frac{\mu c/gm \text{ steam}}{\mu c/gm \text{ water}}$ (Reference - Item 8.3 a.b. of the AEC guide).

g) Condenser halogen partition factor of $1000 \frac{\mu c/gm \text{ steam}}{\mu c/cc \text{ air}}$

*h) Air ejector flow rate of 60 scfm

*i) Radioactive decay during the transient is accounted for.

Doses at Site Boundary and Population Dose

The activity released by this incident is given in Table 7.4-1. Based on these data, the thyroid inhalation dose, the total body dose and skin dose at the site boundary are 6.84×10^{-3} mrem, 2.74×10^{-3} mrem, and 2.41×10^{-3} mrem, respectively. The population dose is 8.14×10^{-3} man-rem.

---

*Not specifically an assumption from the AEC guide.

TABLE 7.4-1

ACTIVITY RELEASE FOR INCREASED FUEL DEFECT LEVEL

Isotope	Activity (Curies)*
I-131	5.16×10^{-3}
I-132	3.16×10^{-4}
I-133	7.20×10^{-3}
I-134	7.63×10^{-5}
I-135	2.49×10^{-3}
Kr-85	0.07
Kr-85m	0.65
Kr-87	0.37
Kr-88	1.14
Xe-133	14.70
Xe-133m	0.33
Xe-135	1.70
Xe-135m	0.05
Xe-138	0.19

---

*0.02% of core inventory in primary coolant

7.4.4 STEAM GENERATOR TUBE RUPTURE

7.4.4.1 Event Description

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 air ejector. A general sequence of events following a tube rupture is as follows:

The operator would be made aware of a radioactivity release within seconds by the condenser air ejector vent monitor.

Pressurizer water level would decrease for one to four minutes before an automatic low pressure reactor trip occurs. Seconds later, low pressurizer level will automatically complete the safety injection actuation signal.

The unit trip would shut off steam flow through the turbine, open steam bypass valves and bypass steam to the condenser.

Automatic actions and cooldown procedures are as follows:

Boration by high head safety injection pumps.

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

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.

Operator-controlled steam dumping to the condenser in order to: reduce the reactor coolant temperature; maintain primary coolant subcooling equivalent to a suitable over-pressure; minimize steam discharge from the affected steam generator.

Isolation of the affected steam generator would be achieved by:

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

Closing the steamline isolation valves connected to the affected steam generator.

Terminating the feedwater flow to the generator.

7.4.4.2 Discussion of Remoteness of Possibility

The potential for catastrophic failure of a steam generator tube is considered minimal. The steam generator tubes are made of Inconel 600, a highly ductile material. The primary side design pressure is 2485 psig, and the secondary (shell) side design pressure is 1285 psig, resulting in a nominal design pressure differential across the tubes of ~1200 psi. However, the tubes have been designed to the requirements of the ASME Boiler and Pressure Vessel Code Section III Class A assuming 2485 psig as the normal operating pressure differential. Further, based on ultimate strength at design temperature, the calculated bursting pressure of a steam generator tube is ~7000 psi.

The steam generator is hydrotested at 3107 psig on the primary side and zero psig on the secondary side. The normal operating pressures are 2250 psia on the primary side and ~990 psia on the secondary, or a differential of ~1260 psi. Hence there is a large margin between nominal operating conditions and pressures which would lead to a tube rupture.

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

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.

This accident is one of the Condition IV events considered in the FSAR and should be included in this report as a Class 8 event. It is discussed here in Class 5 in conformance with the AEC guide.

7.4.4.3 Assumptions

a) Activity in primary coolant based on 0.5% equivalent fuel defects. The accident would cause no additional fuel damage. (Table 7.1-3)

b) The equilibrium secondary system activity is based on steam generator leakage of 20 gpd and a blowdown of 10 gpm/generator. (Table 7.1-4)

c) 15% of the primary coolant is carried over to the secondary side.

d) Steam generator halogen partition factor of 0.1 $\frac{\mu c/gm\ steam}{\mu c/gm\ water}$ (Reference: item 8.3.a.b of AEC guide).

e) Condenser halogen partition factor of 1000 $\frac{\mu c/gm\ steam}{\mu c/cc\ air}$

*f) Blowdown terminated at the initiation of the incident.

*g) Faulty steam generator isolated in 30 minutes.

---

*Not specifically an assumption from the AEC guide.

TABLE 7.4-2

STEAM GENERATOR TUBE RUPTURE ACTIVITY RELEASE

Isotope	Activity (Curies)
I-131	4.19×10^{-3}
I-132	1.57×10^{-3}
I-133	6.82×10^{-3}
I-134	1.02×10^{-3}
I-135	3.74×10^{-3}
Kr-85	1.83
Kr-85m	29.70
Kr-87	16.70
Kr-88	51.70
Xe-133	1101.0
Xe-133m	22.1
Xe-135	79.4
Xe-135m	2.97
Xe-138	10.80

7.4.4.4 Doses at Site Boundary and Population Dose

The activity released to the atmosphere by this incident is given in Table 7.4-2. Based on these data, the thyroid inhalation dose, total body dose and skin dose at the site boundary are 5.99 x 10^{-3} mrem, 1.38 x 10^{-1} mrem and 1.51 x 10^{-1} mrem, respectively. The population dose is 4.09 x 10^{-1} man-rem.

7.5 CLASS 6 - REFUELING ACCIDENTS

7.5.1 DISCUSSION

Accidents which fall into accident Class 6 are: a fuel assembly dropped inside the containment and the dropping of a heavy object onto the fuel in the core.

The only events in the accident class which could possibly result in a release of radioactive gases from a fuel assembly are the mishandling of a fuel element or the dropping of a heavy object onto the fuel in the core. The fuel handling procedures are such that no objects can be moved over any fuel elements being transferred from the core through the refueling canal to the transfer tube. A loss of cooling in the transfer tube will not cause the cladding of a fuel assembly to be damaged since the residual heat generated by the assembly would be removed by natural convection.

7.5.2 FUEL BUNDLE DROP

7.5.2.1 Event Description

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in damage to the equivalent of one row of fuel rods (15 fuel rods) in the assembly. The radioactive gases subsequently released from the damaged fuel elements will bubble through the water covering the assembly, where most of the radioactive iodine will be entrained. The remainder will be released to the containment atmosphere. For the first 5 minutes following the accident, activity is drawn through the containment purge line to the environment. After 5 minutes the purge line is isolated and the only means of escape of any radioactive gases airborne in the containment is by means of leakage through the containment, which is negligible since this accident does not generate a positive pressure in the containment.

7.5.2.2 Discussion of Remoteness of Possibility

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. As the vessel head is raised, a visual check is made to verify that the drive shafts are free in the mechanism housing. After the vessel head is removed the rod cluster control drive shafts are removed from their respective assemblies. A spring scale is used to verify that the drive shaft is free of the control cluster as the lifting force is applied.

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

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

7.5.2.2.1 Criticality

Boron concentration in the coolant is raised to the refueling concentration and verified by sampling. The refueling boron concentration is sufficient to maintain the clean, cold, fully loaded core subscritical 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.

Two Nuclear Instrumentation System source range channels are continuously in operation and provide warning of any approach to criticality during refueling operation. 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.

Only one fuel assembly is transferred at a time, effectively precluding any possibility of inadvertent criticality in the refueling canal.

7.5.2.2.2 Mechanical Damage

Special precautions are taken in all fuel handling operations to minimize the possibility of damage to fuel assemblies during transport to and from the transfer tube 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 supported laterally along their length by Inconel 718 grid clip assemblies which provide a total axial restraining force of 60 pounds 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 by 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 shutdown, the fuel rods contract during the subsequent cooldown and would not be in contact with the bottom plate of the assembly. Analyses have been made assuming the extremely remote situations of a fuel assembly dropping 14 feet and striking a flat surface and of one assembly being dropped on another. The analysis of a fuel assembly assumed dropped and striking a flat surface considered the stresses the fuel cladding would be subjected to and any possible buckling of the fuel rods between the grid clip supports. The results show that the axial load at the bottom section of the fuel rods, which would receive the highest loading (approximately 100 lb.) would be below the critical buckling load (250 lb.) and the stresses would be relatively low and below the yield stress. For the case of one assembly assumed dropped on top of another fuel assembly, the loads would be transmitted through the end plates and the RCC guide tubes of the struck assembly before any of the loads would reach the fuel rods. The end plates and guide thimbles would abosrb a large portion of the kinetic energy as a result of bending in the lower plate of the falling assembly. Also, energy would be absorbed in the struck assembly top end plate before any load would be transmitted to the fuel rods. The results of this analysis indicate that the buckling load on the fuel rods would be below the critical buckling loads and the stresses in the cladding would be relatively low and below yield.

Based on the above, it is unlikely that any damage would occur to the individual fuel rods during handling, and the assumption of a failure of an entire row of rods is a conservative upper limit.

No fuel cladding integrity failures resulting in measureable radioactivity releases have occured during any fuel handling operations involving over 50 reactor years of Westinghouse PWR operating experience in which more than 2200 fuel assemblies have been loaded or unloaded.

7.5.2.3 Assumptions

a) The accident occurs one week following reactor shutdown.

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

*c) The damaged assembly is one that had operated at the average power level.

d) One percent of the inventory of fission products in the 15 rods with ruptured cladding is released to the refueling canal at the time of the accident.

e) 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 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed from the refueling canal water directly to the upper half of the containment.

*g) The purge line flow rate is 25,000 cfm.

*h) The purge is terminated by a high radioactivity level within the containment, a safety injection signal, or a containment isolation signal. For this analysis it is assumed to be terminated within 5 minutes of accident initiation.

i) Containment purge system halogen filter efficiency is 99%. Noble gas filter efficiency is zero.

j) After isolation of the containment, the leak rate through the containment is minimal since the pressure differential across the containment is negligible. The amount of activity leaked from the containment is assumed negligible compared to that escaping through the purge line during the first 5 minutes prior to isolation.

7.5.2.4 Doses at Site Boundary and Population Dose

The activity released to the environment with the above assumptions is given in Table 7.5-1. Based on these data, the doses at the site boundary are 4.12×10^{-4} mrem thyroid inhalation, 7.60×10^{-4} mrem total body and 3.46×10^{-3} mrem skin dose. The population dose is 2.25×10^{-3} man-rem.

7.5.3. HEAVY OBJECT DROP

7.5.3.1 Event Description

This accident is defined as the dropping of a heavy object onto the fuel in the core during refueling. The accident is assumed to result in damage to the equivalent of all the rods in one fuel assembly. The radioactivity released from the damaged fuel assembly will bubble through the water covering the reactor cavity, where most of the radioactive iodine will be entrained, the remainder being released to the containment atmosphere.

---

*Not specifically an assumption from the AEC guide.

7.5.3.2 Discussion of Remoteness of Possibility

Operating procedures prohibit the carrying of heavy objects over the core. However, of necessity the vessel head and the internals must be handled over the core during installation and removal. Special lifting fixtures are provided to safely handle these components. In addition, the cranes and rigging are adequately sized for the expected loads.

All equipment is completely checked out proir to use. All refueling operations are performed under the direct surveillance of personnel technically trained in nuclear safety. Thus the possibility of dropping a heavy object onto the reactor core is considered very remote.

TABLE 7.5-1

ACTIVITY RELEASED TO THE ENVIRONMENT FROM A FUEL BUNDLE DROP INSIDE CONTAINMENT

Isotope	Activity (Curies)
I-131	4.38×10^{-4}
I-133	6.77×10^{-6}
Kr-85	0.45
Xe-133	36.9
Xe-133m	0.27

7.5.3.3 Assumptions

a) The accident accurs 100 hours following reactor shutdown.

b) The accident results in the damaging of one fuel assembly.

c) The damaged assembly is one that had operated at the average power level.

d) One percent of the inventory of fission products in the damaged assembly is released to the refueling water covering the reactor vessel at the time of the accident.

e) The refueling 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 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed from the refueling water directly to the upper half of the containment.

*g) The purge line on the containment is isolated within 5 minutes after the accident. The flow rate through this purge line is 25,000 cfm.

h) The halogen removal efficiency of the containment purge system filter is 99%. Filter removal efficiency for noble gases is zero.

i) After isolation of the containment, the leak rate through the containment is minimal since the pressure differential across the containment is negligible. The amount of activity leaked from the containment is assumed negligible compared to that escaping through the purge line during the first 5 minutes prior to isolation.

7.5.3.4 Doses at Site Boundary and Population Dose

The activity released to the environment with the above assumptions is given in Table 7.5-2. Based on this table, the doses at the site boundary from a heavy object drop onto the fuel in the core are 7.35×10^{-3} mrem thyroid, 1.51×10^{-2} mrem total body and 6.83×10^{-2} mrem skin dose. The population dose from this accident is 4.47×10^{-2} man-rem.

---

*Not specifically an assumption from the AEC guide.

TABLE 7.5-2

ACTIVITY RELEASED TO ENVIRONMENT FROM DROP OF A HEAVY OBJECT ONTO FUEL IN THE CORE

Isotope	Activity (Curies)
I-131	7.6×10^{-3}
I-133	8.8×10^{-4}
Kr-85	6.17
Xe-133	728.0
Xe-135	0.18
Xe-133M	8.85

7.6 CLASS 7 - SPENT FUEL HANDLING ACCIDENTS

7.6.1 DISCUSSION

Accidents which fall into accident Class 7 are: dropping of a fuel assembly into the fuel storage pool, dropping of heavy object onto fuel, or dropping of shielding cask.

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 and design of the fuel handling equipment is such that no equipment or object can be moved over any fuel element being transferred or stored in the spent fuel pool. The shielding and shipping casks are designed to be dropped with no subsequent damage to the fuel assembly. Loss of cooling to the transfer cask also will not result in any damage which will result in activity release to the environment. 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 will be decayed to a negligible level.

7.6.2 FUEL ASSEMBLY DROP IN FUEL STORAGE POOL

7.6.2.1 Event Description

The accident is defined as the mishandling of a spent fuel assembly. The accident is assumed to result in damage to 15 fuel rods, the equivalent of one row in the assembly. The subsequent release of radioactive gases from the damaged fuel rods will bubble through the water covering the assembly, where most of the iodine will be entrained, the remainder being released to the fuel handling building atmosphere.

The fuel handling area ventilation system draws air from outside through filters (pre-filters), passes the air over the fuel pool, and discharges it to the atmosphere after passing through pre and HEPA filters. A slight negative pressure will be maintained in this area during refueling operations. After a postulated fuel handling accident, a signal from the redundant radiation monitors in the exhaust line will automatically secure the ventilation fans and isolate the fuel handling area ventilation system. Two motor operated valves will then be remotely opened to connect the fuel handling area with the penetration room filtration system through the ducts. The fan and filter subsystems of the penetration room filtration system will maintain a slight negative pressure in the fuel handling area. The air from the fuel handling area will pass through particulate, absolute and charcoal filters prior to being released to the environment.

7.6.2.2 Discussion of Remoteness of Possibility

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

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

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

c) Violation of procedures by placing one fuel assembly in any position with a group of racked assemblies will not result in criticality.

In summary, those factors which are discussed under Section 7.5.2.2 "Mechanical Damage" regarding remoteness of possibility of fuel handling accidents within the containment also apply here.

7.6.2.3 Assumptions

a) The accident occurs one week following reactor shutdown.

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

*c) The damaged assembly is one that had operated at the average power level.

d) One percent of the inventory of fission products in the 15 rods with ruptured cladding will be released to the spent fuel pit water at the time of the accident.

---

*Not specifically an assumption from the AEC guide.

e) The spent fuel pit water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reactions. A decontamination factor of 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed into the air above the spent fuel pit and exhausted through charcoal filters with a halogen efficiency of 99%. Noble gas filter efficiency is zero.

*g) The fuel handling area ventilation system purge line will be automatically isolated upon high radiation signal (within 5 minutes).

After isolation of the fuel handling area ventilation system purge line, the penetration room filtration system will be actuated. Activity released into the fuel handling area will be drawn through charcoal and HEPA filters before being discharged to the atmosphere. The efficiency of penetration room filtration system is 99%.

7.6.2.4 Doses at Site Boundary and Population Dose

The activity released to the atmosphere, based on the above assumptions, is given in Table 7.6-1. The doses at the site boundary from a refueling accident outside the containment are 3.30×10^{-3} mrem thyroid, 6.07×10^{-3} mrem total body and 2.77×10^{-2} mrem skin dose. The population dose from this accident is 1.80×10^{-2} man-rem.

7.6.3 HEAVY OBJECT DROP ONTO FUEL RACK

7.6.3.1 Event Description

The accident postulated is a drop of a heavy object over the spent fuel racks such that all of the fuel rods in one assembly are damaged. The subsequent releases of radioactive gases from the damaged fuel elements will bubble through the water covering the assembly, where most of the iodine will be entrained, and be released to the fuel handling building atmosphere.

The fuel handling area ventilation system draws air from outside through filters (pre-filters), passes the air over the fuel pool, and discharges it to the atmosphere after passing through pre and HEPA filters. A slight negative pressure will be maintained in this area during refueling operations. After a postulated fuel handling accident, a signal from the redundant radiation monitors in the exhaust line will automatically secure the ventilation fans and isolate the fuel handling area ventilation system. Two motor operated vlaves will then be remotely opened to connect the fuel handling area with the penetration room filtration system through the ducts. The fan and filter subsystems of the penetration room filtration system will maintain a slight negative pressure in the fuel handling area. The air from the fuel handling area will pass through particulate, absolute and charcoal filters prior to being released to the environment.

The design of the spent fuel storage area and equipment is such that it is not possible to carry heavy objects, such as a spent fuel transfer cask, over the fuel assemblies in the storage racks. The possibility of occurrence of this accident is remote.

7.6.3.3 Assumptions

a) The accident occurs 30 days following reactor shutdown.

b) The accident results in the rupture of the cladding of all the fuel rods in one assembly.

c) The damaged assembly is the one that had operated at the average power level.

d) One percent of the inventory of fission products in the assembly will be released to the spent fuel pit water at the time of the accident.

e) The spent fuel pit water retains a large fraction of the gap activity of halogens by virtue of their solubility and hydrolysis. Noble gases are not retained by the water as they are not subject to hydrolysis reaction. A decontamination factor of 500 for the halogens is used in this analysis.

f) The fission products which are not retained by the water are dispersed into the air above the spent fuel storage pool and exhausted through charcoal filters with a halogen efficiency of 99%.

g) The fuel handling area ventilation system purge line will be automatically isolated upon high radiation signal (within 5 minutes). The flow rate through the purge line is 18,000 scfm.

After isolation of the fuel handling area ventilation system purge line, the penetration room filtration system will be actuated. Activity released into the fuel handling area will be drawn through charcoal and HEPA filters before being discharged to the atmosphere. The efficiency of penetration room filtration system is 99%.

TABLE 7.6-1

ACTIVITY RELEASED TO THE ENVIRONMENT FROM A FUEL ASSEMBLY DROP IN THE FUEL STORAGE POOL

Isotope	Activity (Curies)
I-131	3.5×10^{-3}
I-133	5.4×10^{-5}
Kr-85	3.62
Xe-133	295
Xe-133m	2.18

7.6.3.4 Doses at the Site Boundary and Population Dose

With the above assumptions, the activity released to the atmosphere is given in Table 7.6-2. The thyroid inhalation dose, the total body dose and the skin dose at the site boundary are 6.20×10^{-3} mrem, 4.07×10^{-3} mrem and 2.48×10^{-2} mrem, respectively. The population dose is 1.21×10^{-2} man-rem.

7.6.4 FUEL CASK DROP

7.6.4.1 Event Description

This accident is a drop of a fully loaded (assumed to hold 6 assemblies) fuel cask as it is being transferred out of the auxiliary building. The fall is of such a distance that the cask is breached and all of the fuel rods in all of the assemblies are ruptured. All of the noble gases contained in the pellet-clad gaps are released directly to the atmosphere.

TABLE 7.6-2

ACTIVITY RELEASED TO THE ENVIRONMENT BY

A HEAVY OBJECT DROP ONTO SPENT FUEL RACK

Isotope	Activity (Curies)
I-131	6.61×10^{-3}
Kr-85	49.1
Xe-133	196.0
Xe-133m	0.03

7.6.4.2 Discussion of the Remoteness of Possibility

Loaded fuel casks are handled under carefully detailed procedures with adequately designed equipment. The probability of dropping a cask is low. However, the cask is designed to satisfy a 30 foot drop test onto an unyielding surface without rupture, as required by DOT regulations. Since the cask will survive this drop without rupture and the fuel assemblies are protected by restraints within the cask, a release of radioactivity is considered only remotely possible.

7.6.4.3 Assumptions

*a) The cask is loaded with 6 fuel assemblies.

b) One percent of the total noble gas inventory in all 6 assemblies is released to the atmosphere.

c) The fuel cask drop occurs 120 days after reactor shutdown.

7.6.4.4 Doses at the Site Boundary and Population Dose

With the above assumptions, the activity released to the atmosphere is given in Table 7.6-3. The total body dose at the site boundary is 4.12×10^{-4} mrem and the skin dose is 4.02×10^{-2} mrem. The population dose is 1.24×10^{-3} man-rem.

TABLE 7.6-3

ACTIVITY RELEASED TO THE ENVIRONMENT IN A FUEL CASK DROP

Isotope	Activity (Curies)*
Kr-85	288.0
Xe-133	8.7×10^{-3}

---

*Not specifically an assumption from the AEC guide.

7.7 CLASS 8 - ACCIDENT INITIATION EVENTS CONDISERED IN DESIGN BASIS EVALUATION IN THE FINAL SAFETY ANALYSIS REPORT

7.7.1 DISCUSSION

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

7.7.2 LOSS OF COOLANT ACCIDENT (LOCA) - SMALL PIPE BREAK

7.7.2.1 Event Description

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 up to the first closed valve. Leaks or ruptures of a small cross section would cause expulsion of the coolant at a rate that can be accommedated by the charging pumps. The pumps would maintain an operational water level in the pressurizer permitting the operator to execute an orderly shutdown. A small quantity of the coolant containing fission products normally present in the coolant would be released to the containment.

Should a break occur beyond the capacity of the charging pumps, depressurization of the RCS causes fluid to flow from the pressurizer to the break resulting in a pressure decrease in the pressurizer. Reactor trip occurs when the pressurizer low pressure set point is reached. The Emergency Core Cooling System (ECCS) is actuated when the pressurizer low pressure and low level set points are reached. ECCS actuation and reactor trip are also provided by a high containment pressure signal. The ECCS is comprised of high pressure passive accumulators which discharge water into the cold leg of each coolant loop, and high head safety injection and charging pumps and low head residual heat removal pumps that deliver through the cold legs. These countermeasures limit the consequences of the accident in two ways:

a. Reactor trip and borated water injection supplement void formation by causing rapid reduction of the core thermal power to a residual level corresponding to the delayed fissions and fission product decay.

b. Injection of borated water ensures sufficient flooding of the core to limit the peak fuel cladding temperature such that clad damage does not result.

The fission products present in 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 through minute leaks in the containment shell to the atmosphere. These minute leaks could be expected to be choked by water and water vapor, although credit for this was not taken in evaluating releases. A fraction of the activity is released to the penetration room via containment penetrations and then to the environment through the filters of the purge system used to maintain a negative pressure in the penetration room.

7.7.2.2 Discussion of Remoteness of Possibility

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 followed to make sure that the specific requirements are met during the various stages of design, construction, erection and fabrication.

The reactor coolant system if designed to withstand a Safe Shutdown Earthquake and assure capability to shutdown and maintain the nuclear facility in a safe condition. Pressure-containing components of the reactor coolant system are designed, fabricated, inspected and tested in conformance with applicable Codes as described in the FSAR. The design loads for normal operational fatigue and faulted conditions were selected by conservatively predicting the type and number of cycles that the plant is expected to experience, as described in the FSAR. Also, essential equipment is placed in a structure which is capable of withstanding extraordinary natural phenomena, such as floods, tornadoes, and high wind.

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

The plant is operated under very closely controlled conditions to ensure that the operating parameters are kept within the limits assumed in the design. For example, the concentrations of oxygen and chlorides are kept to low levels below 0.10 and 0.15 ppm respectively, to minimize corrosion of the reactor coolant system surface. The reactor pressure vessel is paid particualr attention because of the shift in nil ductility transition temperature (NDTT) with irradiation. Therefore, technical specification limits are imposed on the maximum heatup and cooldown rates to make sure that the vessel wall temperature is above the NDTT to prevent brittle fractures whenever the stresses become significant.

Materials of construction are selected for the expected environment and service conditions in accordance with the appropriate code requirements.

It is expected that for pipes of the size, thickness, and material used in the RCS significant leakage will occur before catastrophic failure. The plant is provided with various means of detecting leakage from the reactor coolant system, i.e. containment sump level, containment humidity and air particulate measurement, maintenance of water volume inventories, routine surveillance of charging header flow, and radiation monitoring. Leak rates less than one gpm can be detected within a matter of hours. The sensitivity of these leak detection systems gives 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 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, ultrasonic, and radiographic examinations. The in-service inspection program (as described in the FSAR) 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 are analyzed and protection demonstrated by actuation of the following:

a. Reactor protection system trips

b. Pressurizer relief and safety valves

c. Steam side safety and relief valves

These safeguards insure that the system pressures and temperatures attained under unexpected 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.

7.7.2.3 Assumptions

a) Equilibrium activity in the primary coolant based on 0.5% fuel defects. This data is given in Table 7.1-3.

b) All the primary coolant released to the containment.

c) A halogen reduction factor of 20 inside the containment due to plateout and the containment spray system.

*d) There is complete mixing in the containment.

e) The containment leak rate is 0.1%/day for the first 24 hours and 0.05%/day for the next 29 days (design leak rate).

*f) Fifty percent of containment leakage is into the penetration room where filter efficiency is 99%. Penetration room purge system has a flow of 250 cfm.

---

*Not specifically an assumption from the AEC guide.

7.7.2.4 Doses at Site Boundary and Population Dose

With the above assumptions, the activity released from the containment is given is Table 7.7-1. The thyroid inhalation, total body and skin dose at the site boundary are 3.49×10^{-2} mrem, 8.42×10^{-4} mrem and 2.93×10^{-3} mrem, respectively. The population dose is $2.^{50} \times 10^{-3}$ man-rem.

7.7.3 LOSS OF COOLANT - LARGE PIPE BREAK

7.7.3.1 Event Description

This incident is the rupture of a large pipe (greater than 6" diameter) with a resulting loss of coolant. The operation of the ECCS is as described in Section 7.7.2 - Small Pipe Break, except the injection of borated water is insufficient to prevent clad damage, although it is sufficient to prevent clad melting.

Although the ECCS prevents fuel clad melting, as a result of the increase in cladding temperature and the rapid depressurization cladding failures may occur in the hotter 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 activity is slowly released to the environment through minute leaks in the containment. These minute leaks could be expected to be choked by water and water vapor although credit for this was not taken in evaluating releases. A fraction of the containment activity is released to the penetration room via containment penetrations and then to the environment through filters of the purge system used to maintain a negative pressure in the penetration room.

7.7.3.2 Discussion of Remoteness of Possibility

The discussion in Section 7.7.2 - Small Break, is applicable to the large break, also. However, the possibility that a large break would occur is much less than the possibility of a small break. The critical crack length* increases as the pipe diameter and wall thickness increase. Since leakage from the pipe is proportional to the size of the crack, leakage will be greater for a larger pipe than a smaller pipe. A greater amount of leakage before pipe rupture reduces the possibility of pipe rupture in that a) it is easier to detect, and b) more time is available for corrective action once leakage is detected, since the detection threshold is a constant independent of leak rate. In addition, service experience indicates that circumferential rupture of a small branch line at the connection point to a pipe run is much more common than a failure in that pipe run.

7.7.3.3 Assumptions

a) Equilibrium activity in the primary coolant based on 0.5% fuel defects (Table 7.1-3)

b) 100% fuel cladding failure, releasing 2% of the core inventory of noble gases and halogens to the containment.

c) All of the primary coolant is released to the containment.

---

*Critical crack length is that crack which will propagate to pipe rupture during the life of the plant.

*d) There is complete mixing in the containment.

*e) The containment leak rate is 0.1%/day for the first 24 hours and 0.05%/day for the next 29 days (design leak rate).

f) Fifty percent of the containment leakage is into the penetration room where filter efficiency is 99%.

TABLE 7.7-1

LOSS OF COOLANT RELEASE FROM CONTAINMENT - SMALL BREAK

Isotope	Activity (Curies)
I-131	3.46×10^{-2}
I-132	3.0×10^{-4}
I-133	9.25×10^{-3}
I-134	7.5×10^{-5}
I-135	2.03×10^{-3}
Xe-133	30.70
Xe-133m	0.30
Xe-135	0.27
Xe-135m	3.1×10^{-4}
Xe-138	1.23×10^{-3}
Kr-85	7.87×10^{-4}
Kr-85m	5.14×10^{-2}
Kr-87	8.47×10^{-3}
Kr-88	0.113

---

*Not specifically an assumption from the AEC guide.

7.7.3.4 Doses at the Site Boundary and Population Dose

With the above sssumptions, the activity released from the containment is given in Table 7.7-2. The thyroid inhalation, total body and skin doses at the site boundary are $2.10 \times 10^{+2}$ mrem, 1.32×10^{0} and 1.62×10^{0} mrem, respectively. The population dose is 3.91×10^{0} man-rem.

7.7.4 BREAK IN INSTRUMENT LINE FROM PRIMARY SYSTEM THAT PENETRATES THE CONTAINMENT

This incident is not applicable to the Farley Nuclear Plant since this plant does not have any instrument lines connected to the primary system that are not provided with isolation capability inside the containment.

7.7.5 ROD EJECTION ACCIDENT (PWR)

7.7.5.1 Event Description

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 operation of a plant with chemical shim control is such that the severity of an ejection accident is inherently limited. Since control rod clusters are used to control load variations only, and the core depletion is followed with boron dilution, there are only a few partially inserted control rods in the reactor at full power.

The design of the control system utilizes the flexibility in the selection of control rod cluster groupings (both radial locations and axial positions may be adjusted as a function of load) to minimize the peak fuel and clad temperatures for the worst* ejected rod. Analyses of the possible reactivity transients at beginning and end of life at full and zero power, indicate that the resultant power transients do not result in melting of either the fuel pellet or cladding. The 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.

TABLE 7.7-2

LOSS OF COOLANT RELEASE FROM CONTAINMENT - LARGE BREAK

Isotope	Activity (Curies)
I-131	202.0
I-132	7.08
I-133	74.4
I-134	4.67
I-135	27.0
Kr-85	237.0
Kr-85m	159.0
Kr-87	89.7
Kr-88	549.0
Xe-133	13,230
Xe-133m	164.0
Xe-135	438.0
Xe-135m	13.3
Xe-138	47.4

---

*Rod with maximum reactivity effect.

Minor cladding perforation occurs as a result of this accident. Activity in the primary coolant is released to the containment, where sprays and plateout partially reduce the airborne fission product concentration. Fission products escaping to the external environment do so through minute leaks in the containment structure and through the penetration room purge filters.

7.7.5.2 Discussion of Remoteness of Possibility

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 machanism housing is completely assembled and shop tested at higher than normal operating pressure. On-site, the mechanism housings were individually hydrotested at 3750 psi as they are installed, and checked again during the hydrotest at 3107 psig of the complete Reactor Coolant System. These pressures are considerably higher than the normal operating pressure of 2250 psia.

Design of the mechanism considered the stresses due to anticipated system transients at power and the thermal movement of the coolant loops. Moments induced by the safe shutdown earthquake can be accepted within the allowable primary working stress range specified by ASME III for Class A Components. The latch mechanism housing and rod travel housings are each a single length of forged type-304 stainless steel. This material exhibits excellent notch toughness at all temperatures that will be encountered. The joint between the latch mechanism housing and the vessel head adapter, and between the latch mechanism housing and the rod travel housing, are threaded joints, reinforced with canopy type seal welds.

The significant margin of strength in the elastic range together with the large energy absorption capability in the plastic range gives additional assurance that gross failure of the housing will not occur. 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 rod ejection accident is considered minimal.

7.7.5.3 Assumptions

a) Equilibrium activity in the primary coolant based on 0.5% fuel defects (Table 7.1-3).

b) 0.2% of the core inventory released to the coolant.

c) All of the primary coolant released to the containment.

d) A halogen reduction factor of 20 inside the containment due to plateout and the containment spray system.

e) There is complete mixing in the containment.

*f) The containment leak rate is 0.1%/day for the first 24 hours and 0.05%/day for the next 29 days (design leak rate).

g) Fifty percent of the containment leakage is to the penetration room where the filter efficiency is 99%.

---

*Not specifically an assumption from the AEC guide since none are given for Class two events.

7.7.5.4 Doses at Site Boundary and Population Dose

With the above assumptions, the activity released from the containment is given in Table 7.7-3. The thyroid inhalation, total body and skin doses at the site boundary are 2.10 x 10^{+1} mrem, 1.32 x 10^{-1} mrem and 1.62 x 10^{-1} mrem, respectively. The population dose is 3.91 x 10^{-1} man-rem.

TABLE 7.7-3

ROD EJECTION ACCIDENT RELEASE FROM CONTAINMENT

Isotope	Activity (Curies)
I-131	20.2
I-132	.71
I-133	7.44
I-134	.47
I-135	2.7
Kr-85	23.7
Kr-85m	15.90
Kr-87	8.97
Kr-88	54.90
Xe-133	1,323
Xe-133m	16.4
Xe-135	43.8
Xe-135m	1.33
Xe-138	4.74

7.7.6 STEAM LINE BREAK - LARGE BREAK

7.7.6.1 Event Description

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

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

1. Safety injection system actuation from any of the following:
    a) Coincident low pressurizer pressure and level signals.
    b) High differential pressure signals between steam lines.
    c) High steam line flow in two main steam lines in coincidence with either low-low reactor coolant system average temperature of low main steam line pressure in any two lines.
    d) High containment pressure.
2. The overpower reactor trips (neutron flux and ΔT), and the reactor trip occurring upon actuation of the Safety Injection System.
3. Redundant isolation of the main feedwater lines. In addition to the normal control action which will close the main feedwater valves, a safety injection signal will 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 stop valves (designed to close in less than 5 seconds) on:
    a) High steam flow in two main steam lines in coincidence with either low-low reactor coolant system average temperature or low steam line pressure in any two lines.
    b) High-high containment pressure.

Each steam line has a fast closing stop valve with a downstream check valve. These valves prevent blowdown of more than one steam generator for any break location even if one valve fails to close. For example, for a break upstream of the stop valve in one line, closure of either the check valve in that line or the valves in the other lines will prevent blowdown of the other steam generators. In particular, the arrangement precludes blowdown of more than one steam generator inside the containment, thus preventing structural damage to the containment.

If there were 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 air ejectors.

7.7.6.2 Discussion of Remoteness of Possibility

A steam line break is considered highly unlikely. The steam system valves, fittings and piping are conservatively designed. The piping is a ductile material completely inspected prior to installation. The steam and feedwater lines with their supports and structures from the steam generators to their respective isolation valves are designed to seismic Class I specifications. After installation, the entire system undergoes hot functional testing prior to fuel loading. This pre-operational hydrotesting is conducted at 1.25 the design pressure. 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. A chemical treatment is used to prevent the formation of free caustic. These measures 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.

7.7.6.3 Assumptions

a) An equilibrium radioactivity in the secondary system of 0.5% equivalent fuel defects with 20 gpd steam generator leakage and 10 gpm blowdown/generator. (Talbe 7.1-4).

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

c) Volume of one steam generator released to atmosphere.

d) Halogen partition factor of 0.1 $\frac{\mu c/gm\ steam}{\mu c/gm\ water}$ for the activity present in the steam generator before the incident.

e) Primary to secondary leakage of 20 gpd occurs for 8 hours after the accident, the length of time required to cool the plant down.

f) Halogen partition factor of 0.5 $\frac{\mu c/gm\ steam}{\mu c/gm\ water}$ for the activity leaked from the primary side to the secondary during the course of the accident.

g) The break occurs outside the containment.

7.7.6.4 Doses at the Site Boundary and the Population Dose

With the above assumptions, the activity released to the environment is given in Table 7.7-4. The thyroid inhalation, total body, and skin doses at the site boundary are 8.29×10^{-3} mrem, 7.15×10^{-5} mrem and 1.14×10^{-4} mrem, respectively. The population dose is 2.12×10^{-4} man-rem.

7.7.7 STEAM LINE BREAK - SMALL BREAK

This incident has not been separately analyzed. The only different assumption for this incident as compared to the large steam line break (Section 7.7.6) is that a halogen partition factor of 0.1 (μc/gm steam)/

(μc/gm water), instead of 0.5, is used for the steam generator when the tubes are covered by feedwater. An analysis of the length of time required to boil a steam generator dry versus line break size has not been performed. It is considered that the time would be fairly short compared to the time required to cool the plant down, and thus would be only a minor reduction in the doses presented for the large steam line break.

TABLE 7.7-4

STEAM LINE BREAK ACTIVITY RELEASE

Isotope	Activity (Curies)
I-131	6.12×10^{-3}
I-132	1.78×10^{-3}
I-133	8.63×10^{-3}
I-134	9.75×10^{-4}
I-135	4.15×10^{-3}
Kr-85	1.63×10^{-3}
Kr-85m	1.49×10^{-2}
Kr-87	3.34×10^{-3}
Kr-88	1.99×10^{-2}
Xe-133	9.57×10^{-1}
Xe-133m	1.86×10^{-2}
Xe-135	5.29×10^{-2}
Xe-135m	1.24×10^{-4}
Xe-138	4.89×10^{-4}

7.8 SUMMARY OF DOSES FROM EACH CLASS

For each of the accident classes considered in this report an average site boundary thyroid, total body, and skin dose were computed. The total body includes only gamma contributions whereas the skin dose accounts for beta contributions only. The integrated dose to the population within a 50 mile radius of the plant has been computed, based on gamma contributors only. These have been compiled into Table 7.8-1.

TABLE 7.8-1

SUMMARY OF DOSES AND ENVIRONMENTAL EFFECTS

		Site Boundary Dose (mrem)			Environmental Effect (man-rem)
Class	Representative Event	Thyroid	Total Body	Skin	
1.0	TRIVIAL INCIDENTS	*	*	*	*
2.0	SMALL RELEASES OUTSIDE CONTAINMENT	*	*	*	*
3.0	RADWASTE SYSTEM FAILURE				
3.1	Equipment Leakage or Malfunction**				
	A) Gas Decay Tank	$1.41x10^{-2}$	$2.13x10^{-2}$	$1.99x10^{-1}$	$6.30x10^{-2}$
	B) Liquid Waste Storage Tank	$1.70x10^{+0}$	$3.22x10^{-3}$	$1.05x10^{-3}$	$9.55x10^{-3}$
3.2	Release of Waste Gas Storage Tank Contents	$5.62x10^{-2}$	$8.52x10^{-2}$	$7.97x10^{-1}$	$2.52x10^{-1}$
3.3	Release of Liquid Waste Storage Tank Contents	$6.70x10^{+0}$	$1.30x10^{-2}$	$4.19x10^{-3}$	$3.85x10^{-2}$
4.0	FISSION PRODUCTS TO PRIMARY SYSTEM (BWR)	N.A.	N.A.	N.A.	N.A.
5.0	FISSION PRODUCTS TO PRIMARY AND SECONDARY SYSTEMS (PWR)				
5.1	Fuel Cladding Defects and steam Generator Leaks	*	*	*	*
5.2	Off-design Transients That Induce Full Failure Above Those Expected and Steam Generator Leakage	$6.84x10^{-3}$	$2.74x10^{-3}$	$2.41x10^{-3}$	$8.14x10^{-3}$

TABLE 7.8-1 (CONT.)

SUMMARY OF DOSES AND ENVIRONMENTAL EFFECTS (CONT.)

		Site Boundary Dose (mrem)			Environmental Effect
Class	Representative Event	Thyroid	Total Body	Skin	(man-rem)
5.3	Steam Generator Tube Rupture	$5.99x10^{-3}$	$1.38x10^{-1}$	$1.51x10^{-1}$	$4.09x10^{-1}$
6.0	REFUELING ACCIDENTS				
6.1	Fuel Bundle Drop	$4.12x10^{-4}$	$7.60x10^{-4}$	$3.46x10^{-3}$	$2.25x10^{-3}$
6.2	Heavy Object Drop Onto Fuel in Core	$7.35x10^{-3}$	$1.51x10^{-2}$	$6.83x10^{-2}$	$4.47x10^{-2}$
7.0	SPENT FUEL HANDLING ACCIDENT				
7.1	Fuel Assembly Drop in Fuel Storage Pool	$3.30x10^{-3}$	$6.07x10^{-3}$	$2.77x10^{-2}$	$1.80x10^{-2}$
7.2	Heavy Object Drop Onto Fuel Rack	$6.20x10^{-3}$	$4.07x10^{-3}$	$2.48x10^{-2}$	$1.21x10^{-2}$
7.3	Fuel Cask Drop	-	$4.12x10^{-4}$	$4.02x10^{-2}$	$1.24x10^{-3}$
8.0	ACCIDENT INITIATION EVENTS CONSIDERED IN DESIGN BASIS EVALUATION IN THE SAFETY ANALYSIS REPORT				
8.1	Loss-of-coolant Accidents				
	Small Pipe Break	$3.49x10^{-2}$	$8.42x10^{-4}$	$2.93x10^{-3}$	$2.50x10^{-3}$
	Large Pipe Break	$2.10x10^{+2}$	$1.32x10^{+0}$	$1.62x10^{+0}$	$3.91x10^{+0}$
8.1(A)	Break in Instrument Line from Primary System that Penetrates the Containment	N.A.	N.A.	N.A.	N.A.
8.2(A)	Rod Ejection Accident (PWR)	$2.10x10^{+1}$	$1.32x10^{-1}$	$1.62x10^{-1}$	$3.91x10^{-1}$

TABLE 7.8-1 (CONT.)

SUMMARY OF DOSES AND ENVIRONMENTAL EFFECTS (CONT.)

		Site Boundary Dose (rem)			Environmental Effect
Class	Representative Event	Thyroid	Total Body	Skin	(man-rem)
8.2(B)	Rod Drop Accident (BWR)	N.A.	N.A.	N.A.	N.A.
8.3(A)	Steam Line Breaks (PWR's Outside Containment)				
	Small Break	***	***	***	***
	Large Break	8.29×10^{-3}	7.15×10^{-5}	1.14×10^{-4}	2.12×10^{-4}
8.3(B)	Steam Line Breaks (BWR's)	N.A.	N.A.	N.A.	N.A.

---

* These releases will be comparable to the design objectives indicated in Section 3.5.

** 25% of tank contents are released.

*** Not separately analyzed - doses only slightly smaller than for large steam line break.

7.9 CONCLUSIONS

Based on the evaluations of the various postulated accidents and occurrences in Section 7.2 through 7.7 and the resultant radiological results as tabulated in Section 7.8, it is concluded that the environmental impact from these accidents and occurrences are insignificant and inconsequential.

The average natural background radiation exposure in the United States is about 130 mrem. This varies from a low of 100 mrem/yr. in coastal Texas and Louisiana to a high of 250 mrem/yr. in the mountains of Colorado and Wyoming, or a variation of 150 mrem/yr. In the vicinity of the Farley Nuclear Plant it is about 110 mrem/yr. Building construction, whether frame, brick, or stone can result in variations in the radiation exposure inside the structure of greater than 50 mrem/yr. Even the variation in the radiation exposure between a transcontinental round trip by plane as compared to train is 4 mrem. The largest computed total body dose at the site boundary from a postulated accident is 1.32 mrem for the large pipe break loss of coolant.

The annual integrated exposure from natural background to the population within 50 miles of the plant is 43,000 man-rem. By comparison, the largest computed incremental population exposure from any postulated accident is 3.91 man-rem for the large pipe break loss of coolant.

Thus, the exposure resulting from any accident is well within the increment of exposure to the general public corresponding to variations in natural background.

11.0 SUMMARY BENEFIT-COST ANALYSIS

The benefit-cost analysis for the Joseph M. Farley Nuclear Plant was submitted as Appendix A to the Environmental Report - Construction Permit Stage. Only those aspects of the "environmental cost" or "plant cost" which have changed are addressed in this report. Changes in "environmental cost" are due to changes in plant design and/or operating procedures as discussed elsewhere in the report. Changes in "plant cost" are due to increased capital cost and increased projected operating cost. These changes include the following:

Revised Plant Water Use

Changes in Operation of Heat Dissipation System

Changes in the Use of Chlorine

Updated Information on Cooling Tower Drift

Updated Information on Capital Outlay and Levelized Fuel and Operating Cost

11.1 NATURAL SURFACE WATER BODY

11.1.1 Entrainment or Entrapment by Cooling Water Intake Structure

Effect on Primary Producers and Consumers

Available data (1) indicates an assumed organism count in the vicinity of the Joseph M. Farley Nuclear Plant of approximately 3000 organisms/liter. The weight of organisms withdrawn from the river will be approximately 6,400,000 lb/year.

The following methodology was used to obtain this quantity:

3000 organisms/liter x 28.32 liter/ft^3 = 85,000 organisms/ft^3

Withdrawal at 2 unit normal operation = 138 ft^3/sec

Weight per organism = 10^{-5} grams = 2.205 10^{-8} lb

Plant load factor = 0.781

---

(1) Data is same as used in Appendix A of Environmental Report - Construction Stage, except for change in withdrawal rate.

lb/yr = Organisms/ft^3 x ft^3/sec x sec/yr x lb/organisms x

load factor = 6.4×10^6.

Effect on Fisheries

Available data (1) indicate a larvae count of approximately 1 per cubic meter. Due to the low velocities in the vicinity of the intake structure, it is assumed that only larvae will be entrained. With a natural mortality rate of 90% for larvae and a 4 month growing season, the entrainment will be approximately 4,100 lb/yr. The species breakdown is as follows:

Species	% by Weight	lb/yr Entrained
Bass	3	108
Bream (Sunfish)	17	612
Catfish	5	180
Carp-Suckers	19	684
Forage	56	2,016
	100	3,600

The following methodology was used to obtain these quantities:

1 larval/M^3 x $2.84(10^{-2})$ M^3/ft^3 = $2.84(10^{-2})$ larvae/ft^3

Withdrawal at maximum operation = 138 ft^3/sec

Weight per larvae = 0.001 lb.

Larvae growing season = 123 days

Load factor = 0.781

lb/yr = Larvae/ft^3 x ft^3/sec x sec/day x days/yr x lb/larvae

x load factor x mortality adjustment = 3.6×10^3

11.1.2 Heat Discharged to Natural Water Body

Heat will be added to the water used in the service water system and the cooling tower circuit. Assuming 86°F. intake water temperature and 78°F. wet-bulb temperature, the mixture of service water discharge and cooling tower blowdown will be at 93.4°F. At the minimum recorded daily river flow of 1210 cfs, the resulting rise in the river would be 0.5°F. At the most probable flow of 8000 cfs, the rise would be 0.07°F. The following quantities were used to obtain these estimates:

Cooling Tower Blowdown = 10,200 gpm @ 89°F. (78°F. wet bulb + 11°F. Approach)

Cooling Tower Makeup = 17,800 gpm per unit

Service Water Discharge = 12,800 gpm per unit

Heat Rejected by Service Water System = 129 x 10^6 BTU/hr per unit

11.1.3 Chemical Effluents

Chlorine will be used in the cooling tower circuit and in the service water system. The chlorination schedule will be arranged such that the cooling towers and service water system will not be chlorinated at the same time. Also, the two units will not be chlorinated at the same time.

The chlorine injection point for the cooling tower circuit will be downstream of the blowdown take-off. Thus, chlorinated water will have to pass through the condensers and the cooling towers before reaching the blowdown line. The towers will be chlorinated to a maximum concentration of 1 ppm at the top of the towers.

Chlorine will be added to the service water system at the pond intake structure. The concentration at the structure will be 0.5 ppm.

The maximum resulting concentration of free residual chlorine in the discharge will be 0.13 ppm, assuming no chlorine demand to be present in the pond water. However, this demand is expected to be 0.5 to 1.0 ppm.

The concentration of free residual chlorine in the discharge was calculated as follows:

1 Unit Service Water Discharge = 12,800 gpm @ 0.5 ppm

1 Unit Blowdown Rate = 5,100 gpm @ 0. ppm

2nd Unit Discharge Rate = 17,900 gpm @ 0. ppm

Available Dilution Flow = 14,400 gpm @ 0. ppm

$$\text{Concentration of } Cl_2 = \frac{12,800 \times 0.5}{50,200} = 0.127 \text{ ppm} = \sim 0.13$$

11.1.4 Consumptive Use of Water

The evaporation and drift from the Farley cooling towers will amount to approximately 12,732 gpm per unit. Drift has been estimated by the manufacturer to be 0.005% of the circulating water volume, or 32 gpm. Evaporation will be approximately 2% or 12,700 gpm.

This amounts to a consumptive loss for 2 unit operation of 25,464 gpm.

11.2 LAND

11.2.1 Solids Discharged from Cooling Towers

The cooling towers will be operated at approximately 3.5 cycles of concentration. The concentration of solids in the cooling tower drift will be approximately 220 ppm. With a drift rate of 0.005% of the circulating water volume, there will be approximately 24 tons of river water minerals discharged per year.

This calculation was made as follows:

Concentration of Solids in Drift = 220 ppm

Drift Rate = 635,000 x 0.005% = 32 gpm = 0.071 cfs

Plant Load Factor = 0.781

$$\begin{aligned} \text{Lb. solids/yr} &= \text{ft}^3\text{/sec} \times \text{liter/ft}^3 \times \text{gram/liter} \\ &\quad \times \text{sec/yr} \times \text{lb/gram} \times \text{load factor} \\ &= 24{,}000 \text{ lb/yr per unit} \end{aligned}$$

11.3 CAPITAL OUTLAY AND OPERATING COST

The estimated levelized fuel and operating cost for Units No. 1 and No. 2 is 4.66 mills per KWH, based on a levelized plant factor of 78.1% over an estimated 30 year service life including expected escalation. The expected system peak hour capability of the plant after the initial year of operation is 844 MW for each unit or 1688 MW for the 2 units. The present worth factor for a uniform annual series for 30 years at 10.4% (the annual cost of capital) is 9.118.

The levelized annual fuel and operating cost is equal to the levelized cost of fuel and operation per KWH times the levelized plant factor times 8760 hours per year times the capability of the plant in kilowatts, as follows: 2

$.00466 x .781 x 8760 x 1,688,000 = $53,816,000

The present worth of the levelized annual cost for 30 years is:

9.118 x $53,816,000 = $490,694,000

The estimated total generating cost for Units No. 1 and No. 2 is the capital cost of the plant ($740,000,000) plus the present worth of the levelized annual fuel and operating costs during the life of the plant, as follows:

$740,000,000 + $490,694,000 = $1,230,694,000

12. ENVIRONMENTAL APPROVALS AND CONSULTATIONS

The status of licenses, permits and other approvals of plant construction and operations required by Federal, State, Local and regional authorities for the protection of the environment is shown in Table 12-1.

Alabama Power Company will apply to the Alabama Water Improvement Commission for a water quality certification under Section 401 of the Federal Water Pollution Control Act, as amended, for the discharges associated with the operation of the Joseph M. Farley Nuclear Plant. Application for this certification is planned to be submitted in the fall of 1974. Notice of this application will be submitted to the Georgia Water Quality Control Board in view of the fact that the Chattahoochee River is located within the state of Georgia.

The following state, local and regional planning authorities have been contacted in connection with the construction of the Joseph M. Farley Nuclear Plant:

Bureau of State Planning and
Community Affairs
Room 611
270 Washington Street, S.W.
Atlanta, Georgia 30303

Altamaha Area Planning and
Development Commission (APDC)
P.O. Box 328
Baxley, Georgia 31513

Lower Chattahoochee Valley APDC
P.O. Box 1908
Columbus, Georgia 31901

Department of Administration
Attention: Mr. Don Albright
Capitol Building
Tallahassee, Florida

Southeast Alabama Regional Planning
and Development Commission
P.O. Box 1406
Dothan, Alabama 36301

Southwest Georgia Planning and
Development Commission
P.O. Box 346
Camilla, Georgia 31730

Information discussions have taken place at various times not only with these agencies but also with other interested federal, state and local government agencies including:

U. S. Army Corps of Engineers

U. S. Coast Guard

U. S. Environmental Protection Agency

U. S. Geological Survey

County Agents of Houston and Surrounding Counties

Alabama Water Improvement Commission

Alabama Department of Conservation

Alabama Geological Survey

Alabama State Department of Health

Georgia Water Quality Board

Georgia Department of Conservation

Florida Water & Air Pollution Control Agency

Florida Division of Health

Florida Fish and Game Commission

Florida Department of Health and Rehabilitative Services

Florida Air and Water Pollution Control Commission

Florida Department of Natural Resources

Florida State Planning and Development Clearing House

TABLE 12-1

LICENSE AND PERMITS

License or Permit	Regulatory Agency	Status
Certificate of Convenience and Necessity	Alabama Public Service Comm.	Approved August 1969
Construction and Operation (Nuclear)	Atomic Energy Commission	Submitted Oct. 1969 Amended July 1970
Supporting Information-Construction Stage		
(1) Preliminary Safety Analysis Report	Atomic Energy Commission	Approved August 1972
(2) Environmental Report	Atomic Energy Commission	Approved August 1972
(3) Supplement to Environmental Report	Atomic Energy Commission	Approved August 1972
Supporting Information-Operating Stage		
(1) Final Safety Analysis Report	Atomic Energy Commission	Submit for Approval July 1973
(2) Environmental Report	Atomic Energy Commission	Submit for Approval July 1973
Certification for Applicable Water Quality Standards (Section 21B Water Quality Act of 1970)	Georgia Water Quality Board Alabama Water Improvement Comm.	Approved April 1971 Approved April 1971
Construction of Barge Slip, Intake and Discharge Structures	Corps of Engineers Alabama State Docks Dept. Department of Conservation	Approved April 1972 Approved Jan. 1972 Approved March 1972
Operation of Start-up Boiler	Ala. Air Pollution Control Comm.	Submit for Approval Fall 1974
Transmission Lines: Farley-Webb 230 KV	Alabama Highway Department	Approved July 1972
Pinckard-Webb 230 KV	Alabama Highway Department	Approved Oct. 1972
Railroad Easements	Corps of Engineers	Approved May 1972
Flowage and Spoilage Easements	Corps of Engineers	Approved Dec. 1972
NPDES Permit	Environmental Protection Agency or designee.	Submit for Approval Fall 1974
Certification for Applicable Water Quality Standards (Section 401 Federal Water Pollution Control Act, as amended.)	Alabama Water Improvement Comm.	Submit for Approval Fall 1974

APPENDIX I

SUPPLEMENTARY MATERIAL ON THE ECOLOGY OF THE JOSEPH M. FARLEY NUCLEAR PLANT VICINITY

CONTENTS

F16

1.1 TERRESTRIAL INVERTEBRATES

Scant information is available on the terrestrial invertebrates at the Farley Nuclear Plant and surrounding areas. The references on each major taxon are numbered in parentheses and basic information on specific ecology is presented if available.

ORTHOPTERAN GROUPS (6)

COCKROACHES - BLATTIDAE

SPECIES	LOCATION	ACTIVITY PERIOD	HABITAT
Aglaopteryx gemma	Houston County	-	-
Cariblatta lutea lutea	Houston County	Spring - Summer	Low vegetation
Tschnoptera deropeltiformis	Houston County	Summer	Wooded areas - on the ground in dead pine needles and beneath loose bark of trees
Parcoblatta lata	Houston County	-	Beneath pine bark
P. divisa	Houston County	-	Found beneath loose bark of a dead oak tree

WALKING STICKS - PHASMIDAE

SPECIES	LOCATION	HABITAT
Diapheromera femorata	Houston County	Trees and bushes

PYGMY MOLE CRICKETS - TRIDACTYLIDAE

SPECIES	LOCATION	HABITAT
Tridactylus apicalis	Houston County	Sand bars on edges of small creeks

GROUSE LOCUSTS - TETRIGIDAE

SPECIES	LOCATION	HABITAT
Nomotettix cristatus compressus	Houston County	Old fields, woodland borders, and cut-over timberland
Tetrix arenosa angusta	Houston County	Moist areas around lakes, ponds, and streams

ORTHOPTERAN GROUPS (6) (CONT.)

GROUSE LOCUSTS - TETRIGIDAE (CONT.)

SPECIES	LOCATION	HABITAT
Neotettix femoratus	Houston County	Habitats range from wet swampy areas to relatively dry areas in open hardwood or pine forests
N. proavus	Houston County	Found chiefly in leaf litter of open deciduous forests; also found along margins of lakes and streams
Paratettix mexicanus	Henry & Houston Counties	Around margins of lakes and ponds and on stream banks Seldom found in drier situations
Tettigidea lateralis lateralis	Henry & Houston Counties	Habitats range from rather dry woodlands to very wet situations
Tettigidea prorsa	Houston County	Low, wet, or boggy areas and wet meadows in pine woods
Paxilla obesa	Houston County	Wet areas in pine woods and a variety of other wet situations

SHORT-HORNED GRASSHOPPERS - ACRIDIDAE

SPECIES	LOCATION	HABITAT
Radinatatum carinatum carinatum	Henry & Houston Counties	Low vegetation on margins of woods, particularly the drier portions Inhabits wiregrass, broomsedge, and similar grasses
Amblytropidia occidentalis	Henry & Houston Counties	Both in old fields and open woods
Orphulella pelidna pelidna	Houston County	Habitats range from slopes of Cheaha Mountain to sparse vegetation of sand dunes on Gulf Coast Usually found in relatively dry open areas in grasses or other vegetation Also in undergrowth of open pine woods

ORTHOPTERAN GROUPS (6) (CONT.)

SHORT-HORNED GRASSHOPPERS - ACRIDIDAE (CONT.)

SPECIES	LOCATION	HABITAT
Dichromorpha viridis	Houston County	Chiefly in vegetation around ponds, lakes, and ditches Also common in margins of woods, roadsides, and open fields
Arphia sulphurea	Houston County	Chiefly along roadsides and in very open pine woods Also found in rather dry habitats with sparse vegetation
Chortophaga australior	Houston County	Along roadsides, in pastures, abandoned fields, and similar situations
Dissosteira carolina	Houston County	Prefers bare patches of ground; often seen on bare dirt of old logging roads or other unpaved, seldom-traveled roads
Romalea microptera	Houston County	Habitats range from both fresh and brackish marshes to very dry, open pine woods Also along roadsides and in fields
Stenacris vitreipennis vitreipennis	Houston County	Sedges, cattails, and other aquatic or semi-aquatic plants
Shistocerca damnifica	Houston County	Fields, roadsides, and grassy areas in woods
S. alutacea	Houston County	Vegetation near edges of streams, lakes, or ponds
S. obscura	Houston County	Confined chiefly to Coastal Plain Occurs in fields, woodlands, and along roadsides
Gymnoscirtetes morsei	Houston County	Found only in wet, boggy areas i.e. pitcher plant bogs
Melanoplus femurrubrum propinquus	Houston County	-
M. impudicus	Houston County	Chiefly in areas of sparse vegetation Occurs most frequently on bare rocky or sandy areas

ORTHOPTERAN GROUPS (6) (CONT.)

SHORT-HORNED GRASSHOPPERS - ACRIDIDAE (CONT.)

SPECIES	LOCATION	HABITAT
M. keeleri keeleri	Houston County	Grasses and low shrubs of open woodlands Not usually found in open grasslands
Paroxya atlantica atlantica	Houston County	In vegetation bordering lakes and streams and in ditches
P. hoosieri	Houston County	Wet situations similar to those of *P. atlantica*
Aptenopedes sphenariodes appalachee	Houston County	Undergrowth of long-leaf pine forests

KATYDIDS - TETTIGONIIDAE

SPECIES	LOCATION	HABITAT
Belocephalus subapterus subapterous	Houston County	Undergrowth of open fields
Neoconocephalus triops	Houston County	Undergrowth of woods and in clumps of grass in fields and along roadsides Overwinters in both adult and nymphal stage
Orchelimum agile	Houston County	On vegetation in low, wet areas Also in drier areas in fields and along roadsides
O. glaberimum	Houston County	Tall grasses along roadsides and ditches
Conocephalus brevipennis	Houston County	Habitats vary i.e. Rank vegetation near margins of large lakes i.e. Undergrowth of open pine woods i.e. Vegetation along margins of woods and roadsides
C. fasciatus fasciatus	Houston County	Open grassy areas such as low vegetation in pastures, lawns, roadsides, and other open areas

ORTHOPTERAN GROUPS (6) (CONT.)

KATYDIDS - TETTIGONIIDAE (CONT.)

SPECIES	LOCATION	HABITAT
C. saltans	Houston County	Very dry habitats such as undergrowth of open pine woods and areas of very sandy soil
Odontoxiphidium apterum	Houston County	Undergrowth of open, dry woods Also low vegetation along roadsides
Atlanticus americanus hesperus	Houston County	Inhavits leaf litter of deciduous forests

CRICKETS - GRYLLIDAE

SPECIES	LOCATION	HABITAT
Cycloptilum bidens	Houston County	Shrubs and bushes of open woods
C. trigonipalpum	Houston County	Low bushes and shrubs
Nemobius fasciatus	Houston County	Grasses in lawns, pastures, fields, and similar places Often in low, wet areas such as pond margins
N. cubensis	Henry County	Grasses and other low vegetation along edges of ponds, ditch banks, and other rather damp areas Occasionally in drier situations such as lawns and roadside vegetation
N. ambitious	Houston County	Leaf litter of deciduous woods
Miogryllus verticalis	Houston County	Areas of low, scanty vegetation
Gryllus rubens	Henry & Houston Counties	All kinds of grassy situations such as fields, pastures, roadsides, and lawns
G. fultoni	Houston County	Leaf litter of deciduous forests and dry, open fields

ORTHOPTERAN GROUPS (6) (CONT.)

CRICKETS - GRYLLIDAE (CONT.)

SPECIES	LOCATION	HABITAT
Oceanthus celerinictus	Houston County	Chiefly in small vegetation such as weeds growing in old fields Occasionally on lower branches of small trees surrounding such situations
O. quadripunctatus	Houston County	In vegetation in old fields and along edges of roadways
Anaxipha exigua	Houston County	Bushes and tall vegetation along edges of ponds and streams

STONEFLIES - PLECOPTERA (8)

SPECIES	LOCATION
Taeniopteryx burksi	Houston County
T. lonicera	Houston County
Allocapnia recta	Dale County
Nemocapnia carolina	Dale County

PENTATOMIDAE (11)
(STINK BUGS)

SPECIES	LOCATION	HOST PLANTS
Thyanta custator	Houston County	Collected from mixed herbage
T. calceata	Houston County	Collected from mixed herbage
Mormidea lugens	Houston County	Collected from roadside herbage and from grass along edges of woods or in cleared places in woods
Oebalus pugnax	Houston County	Found on grasses and mixed herbage Most abundant stink bug in Ala. Economic pest of rice, corn, wheat, and sorghum

PENTATOMIDAE (11) (CONT.)
(STINK BUGS) (CONT.)

SPECIES	LOCATION	HOST PLANTS
Proxys punctulatus	Houston County	-
Euschistus servus	Henry County	Mixed herbage, grasses, soybeans, milkweed, goldenrod, thistle, cotton, peach, pecan, beans, squash, tomatoes, cocklebur, corn, okra, and pepper
Murgantia histrionica	Houston County	Major pest of vegetables such as cabbage, eggplant, asparagus, potatoes, tomatoes, okra, beets, and squash Other hosts are various ornamental plants, citrus trees, cherry, and plum
Nezara viridula	Henry County	Soybean, corn, small grains, sweet potato vines, oranges, cotton, green string beans, pecans, hackberry, okra, mulberry, pepper, rice, sugar cane, sunflower, tomato, turnip,rutabaga, cauliflower, squash, peanuts, tobacco, eggplant, cabbage, and kumquats
Acrosternum hilare	Henry County	Wild black cherry, hazel, wild grape, ash, catalpa, apple, asparagus, goldenrod, maple, cotton, orange, cabbage, corn, peas, peach, okra, aprocots, pears
Banasa dimidiata	Henry County	Hazel, chokeberry, and other shrubs along margins of swale and tamarack swamps
B. calva	Henry County	Holly and various deciduous trees
Podisus maculiventris	Henry County	A beneficial stink bug as it feeds on over 30 species of injurious insects

CICINDELLIDAE (4,9)

(TIGER BEETLES)

SPECIES	LOCATION	ACTIVITY PERIOD	HABITAT
Cicindela punctulata	Houston County	June - November	Dry, sandy loam, preferably hard-packed, such as on paths and roadways of wooded areas and open pastures Also inhabits tilled fields, sand or clay pits, and sandy banks of streams or creeks
C. tranquebarica	Houston County	-	Sandy or muddy flats near running water, also along roads and pathways

COCCINELLIDAE (7,9)

(LADYBIRD BEETLES)

SPECIES	LOCATION	HABITAT AND/OR FOOD
Hyperaspis binotata	Henry & Houston Counties	Roadside vegetation, feeding on cottony maple scale, *Pulvinaris vittis*, and woody maple scale, *Phanacoccus accericole*
H. signata	Henry & Houston Counties	-
Cycloneda sanguines	Henry & Houston Counties	Ornamental plants, field crops, and other aphid-infested crops, feeding on the aphids
C. munda	Houston County	On field crops
Chilocorus stigma	Henry & Houston Counties	Pecan trees, cherry trees, and other vegetation, feeding on aphids and scale insects
Coccinella novemnotata	Henry & Houston Counties	In spring: clovers, alfalfa, field crops, and grasses, feeding on aphids In summer: corn, feeding on aphids Also on vegetation along roadsides and in wooded areas

COCCINELLIDAE (7,9) (CONT.)

(LADYBIRD BEETLES) (CONT.)

SPECIES	LOCATION	HABITAT AND/OR FOOD
Olla abdominalis	Henry & Houston Counties-Uncommon	Mainly pecan groves, though some ornamental plants, feeding on obscure scale and spider mites
O. a. plagiata	Henry & Houston Counties	Collected from pecan grove in which soybeans were growing
O. a. sobrina	Henry & Houston Counties	-
Hippodamia convergens	Henry & Houston Counties	On field crops and ornamental plants, feeding on aphids
Coleomegilla maculata	Henry & Houston Counties	On crimson clover and seedling cotton, feeding on aphids
Brachyacantha quadripunctata flavifrons	Houston County	-
Epilachna varivestis	Henry & Houston Counties	Is phytophagous - causes economic damage to legumes
Rodolia cardinalis	Henry & Houston Counties	On Pittosporum tobira, feeding on cottony cushion scale
Scymnus (Scymnus) kagelann	Houston County	On corn, feeding on aphids
S. (Diomus) terminatus	Houston County	On corn, feeding on aphids
S. (D.) partitus	Henry County	-
S. (Nephus) flavifrons	Houston County	-
S. (Pullus) natchezianus	Henry & Houston Counties	-
S. (P.) tenebrosus	Houston County	-
S. (P.) puncticollis	Houston County	On corn, feeding on aphids
S. (P.) creperus	Houston County	-
S. (P.) loewii	Henry & Houston Counties	On aphid-infested crops, especially corn, feeding on aphids

CHRYSOMELIDAE (1,2,9)

(LEAF BEETLES)

SPECIES	LOCATION (COUNTY)	ACTIVITY PERIOD	HOST PLANTS AND HABITAT
Lema (*Quasilema*) *cornuta*	Houston	May-August	*Commelina erecta*
L. (*Neolema*) *sexpunctata*	Houston	April-September	*Commelina communis*
L. (*N.*) *albini*	Houston	April-August	-
L. (*N.*) *ephippium*	Houston	-	-
L. sayi	Houston	April-August	*Commelina communis*
Anomoea laticlavia	Houston	April-August	*Lespedeza*, *Gleditsia triacanthos*, *Salix*, and *Satsuma*
Pachybrachis stygicus	Houston	May-August	-
Lexiphanes saponatus	Houston	June-October	*Sambucus canadensis*, *Cephalanthus occidentalis*, *Eupatorium purpureum*
Cryptocephalus incertus	Houston	April-August	-
C. insertus	Henry	June-October	-
C. badius	Houston	June-August	-
Diachus auratus	Houston	April-September	*Sambucus canadensis* and *Salix*
D. squalens	Houston	-	-
Triachus cerinus	Houston	May-August	-
Chlamisus plicatus	Houston	March-October	*Rubus*
Colaspis brunnea flavida	Houston	June-August	-
C. flavocostata	Houston	May	-

CHRYSOMELIDAE (1,2,9) (CONT.)

(LEAF BEETLES) (CONT.)

SPECIES	LOCATION (COUNTY)	ACTIVITY PERIOD	HOST PLANTS AND HABITAT
Graphops curtipennis schwarzi	Henry	April-July	*Hypericum hypericoides* and *Cyrilla racemiflora*
Metachroma longicollis	Houston	April-August	Sorghum
Paria fragariae kirki	Houston	April-August	*Fragaria*, *Rubus*, and *Rosa*
P. scutellaris	Houston	May-July	*Cornus*
P. thoracica	Houston	April-August	*Solidago*, *Aster*, *Trifolium*, *Fragaria virginians*, *Amaranthus retroflexus*
Chrysomela scripta	Houston	April-September	*Salix*
Trirhabda bacharidis	Houston	April-May	*Baccharis halimifolia* and slash pine
Ophraella notulata	Houston	May-September	*Ambrosia artemisiaefolia*
Diabrotica balteata	Houston	June-December	Cucumber (of economic importance)
Cerotoma trifurcata	Houston	Feb.-Sept.	Legumes (of economic importance)
Kuschelina vians	Houston	All Year	-
Capraita sexmaculata	Houston	April-June	-
C. obsidiana obsidiana	Houston	April-August	*Vaccinium*
Disonycha pensylvanica	Houston	March-August	*Polygonum* - not definitely known to be host plant - taken in aquatic habitats
D. admirablis	Houston	April-November	*Cassia* sp. and *Polygonum* sp.
D. glabrata	Houston	March-September	*Ameranthus spinosus*, *Salix*, and *Trifolium incarnatum*
D. xanthomelas	Henry	May-July	*Stellaria media*, *Chenopodium album*, *Amaranthus spinosus*, spinach, and beet

CHRYSOMELIDAE (1,2,9) (CONT.)

(LEAF BEETLES) (CONT.)

SPECIES	LOCATION (COUNTY)	ACTIVITY PERIOD	HOST PLANTS AND HABITAT
Altica foliaceae	Henry & Houston	April-October	Evening primrose and *Cakile endentula*
Syphraea nigritula	Houston	July-August	-
Strabala rufa	Houston	March-September	-
Hornaltica atriventris	Houston	March-August	*Acalypha*, *Vicia* sp., and *Brassica* sp.
Crepidodera nana	Houston	March-September	*Salix*
Epithrix fuscula	Houston	April-June	Eggplants, potatoes, thistles, and *Trifolium*
Orthaltica copalina	Houston	April-June	Poison ivy and sumac
Luperaltica nigripalpis	Henry	August-Sept.	*Ambrosia* sp.
Mantura floridana	Houston	March-November	Plantain and dock
Chaetocnema denticulata	Houston	March-September	-
Systena elongata	Houston	April-November	*Ambrosia* sp., *Vicia* sp., and *Trifolium incarnatum*
S. corni	Houston	July	*Cornus florida*
S. plicata	Houston	June-August	Cypress
Longitarsus testaceus	Houston	March-December	*Cirsium*
Palaeothona picta	Houston	April-August	*Quercus* spp.
Glyptina spuria	Houston	April-September	-
Psylliodes punctulata	Houston	March-November	*Trifolium incarnatum*
Sumitrosis rosea	Houston	April-July	*Cyrilla racemiflora* and *Laportea canadensis*

CHRYSOMELIDAE (1,2,9) (CONT.)

(LEAF BEETLES) (CONT.)

SPECIES	LOCATION (COUNTY)	ACTIVITY PERIOD	HOST PLANTS AND HABITAT
Sumitrosis inaequalis	Houston	April-August	Leguminosae
Chalepus bicolor	Houston	April-August	-
Agroiconota bivittata	Henry & Houston	May-October	Convolvulaceae
Deloyala guttata	Henry & Houston	May-August	Convolvulaceae
Coptocycla repudiata	Houston	March-July	Convolvulaceae
C. pinicola	Henry		Pine and convolvulus(?) or Ipomoea(?)

MOSQUITOES IN DALE COUNTY (3)

(FORT RUCKER)

SPECIES:

Aedes atlanticus
A. canadensis
A. infirmatus
A. mitchellae
A. sollicitans
A. stricticus
A. triseriatus
A. vexans
Anopheles crucians
A. georgianus
A. punctipennis
A. quadrimaculatus
Chaoborus albatus
C. punctipennis
Culex erraticus

SPECIES:

Culex pilosus
C. quinquefasciatus
C. restuans
C. salinarius
C. territans
Culiseta inornata
C. melanura
Mansonia perturbans
Orthopodmyia signifera
Psorophora ciliata
P. confinnis
P. discolor
P. ferox
P. horrida
Uranotaenia sapphirina

TABANIDAE (12)

(HORSEFLIES AND DEERFLIES)

SPECIES	LOCATION (COUNTY)	ACTIVITY PERIOD	REMARKS
Chrysops brimleyi	Henry & Houston	March-May	Larvae in organic matter along lake edges
C. callidus	Henry & Houston	All Summer	Serious pest of livestock and man Eggs on vegetation growing in or overhanging edges of ponds Larvae in organic matter along edges
C. dimmocki	Houston	April-May	Active near marshy areas along rivers
C. flavidus	Houston	April-October	Larvae in organic matter along edges of lakes and ponds, hereafter referred to as the "typical" larval habitat
C. f. celatus	Houston	May-September	Active in vicinity of swampy or marshy areas and edges of ponds
C. f. reicherti	Houston	April-October	Active near ponds and wooded habitats bordering on streams or rivers
C. fulvistigma	Henry	June-August	-
C. f. dorsopunctus	Houston	May-September	-
C. moechus	Henry & Houston	April-August	Active in wooded areas along creeks Indicates breeding habitat dissimilar to "typical" pond, lake, or swamp situation
C. montanus	Houston	May-August	Larvae in "typical" habitat
C. niger	Henry	April-June	-
C. pikei	Houston	May-September	Active in wooded situations along creeks and around ponds or lakes

TABANIDAE (12) (CONT.)

(HORSEFLIES AND DEERFLIES) (CONT.)

SPECIES	LOCATION (COUNTY)	ACTIVITY PERIOD	REMARKS
Chrysops pudicus	Houston	April-September	Active around cypress swamps, beaver ponds, and small lakes or ponds
C. univittatus	Henry	May-September	Active in wooded areas bordering small creeks and beaver ponds Larvae in "typical" habitat
C. upsilon	Houston	June-September	Active in or near swamps and backwaters
C. vittatus	Henry & Houston	May-October	(Serious pest of livestock, other animals, and man) Inhabits all the habitats listed above
Whitneyomyia beatifica atricorpus	Houston	May	Fairly rare
Tabanus americanus	Houston	June-August	Not uncommon but never abundant
T. atratus	Houston	May-October	Seldom abundant but abundant enough to annoy cattle
T. cheliopterus fronto	Houston	July-August	Rare
T. fulvulus	Henry & Houston	May-July	-
T. gladiator	Henry & Houston	July-October	Very numerous in late summer and fall
T. lineola	Henry & Houston	May-September	Larvae in "typical" habitat
T. l. hinellus	Houston	July-August	-
T. longisculus	Henry & Houston	May-July	-
T. longus	Houston	May-August	Rare

TABANIDAE (12) (CONT.)

(HORSEFLIES AND DEERFLIES) (CONT.)

SPECIES	LOCATION (COUNTY)	ACTIVITY PERIOD	REMARKS
Tabanus melanocerus	Henry & Houston	May-September	Numerous but seldom abundant
T. moderator	Houston	May-July	Not common
T. molestus mixis	Houston	April-August	-
T. mularis	Houston	June-September	Not abundant
T. nigripes	Henry & Houston	May-October	Fairly common but never appreciable in abundance Larvae in "typical" habitat
T. pallidescens	Houston	April-July	Very abundant
T. petiolatus	Henry & Houston	May-August	Larvae in "typical" habitat
T. proximus	Henry	June-September	Infrequent in occurrence
T. subsimilis (= T. vitteger schwardti)	Houston	April-October	Fairly sparse in numbers Larvae in "typical" habitat
T. trimaculatus	Henry & Houston	May-September	Occasionally numerous but not abundant Larvae in "typical" habitat
T. turbidus	Houston	May-July	Reported very abundant in Houston County near Florida line
T. zythicolor	Houston	June-September	-
Hybomitia trispila	Houston	May-June	Not common, never numerous enough to be of importance as a pest
Hamatabanus carolinensis	Houston	May-June	Rare

FLEAS - SIPHONAPTERA (10)

SPECIES	LOCATION	HOSTS
Leptopsylla segnis	Houston County	Norway rat, *Rattus norvegicus*
Odontopsyllus multispinosus	Houston County	Raccoon, *Procyon lotor* Mink, *Mustela vison* Red fox, *Vulpes fulva* Gray fox, *Urocyon cinereoargenteus* Bobcat, *Lynx rufus* Eastern cottontail, *Sylvilagus floridanus* Swamp rabbit, *S. aquaticus* Whitetail deer, *Odocoileus virginianus*
Nosopsyllus fasciatus	Houston County	Norway rat, *Rattus norvegicus*
Orchopeas howardii	Houston County	Virginia opossum, *Didelphis marsupialis* Raccoon, *Procyon lotor* Mink, *Mustela vison* Striped skunk, *Mephitis mephitis* Eastern gray squirrel, *Sciurus carolinensis* Eastern fox squirrel, *S. niger* Southern flying squirrel, *Glaucomys volans* Cotton mouse, *Peromyscus gossypinus* Hispid cotton rat, *Sigmodon hispidus*
Rhopelopsyllus gwyni	Henry County	Virginia opossum, *Didelphis marsupialis* Eastern gray squirrel, *Sciurus carolinensis* Rice rat, *Oryzomys palustris* Hispid cotton rat, *Sigmodon hispidus*

FLEAS - SIPHONAPTERA (10) (CONT.)

SPECIES	LOCATION	HOSTS
Cediopsylla simplex	Henry & Houston Counties	Raccoon, *Procyon lotor* Mink, *Mustela vison* Red fox, *Vulpes fulva* Gray fox, *Urocyon cinereoargenteus* Domestic cat, *Felis domestica* Bobcat, *Lynx rufus* Eastern woodrat, *Neotoma floridana illinoensis* Eastern cottontial, *Sylvilagus floridanus* Swamp rabbit, *S. aquaticus* Whitetail deer, *Odocoileus virginianus*
Ctenocephalides felis	Houston County	Virginia opossum, *Didelphis marsupialis* Raccoon, *Procyon lotor* Striped skink, *Mephitis mephitis* Domestic dog, *Canis familiaris* Red fox, *Vulpes fulva* Gray fox, *Urocyon cinereoargenteus* Domestic cat, *Felis domestica* Bobcat, *Lynx rufus* Eastern gray squirrel, *Sciurus carolinensis* Eastern cottontail, *Sylvilagus floridanus*
Xenopsylla cheopis	Houston County	Norway rat, *Rattus norvegicus*
Echidnophaga gallinacea	Houston County	Virginia opossum, *Didelphis marsupialis* Raccoon, *Procyon lotor* Domestic dog, *Canis familiaris* Red fox, *Urocyon cinereoargenteus* Domestic cat, *Felis domestica* Norway rat, *Rattus norvegicus* Eastern cottontail, *Sylvilagus floridanus*

IXODIDAE (5)

(HARD TICKS)

SPECIES	LOCATION	HOSTS
Ixodes cookei	Henry & Houston Counties	River otter, raccoon, opossum, red fox, gray fox, mink, longtail weasel, spotted skunk, striped skunk, woodchuck, cat, dog
Haemaphysalis leporispalustris	Henry & Houston Counties	Eastern cottontail rabbit, swamp rabbit, raccoon, dog, bobcat, fox squirrel, cotton rat, cotton mouse, bob-white quail, crow
Rhipicephalus sanguineus	Houston County	Mainly dog
Dermacentor variabilis	Henry & Houston Counties	(This is the American dog tick) Eastern cottontail rabbit, raccoon, dog, gray fox, bobcat, cat, opossum, striped skunk, cow, gray squirrel, swamp rabbit, cotton rat, rice rat, wood rat, cotton mouse, old-field mouse, golden mouse, pine mouse, woodchuck, white-tailed deer, domestic rabbit, man, bob-white quail
Amblyomma americanum	Houston County	White-tailed deer, eastern cottontail rabbit, raccoon, dog, cat, man, and wild turkey
A. maculatum	Houston County	Man, cotton rats, and ground-inhabiting birds
A. tuberculatum	Houston County	Gopher tortoise and rabbit

REFERENCES (TERRESTRIAL INVERTEBRATES)

1. Balsbaugh, E. J., Jr. The Chrysomelidae of Alabama. unpublished Ph. D. dissertation. Auburn University. 1966.

2. Balsbaugh, E. J. Jr. and K. L. Hays. The Leaf Beetles of Alabama. unpublished manuscript. Auburn University, Department of Zoology and Entomology. 1972.

3. Bargren, W. C. Mosquitoes from Lee County, Alabama. unpublished M. S. thesis. Auburn University. 1958.

4. Bloch, J. A. The Cicindelidae of Alabama. unpublished M. S. thesis. Auburn University.

5. Cooney, J. C. The Ixodidae (Acarina) of Alabama and bionomics of Amblyomma tuberculatum Marx. unpublished Ph. D. dissertation. Auburn University. 1967.

6. Dakin, M. E., Jr. and K. L. A Synopsis of Orthoptera (Sensu Lato) of Alabama. Auburn University Agricultural Experiment Station Bulletin 404. 1970.

7. Grimes, W. H. The Coccinellidae (Coleoptera) of Alabama. unpublished Ph. D. dissertation. Auburn University. 1965.

8. James, A. M. The Stoneflies (Plecoptera) of Alabama. unpublished Ph. D. dissertation. Auburn University. 1972.

9. Loding, H. P. Catalogue of the Beetles of Alabama. Geological Survey of Alabama Monograph 11. 1945.

10. Sanford, L. G. Fleas (Siphonaptera) of Alabama and Their Host Relationships. unpublished Ph. D. dissertation. Auburn University. 1966.

11. Simons, E. E. The Stink Bugs (Pentatomidae) of Alabama. unpublished M. S. thesis. Auburn University. 1969.

12. Watson, R. L. The Tabanidae of Alabama and Some aspects of Their Ecology. unpublished Ph. D. dissertation. Auburn University. 1968.

1.2 AQUATIC INVERTEBRATES

The Chattahoochee River in the vicinity of the Farley site is not expecially rich in plankton and bottom fauna. Personal communication during the site visit with Dr. John M. Lawrence of Auburn University revealed that numerous water samples indicated a low density of plankton. Rapidly shifting bottom sands prevent the establishment of a resident bottom fauna in large portions of the river. Studies by the Georgia Water Quality Board(1) substantiate this opinion.

Water samples taken upstream at Columbus, Georgia, indicated a range of 100 to 6200 (average 1434) plankton organisms per milliliter of river water(3). Average composition of plankton samples taken twice monthly for a year was algae, 26.3; flagellates, 12.8; diatoms, 50.7: protozoa, 0.5; rotifers, 9.0: and crustaceans, 0.7%. The greatest diversity and density of these organisms occurred during June through August. Samples taken in August contained the greatest number of organisms (4800-6200/ml) while samples taken in December contained the least number (100-400/ml).

Major algal types and macrophytes are listed in Table 1. These were identified in Lake Seminole below the Farley site(2), and the macrophytes are not found in the river at the station site. The rapid flow and varying levels of the Chattahoochee River prevent establishment of larger aquatic plants, which are confined to stiller water in Lake Seminole downstream.

Other studies on the benthos-macroinvertebrates have been carried out in the lower portion of Lake Seminole and in the Apalachicola River below Woodruff Lock and Dam. These studies are discussed extensively in two unpublished reports (4,5).

TABLE 1 - FLORA OF LAKE SEMINOLE

MAJOR ALGAE

Chara sp.
Pithophora sp.
Cladophora sp.
Spirogyra spp.
Giant Spirogyra sp.
Rhizoclonium sp.
Hydrodictyon sp.
Oedogonium sp.
Mougeotia sp.
Lyngbya sp.
Nitella sp.
Microcystis sp.
Aphanizomenon sp.
Anabaena sp.
Euglena sp.

AQUATIC MACROPHYTES

Alternanthera phylloxeroides (alligator weed)
Eichhornia crassipes (water hyacinth)
Justicia americana (water willow)
Polygonum spp. (smartweeds)
Myriophyllum brasiliense (parrot's-feather)
Myriophyllum spicatum (Eurasian milfoil)
Paspalum fluitans (grass)
Cephalanthus occidentalis (buttonbush)
Zizaniopsis miliaceac (giant cut-grass)
Eleocharis acicularis (needlerush)
Vallisnera americana (eelgrass)
Potamogeton crispus (curly leaf pondweed)
Bacopa sp.
Nymphaea tuberosa (white waterlily)
Nymphaea mexicana (banana waterlily)
Hydrocotyle sp.

REFERENCES

(PLANKTON, MACROPHYTES, AND BENTHOS - MACROINVERTEGRATES)

1. Georgia Water Quality Board. Chattahoochee River Studies. 1971.

2. Lawrence, V. M. Dynamics of Chemical and Physical Characteristics of Water, Bottom Muds, and Aquatic Life in a Large Impoundment on a River. Auburn University, Water Resources Research Institute, Office of Water Resources Research Project B-010-ALA. 1971.

3. U.S.H.E.W., P.H.S. National Water Quality Network, Annual Compilation of Data. October 1, 1960 - September 30, 1961.

4. Schneider, R. F. A Biological Report of the Apalachicola River. Florida State Board of Health, Bureau of Sanitary Engineering. Winter Survey, November 28, 1960 - December 14, 1960 and Summer Survey, September 10, 1961 - September 22, 1961.

5. Cox, D. T. Stream Fish Population and Environmental Studies, Apalachicola River. Florida Game and Fresh Water Fish Commission. D. J. Project F-25-3. July 1, 1969 - June 30, 1970.

1.3 FISHES

Of the approximately 80 species of freshwater fishes found in the Apalachicola River drainage, around 43 species are of commercial and sport interest (13, 18, 34). Table 1-3.1 shows the commercial and sport fish species that either probably or are known to occur in the Chattahoochee River at the Farley Nuclear Plant. The status of several species in jeopardy or in a precarious position are noted (1). The presence of locks and dams on the Chattahoochee has restricted the movement of anadromous species. The narratives on each of the important species was obtained from references which are listed in parentheses and cited at the end of the fish discussion. Table 1-3.2 shows the critical temperature of select species which was obtained from a literature survey.

TABLE 1.3.1

COMMERCIAL AND SPORT FISH SPECIES NEAR PLANT SITE

(Chattahoochee River)

Scientific Name	Common Name	Status*	Relative Abundance
Acipenser oxyrhynchus ✓	Atlantic Sturgeon	R-2	Rare
Lepisosteus oculatus ✓	Spotted Gar		Abundant
Lepisosteus osseus ✓	Longnose Gar		Abundant
Amia calva	Bowfin		Fair
Alosa alabamae	Alabama Shad	SU	Unknown
Alosa chrysochloris ✓	Skipjack Herring		Unknown
Dorosoma cepedianum ✓	Gizzard Shad		Abundant
Dorosoma petenense ✓	Threadfin Shad		Abundant
Esox americanus	Redfin Pickerel		Abundant
Esox niger	Chain Pickerel		Abundant
Cyprinus carpio	Carp		Abundant
Carpiodes cyprinus	Quillback		Abundant
Erimyzon sucetta	Lake Chubsucker		Fair
Minytrema melanops	Spotted Sucker		Abundant
Moxostoma carinatum	River Redhorse		Abundant
Moxostoma lachneri	Great Jumprock		Abundant
Moxostoma poecilurum	Blacktail Redhorse		Abundant
Moxostoma sp.	Redhorse		Abundant
Ictalurus brunneus	Snail Bullhead		Abundant
Ictalurus catus	White Catfish		Rare
Ictalurus natalis	Yellow Bullhead		Abundant
Ictalurus nebulosus	Brown Bullhead		Abundant
Ictalurus punctatus	Channel Catfish		Abundant
Ictalurus serracanthus	Spotted Bullhead	R-2	Abundant
Morone chrysops	White Bass		Abundant
Morone saxatilis	Striped Bass		Unknown
Amblophites rupestris	Rock Bass		Rare
Centrarchus macropterus	Flier		Rare
Lepomis gulosus	Warmouth		Fair
Lepomis auritus	Redbreast Sunfish		Fair
Lepomis cyanellus	Green Sunfish		Abundant
Lepomis humilis	Orangespotted Sunfish		Rare
Lepomis macrochirus	Bluegill		Abundant
Lepomis marginatus	Dollar Sunfish		Fair
Lepomis megalotis	Longear Sunfish		Abundant
Lepomis microlophus	Redear Sunfish		Abundant
Lepomis punctatus	Spotted Sunfish		Fair
Micropterus coosae	Redeye Bass	R-2	Rare
Micropterus punctulatus	Spotted Bass		Fair
Micropterus salmoides ✓	Largemouth Bass		Abundant
Pomoxis annularis	White Crappie		Abundant
Pomoxis nigromaculatus	Black Crappie		Abundant
Perca flaverscens	Yellow Perch		Rare

*See Rare and Endangered Fishes of Alabama, p. 57-86. In Rare and Endangered Vertebrates Alabama. 1972. Alabama Department of Conservation and Natural Resources.

TABLE 1.3.2

UPPER AND LOWER LETHAL TEMPERATURES OF SOME IMPORTANT Fish Species in the Chattahoochee River

Species	Temperatures						Sources of Information
	Acclimation		Upper Lethal		Lower Lethal		
	C	F	C	F	C	F	
Dorosoma cepedianum,	35.0	95.0	36.5	97.7	-	-	8
Gizzard Shad	-	-	36.4	97.5	-	-	11
Dorosoma petenense,	-	-	-	-	7.0	45.0	7
Threadfin Shad							
Cyprinus carpio,	20.0	68.0	31-34	87.8-93.2	-	-	8
Carp	26.0	78.8	35.7	96.3	0.7	33.3	8
Ictalurus nebulosus,	5.0	41.0	28.6	83.5	-	-	8
Brown Bullhead	10.0	50.0	30-30.2	86-86.4	-	-	8
	20.0	68.0	33-33.4	91.4-92.1	-	-	8
	25.0	77.0	35-35.5	95.0-95.9	-	-	8
	30.0	86.0	36.5-37	97.7-98.6	-	-	8
	36.0	96.8	37.5	99.5	-	-	8
Ictalurus punctatus,	15.0	59.0	30.3	96.5	-	-	8
Channel Catfish	20.0	68.0	32.8	91.0	-	-	8
	25.0	77.0	33.5	92.3	-	-	8
	22.2	72.0	34.4	94.0	-	-	3
	26.1	79.0	36.7	98.0	-	-	3
	30.0	86.0	37.2	99.0	-	-	3
	33.9	93.0	37.8	100.0	-	-	3
	26.0	78.8	36.6	97.9	-	-	2
	30.0	86.0	37.3	99.1	-	-	2
	34.0	93.2	37.8	100.0	-	-	2
Morone saxatilis,	-	-	34.4	94.0	-	-	11
Striped Bass							
Lepomis macrochirus,	15.0	59.0	30.7	87.3	2.8	36.5	17
Bluegill	20.0	68.0	31.5	89.0	5.0	41.0	17
	30.0	86.0	33.8	92.9	7.5	45.5	17
	-	-	36.7	98.0	-	-	11
Micropterus salmoides,	10.0	50.0	28.0	82.4	-	-	9
Largemouth Bass	20.0	68.0	31.8-32.5	89.2-90.5	5.2-5.5;	41.4-41.9	9
	20-21.8	68-71.2	28.9	84.0	-	-	9
	25.0	77.0	32.7-34.5	90.9-94.1	7.0	44.6	9
	30.0	86.0	33.7-36.4	92.7-97.5	10.5-11.8;	50.9-53.2	9
	-	-	35.6	96	-	-	11

Table 1.3.2 (Continuation of fish temperatures)

Species	Temperatures						Sources of Information
	Acclimation		Upper Lethal		Lower Lethal		
	C	F	C	F	C	F	
Perca flavescens, Yellow Perch	5.0	41.0	21.3	70.3	-	-	6
	10.0	50.0	25.0	77.0	1.1	34.1	6
	15.0	59.0	27.7	81.9	-	-	6
	25.0	77.0	29.7	85.5	3.7	38.7	6
	-	-	32.2	90.0	-	-	11

Acipenser oxyrhynchus, Atlantic Sturgeon (8, 16, 34)

An anadromous fish, the Atlantic sturgeon spends most of its life in the sea, entering fresh water rivers to spawn. Large Atlantic sturgeon are caught each year below the Jim Woodruff Dam on the Apalachicola River. Coversations with conservation officers reveal that large sturgeon (over 50 lbs) have been caught on rare occasions by commercial fishermen in Lake Seminole above the dam.

In Georgia, the adults begin their spawning migrations in February on the Atlantic Coast, breeding when the water temperature is between 55° and 64°F. After migrating upstream, the eggs are deposited on gravel beds. Neither the eggs nor the young receive parental care.

The sturgeon feeds along the bottom. In fresh water, the main foods are aquatic insects, amphipods, and oligochaetes. Gastropods, shrimp, and amphipods are the main foods in estuarine waters.

Lepisosteus spp., Gars (9, 14)

The spotted gar, Lepisosteus oculatus, is usually found in clear waters with abundant vegetation. Fish are its principal food and feeding activity is mostly in early morning. Blue crabs, crayfish, amphipods and insects are eaten. No data was available on the reproductive biology, temperature preferences or other aspects of this species' ecology.

The longnose gar, Lepisosteus osseus, is abundant in southern waters. It is frequently found inbrackish waters. In central Florida lakes this species feeds principally on nongame forage fish and does not extensively utilize game fish species. Nongame forage fish comprised 57 percent of the total number of food items consumed, while only 11 percent were game fish. Male longnose gar mature at 3 to 4 years, and females at 6 years in Missouri, and at about 30 inches in Kansas. In Florida this species spawns in March - August with the peak in April. The left ovary tends to be larger than the right and the eggs are green, toxic and 2.1 to 3.2 mm in diameter. This species, up to 2 inches feeds on entomastraca and insect larvae, but when longer they eat fish.

Amia calva, Bowfin (8, 35)

The bowfin lives in sluggish rivers and lakes, generally in clear water that has abundant vegetation.

The breeding season ranges from April to July. Males build their nests in colonies by clearing out vegetation in sheltered areas. The main diet of fingerlings is diptera larvae and crustaceans. Adults eat mainly crayfish and nongame fish, game fish being eaten only occasionally. Also eaten by the adults are insects, molluscs, earthworms, frogs, and leeches.

Dorosoma cepedianum, Dorosoma petenense and Alosa alabamoe, the Shads (8, 27)

The life histories of the gizzard shad, Dorosoma cepedianum, and the threadfin shad, Dorosoma pretenense, are discussed in detail (8). Both species are very important at all life stages as forage for fish and other aquatic vertebrates.

The life history of the Alabama shad, Alosa alabamoe from the Apalachicola River in Florida is discussed in detail (27). The status of this species in the Chattahoochee River near the Farley Nuclear Plant is unknown.

Esox americanus, Redfin Pickerel (8)

The Redfin Pickerel lives in sluggish streams and backwaters, rarely in lakes and ponds.

Spawning occurs at 50°F, with the eggs hatching in 12 to 14 days. One week after hatching the fry begin feeding on plankton. Until about 3 inches long, cladocera, amphipods, and immature insects are the main food items. After reaching 3 inches in length, the redfin pickerel eats mainly fish, crayfish, and dragonfly nymphs.

Esox niger, Chain Pickerel (8)

The Chain Pickerel is a solitary fish, moving into the shallows at night and the depths during the day. The young, however, seldom enter water exceeding 2 feet in depth.

In Alabama, spawning occurs during the second or third year of life when the water reaches about 61°F. Fish enter swampy or flooded areas that have large amounts of vegetation where they lay glutinous strings of adhesive eggs which stick to the vegetation. These eggs hatch in 6 to 12 days, depending on the water temperature. The sac fry remain inactive for 6 to 8 days, attaching themselves to debris and vegetation during this time.

Both the fry and the eggs face the dangers of being stranded by drops in the water level and of being washed ashore during a storm.

Chain Pickerel feed and grow throughout the year. Up to a length of 4 inches, invertebrates, such as insects and crustaceans, are the main foods. Above 4 inches, fish are the main foods. Less important in the diet are frogs, crayfish, salamanders, and snakes.

Cyprinus carpio, Carp (8, 34, 37)

The carp, originally native to Asia, has been introduced in North America and elsewhere throughout the world. It thrives best in low-gradient streams, lakes and impoundments, spending a large amount of its time in the shallows rooting around in the vegetation.

Spawning occurs in the spring when the water temperature reaches 59° to 70°F. The adults enter very shallow water, usually less than 1 foot deep.

The adhesive eggs are scattered over the plants and debris, hatching within 3 to 6 days. Fluctuating water levels often expose the eggs to the air and cause them to die through desiccation. Water temperatures below 52°F also kill the eggs.

Fry and fingerlings generally feed on zooplankton, usually avoiding algae. Adults, however, root around the vegetation in the shallows, feeding on plant material, organic detritus, and bottom fauna such as chironomids and zooplankton.

Carpiodes cyprinus , Quillback Carpsucker (8, 10)

The quillback prefers rivers and streams. Its habits are similar to the river carpsucker (Carpiodes carpio). Young river carpsuckers feed mostly on diatoms, a few copopods, ostracods, rotifers, midge larvae, and filamentous algae. Adults feed on similar organisms. The quillback breeding and feeding habits are probably similar to those of the river carpsucker which are reported to spawn during May and early June in Missouri, in Kansas and in South Dakota. In the Des Moines River, Iowa, spawning is from late April into July and appears to be somewhat intermittent. Published data is not available on spawning temperatures for the South.

Erimyzon sucetta, Lake Chubsucker (8, 34)

The lake chubsucker inhabits low-gradient streams and oxbow lakes. In Illinois, spawning occurs from March to April. Due to a warmer climate, the spawning dates are probably earlier in Alabama. Nests are constructed by the male by cleaning an area in gravel riffles.

Fingerlings feed on zooplankton and insect larvae. Adult feeding habits are probably similar to those of the creek chubsuckers (Erimyzon oblongus), which feed on zooplankton, rotifers, small insects, and algae.

Minytrema melanops, Spotted Sucker and the Moxostoma spp., Redhorse (20, 21, 34)

General characteristics of Minytrema melanops, Mosotoma carinatum, M. lachneri, M. poecilurum, and M. sp. will be presented collectively.

These suckers live in large streams and rivers having good current, riffles, and pools. Breeding occurs in riffle areas in the spring of the year. Food is obtained by sucking food containing material from the bottom into the protrusible mouth and swallowing the sediments along with the food items. These fishes also graze on aufwuks and periphyton attached to submerged logs and rocks.

Ictalurus brunneus, Snail Bullhead (42)

The snail bullhead prefers streams that have hard, rocky bottoms and a moderate to swift current. They inhabit pools adjoining mountain streams, pools below waterfalls and dams, riffles, and piedmont-type streams with a good current.

Spawning occurs from February to July. The snail bullhead is omnivorous, feeding on aquatic vegetation, aquatic insects, snails and minnows.

Ictalurus catus, White Catfish (8, 36)

The habitat of the white catfish is freshwater streams to slightly brackish streams. This species prefers intermediate current conditions, whereas, channel catfish prefer fast current and bullheads prefer slow current.

At water temperatures between 75° and 84°F, spawning occurs. The male guards and aerates the eggs until they hatch. After hatching, he cares for the young.

White catfish feed mainly on other fish; many of them being game species. Also part of the diet are pond weeds and insect larvae.

Ictalurus natalis, Yellow Bullhead (26)

The habitats of the yellow bullhead are large bays, lakes, ponds, and low gradient streams. They inhabit the shallows where there is clear water and abundant vegetation.

In the Colorado River, spawning takes place in the late spring and early summer. The male builds the nest in 1.5 to 4 feet of water and guards the young until they are about 2 inches long.

The main foods of the yellow bullhead are insects, crustaceans, molluscs, and small fishes. A large part of the diet is often plant materials.

Ictalurus nebulosus, Brown Bullhead (8, 28)

Brown bullheads prefer slow current conditions. In Alabama and Florida, spawning occurs between March and September. The eggs hatch when the water at a depth of 6 inches is 70°F. Usually just the male, but sometimes both parents, become involved in nest building and caring for the eggs and young.

Fry and fingerlings up to 3 inches long eat zooplankton and chironomids. Larger fish and adults feed on insects, especially midge larvae and mayfly nymphs, fish and fish eggs, molluscs, and plant materials.

Ictalurus punctatus, Channel Catfish (1926)

Channel catfish are found mainly in moderate to swiftly flowing streams. They are also abundant in some sluggish streams, lakes and many large reservoirs. Sand, gravel, and rubble are preferred bottoms; these sometimes being mixed with mud. Turbidity apparently has little effect on the channel catfish as it often lives in muddy water. Seldom is dense aquatic vegetation inhabited. Warm waters are preferred; little growth occuring below 70°F.

Nests are usually constructed in secluded, semi-darkened areas such as under rocks, in log jams, in holes, and in other protected sites. Spawning takes place at temperatures between 70°F and 85°F. The male builds and protects the nest after spawning, aerating and cleaning the eggs by fanning with his pelvic fins.

The channel catfish usually feeds near the bottom. Fingerlings and young catfish up to 12 inches long feed mainly on insects and some fish. Above 12 inches small fish become increasingly important in the diet. Large catfish feed almost exclusively on fish.

Ictalurus serracanthus, Spotted Bullhead (42)

The spotted bullhead lives mainly in larger streams and rivers that have a moderate current. They prefer rock bottoms and rocky holes or sand bottoms in close proximity to rock. The only lakes with a snail bullhead population are those formed by impoundments. Very little research has been carried out on the breeding and feeding habits. Spawning is believed to occur from late winter to late spring. Molluscs appear to be the main food.

Morone chrysops, White Bass (30, 40)

The white bass is usually found in rivers and impoundments. In the spawning season, they begin migrating from the open waters into streams when the water temperature reaches 45°F. Most writers say spawning occurs between 58° and 75°F, but in Center Hill Lake, Tennessee, spawning was observed at 53°F. The females remain in deep pools below the riffles, entering the riffles only when they are ready to spawn immediately.

Fingerlings mainly feed on invertebrates, such as crustaceans and insect larvae, with fish being a minor part of their diet. Adults, however, mainly feed on fish, with invertebrates being a minor part of their diet.

Morone saxatilis, Striped Bass (5, 23, 38)

The striped bass is an estuarine species, migrating into coastal rivers to spawn. However, two well known land-looked populations exist in Santee-Cooper Reservoir, South Carolina and Kerr Reservoir, Virginia and North Carolina.

The Florida Game and Freshwater Fish Commission became interested in the Apalachicola River striped bass during 1957, when fishermen below Jim Woodruff Dam began catching large numbers of young of this species. Fishermen caught these fish in such large numbers that they were considered a nuisance. The young striped bass were thrown on the bank to die or used as bait. Fishermen on the Flint and upper Apalchicola Rivers have been catching striped bass sporadically for many years. Creel checks and fishermen interviews show that striped bass were caught in that area every month of the year, but more were caught during October and May.

Striped bass in the Apalachicola River spawned in March and April. Spawning probably extends into May during some years. This species has strict spawning requirements. Natural spawning is reported to occur only in flowing water at temperatures of 58°F to 71°F. The fertilized egg must remain suspended by currents during the period of incubation (44 hours at 65°F). The ova and larvae must be maintained in water temperatures between 54°F and 72°F. When delicate larvae are hatched, they have little chance for survival if water currents are insufficient to keep them from settling to the bottom. The larvae become fry 5 to 7 days after hatching, and their chances for survival increase following this stage of development if suitable food is available.

The fry begin feeding when they are 5 to 8 days old; their food being the early instars of copepods and cladocerans. When about 15 days old, their mouths are large enough to eat the adult copepods and cladocerans, which they consume until they are about 1/2 inches long. At this length and until about 3 1/2 inches long, they continue feeding on adult copepods, especially cyclops, but they eat fewer cladocerans. Between 3 1/2 and 4 inches in length, this phenomenon is reversed with fewer copepods and more cladocerans consumed. Insect larvae are also consumed at that size range. At 4 to 5 inches in length, insect larvae compose the majority of the diet. Above 5 inches in length, insect larvae are less significant in the diet and fish are consumed. Larger striped bass and adults are free-swimming pelagic predators that consume forage fish species, especially the shads.

Ambloplites rupestris, Rock Bass (41)

The streams with a good gravel or rock (preferably limestone) bottom, with boulders of various sizes and a good current, are the most suitable situations, such as a bar over which a slight current is flowing. Depth of the nests varies from 1 to 4 feet.

The young feed mainly upon microscopic crustaceans, worms, snails, small insects, and their larvae. The adults, while eating the same food to a certain extent, feed primarily on crayfish and fish.

Centrarchus macropterus, Flier (9, 34)

The flier prefers sluggish streams, overflow ponds, or swamps for its habitat.

In Alabama, spawning occurs from late February to May when the water temperature is 62°F. The nests are in colonies and very close together; eggs and fry being guarded by the males.

The main foods are zooplankton, aquatic insect larvae, and other aquatic invertebrates.

Lepomis gulosus, Warmouth (9)

The warmouth prefers weedy areas in ponds and lakes, occasionally living also in streams. Breeding occurs between June and August; nests being built close to stumps, clumps of vegetation, or other cover. Unlike the bluegill, the warmouth never uses clean sand for nest construction. Normally the nests are well separated, being in colonies only when the population is crowded.

Insects, crayfish, and fish are the main foods for all sizes except the smallest fingerlings which feed on zooplankton. Because of its large mouth the warmouth is more piscivorous than most sunfishes.

Lepomis auritus, Redbreast Sunfish (15)

The redbreast sunfish prefers natural physical obstructions in its habitat. At a temperature of 71°F, beds are constructed in or near sheltered areas, such as logs, fallen trees, and stumps, where water depth is 14 to 15 inches. Sand and small gravel are desired as a substrate in which to build the nests. Silt or detritus is seldom used and spawning is usually unsuccessful. when present.

Redbreast sunfish feed on aquatic insects. They are selective for beetles, mayfly, dragonfly, and damselfly larvae.

Lepomis cyanellus, Green Sunfish (9, 25, 29)

The green sunfish inhabits weed beds in warm water lakes and reservoirs and shallow areas of streams.

Spawning occurs at water temperatures between 72° and 79°F. The adhesive eggs attach to gravel or clay lumps in the circular nests. This species nests in colonies. Males guard gravel nests in water less than 12 inches deep and receiving maximum sunlight.

Green sunfish, 2 to 8 inches long, feed on oligochaetes and insects. Adults prefer to eat fish, dragonfly larvae, freshwater shrimp, and aquatic snails.

Lepomis humilis, Orangespotted Sunfish (9)

Muddy streams and weedy lakes and ponds are the preferred habitats of the orangespotted sunfish. Spawning in Louisiana occurs from April to September. Insects compose the largest part of the diet.

Lepomis macrochirus, Bluegill (9, 17)

The bluegill sunfish is abundant in ponds, lakes and sluggish streams where shelter is available. They prefer clear, quiet waters, scattered beds of vegetation, and a bottom composed of sand, gravel or muck.

In Alabama, spawning begins in April, often extending until October, when the water temperatures are between 70° and 80°F. Males build their nests in colonies by fanning out shallow depressions in sand, gravel, dead leaves, sticks, or mud in water from 2 to 6 feet deep; usually in areas exposed to the sun.

Zooplankton and aquatic insects are the dominant foods; insects becoming more important and zooplankton less important as the bluegill grows. When available, small fish, fish eggs, snails, molluscs, mites, small crayfish, and amphipods will also be eaten.

Lepomis marginatus, Dollar Sunfish (9, 10)

Scant information is available on the dollar sunfish. According to Carlendo (8) it ranges from Oklahoma to South Carolina and Florida. According to Carr and Goin (10) its habitat is small ponds and streams.

Lepomis megalotis, Longear Sunfish (9)

An inhabitant of sluggish streams, the longear sunfish grows more rapidly downstream than in headwaters. Growth is also better in lakes than in rivers and streams.

Males construct gravel nests in water 6 inches to 10 feet deep. Spawning takes place when the water temperature is between 75° and $86^{\circ}F$.

Longear sunfish less than 2 inches long prefer aquatic insects, but will also eat zooplankton. Terrestrial foods are preferred by fish greater than 4 inches long, but aquatic insects and fish eggs are also eaten.

Lepomis microlophus, Redear Sunfish (9)

The redear sunfish is commonly found in large, warm rivers, bayous, lakes, and occasionally, in brackish waters. Where introduced, they seem to require relatively clear waters and some vegetation.

Spawning occurs in the spring and the fall when the water temperature is about $75^{\circ}F$. Very little spawning occurs during the summer months. Nests are usually in water of 17 to 35 inches depth, arranged in colonies, and in submerged vegetation.

Molluscs are the main foods, but aquatic insect larvae are also eaten. Redear sunfish seldom feed on surface insects as do bluegill.

Lepomis punctatus, Spotted Sunfish (9, 18)

The spotted sunfish prefers quiet, sluggish waters. However, it was found in all the habitats studied by Gilbert (18).

Spawning in Florida occurs from early spring into November. Peak spawning occurs when the water temperature is between 80° and 84°F. Males are the most pugnacious in defending the nests of all the sunfish species.

Feeding habits are similar to those of other sunfish.

Micropterus coosae, Redeye Bass (9, 43)

The redeye bass lives in streams of intermediate temperatures compared to those inhabited by warmwater fish and trout. When living in streams also inhabited by smallmouth bass, the redeye bass occupies the headwaters while the smallmouth bass lives downstream. Little overlap of distribution occurs between the two.

The redeye does not adapt well in ponds and reservoirs.

Spawning occurs from May to July between 62° and 69°F. The nests are located in coarse gravel at the heads of pools.

Insects on the surface are the main foods, but crayfish, salamanders, and aquatic insects may also be eaten.

Micropterus punctulatus, Spotted Bass (4, 9, 22, 31)

The spotted bass lives predominantly in streams but also resides in reservoirs. Aquatic vegetation does not seem to be a major habitat requirement. The spotted bass prefers a habitat that is intermediate to those of largemouth and smallmouth bass when living in a stream.

Growth is more rapid in reservoirs than in streams and, likewise, more rapid in rivers than in tributaries and smaller streams.

Spawning occurs at temperatures between 60° and 70°F, depending on location. Spawning occurs at the cooler temperatures in the northern part of the range and the warmer temperatures in the south. Spawning usually takes place from April to June, shortly after or at the same time that largemouth bass spawn. Nests are built on mud or gravel bottoms.

Fry first feed on zooplankton, midge larvae, and other aquatic insects. Fingerlings eat small crustaceans, aquatic insects, and fish fry. Adults feed on fish, crayfish, and insects. Insects are very important to all sizes of the spotted bass, but the larger sizes are more piscivorous.

Micropterus salmoides, Largemouth Bass (9, 22, 24, 39)

The preferred habitat of largemouth bass is clear water, little or no current, and aquatic vegetation.

Spawning occurs from March to May when the water temperature stabilizes above 60°F. Nests are constructed 3 to 5 feet deep in areas protected by boulders, pilings, etc. Preferred nest materials are sand, small and medium gravel, roots, and aquatic vegetation. Silt is never used. Fluctuating water levels during the spawning period decreases the hatch by exposing some of the eggs to the air. Rising water levels, however, have litter or no effect.

Fry feed on zooplankton. Fingerlings eat zooplankton aquatic insects, and fish; fish becoming more important in the diet as size increases. When available, crayfish are heavily preyed upon.

Pomoxis annularis, White Crappie (19, 32)

Ponds, lakes, bayous, low gradient streams and rivers provide good habitats for the white crappie. Protective cover, such as brush piles, enhances the crappie fishery. The white crappie can tolerate warmer, more turbid waters than can the black crappie.

Spawning takes place from March to July at water temperatures of 64 to 68°F. The nest is built and defended by the male. The site chosen for the nest varies, depending on the substrate-depth combinations available. In most cases areas are chosen for nest construction that have protective cover or vegetation. Brush piles, stumps and rock outcroppings are often used as nest sites.

Fry feed on zooplankton. As the young fish increases in size, insects become more important and zooplankton becomes less important. As adult size is reached, fish becomes the most important.. Crappie tends to compete with largemouth and smallmouth bass more so than with other panfish.

Pomoxis nigromaculatus, Black Crappie (19, 32)

Black crappie differs from white crappie in that it requires clearer, cooler water. It also differs in that it spawns on gravel or areas more muddy than preferred by most sunfishes. Spawning occurs between 58° and 64°F. Other habits are similar to the white crappie.

Perca flavescens, Yellow Perch (12, 18, 33)

The occurrence of the yellow perch in the Chattahoochee River near the Farley Nuclear Plant would be the southern limits of its range.

The yellow perch has been collected in habitat types ranging from impoundment backwaters to riffles in streams.

Spawning occurs near the shore in the spring, when the water temperature is between 45° and 55°F. The eggs, in long, gelatinous strings, are woven in and around aquatic plants and brush. The parents do not guard the eggs. After hatching, the young school and generally continue to school throughout their lives.

The young first feed on zooplankton. As they grow larger they feed on small crustaceans, molluscs (especially small snails), and aquatic insect larvae and nymphs. Very few surface or adult insects are eaten. Only a few fish are eaten; becoming a part of the diet when 2 years old.

REFERENCES (FISH)

1. Alabama Department of Conservation and Natural Resources. Rare and Endangered Vertebrates of Alabama. 1972.

2. Allen, K.O. and K. Strawn. "Heat Tolerance of Channel Catfish (Ictalurus punctatus)". Proceedings of the 21st Annual Conference of Southeastern Association of Game and Fish Commissioners. 1967.

3. Allen, K.O. "Thermal Variation Dangers in Aquatic Transfer Process." American Fish Farmer. 1970. June issue.

4. Applegate, R.L., J. W. Mullan and D.I. Morias. "Food and Growth of Six Centrarchids from Shoreline Areas of Bull Shoals Reservoir". Proceedings of the 20th Annual Conference of Southeastern Association of Game and Fish Commissioners. 1966.

5. Barkuloo, J.M. "Taxonomic Status and Reproduction of Striped Bass (Morone chrysops) in Florida". USDI, Bureau of Sport Fisheries and Wildlife Technical Paper No. 44. 1970.

6. Bennett, G.W. Management of Artificial Lakes and Ponds. Rheinhold Publishing Co., N.Y. 1965.

7. Burns, J.W. Inland Fisheries Management. Alex Calhoun, Editor. California Department of Fish and Game. 1966.

8. Carlander, K.D. Handbook of Freshwater Fishery Biology. Vol. I Iowa State University Press, Ames.

9. Carlander, K.D. Handbook of Freshwater Fishery Biology. Vol. II unpublished manuscript. Iowa State University Press, Ames. 1972.

10. Carr, A. and C.J. Goin. Guide to the Reptiles, Amphibians, and Fresh-Water Fishes of Florida. University of Florida Press, Gainesville. 1959.

11. Clark, J.R. "Thermal Pollution and Aquatic Life". Scientific American. Vol. 220, No. 3. 1969.

12. Coots, M. Inland Fisheries Management. Alex Calhoun, Editor. California Department of Fish and Game. 1966.

13. Cox, D.T. Stream Fish Population and Environmental Studies - Apalachicola River, 1969-70. Florida Game and Fresh Water Fish Commission. Federal Aid D-J Project F-25-3.

14. Crumpton, J. "Food habits of Longnose Gar (Lepisosteus osseus) and Florida Gar (Lepisosteus platyrhincus) Collected from Five Central Florida Lakes. Proceedings of the 24th Annual Conference of Southeastern Association of Game and Fish Commissioners. 1970.

15. Davis, J.R. "The Spawning Behavior, Fecundity Rates, and Food Habits of the Redbreasted Sunfish in Southeastern North Carolina". Proceedings of the 25th Annual Conference of Southeastern Assocaition of Game and Fish' Conmissioners. 1971.

16. Eddy, S. How to Know the Freshwater Fishes. Wm. C. Brown Co., Dubuque, Iowa. 1957.

17. Emig, J.W. Inland Fisheries Management. Alex Calhoun, Editor. California Department of Fish and Game. 1966.

18. Gilbert, R.J. The Distribution of Fishes in the Central Chattahoochee River Drainage. unpublished M.S. thesis. Auburn University. 1969.

19. Goodson, L.F., Jr. Inland Fisheries Management. Alex Calhoun, Editor. California Department of Fish and Game. 1966.

20. Hackney, P.A., W.M. Tatum and S.L. Spencer. "Life History of the River Redhorse, Moxostoma carinatum (cope) in the Cahaba River, Alabama, with Notes on the Management of the Species as a Sportfish". Proceedings of the 21st Annual Conference of the Southeastern Association of Game and Fish Commissioners. 1967.

21. Hackney, P.A., G.R. Hooper and J.F. Webb. "Spawning Behavior, Age and Growth and Sport Fishery for the Silver Redhorse, Moxostoma anisurum (Rafinesque) in the Flint River, Alabama". Proceeding of the 24th Annual Conference of the Southeastern Association of Game and Fish Commissioners. 1970.

22. Hodson, R.G. and K. Strawn. "Food of Young-of-the Year Largemouth and Spotted Bass During Filling of Beaver Reservoir, Arkansas". Proceedings of the 22nd Annual Conference of Southeastern Association of Game and Fish Commissioners. 1968.

23. Humphries, E.T. and K.B. Cummings. "An Evaluation of Striped Bass Fingerling Culture". Transactions of the American Fisheries Society. Vol. 102, No. 1. 1973.

24. Hunsaker, D., II and R.W. Crawford. "Preferential Spawning Behavior of the Largemouth Bass, Micropterus salmoides. Copeia. No. 1. 1964.

25. McKechnie, R.J. and R.C. Tharrat. Inland Fisheries Management. Alex Calhoun, Editor. California Department of Fish and Game. 1966.

26. Miller, E.E. Inland Fisheries Management. Alex Calhoun, Editor. California Department of Fish and Game. 1966.

27. Mills, J.G., Jr. Biology of the Alabama Shad in Northwest Florida. Florida Department of Natural Resources Technical Series No. 68. 1972.

28. Moore, J.W. "Piscivorous Activities of Brown Bullheads in Lockhard Pond, Ontario, Canada". Progressive Fish Culturist. Vol. 34, No. 3. 1972.

29. Mullan, J.W. and R.W. Applegate. "Centrarchid Food Habits in a New and Old Reservoir During and Following Bass Spawning". *Proceedings of the 21st Annual Conference of Southeastern Association of Game and Fish Commissioners*. 1967.

30. Olmsted, L. and R.V. Kilambi. "Stomach Content Analysis of White Bass (*Roccus chrysops*) in Beaver Reservoir, Arkansas". *Proceedings of the 23rd Annual Conference of Southeastern Association of Game and Fish Commissioners*. 1969.

31. Ryan, P.W., J.W. Avault, Jr., and R.O. Smitherman. "Food habits and Spawning of the Spotted Bass in Tchefuncte River, Southeastern Louisiana". *Progressive Fish Culturist*. Vol. 32, No. 3. 1970.

32. Siefert, R.E. "Reproductive Behavior, Incubation and Mortality of Eggs, and Post-larval Food Selection in the White Crappie". *Transaction of the American Fisheries Society*. Vol. 97, No. 3. 1968.

33. Siefert, R.E. "First Food of Larval Yellow Perch, White Sucker, Bluegill, Emerald Shiner, and Rainbow Smelt". *Transaction of the American Fisheries Society*. Vol. 101, No. 2. 1972.

34. Smith-Vaniz, W.F. *Freshwater Fishes of Alabama*. Auburn University Agricultural Experiment Station. 1968.

35. Stacy, G. III, R.O. Smitherman and J.W. Avault, Jr. "Food Habits of the Bowfin in Lacassine National Wildlife Refuge and Other Locations in Southern Louisiana". *Progressive Fish Culturist*. Vol. 32, No. 3. 1970.

36. Stevens, R.E. "The White and Channel Catfishes of the Santee-Cooper Reservoir and Tailrace Sanctuary". *Proceedings of the 13th Annual Conference of Southeastern Association of Game and Fish Commissioners*. 1959.

37. Swee, U.B. and H.R. McCrimmon. "Reproductive Biology of the Carp, *Cyprinus carpio* L., in Lake St. Lawrence, Ontario". *Transactions of the American Fisheries Society*. Vol. 95, No. 4. 1966.

38. Talbot, G.B. "Estuarine Environmental Requirements and Limiting Factors for Striped Bass". *A Symposium on Estuarine Fisheries*. American Fisheries Society Special Scientific Publication No. 3. 1966.

39. Taub, S.H. "Exploitation of Crayfish by Largemouth Bass in a Small Ohio Pond". *Progressive Fish Culturist*. Vol. 34, No. 1. 1972.

40. Webb, J.F. and D.D. Moss. "Spawning Behavior, and Age and Growth of White Bass in Center Hill Reservoir, Tennessee." *Proceedings of the 21st Annual Conference of Southeastern Game and Fish Commissioners*. 1967.

41. Wickliff, E.L. and M.B. Trautman. Some Food and Game Fishes of Ohio. Ohio Department of Agriculture, Division of Conservation and Natural Resources. 1931.

42. Yerger, R.W. and K. Relyea. "The Flathead Bullheads (Pisces: Ictaluridae) of the Southeastern United States, and a New Species of *Ictalurus* from the Gulf Coast. *Copeia*. No. 2. 1968.

43. Smitherman, R.O. and J.S. Ramsey. "Observations of Spawning and Growth of Four Species of Basses (*Micropterus*) in Ponds". Proceedings of the 25th Annual Conference of the Southeastern Association of Game and Fish Commissioners. 1971.

1.4 AMPHIBIANS AND REPTILES

Of the 43 species and subspecies of amphibians which probably occur in Houston County, 32 species and subspecies have been either collected, sighted or heard calling (2)*. Fifty-nine species and subspecies of reptiles probably occur in this county while 35 species and subspecies have been collected or sighted there (10)*. The narratives on each species was obtained from the previously mentioned references. Table 1.4.1 shows the different amphibians and reptiles found in Houston County. The distributions and narratives on the natural history of the different forms can be found in the references cited. Those species or subspecies in an undetermined or precarious status are designated accordingly (1)*.

TABLE 1.4.1

Amphibians and Reptiles Found in Houston County

SPECIES	STATUS**	SPECIES	STATUS**
Eastern Spadefoot Toad		Southern Chorus Frog	
Southern Toad		Ornate Chorus Frog	
Fowler's Toad		Eastern Narrow-mouthed Toad	
Oak Toad		Bullfrog	
Southern Cricket Frog		Pig Frog	
Northern Cricket Frog		River Frog	R-2
Northern Spring Peeper		Bronze Frog	
Pine Woods Treefrog		Southern Leopard Frog	
Squirrel Treefrog		Dusky Gopher Frog	R-1
Gray Treefrog		Two-toed Amphiuma	
Western Bird-voiced Treefrog		One-toed Amphiuma	
Barking Treefrog		Waterdog	
Least Treefrog	R-2	Eastern Lesser Siren	

* See Bibliography at end of section for references.

** See Rare and Endangered Amphibians and Reptiles of Alabama.

TABLE 1.4.1
(Contd.)

SPECIES	STATUS
Greater Siren	R-2
Dwarf Slender Siren	
Central Newt	
Spotted Salamander	
Marbled Salamander	
Reticulated Flatwoods Salamander	R-1
Mole Salamander	
Eastern Tiger Salamander	
Dusky Salamander	
Slimy Salamander	
Southern Red Salamander	
Gulf Coast Mud Salamander	
Three-lined Salamander	
Two-lined Salamander	
Dwarf Salamander	
Four-toed Salamander	
American Alligator	E
Alligator Snapping Turtle	
Common Snapping Turtle	
Common Musk Turtle	
Loggerhead Musk Turtle	
Stripe-Necked Musk Turtle	
Eastern Mud Turtle	
Gopher Tortoise	
Gulf Coast Spiny Soft-shell Turtle	
Eastern Box Turtle	
Three-toed Box Turtle	
Chicken Turtle	
Barbour's Map Turtle	R-2
Yellow-bellied Turtle	
Florida Cooter	
Green Anole	
Southern Fence Lizard	
Six-lined Racerunner	
Eastern Glass Lizard	
Slender Glass Lizard	
Ground Skink	
Broad-headed Skink	
Five-lined Skink	
Southeastern Five-lined Skink	
Red-tailed Skink	
Eastern Smooth Earth Snake	
Florida Red-bellied Snake	
Midland Brown Snake	
Midland Water Snake	
Banded Water Snake	
Red-bellied Water Snake	
Brown Water Snake	
Glossy Water Snake	
Black Swamp Snake	
Eastern Garter Snake	
Eastern Ribbon Snake	
Rainbow Snake	SU
Eastern Mud Snake	
Eastern Hognose Snake	
Southern Hognose Snake	
Southern Ringneck Snake	
Eastern Work Snake	
Southern Black Racer	
Eastern Coachwhip	
Rough Green Snake	
Florida Pine Snake	E
Gray Rat Snake	
Corn Snake	
Scarlet Snake	
Scarlet Kingsnake	
Mole Snake	
Eastern Kingsnake	
Southeastern Crowned Snake	
Eastern Coral Snake	
Southern Copperhead	
Eastern Cottonmouth	
Dusky Pigmy Rattlesnake	
Canebreak Rattlesnake	
Eastern Diamondback Rattlesnake	

ORDER ANURA

Family Pelobatidae

Scaphiopus holbrooki Harlan. Eastern Spadefoot Toad. This subterranean species is usually found in temporary rain pools after heavy rainfall (Wright and Wright, 1949). Two specimens (AUM 19841 and 19909) were found on paved roads at night during and following heavy rains.

Collections -- AUM nos. 3388, 18520-2, 19841 and 19909.

Family Bufonidae

Bufo terrestris Bonnaterre. Southern Toad. This is the most abundant toad in the county, and occurs in a great variety of habitats. It was especially common on paved roads at night.

Collections -- AUM nos. 1451-2, 1467-8, 18505-6, 18528-30, 19352-5, 19610-2, 19837-9, 19864-7, 19873-6. UAHC no. 52: 1257-60.

Bufo woodhousei fowleri Girard. Fowler's Toad. Specimens of this species were found in the more sandy areas of the county, especially along roadsides. One specimen (AUM 19868) was collected along the bank of a cypress pond.

Collections -- AUM nos. 1469-70, 19840, 19868 and 19872.

Bufo quercicus Holbrook. Oak Toad. Two specimens (AUM 19892 and 19910) were taken from temporary rain pools after their distinctive breeding choruses were recognized at night.

Collections -- AUM nos. 6044-6, 19892 and 19910. UAHC no. 52: 858-9.

Family Hylidae

Acris gryllus gryllus Le Conte. Southern Cricket Frog. Specimens of the southern cricket frog were found in a variety of aquatic habitats. They seemed most numerous in roadside pools and cypress ponds, especially where the shallow margins were choked with hydrophytes.

Collections -- AUM nos. 3499-503, 3545-52, 4377-9, 6053, 16993-5, 19710, 19791-2, 19849-51 and 19887-90. UAHC nos. 50: 115-6, 50: 123-5, and 51: 452.

Acris crepitans crepitans Baird. Northern Cricket Frog. Although no specimens of this species are present in the two museums surveyed, it is probable that this species occurs in at least the northwestern portion of the county.

Hyla crucifer crucifer Wied. Northern Spring Peeper. This species is normally abundant around woodland ponds early in the spring but difficult to find later in the season. Only one specimen (AUM 19560) was collected during the course of this study.

Collections -- AUM nos. 3492-6, 3530-1, 18531 and 19560. UAHC no. 49: 235.

Hyla cinerea Schneider. Green Treefrog. This species is common in most aquatic habitats throughout the county. It was collected in cypress ponds, along lakeshores, in cattail marshes, and in association with creeks and streams. During heavy rainfall specimens were found on paved roads at night.

Collections -- AUM nos. 6026-7, 9047-9, 18522-3, 19356, 19559, 19578, 19782, 19846-8 and 19870. UAHC nos. 49: 613, 65: 2560-5, and 65: 2569-76.

Hyla femoralis Latreille. Pine Woods Treefrog. An arboreal frog that is frequently observed high in the trees, this species is commonly found in pine flatwoods and in or near cypress swamps (Conant, 1958).

Although such habitats were frequently collected, no specimens of this elusive species were collected during the course of this study.

Collections -- AUM nos. 3532-5, 6047-9 and 18267-8.

Hyla squirella Latreille. Squirrel Treefrog. A frog of non-discriminatory taste, this species is found in a variety of habitats from open pond and roadside pools to fields and gardens. During rainy weather, it is often observed on porches and clinging to windowpanes.

Collections -- 3536-9, 6039-40, 6050-2, 16990, 18265-6, 18525-7, 19845 and 19869. UAHC nos. 50: 117-22 and 52: 857.

Hyla versicolor versicolor Le Conte. Gray Treefrog. Males of this species were found calling from limbs or tree trunks around lakes and ponds after dark. Four specimens (AUM 19571-4) were found on a paved road after dark during a rainstorm.

Collections -- AUM nos. 6042, 18524, 19557, 19571-4 and 19804-5.

Hyla avivoca Viosca. Bird-voiced Treefrog. Primarily an inhabitant of cypress swamps, this species was collected from perches some two to four feet above the water in shrubs and trees, and on paved roads during periods of heavy rainfall after dark.

Collections -- AUM nos. 6041, 19441, 19613-4 and 19801-3. UAHC nos. 49: 893.

Hyla gratiosa Le Conte. Barking Treefrog. Both a high climber and a burrower (Conant, 1958), this species typically inhabits the trees of pine barrens, hammocks, and bays (Wright and Wright, 1949). One specimen (AUM 19844) was collected in a cypress pond after dark on May 8, 1971.

Hyla ocularis Bosc and Daudin. Least Treefrog. An inhabitant of moist, grassy situations around ponds and cypress swamps, this treefrog's climbing is restricted to low vegetation. Only one specimen (AUM 19908) was collected during the course of this study, and then only after a long and diligent search.

Collections -- AUM nos. 6054-9, 18264 and 19908. UAHC no. 52: 1368.

Pseudacris nigrita nigrita Le Conte. Southern Chorus Frog. An early breeder (December to April according to Wright and Wright, 1949), this species was not encountered during the course of this survey.

Collections -- AUM nos. 3486-91, 3543 and 18263. UAHC nos. 50: 112-4 and 52: 1370-2.

Pseudacris ornata Holbrook. Ornate Chorus Frog. A winter breeder (Wright and Wright, 1949), this species inhabits cypress swamps and ponds, flooded meadows, and flatwoods ditches (Conant, 1958). This species was not encountered during the present study.

Collections -- AUM nos. 4597 and 4353-76. UAHC nos. 50: 106-10 and 52: 1373-7.

Family Microhylidae

Gastrophryne carolinensis Holbrook. Eastern Narrow-Mouthed Toad. Individuals of this species were found in moist situations under almost any kind of cover. Frequently a half-dozen or more specimens would be found under one log or large rock. They were most commonly uncovered around ponds, swamps, and streams.

Collections -- AUM nos. 1465, 1477-80, 16992, 19784-6, 19852-3. UAHC no. 52: 856.

Family Ranidae

Rana catesbeiana Shaw. Bullfrog. This strongly aquatic species prefers larger bodies of water, but may be found in almost any aquatic situation.

Collections -- AUM nos. 3540-2, 19357, 19570, 19843 and 19877.

Rana grylio Stejneger. Pig Frog. This exceedingly shy species is strongly aquatic and seems to prefer large bodies of quiet water. No new specimens were collected.

Collection -- AUM no. 5609-10.

Rana heckscheri Wright. River Frog. This species is reported to prefer the swampy edges of rivers and streams by Conant (1958) and by Wright and Wright (1949). Although it probably occurs in Houston County, no museum specimens are available at Auburn University or at the University of Alabama.

Rana clamitans clamitans Rafinesque. Bronze Frog. A species of shallow water, the bronze frog was often seen on a bank above water. When disturbed, specimens frequently reached the safety of deep water with a single leap. During heavy rain, specimens were caught on paved roads after dark.

Collections -- AUM nos. 16930, 19577, 19800 and 19879-80.

Rana pipiens sphenocephala Cope. Southern Leopard Frog. This species is abundant in the vicinity of streams, ponds, lakes or swamps in Houston County, and is frequently encountered well away from permanent water. An excellent jumper, it is often difficult to capture except at night with the aid of a head lantern.

Collections -- AUM nos. 1483, 3498, 6043, 19555, 19575-6, 19798-9, 19842 and 19878. UAHC nos. 49: 233-4 and 50: 104-5.

Rana areolata Baird and Girard. Gopher Frog. Although not yet reported from Houston County, the gopher frog probably occurs there. Conant (1958) states that both the Florida and dusky gopher frogs utilize gopher tortoise burrows for shelter. A nocturnal species, the gopher frog spends the daylight hours underground. Further work on the gopher tortoises of Houston County should reveal the presence of this secretive species of frog.

ORDER CAUDATA

Family Amphiumidae

Amphiuma means Garden. Two-toed Amphiuma. This species is almost completely aquatic, although it is reported to occasionally move overland between swamps. The only museum specimen of this species from Houston County (AUM 19885) was taken from a man-made canal on Boggy Creek within the city limits of Cottonwood on April 21, 1971.

Amphiuma pholeter Neill. One-toed Amphiuma. This dwark species is characterized by the presence of only one toe per limb, and its known maximum size is less than 12 inches. An extremely difficult species to collect, the one-toed amphiuma inhabits the sludge and mud of swamps, streams and rivers of the lower Chattahoochee drainage. Dr. Bruce Means is currently evaluating the systematic status of this little-known species.

Family Proteidae

Necturus sp. Rafinesque. Mudpuppy or Waterdog. The systematics of this genus in the southeast are in a state of confusion at present. For this reason, designation of a specific epithet for specimens of *Necturus* from Houston County shall be foregone at this time. Dr. Brode of the University of Southern Mississippi has been working on the taxonomic status of this group. One specimen (AUM 19881) was caught April 28, 1971 on hook-and-line by a local fisherman at Big Creek where County Road 203 crosses it.

Collections -- AUM nos. 5614-20, 18533 and 19881.

Family Sirenidae

Siren intermedia intermedia Le Conte. Eastern Lesser Siren. Houston County is well within the known range of this species, although no specimens of this species are in the two museums surveyed. It is interesting, though, that no specimens were collected during the present survey, since the author was actively seeking specimens of this family.

Siren lacertina Linnaeus. Greater Siren. As was true with the lesser siren, no specimens of the greater siren are to be found in the two major herpetological museums in the state. However, Houston County is well within the known range of this species, also.
Dr. J. L. Dusi of Auburn University reports seeing otters feeding on large specimens of sirens in the vicinity of a heron colony near Pansy.

These specimens are presumed to be greater sirens. Future collecting efforts will probably turn up specimens of this species from the county.

Pseudobranchus striatus spheniscus Goin and Crenshaw. Dwark Slender Siren. No specimens are known from Alabama. However, this species has been collected at Mariana, Florida, just south of the state line. It has also been collected from an overflow pool 0.5 mile west of the Choctawhatchee River near Caryville in Holmes County, Florida.

Family Salamandridae

Notophthalmus viridescens louisianensis Harlan. Central newt. Only two collections of this species are known from Houston County. One of these (UAHC 51: 448-51) contains four adult specimens from Howards Mill Creek, located approximately 2.5 miles northwest of the Chattahoochee River on U. S. Highway 84. The other collection contains a single specimen (UAHC 51: 454), an eft, from the Chattahoochee State Park.

Family Ambystomatidae

Ambystoma maculatum Shaw. Spotted Salamander. This fossorial species is occasionally found under logs or rocks during the day, but may be found wandering about at night. Presently unknown from Houston County, this species probably occurs in the hardwood pine forests adjacent to swamps and creeks in the county.

Ambystoma opacum Gravenhorst. Marbled Salamander. The marbled salamander is usually found in wooded hilly areas, often in surprisingly arid situations. One specimen (AUM 19836) was collected from such a habitat at Chattahoochee State Park.

Collections -- AUM nos. 16928-9 and 19836.

Ambystoma cingulatum bishopi Cope. Reticulated Flatwoods Salamander. According to Conant (1958), this species inhabits slash pine - wiregrass flatwoods, especially under objects near the small shallow cypress ponds characteristic of such areas. However, only one adult specimen of this species has been collected in Alabama (Covington County) since 1922 (Kelly Thomas, pers. comm.), indicating that the species is extremely rare in the state.

Ambystoma talpoideum Holbrook. Mole Salamander. The only specimen of this strongly fossorial species known from Houston County (AUM 19859) was collected on May 9, 1971 near a cypress pond approximately 3.8 miles northeast of Grangeburg. It was found under a log some 15 feet from the water's edge.

Ambystoma tigrinum tigrinum Green. Eastern Tiger Salamander. This species is reportedly both nocturnal and fossorial, and is seldom seen unless discovered under a log or rock. One specimen (AUM 19860) was collected on May 9, 1971 some 50 feet from where the A. talpoideum described above was taken.

Collections -- AUM nos. 3484-5, 3529 and 19860.

Family Plethodontidae

Desmognathus fuscus Green. Dusky Salamander. This species is a common inhabitant along the edges of small streams, springs, and woodland pools. Specimens are usually found under rocks, logs, leaves, or other forms of debris.

Collections -- AUM nos. 1464, 2174, 15292-4, 18490-1, 19790 and 19833.

Plethodon glutinosus Green. Slimy Salamander. Abundant in Houston County as it is in the remainder of Alabama, the slimy salamander is usually found under logs or rocks in moist woodlands.

Collections -- AUM nos. 1454-9, 1481-2, 2794, 16925-7 and 19834-5. UAHC no. 51: 453.

Pseudotriton ruber vioscai Sonnini. Southern Red Salamander. Typically found in and near springs, small streams, or under rotting logs, only two specimens of this species from Houston County have been deposited in local museums. This collection was AUM 1460-1.

Pseudotriton montanus flavissimus Baird. Gulf Coast Mud Salamander. This species is usually encountered in the muddy seepages of springs and small streams in Alabama. No specimens are available from Houston County at this time.

Eurycea longicauda guttolineata Holbrook. Three-lined Salamander. Found in a number of aquatic habitats with adequate amounts of vegetation, this species is often encountered at considerable distances from water. One specimen (AUM 19579) was found on the road at night following a hard rain. Another specimen (AUM 19558) was taken from the swampy environment around Boggy Creek, just south of Cottonwood.

Collections -- AUM nos. 1453, 1474-5, 18486-7, 18504, 19558 and 19579.

Eurycea bislineata Green. Two lined Salamander. This species is usually found in small, rocky streams and in springs or seeps in wooded situations. No new specimens were encountered.

Collections -- AUM nos. 1485 and 18488-9. UAHC nos. 51: 455-8 and 65: 982-4.

Manculus quadridigitatus Holbrook. Dwarf Salamander. Common in the low swampy areas of the Coastal Plain, this species was taken from under all types of shelter in the moist perimeters of cypress ponds and swamps.

Collections -- AUM nos. 3555-78, 19787-9, 19854-8 and 19862. UAHC nos. 50: 111.

Hemidactylium scutatum Schlegel. Four-toed Salamander. This species is reportedly a bog animal, occurring under logs, bark, or sphagnum of woodland ponds (Conant, 1958). No specimens are known from Houston County, although suitable habitat is abundant. It has been collected in Torreya State Park, Florida, about 60 miles southeastward.

RESULTS AND DISCUSSION

Thirty-two species representing 10 families and two orders of Amphibians are presently known from Houston County. An additional 11 species are suspected to occur here, but have not yet been collected from the county. These species of probable occurrence are discussed in the annotated list.

One example of intergradation was observed during the course of the study: Acris gryllus gryllus x Acris gryllus dorsalis. Most specimens were readily referable to A. g. gryllus, but specimens from the southeastern corner of the county showed the leg-striping pattern described by Conant (1958) as characteristic of A. g. dorsalis. However, anal warts were present, which is characteristic of the A. g. gryllus subspecies. More definitive work needs to be done on this problem.

Houston County is the only place that Hyla ocularis is known to occur in Alabama. Its western-most distribution in the county seems to be in the vicinity of County Road 55, which bisects the county in a north-south direction. Suitable habitat occurs further west than this, and the author suspects that subsequent collecting will reveal the presence of this elfin species as far west as the Choctawhatchee River in Geneva County.

The lack of museum specimens of Siren intermedia and Siren lacertina is probably a reflection of these species' habitat preference more than on their presence or absence in the county. Future collecting will probably reveal the presence of both of these species in Houston County.

Barclay undertook this survey partially to determine whether Pseudobranchus striatus occurs in Alabama. Much time and energy were spent in a diligent search for individuals of this species. Seemingly suitable habitats were systematically seined and dredged, but without avail. This elusive species may be present in Houston County.

CONCLUSIONS

The homogeneity of habitats afforded by the physiography of Houston County, Alabama, along with the widespread cultivation of the land in this area, renders this region a relatively mediocre one for supporting a wide variety of Amphibians. These same factors tend to limit the number of individuals of each species present in the area. The above notwithstanding, the strategic location of Houston County is evidenced by the number of species collected during this study, which approaches one-half of the state total as compiled by Dr. R. H. Mount (pers. comm.).

ANNOTATED CHECK LIST

The following is an incomplete list of the reptiles to be found in Houston County. This list consists of specimens present in the Auburn University Museum which were reviewed by Robert Oliver, a specimen from the University of Alabama Hepetological Collection, and specimens collected and sighted by Robert Oliver and his co-worker, Lee A. Barclay, Jr., in a survey of the herpetofauna of Houston County.

CLASS REPTILIA

Order Chelonia

Family Chelydridae

Chelydra serpentina serpentina Linnaeus. Snapping Turtle.

This aquatic turtle can be taken in most any large stream, slough or lake. One specimen was captured in a funnel trap in the Chattahoochee State Park. It was kept alive at Auburn University but later released.

Sternothaerus odoratus Latreille. Common Musk Turtle (Stinkpot).

Another aquatic, carnivorous turtle (as all the chelydrids are), it has the same general habits and habitats. One specimen in the Auburn University Museum was caught one mile east of the Choctawhatchee River on U. S. Highway 84 (Dale County).

AUM 9449 AUM 10388

Sternotherus minor minor Agassiz. Loggerhead Musk Turtle.

This also is an aquatic turtle found in slow-moving water. Evidence of this is the one specimen taken from a canal on Cowart's Creek north of Grangeburg.

AUM 9124

Sternotherus minor peltifer Smith and Glass. Stripe-necked Musk Turtle.

This turtle is usually found in streams and standing bodies of water such as large, slow-moving lakes and ponds, and large stagnant sloughs. This specimen was caught while skin-diving under dense, overhanging vegetation in the Chattahoochee State Park. It shows many characteristics of *Sternotherus minor minor*.

AUM 20,008

Kinosternon subrubrum subrubrum Lacepede. Eastern Mud Turtle.

This turtle prefers standing water such as lakes and ponds. It is usually found under decaying vegetation in the slower-moving water situations such as the Chattahoochee State Park where one specimen was taken.

AUM 1450 AUM 16692

Family Emydidae

Terrapene carolina carolina Linnaeus. Eastern Box Turtle.

This is a terrestrial turtle. It can be caught almost any warm morning crossing roads when the dew has not quite dried from the grass. Numerous specimens were collected in this manner but released. Only one specimen, which was caught on County Road 6 about a mile east of

Grangeburg, was preserved.

AUM 19871

Terrapene carolina triunguis Agassiz. Three-toed Box Turtle.

The only specimen in the Auburn University Museum was caught on a little-used country road (95), 8 miles south of Columbia. This was a fortunate catch since the range of the three-toed Box Turtle barely extends south into Houston County.

AUM 1486

Graptemys barbouri Carr and Marchand. Barbour's Map Turtle.

This shy and wary species is known to occur in the lower Chattahoochee and upper Apalachicola River and the Flint River of Georgia and the Chipola River of Florida. One specimen was caught in the Chattahoochee River adjacent to the Chattahoochee State Park. Dr. Harold Wahlquist has observed several specimens basking on logs in the Chattahoochee River between Highways 84 and 52 bridges. This species is unique in that adults feed primarily on snails and mussels.

AUM 14278

Pseudemys scripta scripta Schoeff. Yellow-bellied Turtle.

This is a turtle which can be seen in most aquatic habitats of Houston County. It has been sighted many times. Numerous specimens were caught by skin-divers in the Chattahoochee State Park. It was noted from observations of the specimens caught that Pseudemys scripta scripta showed many degrees of intergradation with Pseudemys scripta troosti (Cumberland Turtle). Dr. Harold Wahlquist has sighted many specimens basking on logs between Highways 84 and 52 bridges. Several specimens were collected during fish sampling in the river.

AUM 5478 AUM 14964 AUM 19629-30 AUM 19722-25

Pseydemys floridana floridana LeConte. Florida Cooter.

This turtle inhabits lakes, swamps, marshes and rivers. One specimen was caught in Bazemore's Mill Pond 1.4 miles northeast of Grangeburg. It was expected to be found in the Chattahoochee State Park, but diligent collecting failed to fulfill this expectation.

AUM 6124 AUM 11094

Pseudemys concinna LeConte. River Cooter.

This aquatic turtle prefers larger streams and swifter-flowing water than do the two previous species. Specimens were taken from the Chattachoochee State Park. Dr. Harold Wahlquist has sited several specimens basking on logs in the river near the nuclear plant.

AUM 12429 AUM 14276 AUM 19776

Order Squamata

(Suborder Lacertilia)

Family Iguanidae

Anolis carolinensis carolinensis Voight. Green Anole.

This is an abundant, semi-arboreal lizard that favors the vegetation around lakes, ponds, swamps, and any relatively large body of water. They are easily captured when seen scampering up a small tree or bush. Two of the specimens in the Auburn University Museum were caught in the Chattahoochee State Park.

AUM 1448 AUM 3585 AUM 19561-62

Sceloporus undulatus undulatus Latreille. Southern Fence Lizard.

An iguanid also, it prefers drier upland scrub hardwood-pint situations compared to the Anole. It can often be found under the bark of standing dead trees in semi-arid conditions.

AUM 1462-63 AUM 1476 AUM 6406

Family Teidae

Cnemidophorus sexlineatus Linnaeus. Six-lined Race Runner.

This is the only teid found in the United States. Like the Fence Lizard, it prefers arid, sandy areas. However, it does not possess the ability to climb like *Sceloporus* and relies more on its speed to escape enemies. Numerous individuals were spotted in one sandy area south of Cottonwood.

AUM 1484

Family Anguidae

Ophisaurus ventralis Linnaeus. Eastern Glass Lizard.

This is a highly specialized, legless lizard that prefers grassy and vegetated areas. It can best be collected at dusk and night while crossing unpaved, sandy or gravelled roads. No specimens were taken alive in this survey, but two were found dead on U. S. Highway 84 west of Dothan and another just north of the Chattahoochee State Park.

AUM 19563 AUM 19886 AUM 19891

Family Scincidae

Lygosoma laterale Say. Ground Skink.

A terrestrial lizard, this skink prefers forested areas where an abundance of insects are found. It can often be caught crawling under leaves or when turning logs in pine tree situations such as the area south of Gordon and west of Cottonwood close to Rock Creek Farms.

AUM 1449   AUM 2558   AUM 19863

Eumeces laticeps Schneider. Broad-headed Skink.

Specimens were collected in the Chattahoochee State Park under logs and close to a large cypress swamp on County Road 81 south of Ardilla.

AUM 2046   AUM 4844   AUM 19793-96

Eumeces fasciatus Linnaeus. Five-lined Skink.

This is a terrestrial skink that favors dead and decaying logs and trees in damp situations. One specimen was caught near Cedar Creek on Alabama Highway 95.

AUM 18532

Eumeces inexpectatus Taylor. Southeastern Five-lined Skink.

A skink that is equally terrestrial or arboreal, this lizard can be found in slightly drier habitats than Eumeces fasciatus. Only one specimen has been collected from Houston County and this was on County Road 95 south of Columbia.

AUM 1466

(Suborder Sepentes)

Family Colubridae

Natrix erythrogaster Forester. Red-bellied Water Snake.

This fully aquatic water snake prefers water that contains small to medium-sized fish upon which it feeds. It is most likely to be caught by swimming under specimens which are sunning on logs and trees hanging over creeks and large streams. The species was sighted at least twice. One snake was seen in a large slough next to Cowart's Creek just off County Road 75 near Bethlehem Church. The other sighting was on the western side of the county, where Alabama Highway 203 crosses Big Creek.

Natrix sipedon pleuralis Linnaeus. Midland Water Snake.

This snake may often be caught when it is sunning along the banks of ponds and swamps. Two specimens were caught along the Chattahoochee River at Columbia.

AUM 10381-82

Natrix fasciata Linnaeus. Banded Water Snake.

This water snake prefers sluggish, slow-moving, stagnant water such as sloughs and swamps. It can be caught on the edge of the bodies of water during any summer month. One specimen was taken in the same canal on Cowart's Creek above Grangeburg where Natrix erythrogaster had been sighted. A large, gravid female was caught during this survey at the edge of a cypress swamp just off U. S. Highway 84 on County Road 81. At least 24 specimens (one gravid female which later gave birth to 22 young -- AUM 11016-39 -- and another specimen -- AUM 2355 -- catalogued in the Auburn University Museum as Natrix sipedon are thought to be Natrix fasciata. This conclusion was drawn as a result of visual examination of the specimens, the locality records, and Mr. Terry Schwaner's Master of Science thesis.

AUM 9156 AUM 2355 AUM 11,016-39 AUM 17106 AUM 19797

Natrix taxispilota Holbrook. Brown Water Snake.

Only one specimen has been catalogued in the Auburn University

Museum as coming from Houston County. This Brown Water Snake was caught at Columbia on the Chattahoochee River. Dr. Harold Wahlquist has observed several specimens in the river near the Farley Plant.

AUM 10717

Thamnophis sauritus sauritus Linnaeus. Eastern Ribbon Snake.

This serpent is semi-aquatic and is seldom found far from sizeable bodies of water. A slender snake, it is fairly difficult to catch because of its ability to conceal itself on the vegetation surrounding the water. There is only one on record in the Auburn University Museum. This specimen was caught on Alabama Highway 203 two miles south of Rehobeth.

AUM 19883

Farancia abacura abacura Holbrook. Eastern Mud Snake.

This is an aquatic, nocturnal snake much like the Natricines. It favors stagnant water and heavy vegetation. Since Mud Snakes are secretive and there are few water sources in Houston County that have extensive vegetation growing in them, it is understandable that only one specimen has been taken from this county. This snake was captured in a swampy area at the junction of Cowart's Creek, Rocky Creek and Bruner's Gin Creek. These three creeks are large tributaries of the Chipola River.

AUM 5995

Diadophis punctatus Linnaeus. Ringneck Snake.

This small snake prefers damp situations under rocks and logs. It can be taken if diligently sought by turning decaying logs and digging shallowly in the earth beneath. Only one specimen, however, is recorded from the county from a large cypress swamp on

County Road 81 southeast of Ardilla. This specimen is an intergrade between Diadophis punctatus punctatus (Southern Ringneck Snake) and Diadophis punctatus stictogenys (Mississippi Ringneck Snake).

AUM 19783

Coluber constrictor priapus Linnaeus. Southern Black Racer.

This snake favors grassy, bushy and semi-wooded areas where there is a sufficiency of food. It is quite often seen but is fairly hard to capture because of its quickness. It can be taken by scouting along roads in the early morning or late afternoon. One specimen was taken at the Chattahoochee State Park and another on Alabama Highway 52 three miles southwest of Dothan. Numerous other specimens were found dead on roads throughout the county, but were not preserved because of their mutilated condition.

AUM 1728 AUM 19380

Elaphe obsoleta spiloides Dumeril, Bibron, Dumeril. Gray Rat Snake.

An abundant snake in temperate North America, this species can be found in deserted farm houses or barns in rural parts of Houston County. It is quite frequently caught crossing roads during the hot days of spring and summer. One specimen in the Auburn University Museum was caught crossing Alabama Highway 203 about a mile south of Rehobeth.

AUM 2995 AUM 19615

Elaphe guttata guttata Linnaeus. Corn Snake.

This species is very similar in habits and habitat to Elaphe obsoleta spiloides. The same method of capture for the Gray

Rat Snake also holds true for the Corn Snake. One specimen was caught on County Road 85 six and one-half miles south of Columbia and another on County Road 89 just north of the Chattahoochee State Park. The only reptile from Houston County in the University of Alabama Herpetological Collection was caught in the Chattahoochee State Park in March, 1950.

AUM 1471 AUM 19564 AUHC 50-374

Lampropeltis getulus getulus Linnaeus. Eastern Kingsnake.

This ophiophagous snake can be in almost any situation since its prey (other snakes) inhabits a wide range of habitats. It is usually caught by scouting along hard-top roads on warm days. There is one record in the Auburn University Museum from the Chattahoochee State Park. One other specimen, which seemed to show evidence of intergradation with Lampropeltis getulus holbrooke (Speckled Kingsnake), was found dead on County Road 89 just north of the Chattahoochee State Park. It was mutilated too badly to be preserved.

AUM 2096

Family Elapidae

Micrurus fulvius fulvius Linnaeus. Eastern Coral Snake.

This secretive snake inhabits various situations, from well-drained pine woods to moist environments such as lake borders. The only specimen in the Auburn University Museum was found dead on Highway 27 just north of the Florida state line.

AUM 18485

Family Viperidae

Agkistrodon contortrix contortrix Linnaeus. Southern Copperhead.

This dangerous serpent prefers low areas around streams and swamps. The only specimen available for study had insufficient locality data to pinpoint its actual capture.

AUM 19808

Agkistrodon piscivorus piscivorus Lacepede X Agkistrodon piscivorus conanti Gloyd.

This is a semi-aquatic snake that prefers slow-moving water such as ponds and beaver swamps. Two specimens were caught in this survey less than a mile south of Rehobeth on Alabama Highway 203. These two specimens were intergrades, as noted, between the Eastern Cottonmouth and the Florida Cottonmouth, which is a new species recently described by Gloyd.

AUM 19608-9

Crotalus adamanteus Beauvois. Eastern Diamondback Rattlesnake.

This impressive snake prefers dry pine-oak situations in sandy soils. This rattlesnake is often found quite unexpectedly when walking through the woods. The best procedure for collection, however, is to scout dry sandy roads. Two of the Auburn University Museum's three specimens were found 6-8 miles west of the Chattahoochee State Park. The other specimen was caught crossing Alabama Highway 53 four miles south of Cottonwood.

AUM 2185 AUM 2188 AUM 9696

Order Crocolilia

Family Crocodylidae

Alligator mississipiensis Daudin. American Alligator.

No specimens were collected during this survey. It was heard, however on two different occasions, in the Chattahoochee State Park.

CONCLUSION AND DISCUSSION

This survey resulted in a study of specimens of 3 orders, 10 families, and 32 species. There were no specimens of unexpected species caught; however, there were species collected that had not been collected before in Houston County. These previously uncollected species confirmed range maps such as Graptemys barbouri (Barbour's Map Turtle) and Agkistrodon piscivorus (Cottonmouth).

This survey also provided data and specimens, which hopefully will be of future use to students, teachers and researchers.

REFERENCES: AMPHIBIANS AND REPTILES

1. Alabama Department of Conservation and Natural Resources. Rare and Endangered Vertebrates of Alabama, 1972.

2. Barclay, L. A., Jr., A Survey of the Amphibians of Houston County, Alabama. Unpublished report, Auburn University, Department of Zoology and Entomology, 1971.

3. Bishop, S. C., Handbook of Salamanders. Comstock Publishing Co., Ithaca, N.Y., 1943.

4. Chermock, R. L., A Key to the Amphibians and Reptiles of Alabama. Geological Survey of Alabama Museum Publication 33, 1952.

5. Cochran, D. M. and C. J. Goin, The New Field Guide of Reptiles and Amphibians. G. P. Putnam's Sons, N.Y., 1970.

6. Conant, R., A Field Guide to Reptiles and Amphibians. Houghtin Mifflin Co., Boston, 1958.

7. Ernst, C. L. and R. W. Barbour, Turtles of the United States. University of Kentucky Press, Lexington, 1973.

8. Mount, R. H., "The Natural History of the Red-Tailed Skink, Eumeces egreqius Baird". American Midland Naturalist, Vol. 70, No. 2, 1963.

9. Neil, W. T., The Last of the Ruling Reptiles: Alligators, Crocodiles and Their Kin. Columbia University Press, N.Y., 1971.

10. Oliver, R., A Survey of the Reptiles of Houston County, Alabama. Unpublished report, Auburn University, Department of Zoology and Entomology, 1971.

11. Smith, H. M., Handbook of Lizards of the United States and Canada. Comstock Publishing Company, Ithaca, N.Y., 1946.

12. Wright, A. H. and A. A. Wright, Handbook of Frogs and Toads of the U.S. and Canada. Comstock Publishing Company, Ithaca, N.Y., 1949.

13. Wright, A. H. and A. A. Wright, Handbook of Snakes of the U.S. and Canada, Vols. I and II. Comstock Publishing Company, Ithaca, N.Y., 1957.

1.5 BIRDS

The attached list indicates birds which have either been sighted or are expected to occur in the three counties surrounding the Farley Nuclear Plant (Table 1.5-1). Approximately 200 species of birds occur in the area, of which half (100 species) are resident and the other half are migrants or strays. The possibility exists for the occurrence of six endangered or rare species near the Farley Nuclear Plant (1) . However, none of these rare or endangered species are known to breed in this area (see Section 4.2).

The narratives on the ecology, breeding and population dynamics of the birds known to occur near the Farley Nuclear Plant were obtained from several references which are listed in the bibliography.

Birds are important to the ecosystem because of their diversified food habits. Birds of prey fulfill a vital role since they consume large numbers of rodents which are a pest to the important grain crops consumed by man. Vultures consume dead animals or carrion which are a source of disease and sickness to man and his domestic animals. Insectivorous birds prey heavily on insect pests which take a high toll and cause extensive economic loss to man's grain crops and vegetables.

Since birds have freedom of movement by use of their wings, they have the flexibility to move during stress periods on their environment and to move long distances during migration. Since nearly half of the known species that occur near the Farley Nuclear Plant are migrants, this adds extensive stress on the limited food supply during the unproductive cold months. The number of species and their abundance are in a constant state of flux.

TABLE 1.5-1

Birds Found in Henry and Houston Counties, Alabama, and Early County, Georgia

Species	Status*	Species	Status*
Pied-billed Grebe	R	Bald Eagle	E
Anhinga	R	Marsh Hawk	M
Great Blue Heron	R	Osprey	E
Green Heron	R	Sparrow Hawk	R
Little Blue Heron	R	Bobwhite Quail	G,R
Cattle Egret	R	Turkey	G,R
Common Egret	R	King Rail	G,R
Snowy Egret	R	Sora Rail	M
Black-crowned Night Heron	R	Purple Gallinule	G,R
Yellow-crowned Night Heron	R	Common Gallinule	G,R
Least Bittern	R	American Coot	G,M
American Bittern	M	Semipalmated Plover	M
Wood Ibis	M	Kildeer	R
White-faced Ibis	S	American Woodcock	G,R
White Ibis	R	Common Snipe	G,M
Scarlet Ibis	S	Whimbrel	M
Canada Goose	G,M	Upland Plover	M
Mallard Duck	G,M	Spotted Sandpiper	M
Black Duck	G,M	Solitary Sandpiper	M
Pintail	G,M	Willet	S
Green-winged Teal	G,M	Lesser Yellowlegs	M
Blue-winged Teal	G,M	Pectoral Sandpiper	M
American Widgeon	G,M	Least Sandpiper	M
Shoveler	G,M	Herring Gull	S
Wood Duck	G,R	Ring-billed Gull	S
Ring-necked Duck	G,M	Forster's Tern	M
Canvasback	G,M	Mourning Dove	G,R
Lesser Scaup	G,M	Ground Dove	G,R
Ruddy Duck	G,M	Yellow-billed Cuckoo	R
Red-breasted Merganser	G,M	Barn Owl	R
Turkey Vulture	R	Screech Owl	R
Black Vulture	R	Great Horned Owl	R
Sharp-shinned Hawk	E	Barred Owl	R
Cooper's Hawk	E	Short-eared Owl	M
Red-tailed Hawk	R	Chuck-will's-widow	R
Red-shouldered Hawk	R	Whip-poor-will	R
Broad-winged Hawk	R	Common Nighthawk	R

*Status: E - Endangered or Rare; G - Game; M - Migrant; R - Resident
S - Stray

TABLE 1.5-1
(Contd.)

Birds Found in Henry and Houston Counties, Alabama, and Early County, Georgia

Species	Status	Species	Status
Chimney Swift	R	Swainson's Thrush	M
Ruby-throated Hummingbird	R	Gray-cheeked Thrush	M
Belted Kingfisher	R	Veery	M
Yellow-shafted Flicker	R	Eastern Bluebird	R
Hairy Woodpecker	R	Blue-gray Gnatcatcher	R
Downy Woodpecker	R	Golden-crowned Kinglet	M
Pileated Woodpecker	R	Ruby-crowned Kinglet	M
Red-bellied Woodpecker	R	Water Pipit	M
Red-headed Woodpecker	R	Cedar Waxwing	M
Yellow-bellied Sapsucker	M	Loggerhead Shrike	R
Red-cockaded Woodpecker	E,R	Starling	R
Eastern Kingbird	R	White-eyes Vireo	R
Western Kingbird	M	Yellow-throated Vireo	R
Great Crested Flycatcher	R	Solitary Vireo	M
Eastern Phoebe	M	Red-eyed Vireo	R
Acadian Flycatcher	R	Philadelphia Vireo	M
Eastern Wood Pewee	R	Black-and-white Warbler	M
Tree Swallow	M	Prothonotary Warbler	R
Bank Swallow	M	Swainson's Warbler	R
Rough-winged Swallow	M	Golden-winged Warbler	M
Barn Swallow	M	Blue-winged Warbler	M
Cliff Swallow	M	Hooded Warbler	R
Purple Martin	R	Bachman's Warbler	E
Blue Jay	R	Tennessee Warbler	M
Common Crow	R	Orange-crowned Warbler	M
Fish Crow	R	Parula Warbler	M
Carolina Chickadee	R	Yellow Warbler	M
Tufted Titmouse	R	Magnolia Warbler	M
White-breasted Nuthatch	R	Myrtle Warbler	M
Brown-headed Nuthatch	R	Yellow-throated Warbler	R
Brown Creeper	M	Chestnut-sided Warbler	R
House Wren	M	Bay-breasted Warbler	M
Winter Wren	M	Blackpoll Warbler	M
Carolina Wren	R	Pine Warbler	R
Long-billed Wren	M	Palm Warbler	M
Short-billed Wren	M	Kentucky Warbler	R
Mockingbird	R	Yellowthroat	R
Catbird	R	Yellow-breasted Chat	R
Brown Thrasher	R	American Redstart	R
Robin	M	House Sparrow	R
Wood Thrush	R	Bobolink	M
Hermit Thrush	M	Eastern Meadowlark	R

TABLE 1.5-1
(Contd.)

Birds Found in Henry and Houston Counties, Alabama, and Early County, Georgia

Species	Status	Species	Status
Redwinged Blackbird	R	American Goldfinch	M
Orchard Oriole	R	Rufous-sided Towhee	R
Baltimore Oriole	M	Savannah Sparrow	M
Rusty Blackbird	M	Grasshopper Sparrow	R
Brewer's Blackbird	M	Le Conte's Sparrow	M
Common Grackle	R	Vesper Sparrow	M
Brown-headed Cowbird	R	Lark Sparrow	R
Scarlet Tanager	R	Bachman's Sparrow	R
Summer Tanager	R	Slate-colored Junco	M
Cardinal	R	Chipping Sparrow	R
Rose-breasted Grosbeak	M	Field Sparrow	R
Blue Grosbeak	R	White-crowned Sparrow	M
Indigo Bunting	R	White-throated Sparrow	M
Painted Bunting	M	Fox Sparrow	M
Dickcissel	M	Swamp Sparrow	M
Purple Finch	M	Song Sparrow	R
Pine Siskin	M	Ovenbird	M
Northern Waterthrush	M	Louisiana Waterthrush	R

Podilymbus podiceps, Pied-billed Grebe

In winter, the Pied-billed Grebe is common to abundant on ponds and lakes throughout Alabama. It summers here often, and occasionally breeds here. Generally it frequents the smaller bodies of water, and it is one of the few water birds more common inland than on the coast. Scattered individuals occur on almost all suitable ponds, and sometimes there are large flocks on migration.

The nest is a soggy mass of decaying vegetation, often free floating but occasionally attached to reeds. There are four to six whitish eggs, which this grebe covers when it leaves the nest. The pond it prefers for nesting is small and has reedy borders. This species feeds on crustaceans, small fish, water insects, frogs and other aquatic animals, and the seeds and soft parts of water plants. Definite breeding has been sighted in the Henry-Houston Counties area, and most likely in Early County.

Anhinga anhinga, Anhinga

This bird is an uncommon to fairly common breeding summer resident in swamps, lakes, and ponds of the Coastal Plain. The anhinga breeds in small, often loose colonies, by itself, or in heronries. The nest is a bulky one built of sticks and sometimes decorated with Spanish moss and fresh leaves. It nests from 10 to 45 feet up in a bush or tree, perhaps a Cyprus, Tupelo gum, a buttonbush, hanging over the water in swamps or sloughs. The two to five elongated eggs are bluish to dark greenish-white with a chalky deposit.

This bird varies its diet of mullet, sunfish, catfish, suckers and pickerel, with crawfish, crabs, shrimp, aquatic insects, tadpoles, water snakes and small terrapins. It captures these prey by underwater pursuit.

Ardea herodias, Great Blue Heron

This species occurs over a more widespread area in Alabama than any other heron, but in summer it is often outnumbered in a particular locality by the Little Blue Heron. The Great Blue Heron is usually found throughout the year near its breeding colonies, and these, so far as is known, are in the Tennessee Valley and the Coastal Plain of both states. Outside the breeding season it may be found in salt and fresh water habitats throughout Alabama, but it is uncommon in the eastern half of the Lower Coastal Plain.

Frequently this heron nests in colonies of from four to several hundred pairs, often with other herons, on the shore of a pond or river, or in a swamp. Its nest is bulky and built of twigs high in a tall tree - a pine or tupelo gum for instance. It lays three to six eggs.

The Great Blue Heron varies its diet with frogs, crawfish, small snakes, salamanders, other water animals and even grasshoppers and mice.

Butorides virescens, Green Heron

This bird is a common, breeding, summer resident throughout Georgia and Alabama, not as numerous as many other herons but more widely distributed. It finds suitable almost all the wetter areas frequented by other herons and also many smaller ponds, streams and marshes. In general, it is a solitary bird and is most active in early morning and later evening.

Usually the Green Heron nests alone, but occasionally several pairs may breed near each other. The nest is a small, loosely-made, twig platform resting in the uppermost branches of a small tree which either hangs over water or is not far from it. This species lays three to five pale greenish eggs.

The Green Heron eats fish, frogs, crayfish, salamanders, spiders, water insects, and other small water animals.

Florida caerulea, Little Blue Heron

The Little Blue Heron is a common to abundant, breeding, summer resident in the Coastal Plain of both states. In late summer and fall it occurs commonly throughout Alabama and is then the most abundant and widespread heron. It winters in small numbers on the coast and occasionally farther north in the Coastal Plain.

This heron nests, usually with other herons, in large colonies on lake shores, in swamps, or on islands. It probably breeds in the Henry-Houston Counties area. The typical heron twig nest may be high in a tree or in a low brush over water. This species lays two to four bluish-green eggs.

According to information based on four birds collected in Alabama, the Little Blue Heron eats crayfish, small frogs, small fish, dragonflies and spiders. This conforms to field observations both in Alabama and Georgia (4, 5, 6).

Bubulcus ibis, Cattle Egret

The Cattle Egret is an Old World species, first noted in the Western Hemisphere in Surinam, South America, between 1877 and 1882. About 1950 it invaded the eastern United States via Florida, and since 1957, at least, has been noted north along the Atlantic Coast to Nova Scotia (breeding to New Jersey) and along the Gulf Coast to Texas (breeding). It winters from the northern Gulf Coast southward.

The nest and eggs of the Cattle Egret are similar to those of other small herons. It usually breeds in colonies of other egrets and herons. Breeding colonies exist near Dothan in Houston County and adjacent Georgia and Florida (6).

Though it most often feeds in pastures among grazing cattle, it also feeds in salt marshes, along roadsides, or in any grassy area - commonly drier ones than those frequented by other herons. This bird feeds extensively on insects stirred up by large grazing animals, and on ticks from their bodies. Items from Alabama specimens include grasshoppers, crickets, beetles, earwigs and slugs. This diet is supplemented by aquatic animals, such as fish and frogs, obtained from marshes and ponds in the usual heron manner.

Casmerodius albus, Common Egret

The Common Egret is a common to abundant, breeding, summer resident in the Coastal Plain. The species inhabits the same marshes and swamps as does the Great Blue Heron and in late summer and fall visits ponds and lakes in both states.

This bird nests in colonies, often with the Great Blue Heron or the Little Blue Heron. It constructs its rather bulky nest of twigs high in tall trees standing in swamps, or in low bushes in inaccessible islands. It lays three to five bluish-green eggs. In 1924, when Arthur Howell wrote *Birds of Alabama*, no species of egret was known to nest in Alabama.

Besides small fish, this heron eats frogs, lizards, mice, moles, insects, small water snakes, and even pond-lily seeds. Like other large herons, it feeds by standing still in or near the water and waiting for its prey to swim by.

Leucophoyx thula, Snowy Egret

This bird is a common, breeding, summer resident in some parts of the Coastal Plain. It frequents the same places as does the Common Egret, but this species is more southernly and coastal in distribution. This species is abundant in Henry, Houston and Early Counties.

The Snowy Egret often joins colonies of other herons for breeding, especially near the coast. It builds a small nest of twigs, usually in low bushes in swamps or on islands, and lays two to five pale, bluish-green eggs.

It feeds actively in shallow waters on small fish and other small water animals, and on grass insects in pastures, where it associates as closely with cattle as does the Cattle Egret.

Ecology of Wading Bird Colonies near the Farley Nuclear Plant

The following wading bird colonies have been investigated in Houston County, Alabama (6):

1. Bonfire Colony - About two miles south of the Bonfire Club (U.S. Highway 84, east of Gordon) on Houston County Road 95. It is a small swamp colony estimated at about 1,000 birds, mostly Cattle Egrets, White Ibis and Little Blue Herons. This colony was first formed in 1970, probably from remnants of the Pansy (Gordon) Colony, which was only a few miles away.
2. Pansy or Gordon Colony - Formerly a moderately large swamp colony, located three miles southeast of Pansy, Houston County, Alabama. It was an active colony until June, 1969. At its peak it had about 9,000 birds: 85 percent Cattle Egrets and 15 percent White Ibises and Little Blue Herons. Occasionally Anhingas, Snowy Egrets and Common Egrets were also present.

No other breeding colonies of wading birds have been reported near the Farley Nuclear Plant in Henry County, Alabama or Early County, Georgia. However, colony distribution varies from year to year and the birds always moved to the same upland or aquatic type habitat previously occupies (see Section 4.2).

Studies of nesting success of Cattle Egrets in a mixed colony were carried out at the Pansy Colony. Data from 1965 (5) showed 100 percent mortality of Cattle Egret nestlings before they left their nests. At the same colony in 1967, 14.8 percent of the eggs laid in the nest studied hatched and successfully left their nests. This is a mortality rate of 85.2 percent (6).

In a study (4) of banding of Little Blue Herons, it was estimated that during the first year banded nestlings had a mortality rate of about 74 percent and after that 33 percent for each remaining year. The oldest birds recorded by the banding results were 12 to 13 years.

The greatest importance of water as a protection to the nesting colony was the protection from many land predators. Water greatly reduced the number of mammalian and reptilian predators. It discourages humans, especially in marshy areas and if alligators are present. Avian predators are apparently not affected by presence or absence of water under the nest. Man is the most important predator or disturber of nests. Other predators include the Gray Rat Snake, Barred Owl, Fish Crow and Blue Jay (5). The role of the alligator, if present, was actually more of a scavenger than a predator. Alligators ate young birds that fell from their nests and died. They also kept predators such as Raccoons from swimming to the nests and prevented many other land creatures from disturb-the birds.

The zone of activity around any given colony depended on the species present and the land use of the area. Cattle Egrets require open grassy areas; Little Blue Herons and White Ibises require shallow ponds, river edges and marshes; and the Great Blue Herons and Common Egrets, deeper and more open pond and river areas.

Research (2) showed that individual birds will sometimes move 20 to 25 miles from the colony area. If one considered a conservative 16 mile radius, one sees that many zones of activity of adjacent colonies overlap. This explains why birds are sometimes seen in areas which seem to be quite removed from any known breeding colony and it may explain why some birds, tagged with radios, seem to disappear from the colony area. They probably moved to another colony in the same general zone of activity. This would tend to weaken any attachment to a given colony area, thus explaining data (6) which show that few birds return to the same colony area in succeeding years. Finally it would explain why colonies that move tend to adopt a new area within 10 to 15 miles from the old colony area. They have a good opportunity to become well acquainted within the zone of activity and thus know the other suitable colony areas within it.

Nycticorax nycticorax, Black-crowned Night Heron

The Black-crowned Night Heron is uncommon inland, but is well distributed on migration. It breeds and winters rarely in Alabama and Georgia. This species has been sighted in the tricounties area. It feeds actively in salt marshes and on the borders of large bodies of water. For roosting and nesting it chooses a variety of trees but especially likes cedars and other evergreens. This night heron feeds at any hour, but it usually prefers to eat at night and then spend the day in its roost. This species breeds in small numbers by itself or with other herons. The nest, loosely made of twigs, is constructed in trees, in bushes, or upon rare occasions on the ground, generally many miles from the feeding grounds. This species lays three to six pale, sea-green eggs.

The main food of this night heron is fish, but it also eats crayfish, shrimp, crabs, frogs, tadpoles, lizards, mice, grasshoppers and other insects.

Nyctanassa violacea, Yellow-crowned Night Heron

Yellow-crowned Night Herons are fairly common summer residents, becoming more local north of the Coastal Plain. A few winter in Alabama, usually near their breeding places, both inland and on the coast. The species generally frequents the same haunts as other herons, but isolated pairs often occur in timbered river bottoms where other herons are scarce. Few birds breed within 30 miles of the coast, but the species is common there in late summer and fall.

This species breeds in single pairs, in small or large groups by themselves, or in small and large numbers in colonies of other herons. They build a nest of loosely-bound twigs which is fairly sturdy, and is frequently lined with Spanish moss. A clutch consists of three to six dull, bluish eggs.

Besides fish, the diet consists of crabs, snails, crayfish, mussels, small mammals, lizards and snakes.

Ixobrychus exilis, Least Bittern

The Least Bittern is a common, breeding, summer resident in fresh and salt marshes of Alabama. It is abundant on the coast in fresh water marshes, but inland where its distribution is limited by lack of suitable marshes it is rare. In winter, it has been recorded only once on the coast. It has been sighted at Columbia, Alabama. This species is shy and retiring, and therefore is often overlooked.

This bird builds a compact platform of reeds or other marsh grasses, often over a loose foundation of small twigs. It lays three to six pale blue eggs. Where nesting habitat is limited, several pairs sometimes build close to each other.

Its food consists of small fish, snails, frogs, tadpoles, small shews, mice, insects and lizards.

Botaurus lentiginosus, American Bittern

This bird is fairly common on migration and uncommon in winter, occurring mostly on the coast. It is not known to breed in Alabama. Inland on migration it may be found in various wet situations, such as grassy pond borders and flooded fields. This species has been sighted at Columbia, Alabama.

The American Bittern lays three to five brownish eggs in a nest of rushes in the marsh. It eats crayfish, lizards, frogs, snakes, small fish, spiders and large insects.

Mycteria americara, Wood Ibis

The Wood Ibis is fairly common in the Coastal Plain in summer and fall. The species chooses wet places. It has been sighted in Houston County. In swamps it often perches in dead treetops or soars high overhead for long periods of time. It forages in shallow ponds, on the shores of deep fresh water lakes, in river bottom sloughs, and sometimes on marshes or wet meadows. Thus far it has not been recorded in either state near salt or brackish water, nor has it been known to breed here.

Hundreds of Wood Ibis nest together in south Florida, and they also nest farther north, but in smaller numbers. The nests are built high in the trees and consist of rather bulky platforms of sticks, to which the birds add extra material each year. The females lay two or three, sometimes five, white eggs which are regularly stolen by Fish Crows.

These birds feed by stirring up the bottom of shallow ponds, forcing aquatic animals to the surface, and then spearing them. Young alligators, fish, frogs, and other water animals are the main items of food.

Plegadis chihi, White-faced Ibis

In Alabama, dark ibises are rare visitors in the Coastal Plains, and are seen in summer and near salt water. This species has been sighted near Headland in Henry County, Alabama. They do not breed here. These birds frequent marshes, mudflats, and the shores of large bodies of water, usually in small numbers by themselves but occasionally in large flocks of White Ibis and herons.

The nest is a loose platform of sticks in shrubs or small trees usually within ten feet of the water. The female lays three or four pale bluish-green eggs. Aquatic animals constitute the major food, including crayfish, other crustaceans, water insects, earthworms, frogs, small snakes grasshoppers, and leeches.

Eudocimus albus, White Ibis

Like herons, the White Ibis frequents swamps, marshes and pond shores. In Alabama it breeds locally in swamps of the tri-state area in summer and during fall spreads out over most of the Coastal Plain. This species is common or sometimes locally abundant, in the Coastal Plain, particularly on the coast and in large river valleys. It has been sighted on numerous occasions in the lower Chattahoochee Valley.

Ordinarily large numbers of this bird nest together, but occasionally small numbers nest in heron colonies. The compact stick nests are often close together in low bushes or small trees over water. Three to five pale grayish-blue eggs with brown, yellow and rufous spots are laid. Although Fish Crows eat many of these eggs, female ibises continue to lay until young hatch successfully.

White Ibises eat small water animals including mammals, reptiles, insects, fish and crustaceans. One species from Alabama had a stomach full of maggots of tabanid (blood-sucking) flies.

Branta canadensis, Canada Goose

The Canada Goose is common on migration throughout Alabama, but especially in the Tennessee Valley and the eastern half of the state. It also winters on smaller ponds and lakes, particularly in the Coosa, Tallapoosa, and Chattahoochee Valleys, or wherever it is given sufficient protection and food. It has been sighted at Columbia, Alabama.

This goose eats roots, stems, leaves and seeds of a variety of water plants such as wild rice and sedges. It also eats waste grain from stubble fields, tender shoots of various grasses, and occasionally insects, crustaceans and mollusks.

Anas platyrhynchos, Mallard Duck

The Mallard is Alabama's commonest tip-up duck. In suitable habitat it is abundant in winter and on migration. This species does not breed in the lower Chattahoochee Valley. It frequents the shallower ponds, lakes and rivers of all sizes and also swamps, timbered bottomlands, and most marshes. It is reported from the lower Chattahoochee River Valley.

The Mallard builds a nest of fine reeds, grass or leaves, lined with down in a clump of grass on the ground, and generally chooses a spot well hidden under shrubs and near water. The female lays from eight to ten light greenish-buff eggs.

The edible parts of most fresh-water plants and many cereals form the bulk of the Mallard's food. The diet includes sour gum, grape, bayberry and dogwood. This duck also eats most of the larger insects found around and in the water, as well as frogs, toads, small fish, mollusks, earthworms, crustaceans (especially crayfish), lizards, and other small animals, and occasionally even mice.

Anas rubripes, Black Duck

This species is common to abundant on migration and in winter in both states. It occurs in the same habitats as does the Mallard, but the Black Duck likes salt marshes and bays. In Alabama, it is known to breed only in the eastern half of the Tennessee Valley. The Black Duck is common in the Tennessee Valley and the Chattahoochee Valley. It prefers to feed at night on the marshes and to spend its days on open water.

For its nest the Black Duck chooses a shrubby, brushy or grassy spot on the ground near water. The large, well-built nest of grasses and weeds is deeply cupped and lined with down and feathers. It usually contains six to twelve pale buff or pale greenish eggs.

This bird eats many water plants, including pondweeds, eelgrass, wild celery and also grasses, sedges, wild rice, grains, many kinds of seeds, nuts and berries In addition, it feeds on many mollusks, especially the blue mussel, and small water animals such as snails, shrimp, frogs, toads, insects, other crustaceans, and occasionally fish.

Anas acuta, Pintail

In winter and on migration, the Pintail is common in both states and often abundant in the Tennessee Valley and on the Gulf Coast. It is not known to nest in either state. It winters in suitable habitat, provided there is little hunting pressure. It frequents the same places as other tip-up duck.

Most of its food is vegetable matter, with seeds of pondweeds and sedges as its favorite. It also eats a few mollusks, crustaceans and insects.

Anas carolinensis, Green-winged Teal

In Alabama, the Green-winged Teal is common in winter and on migration, but is not known to breed here. It often feeds in shallower waters and smaller ponds, but it frequently flocks with larger ducks in deeper waters.

Plants are the major part of this duck's food. Favorites are seeds, especially those of sedges, pondweeds, grasses, algae, wild nuts, wild millet, and wild rice. Other food items are water milfoil, chestnuts, grapes, berries, some insects, snails and small crustaceans.

Anas discors, Blue-winged Teal

The Blue-winged Teal is common to abundant on migration throughout Alabama. It rarely winters north of the Fall Line and uncommonly in the Coastal Plain. This duck rarely breeds in several well scattered places (breeding positive in Henry-Houston Counties). It frequents marshes, mudflats, sandbars, and the shallower parts of ponds, and it feeds by dabbling.

This species prefers prairie country for nesting and often chooses to build its nest close to places frequented by man. The nest is made of grasses, lined with down, and usually covered over with down when the female is absent. This bird lays 10 to 13 dull white, creamy-white or pale olive-white eggs.

Seeds of sedges and the seeds, stems and leaves of pondweeds are this duck's favorite food. It also eats wild grasses, wild rice, smartweed, algae, waterlilies, snails, tadpoles, crustaceans, insects, especially immature forms of caddisflies, dragonflies and beetles.

Mareca americana, American Widgeon

This duck is common to abundant during winter and on migration. Although it occasionally lingers until late May and June, it is not known to nest here. It is a typical pond and lake duck. This duck is apt to spend time also in fairly deep water where it snatches food from the American Coot, Redhead, and others, and so is called "Robber Duck". The American Widgeon feeds on pondweeds, grasses, algae, sedges, wild celery, water weeds, water milfoil, duckweed, smartweed, and occasionally it consumes small mollusks and insects.

Spatula clypeata, Shoveler

This duck is common and local in winter and on migration during spring. It occurs in the same places as other tip-up ducks, but it also frequents the shallower margins of ponds, lakes and swamps. It feeds by dabbling with its huge bill in muddy places. In 1937 and 1938 the species nested in the Tennessee Valley, but these are the only known breeding records for Alabama.

The Shoveler feeds on small aquatic animals, especially snails and other mollusks, insects, crustaceans, tadpoles, worms, and occasionally small fish. It also eats the seeds, stems and bulbs of many varieties of aquatic plants. The large bill is worked through the mud and shallows, straining debris and water out the sides and retaining food particles. It eats more animal matter than any other tip-up duck with the possible exception of the Mallard Duck.

Aix sponsa, Wood Duck

The Wood Duck is a common, breeding, permanent resident in most of Alabama and Georgia. It frequents swamps and other bottomlands, especially beaver ponds and other ponds with wooded borders. Seldom does it occur with other ducks, and in winter it usually roosts in large flocks in swamps.

This duck nests in a hole from 10 to 40 feet up in a tree. Usually it finds a natural cavity, but it will use a nest box. The nest tree may be over water or as much as half a mile away. The female lays eight to fourteen creamy-white eggs in a nest of down. When the young are one or two days old, they flutter to the ground as best they can and the female then leads them to water.

The Wood Duck eats large amounts of duckweeds, core scales and galls from cypress, and the seeds of sedges, rushes and grasses, especially those of wild rice, smartweeds, pondweeds, and waterlilies. It eats the fruit of many trees and shrubs, such as water elm, water hickory, wild grape, swamp privet, buttonbush, oaks, other hickories, beech, and tupelo gum. A small amount of its food consists of small water animals, especially large insects, spiders and crustaceans.

Aythya _collaris_, Ring-necked Duck

In winter, the Ring-necked Duck and the Lesser Scaup occur over a more widespread area of Alabama than any other ducks. Although the Ring-necked Duck sometimes lingers until May and occasionally summers in the state, it is not known to nest here. The deeper artificial lakes and ponds, particularly those with wooded shores, are ideal for this duck. It is well distributed in small flocks instead of concentrated in a few favored places.

The Ring-necked Duck eats the seeds and foliage of such water plants as pondweeds, waterlilies, ditchgrass, sedges, smartweeds, muskgrass, delta potato, wild rice, hornwort and purple watershield. It also feeds on the seeds of dogwood and tupelo gum, snails, tadpoles, insects, crayfish and occasionally minnows.

Aythya _valisineria_, Canvasback

This duck is fairly common in winter and on migration in Alabama. It has not been known to breed here. The Canvasback occurs on the same ponds, lakes, and bays with other ducks but prefers the wider expanses of not-too-deep water in the Tennessee River and Mobile Bay.

This duck likes to feed on wild celery from which its specific name, valisineria, is derived. It also eats pondweeds, wild potato, sedges, widgeon grass, foxtail grass, coontail, banana waterlilies, and nutgrass or chufa. Occasionally it takes waste grain, especially wheat, and mollusks, insects and fish.

Aythya affinis, Lesser Scaup

This duck is abundant in winter and on migration and occasionally it summers here. With the Ring-necked Duck it shares the distinction of being both states' most widespread duck in winter. It prefers the deeper inland lakes and ponds. This species rafts in large numbers over beds of mussels and other mollusks and dabbles in shallows. Usually it associates with other scaups, but at times it forms pure stocks. It is not known to breed here.

It prefers plant food such as the foliage and seeds of pondweeds, water milfoil, wild celery, muskgrass, coontail, smartweeds, waterlilies, and sedges. It also eats snails, mussels, crabs and aquatic insects.

Oxyura jamaicensis, Ruddy Duck

Fairly common as a transient, the Ruddy Duck occurs in the shallower parts of the deep ponds along with the American Coot and other members of the scaup ducks. Although it has summered a few times around Marion, it is not known to breed anywhere in Alabama.

In fresh water the Ruddy Duck lives on the roots, leaves and seeds of water plants such as wild rice, wild celery, pondweeds, arrowhead and waterlilies. On salt water it eats mollusks, snails, fiddler crabs, young crabs, and small fish.

Mergus serrator, Red-breasted Merganser

In winter and on migration, the Red-breasted Merganser is abundant on the Alabama Gulf Coast and fairly common inland, especially in the Tennessee Valley. It has been sighted as a rare transient near Columbia, Alabama. This species is not known to nest in the state.

The Red-breasted Merganser eats fish, shrimp and shellfish.

Cathartes aura, Turkey Vulture

The Turkey Vulture is a common to abundant, breeding, permanent resident. This widely-distributed species commonly sighted in wooded, mountainous country and least common over coastal marshes and beaches. Usually it is abroad on sunny, windy days when thermal updrafts develop and it can soar on motionless wings over ridge and woodland. On rainy or cloudy days it seldom flies. It roosts, sometimes in large groups, in dead treetops in a sheltered place, often on a mountain.

This species does not build a nest for its one or two creamy-white, lavender-spotted eggs. In bottomlands it uses hollow trees, stumps and fallen logs, and in the highlands it hides or completely conceals the eggs on the ground between rocks, in crevices, or on ledges in cliffs. The offspring are buffy-white, downy and quite ugly, and they are fed by disgorging predigested food.

The Turkey Vulture is a carrion-eater. Birds come from many miles to feast on any dead animal. The value of this bird as a scavenger is well established; furthermore, it rarely disturbs livestock as the Black Vulture does.

Coragyps atratus, Black Vulture

The Black Vulture is a common to abundant, breeding, permanent resident. Although not as widely distributed as the Turkey Vulture, it occurs in large flocks, particularly in South Alabama. This species is more prevalent in agricultural regions, especially where livestock is raised. It often loiters around pigsties or any place where it can obtain garbage, dead animals, or other offal.

The one or two greenish-white or bluish-white eggs marked with dark brown or brownish-purple are laid in a hollow tree, stump, or log on the ground, in rocky places, small caves, swampy bottomlands, or dense thickets. The young are quite similar to those of the Turkey Vulture, and they feed on the disgorged, predigested food of their parents.

The Black Vulture will eat any kind of dead or decaying animal matter, including sewage, garbage, or carcasses. It sometimes kills newly-born livestock. This vulture often stays around heronries, feeding on anything that falls from the nests, whether young heron or dead fish.

Accipiter _striatus_, Sharp-shinned Hawk, and _A_. _cooperi_, Cooper's Hawk

Rare Endangered Species of Alabama (1972) lists both the Sharp-shinned Hawk and the Cooper's Hawk as rare-2 status species. Bird census data does not reveal the presence of either species in Henry and Houston Counties, Alabama, or in Early County, Georgia (see Bureau of Sport Fisheries and Wildlife Breeding Bird Survey for Grangeburg Route at end of Birds Section).

The Sharp-shinned Hawk was a locally common, permanent resident in the northern half of Alabama. It winters throughout the state, and on migration it is sometimes locally common. As a predator near the top of the food chain, the reason for its decline may be widespread use of pesticides.

The Cooper's Hawk was a common, breeding, permanent resident throughout the state. Although not numerous, it was widespread and wide-ranging, and was recorded commonly, especially in moderately wooded areas. It is more common in winter, when northern birds augment the local population. The Cooper's Hawk population appears to be decreasing more rapidly than the Sharp-shinned Hawk population and probably for the same reason.

Buteo jamaicensis, Red-tailed Hawk

The Red-tailed Hawk is common throughout Alabama, particularly in hardwood terrain and in valleys. This species has been sighted in Houston County. On migration (October to April) its numbers are increased by birds from the North. This hawk breeds in heavily-wooded areas, usually hilly terrain.

The nest is a large and bulky affair of sticks, twigs, leaves and moss. It is most often built in the fork of a large tree, 40-80 feet above ground, but occasionally it is found well out on a limb near the top of a tall pine. The one to three dull whitish or bluish-white eggs are plain or variously marked with brown and reds.

A large portion of the diet of this species consists of destructive rodents and rabbits. The remainder includes grasshoppers, crickets, beetles and, upon rare occasions, wild and domestic birds.

Buteo lineatus, Red-shouldered Hawk

This bird is the most common and most widespread of all soaring hawks in Alabama. It is a permanent resident, breeding throughout Alabama and Georgia. In winter its numbers are increased by an influx of northern birds. At least one pair occupies every large-sized tract of woodland, with more pairs in tracts of bottomland, hardwood, and fewer in mountainous areas.

The large and bulky nest is built 20 to 100 feet above ground in a hardwood or a pine. It is composed of sticks and grasses with a lining of softer materials such as green leaves, pine needles, and Spanish moss. The one to three dull white or bluish-white eggs vary in color, ranging from dirth white to those marked heavily with brown, gray, and lavender spots and blotches.

This highly valuable hawk eats destructive insects and rodents. Roughly one percent of its diet is poultry and game. Its food includes many rats, rabbits, shrews, grasshoppers, spiders, beetles, caterpillars, crickets, dragonflies, centipedes, snakes, frogs, fish, crayfish, lizards, earthworms and snails.

Buteo platypterus, Broad-winged Hawk

The Broad-winged Hawk is a locally common, summer resident, and as a transient it is fairly common in spring and common to abundant in fall. In winter it is occasionally sighted in the Coastal Plain. It migrates in fairly large flocks, usually along ridges but sometimes along the shores of the Gulf. In summer it nests in wooded areas, especially in the northern half of the state.

This hawk prefers to build its nest in a crotch of a hardwood 10 to 80 feet up, but sometimes it selects a pine. It is made of twigs and bits of bark, lined with bark strips, moss, and sometimes leafy green twigs. The two to four pale greenish or grayish-white eggs are heavily marked with brown spots.

This very beneficial bird lives on snakes and other reptiles, large insects and rodents.

Haliaectus leucoephalus, Bald Eagle

Rare and Endangered Vertebrates of Alabama (1972), along with the U.S. Department of Interior, lists the Bald Eagles as an endangered species. The State of Alabama publication reports that this bird was once locally common during the winter months on the Gulf Coast and in the Tennessee Valley and uncommon in the winter in the remainder of the state. It occurs near rivers and lakes, and has been sighted in Henry County (see Section 4.2). It formerly nested along the Gulf Coast and in the Tennessee Valley but no recent nesting records are known in Alabama. Reasons for its decline include human disturbance at nesting sites, illegal shooting and pesticides.

Circus cyaneus, Marsh Hawk

The Marsh Hawk is common on migration and in winter throughout both states. Although it summers here occasionally, even in pairs, no evidence of breeding has as yet been found in Alabama. This species occurs commonly over meadows, marshes, and other open country. It has been sighted near Columbia, Alabama.

The Marsh Hawk prefers to eat rodents and rabbits. It also takes grasshoppers, other insects, water birds, small grass-dwelling birds, frogs, lizards and snakes.

Pandion haliaetus, Osprey

Rare and Endangered Vertebrates of Alabama (1972) designated the Osprey as an endangered species. The Osprey was formerly common on migration in spring and uncommon in fall throughout Alabama. On the Gulf Coast, in the Tennessee Valley and possibly in the intervening area, it was a common, breeding, summer resident. It frequents the vicinity of rivers, ponds, lakes and bays or the Gulf.

The nest of the Osprey is a large, bulky affair usually built in the top of a tall tree near water. It looks very much like the nest of the Bald Eagle, but the Osprey prefers dead trees. This species feeds exclusively on fish, and the reasons for its decline are similar to those of the Bald Eagle, including pesticides, illegal shooting and human disturbances at the nesting sites.

Falco sparverius, Sparrow Hawk

The Sparrow Hawk is a common, but somewhat local, permanent resident. It is much more abundant from September to March when its numbers are more than tripled by birds from farther north. During summer in the southern part of Alabama it is found in open areas. In flat country a telephone pole near a field is its favorite perch.

This bird nests in natural cavities, abandoned woodpecker holes, or sometimes in holes under the roof of a building. It rearly uses any nesting material and lays four or five eggs, which are often heavily marked with reddish-brown.

The Sparrow Hawk is an insect eater, with a marked preference for grasshoppers and crickets. When these items are scarce, it eats beetles, spiders, shrews, mice, small snakes, lizards, and rarely, small birds.

Colinus virginianus, Bobwhite

This important game species is a widespread, common to abundant, breeding, permanent resident. It is particularly common in farming areas, weedy, bushy fields, and shrubby woodlands, but is less common in wild, hilly country and areas near salt water. Clean farming methods, which eliminate hedgerows and excess grain and seeds, or the raising of livestock, which keep cover at a minimum and may trample nests, leave little available habitat for these birds.

The well hidden nest is located on the ground under thick cover, often at the base of a tree or stump. It is arched and made of dry grasses, weeds, and leaves. The clutch ranges from 11 to 22 pure white eggs which are pear-shaped and fit close together in compact layers.

More than half of the Bobwhite's diet consists of weed seeds and various legumes. Beetles, grasshoppers, bugs and other injurious insects, grain and fruit give variety to its diet. Fruits, which include berries, sumac, and wild rose hips, are eaten chiefly in fall and winter while the insects are taken mainly by the young in summer.

Meleagris gallopavo, Turkey

This bird is a common and widespread, breeding, permanent resident in both states. It is a woodland bird and seems to thrive best on well-watered forests that are mixed, with a good proportion of oaks, broken by well-dispersed clearings of native grasses, legumes, and succulent fruits. By managing and selective planting of the above-mentioned vegetation along transmission line rights-of-way, the habitat of the turkey and other game animals that require this ecotone type, could be enhanced.

The main foods of the Turkey, in order of importance and with the principal times of the year when they are consumed are: Grasses (leaves, mid-spring to mid-fall; seeds, mid-August to mid-October); insects, chiefly grasshoppers, beetles and bugs (early spring through early winter); mast, especially of oaks, beech, dogwood, black gum, and hackberry (late fall to early spring); succulent fruits, mainly berries, grapes, persimmons, and haws (summer and fall).

The nest is constructed on the ground and is well concealed under weeds, often near the base of a tree. The eight to sixteen eggs are yellowish-white, dotted all over with reddish-brown. One gobbler will service three to five hens, but he takes no part in incubation or rearing the young.

Rallus elegans, King Rail

The King Rail is a locally common, permanent resident in the Coastal Plain of Alabama, especially near the coast. It is known to nest in most places where it has been recorded in summer. This rail lives in fresh or brackish marshes. Often, when ideal habitat is scarce, the King Rail lives in wet, grassy areas that could hardly be called marshes.

The nest is on the ground, or low in a buttonbush, in marshes or wet grassy places. The nest is built from the surrounding grasses and arched over to conceal six to twelve dull white or pale buff eggs spotted lightly with lilac and reddish-brown.

This bird eats frogs, tadpoles, crayfish, snails, small fish, spiders, insects, and the seeds of a variety of marsh grasses. The insects include beetles, grasshoppers, aquatic bugs, and nymphs of dragonflies.

Porzana carolina, Sora Rail

The Sora is a freshwater rail, although on migration it is likely to occur throughout both states in any wet, grassy locality, including salt marshes. It is common throughout Alabama on migration, and common in winter south of the Tennessee Valley. Although no nesting has been recorded in the state, the bird has been noted several times in summer.

Because of its short bill, this bird cannot probe in the marsh mud for animals as do the large-billed rails. During winter the Sora Rail eats chiefly plant matter, such as seeds of paspalum, wild rice, duckweeds, algae, cordgrass, smartweeds, and other water plants. It also feeds on beetles, other insects, snails, spiders and crustaceans.

Porphyrula martinica, Purple Gallinule

The Purple Gallinule is uncommon and local in summer in the Coastal Plain of Alabama. It is known to breed only south of the Black Belt and is widespread and reasonably common only on the Gulf Coast. It nests regularly near Columbia, Alabama and hearby Georgia. This species lives in freshwater marshes and in reedy borders of lakes and ponds, especially where waterlilies grow. Apparently it prefers deeper water compared to other fresh water rails. This gallinule often walks across lily pads or swims in nearby open water.

The nest is constructed from marsh grasses, arched over for concealment, and is found over water. The female lays six to ten creamy eggs thinly spotted with lavender.

The Purple Gallinule feeds mainly on the seeds, fruits, and other parts of wild rice, windmill grass, parpalum, duckweed, wild millet, signal grass, spikerush, and other aquatic plants. It also takes aquatic insects, mollusks, and other small water animals.

Gallinula chloropus, Common Gallinule

The Common Gallinule is an uncommon and local summer resident in suitable habitat, mostly in the Coastal Plain. Breeding data are few, but it probably breeds throughout the Coastal Plain. It lives in the same type of marsh, has similar breeding and feeding habits as the Purple Gallinule, but ranges farther north.

Fulica americana, American Coot

The American Coot is abundant in winter and on migration. In winter this not-so-wary bird occurs on practically all bodies of fresh water in both states and often forms dense rafts on open water. In summer it usually occurs singly or in small groups on small, marshy ponds where it probably breeds more often than noted. Some summering birds are undoubtedly hunting season casualties.

The nest, sometimes found floating, is a rather large platform of grasses and dead or decaying marsh vegetation. This coot lays seven to sixteen creamy eggs, finely and evenly spotted with dark brown and black.

In the southeastern states, the food of this species consists of the leaves and seeds of water plants, such as duckweed, widgeon grass, pondweeds, muskgrass, and spikerush. This is varied, especially in summer, with fish, snails, aquatic insects, mollusks, crustaceans, worms and spiders.

Charadrius semipalmatus, Semipalmated Plover

This plover is an uncommon to common inland migrant. It is not known to breed in either state. This species frequents mudflats where it associates with the small sandpipers. Occasionally it can be found on sandy areas, and inland it usually occurs on exposed flats of large rivers or ponds. Much of the food eaten by this bird consists of low-flying insects -- grasshoppers, locusts and mosquitoes. In addition, it takes small crustaceans, mollusks and the eggs of aquatic animals.

Charadrius vociferus, Kildeer

A plover of the uplands, it is especially common around farms, in pastures, in short-grass fields, and on pond and lake margins. In winter it is abundant and occurs throughout the whole state. As a breeder in summer, it is common north of the Fall Line but is less common and more widely scattered southward in the Coastal Plain.

Generally this bird rests on the bare ground, especially in gravelly places, within fifty yards of water. The three to four eggs which it lays are dull buff, and are thickly spotted and blotched with black and with dark brown.

The Kildeer subsists on insects and crustaceans. These include weevils, grasshoppers, crickets, mosquitoes, many kinds of beetles, flies, ticks, worms, crayfish and various aquatic worms.

Philohela minor, American Woodcock

This game bird is an uncommon and local, permanent resident in both states. It is most commonly recorded from November to March when northern birds are present and local breeders are more noticeable because of courtship. A mysterious bird, it occurs in low, wet woods, especially swampy thickets, and feeds extensively on nearby open, damp, grassy areas at night. It is usually active at early dawn, late dusk, or on moonlit nights and cloudy days; therefore, it may go unrecorded. A diligent search often proves it to be a resident.

The American Woodcock nests in a depression in dead leaves, often using pine needles for a lining. It may select wet woods near water or open, dry woods a short distance from its foraging haunts. The female lays three or four eggs, buffy to grayish-white, and usually thickly spotted with reddish-brown.

This bird feeds almost entirely on earthworms and the grub larvae of insects. Since it catches them by probing with its long, flexible-tipped bill, it cannot feed well in dry or frozen grounds. Occasionally, it eats beetles, locusts, grasshoppers, crane flies, other insects, and sometimes small seeds.

Capella gallinago, Common Snipe

The Common Snipe occurs in fresh water marshes, wet, grassy areas, and occasionally on mudflats. This bird is common to abundant in fall and winter, and abundant in spring in those areas which provide its natural habitat. It is not known to breed here.

The main portion of this bird's diet consists of insects, such as grasshoppers, locusts, diving beetles and crane flies. It also eats crayfish, leeches, earthworms and the seeds and roots of a few plants such as smartweed.

Numenius phaeopus, Whimbrel

This curlew is a rare migrant through inland Alabama and has been noted inland earlier in spring and later in fall than on the coast. A specimen has been shot and recorded near Columbia, Alabama. This bird is not known to breed in the state. It frequents mudflats and sandbars, but it often feeds in short grass or on plowed fields. It feeds on fiddler crabs, sand spiders, June bugs, other beetles, grasshoppers, and worms.

Bartramia longicauda, Upland Plover

The Upland Plover is fairly common on migration in Alabama, especially in spring. It has been sighted in Houston County. Although birds are often noted in June and July, this species is not known to breed here. This plover frequents short-grass fields around airports, hay meadows, pastures and golf courses. Formerly very common, this species has been so decimated by hunting and destruction of its habitat that 25 years ago it was thought to be headed for extinction. The destruction of this species has now practically ceased, but the destruction of its habitat has not.

The Upland Plover subsists almost entirely on large grass-dwelling insects. These include grasshoppers, locusts, boll weevils, other weevils, beetles, crickets, cutworms and grubs. It is also known to eat crawfish.

Actitis macularia, Spotted Sandpiper

On migration this sandpiper is common throughout both states, especially in the spring. No definite breeding has been observed in Alabama. This bird occurs on exposed lake, pond, and stream borders, and rarely on tidal flats. Except for the Kildeer, and possibly the Common Snipe, it is more widely distributed in Alabama than any other shorebird. Although it frequently occurs on the coast, it is essentially an inland bird.

The Spotted Sandpiper is primarily an insect eater, feeding on grasshoppers, beetles, Mayflies, cutworms, aquatic insects, and sometimes crawfish.

Tringa solitaria, Solitary Sandpiper

This species is common on migration, especially inland, but it is not known to breed here. It prefers woodland pools, but also frequents the same pond and stream borders that attract the Spotted

Sandpiper. Contrary to its name, this bird frequently occurs in small flocks.

This species eats grasshoppers, moths, beetles, caterpillars, worms, spiders, small crustaceans, aquatic insects, small molluscs and small frogs.

Catoptrophorus semipalmatus, Willet

On the Gulf Coast of Alabama, this shorebird is a common resident in summer and uncommon in winter. Inland it is uncommon to rare on migration. It has been sighted near Columbia, Alabama. This species is known to breed only on the coast. It occurs inland on exposed margins of lakes, rivers and ponds.

This bird subsists on worms, aquatic insects, mollusks, shrimp, and small crabs. It probes for its food in the mud, and sometimes it turns over stones and other beach debris.

Totanus flavipes, Lesser Yellowlegs

On migration, the Lesser Yellowlegs is fairly common to common in Alabama. It is rare in summer and winter on the coast, and it is not known to breed in the state. More numerous and widespread than the Greater Yellowlegs, it occurs in the same habitat, namely, mudflats and pond borders.

Insects, including ants, bugs, flies, and grasshoppers, are the principal food. The bird varies its diet with worms, snails, small fish, and small crustaceans.

Erolia melanotos, Pectoral Sandpiper

In Alabama, this bird is common on migration inland. It is not known to breed here. This bird occurs in wet, grassy areas such as the margins of inland lakes and ponds, marshes and prairie pools where it frequently associates with the Common Snipe and the Least Sandpiper.

Crickets, grasshoppers, insect larvae, earthworms, snails, and shellfish form the major part of its food.

Erolia minutilla, Least Sandpiper

The Least Sandpiper is abundant on migration throughout both states. It does not breed here. This species has been sighted in Houston County, Alabama. It frequents marshes where grass is sparse, the muddier areas, and pond and lake borders. This bird flocks with other sandpipers.

The Least Sandpiper's diet consists of larval and adult insects such as mosquitoes, midges and other flies. It also eats grasshoppers, diving beetles, etc.

Larus argentatus, Herring Gull

The Herring Gull is uncommon to common inland along river valleys and on lakes during and immediately after rain. This species is not known to breed in the state. It has been sighted in Houston County.

The Herring Gull eats various dead or live sea animals, especially fish, molluscs, and crustaceans. To facilitate eating shellfish, this bird often drops them in flight onto a hard surface to break their shell. It also takes garbage and offal.

Larus delawarensis, Ring-billed Gull

The Ring-billed Gull is fairly common to uncommon in winter, especially as a visitor to lakes, ponds, and rivers during or after rain. It occurs more commonly inland than the Herring Gull. This species is not known to nest in Alabama. Its diet is similar to that of the Herring Gull except that it eats less garbage, and inland it eats large insects, especially grasshoppers.

Sterna forsteri, Forster's Tern

Forster's Tern is probably the most widespread of its genus in Alabama. Inland, it is rare to uncommon on migration. This species supposedly has a more varied diet than other terns. It not only eats all manner of insects, caught both on the wing and on the water, but also various small aquatic animals, especially fish.

Zenaidura macroura, Mourning Dove

This game bird is a common and often abundant, widespread, breeding, permanent resident. Northern birds substantially increase its ranks in winter. It generally occurs in farming areas, and often uses the woodlots for nesting and the nearby fields for feeding. Frequently it roosts on the ground.

The nest is a very flat, loosely-built platform of twigs, pine needles, and grass. It is usually built in a pine or cedar tree about 10 to 20 feet above the ground, but occasionally the nest is constructed on the ground. The nest tree is often located in a farmyard or on the edge of a field. The Mourning Dove lays two, or occasionally three, white eggs and may often raise as many as three successful broods per year.

Most of the Mourning Dove's food is weed seeds, legumes, and waste grain, but it occasionally takes small fruits and a very small

amount of animal matter. This bird consumes cowpeas, soybeans, and peanuts, but prefers wheat, waste corn, rye, barley and buckwheat.

Columbigallina passerina ,Ground Dove

The Ground Dove is a common, but irregular and local, breeding, permanent resident on the Coastal Plain. It nests and breeds in Henry and Houston Counties. It frequents sandy areas such as roadsides, farms, dooryards, and even sheltered beaches. This bird spends a great deal of its time on the ground.

The nest is a frail, loose structure of weeds and some sticks usually built low in a tree or on the ground in low cover. Occasionally this dove will choose to build on top of an old nest abandoned by another species. Accumulated droppings in the flimsy nest give it added strength as the young mature. Two white or creamy white eggs make a clutch.

The Ground Dove feeds on berries and seeds of weeds and grasses. Two birds collected in Alabama contained seeds of privet and wood sorrel.

Coccyzus americanus, Yellow-billed Cuckoo

The Yellow-billed Cuckoo is a common, breeding, summer resident and a common transient. It frequents hardwoods, preferring the leafier middle story, and often occurs in the shade trees of towns. It is generally motionless when perched, so that it may be undetected unless it calls or flies.

The nest is a very flat, loosely-built platform of twigs, grass, leaves, and sometimes Usnea moss.It is usually built less than 20 feet from the ground on a horizontal limb in a thick part of a tree.

It lays two to four pale greenish-blue eggs.

A great destroyer of caterpillars, this bird eats the hairy species disdained by most birds. The stomach becomes so felted with caterpillar hairs that the bird often sheds the lining and grows a new one. It also eats large quantities of beetles, bugs, locusts, grasshoppers, ants, wasps, flies, dragonflies, crickets, and even small treefrogs. Occasionally it eats the eggs of other birds, and often small fruits such as raspberries,blackberries, mulberries, and wild grapes.

Tyto alba, Barn Owl

The Barn Owl is an uncommon to fairly common, breeding, permanent resident throughout both Alabama and Georgia, including the Farley Plant area. Many times after a diligent search, this species is discovered where its presence has been entirely unsuspected. It is strictly nocturnal, and commonly spends the day in the top of a deserted structure - a barn, cupola, church steeple, or perhaps in a hollow tree. At night, it hunts over open areas such as meadows, farmlands, city dumps, or wherever rodents are abundant.

This owl usually lays its three to seven or more chalky-white eggs at irregular intervals so that eggs and young of various ages may be in one nest simultaneously. The nest is almost always in some sort of cavity, often in a building or a hollow tree. The owl seldom brings in nesting material, but disgorges pellets to form a bed for the eggs.

The highly beneficial Barn Owl is a prodigious eater of rodents, and is known to eat its weight in mice and rats in one night. Gophers, shrews, ground squirrels, and other small animals are included in its diet, and occasionally it takes a grass-dwelling bird, a large insect or even a frog. It is not known to prey on poultry, and it lives amicably close to domestic pigeons. Like most owls, it swallows its food whole or in large chunks, and the indigestible bones and hair are disgorged in the form of round pellets.

Otus asio, Screech Owl

This bird is a common and widespread, breeding, permanent resident. It often leves around houses and farms, particularly in orchards and more open hardwoods. Although strictly nocturnal, the bird is occasionally seen during the day sitting in a nest box or tree hole, or perched on a limb closely pressed to the trunk with its eartufts raised so that it resembles a part of the tree.

The nest is in a tree cavity, often in a gnarled old tree, or in a nest box. The Screech Owl rarely uses nest material for the three to seven pure white eggs.

This owl consumes mice, rats, shrews, chipmunks, squirrels, bats, large beetles, grasshoppers, crickets, locusts, moths, caterpillars, and other insects. It also catches an astonishing variety of birds including those bigger than itself, and a variety of reptiles, amphibians, crawfish, spiders, snails, and fish. Insects, mice and birds in that order, form the bulk of its diet.

Bubo virginianus, Great Horned Owl

This big owl is widespread in woodlands throughout the year. It often occupies the top of a clump of tall pines, usually in wilder, more rugged wooded areas of the state. In Alabama the Great Horned

Owl nests very early.

This bird ordinarily appropriates the stick nest of some other large bird, especially the Red-tailed or Red-shouldered Hawk. It sometimes remodels or clears out some of the debris before it lays its one or two white eggs. The typical nest is found fairly high in a pine or some other evergreen.

The Great Horned Owl feeds chiefly on medium sized mammals. Rabbits are the most frequent meal, but it also eats mice, rats, skunks, and opossums. It has been known to attack porcupines, domestic cats and dogs. It has an extensive appetite for birds, including domestic poultry, game birds, hawks and other owls. Wherever domestic or game birds are readily available, this owl does considerable damage, but it eats whatever is easiest to obtain, and this is most often rodents.

Strix varia, Barred Owl

Perhaps our most common owl, this is a widespread breeding, permanent resident. Its favorite haunts are swamps, bottomlands, hammocks, and lake borders, but it occurs as well in most wooded areas in the state. It is not as nocturnal as the Screech Owl, for it often hoots or flies about in the late afternoon or on cloudy days.

Most of the time the Barred Owl nests in a natural tree cavity, often appropriating an old hawk or squirrel nest. It usually lays one or two white eggs, which are sometimes destroyed by flooding from heavy rains when the bird has selected an open-topped cavity.

The Barred Owl depends on what is locally available for its food. It usually eats a large variety of mammals, especially ground-dwelling rodents. It also takes insects, small birds, rarely domestic poultry, occasionally other owls, frogs, snakes, and crawfish.

Asio flammeus, Short-eared Owl

The Short-eared Owl frequents marshes and meadows, and is often abroad in daylight. Generally it flushes from the ground, especially from tall grass, and can be identified by its erratic, moth-like flight. At dawn and dusk it flies over open areas, taking over the role that the Marsh Hawk practices during the day. This species is rare and irregular in winter throughout the Coastal Plain. A specimen was shot near Columbia during December, 1929. It often occurs in flocks, but it does not breed here.

This owl subsists chiefly on harmful rodents such as meadow mice, house mice and cotton rats. When rodent food is scarce, it eats small grass-dwelling birds and injurious insects, grasshoppers, May beetles and cutworms.

Caprimulgus carolinensis, Chuck-will's-widow

This goatsucker is common in woodlands in summer and breeds throughout both states, even in the breeding range of the Whip-poor-will. It seems to prefer woodlands that contain both oaks and pines, and in hilly country lives along tributaries in bottoms and thickets. It spends the day on the ground, on a fence post, or perched lengthwise on a limb.

The two mottled, rich creamy to pale creamy eggs are laid on dead leaves on the ground in partially-shaded woods, usually in an opening or near an old road. The sitting parent is well camouflaged, but, when flushed, it often acts as if injured in order to lure the enemy from the nest

Feeding almost entirely on night-flying insects, this goatsucker takes May beetles, other beetles, moths, dragonflies, grasshoppers, mosquitoes, flying ants, and bugs. On occasions it swallows, apparently by accident, a small bird, usually a hummingbird or warbler.

Caprimulgus vocifeus, Whip-poor-will

This bird occurs, like the Chuck-will's-widow, in woodlands of oak and pine, along tributaries in the bottoms and thickets of hilly country. Although only two definite breeding records are known from the state, the species undoubtedly breeds in June wherever it occurs. It is rare to uncommon in migration in the lower Coastal Plain.

Its food habits are similar to the Chuck-will's-widow.

Chordeiles minor, Common Nighthawk

This bird is a common, breeding, summer resident. In fall it is often abundant on migration. It frequents bare open areas, particularly those that are gravelly, sandy or paved. It hunts mostly at night, dawn or dusk hours, even flying among the taller buildings in the center of our cities. Although it sometimes hunts in broad daylight, it normally passes the day perched on a gravelled roof or another bare area, or perched lengthwise on a limb of a tree.

The one or two pale buff or creamy eggs are heavily marked with brown, black, and gray, and are laid in almost any bare area. Frequently this is a flat, gravelly roof, a sand drive or a recently plowed field.

This nighthawk lives almost entirely on injurious insects caught on the wing. These include winged ants (especially carpenter ants), beetles, grasshoppers, locusts, mosquitoes, flies, moths, sweat bees, plant lice, leaf chafers, boll weevils and stoneflies.

Chaetura pelagica, Chimney Swift

The Chimney Swift is a common, breeding, summer resident. It is abundant as a migrant, especially in fall. It is common around towns but seems to be equally numerous over bodies of freshwater and over mountainous terrains. In September and October, it gathers in flocks of several thousand, and each flock roosts in a favorite chimney.

Before this country was settled, the Chimney Swift nested in hollow trees, but now it nests about exclusively in chimneys. The nest is a saucer-shaped hammock of dead twigs broken off in flight with the feet or bill and glued to the side of the chimney with the bird's specially-adapted saliva. The Chimney Swift lays three to five pure white eggs.

This swift feeds almost entirely on flying insects captured on the wing. Items known to be taken in large numbers are May flies, crane flies, beetles, mosquitoes, flying ants, wasps, bugs and grasshoppers.

Archilocus colubris, Ruby-throated Hummingbird

This bird is a common, breeding summer resident. It is a woodland bird that frequently visits gardens. In fall migration (mid-August to mid-October) it is sometimes abundant, especially in gardens.

The nest is a tiny, lichen-covered cup, barely an inch in diameter. It is lined with soft plant down and straddled on a thin, horizontal or down-sloping limb, often over water. The female lays two tiny, creamy-colored eggs.

The Ruby-throated Hummingbird is especially attracted to red flowers. Favorites in Alabama are red buckeye in early spring; cardinal flower and jewelweed in woods in summer; and salvia and hibiscus in fall. Other favorites are mimosa, gladiolas, petunia, butterflybush, iris, fuchsia, morning glory, lantana, trumpet vine, and beebalm (Monarda). Besides the nectar of these and many other flowers, it eats many spiders and small insects.

Megaceryle alcyon, Belted Kingfisher

This species is a common, breeding, permanent resident near water. In summer it is uncommon near the coast. It frequents most watercourses but avoids the narrow, heavily-shaded branches and the open salt water. Except for the breeding season, each bird generally remains alone and jealously guards its territory.

With its big bill and shovel-like claws, this kingfisher digs a three-to-six-foot burrow near the top of an exposed bank. It lays five or eight pure white eggs on the bare soil at one end of the burrow. Occasionally it collects bits of clean fish bones, leaves, scales, and skeletons of large insects to form a small nest.

This bird lives almost entirely on small fish, usually nongame species. Around fish hatcheries, however, the temptation is too great for the kingfisher, and it sometimes becomes a nuisance. When fish are difficult to obtain, the bird eats molluscs, crustaceans, amphibians and small reptiles.

Colaptes auratus, Yellow-shafted Flicker

The Yellow-shafted Flicker is a common to abundant, breeding, permanent resident whose numbers are substantially increased in winter by migrants from the north. The species is adaptable to nearly all upland habitats, but it is partial to open woodlands, especially hardwoods. Probably more than any other woodpecker, it feeds on the ground, particularly on lawns.

This flicker nests in self-dug holes from one to 100 feet above the ground, preferably in dead trees. Sometimes it uses natural cavities, and more often than other woodpeckers, a nest box.

The Yellow-shafted Flicker eats more ants than any other North American bird. It also takes a large variety of other insects, especially beetles, grasshoppers, crickets, cockroaches, caterpillars, bugs and flying insects. It also occationally eats berries and other fruits, nuts, and seeds, especially poison-ivy.

Dryocopus pileatus, Pileated Woodpecker

The Pileated Woodpecker is a common, breeding, permanent resident in all wooded areas. Formerly, it lived almost entirely in virgin hardwood bottomland forests, as did the Ivory-billed Woodpecker. As these tracts declined, so did the Pileated Woodpecker, but it has adapted to second-growth timberlands. It now occurs frequently near houses, and even occasionally in backyards and at feeding stations. Few sizeable patches of woodland in Alabama now lack a pair of these birds.

Every year this woodpecker excavates a fresh nest hole, 20 to 85 feet up in a hardwood or pine and preferably in dead wood. In this cavity it lays three to five, usually four, glossy white eggs.

Ants form the largest share of this woodpecker's food, with beetles, especially wood borers, a close second. Besides other insects, it eats small amounts of fruits, especially wild berries and nuts. It feeds within the forest, and makes great excavations in trees in search of carpenter ants and beetles.

Centurus carolinus, Red-bellied Woodpecker

The Red-bellied Woodpecker is a common to abundant permanent resident. It lives and breeds commonly in all types of woodlands, even around houses.

This woodpecker drills its hole in almost any kind of tree from five to eighty feet from the ground. It lays three to five white eggs.

Unlike most woodpeckers, this bird eats more fruit than insects, especially in winter. Its fruit diet is quite varied and consists mostly of wild berries. It also eats nuts, especially acorns and occasionally it drinks sap. Its insect food includes beetles, grasshoppers and flies. Frequently it stores insects and nuts in cracks in wood.

Melanerpes erythrocephalus, Red-headed Woodpecker

The Red-headed Woodpecker is a locally common, breeding, permanent resident, yet it is sometimes absent from apparently suitable places. In winter it often moves to swamps or migrates southward. Around towns it chooses telephone poles for foraging and nesting.

This woodpecker drills a nest hole from three to eighty feet above the ground in dead wood. The nest site may be a telephone pole or a fence post. Starlings frequently evict the woodpecker after the hole is complete. The woodpecker lays three to seven white eggs on a bed of wood chips. A Red-headed Woodpecker may raise two broods.

Insects made up about half of the food of this species, especially ants, beetles (including weevils), grasshoppers, catepillars, bugs, and other small fruits, nuts (especially acorns), and a few seeds and grains. It has the habit of storing food for future consumption in cracks and crannies.

Sphyrapicus varius, Yellow-bellied Sapsucker

This is the only woodpecker listed that does not breed in either Alabama or Georgia. It is common in winter in both states in nearly all types of woodland. Usually a quiet, solitary bird, it is often overlooked because it spends much of its time clinging quietly to a tree trunk.

Its food is primarily the sap of trees which bear nuts and fruit, including pine and cypress. It also eats the cambium layer, which is a soft inner bark and carries the sap. Additionally, it eats ants, flies caught on the wing, some beetles, catepillars, spiders, centipedes, many wild fruits, and rarely wood borers. Its dependence on sap probably explains why it is one of the few woodpeckers that are known to migrate. Rows of holes drilled around the trunk readily mark those trees attacked by this bird. Little harm is done if it moves on, but in the South where it remains all winter, the tree may be ruined for lumbering purposes or even killed.

Denrocopos villosus, Hairy Woodpecker

This woodpecker nests in the wilder and deeper woodlands, and is fairly common throughout the year. It generally occurs alone or in pairs, but occasionally associates with roving bands of other small woodland birds in winter. Although it is a retiring bird, it sometimes visits feeding stations in winter.

This bird's nest hole is dug from nine to sixty feet above the ground usually in a hardwood. There are three to six, usually four, white eggs in a clutch.

The main food items are insects especially the wood-boring larvae of beetles, ants, catepillars, weevils, aphids, spiders, and millipedes. This diet is varied, especially in winter, with small amounts of fruits, grains, seeds and nuts.

Dendrocopos pubescens. Downy Woodpecker

The Downy Woodpecker is a common and widespread, breeding, permanent resident, fot it occurs wherever there are trees. It is the most trustful woodpecker, often coming to feeding stations, where in colder weather it is particularly attracted by suet. It usually occurs in groups, and in winter it commonly associates with titmice and other insect-eating woodland birds.

The nest hole is dug in a hardwood from eight to fifty feet above the ground. In the Coastal Plain of Alabama, cottonwood and willow trees are frequent sites. This bird sometimes uses a nest box. The three to five eggs are white.

Beetles, ants, catepillars, and moths, in that order, make up the main food supply. This is supplemental with some wild fruits, especially berries of poison-ivy and dogwood. Frequently this woodpecker forages on the smaller twigs of trees and shrubs and even on tall weeds.

Dendrocopos borealis, Red-cockaded Woodpecker

The Red-cockaded Woodpecker is a local, permanent resident in piney woods. It usually lives and nests in woodlands where one-quarter or more of the trees are pine. This species is listed as endangered by the

U.S. Department of Interior. The reason for decline is the elimination of breeding habitat.

This species nests about 30 feet above the ground, almost invariably in a living pine that has a dead heart. The outsides of its nest hole is smeared with pitch, and in a bed of wood chips it lays two to six glossy white eggs. Often several pairs nest close together, and if they are not disturbed will use the same tree year after year.

Pine mast and the larvae of wood boring insects form the greater part of this woodpecker's food. It also eats adult beetles, ants, grasshoppers, crickets, wild berries and seeds. From time to time it feeds near cultivated areas, often on corn worms.

Tyrannus tyrannus, Eastern Kingbird

This kingbird, usually the only one in eastern North America, is a common, breeding, summer resident and is often abundant on migration. It frequents open areas, especially around farms, and commonly perches on fences or isolated trees. In the nesting territory it drives away many larger birds, particularly crows.

The nest is a rather bulky cup of twigs, rootlets, and finer material built away from the trunk on a limb 10 to 30 feet above the ground. Isolated trees such as shade trees or those in orchards are preferred but from time to time it even builds in a hole in a hollow tree. The usual clutch is three to five creamy-white eggs marked boldly with various shades of brown, black and lavender.

This kingbird eats primarily injurious insects and varies its menu with wild fruits. It does eat bees, as its common name implies, but not so extensively as to be of much harm. Insect food includes boll weevils, other beetles, butterflies, wasps, ants, flies, bugs, mosquitoes, and catepillars. Almost all wild berries, especially wild cherries, sassafras, red cedar, dogwood and magnolia berries are included.

Tyrannus verticalis, Western Kingbird

During fall the Western Kingbird is rare inland on the Coastal Plain. It has been sighted near Columbia, Alabama. This species is not known to nest in this state. Its food habits are similar to the Eastern Kingbird.

Myiarchus crinitus, Great Crested Flycatcher

The Great Crested Flycatcher and the Eastern Wood Pewee are the most common woodland flycatchers. The Great Crested is a summer resident which nests throughout both states and is equally common in pines or hardwoods, in wilder woodlands, or around farms, and in wooded suburbs. It is easy to find, for it calls often and used exposed perches.

The Great Crested Flycatcher nests in holes, using natural cavities, abandoned woodpecker holes, nest boxes near houses or in rather open woods, and (rarely) even mail boxes. The bird uses dead leaves to fill up a large cavity and provide a foundation, and then builds the nest proper, using a great variety of materials, but almost always including a snake skin or feathers. The four to six creamy to buffy eggs are handsomely marked with various shades of brown and lavender.

This species lives almost entirely on insects.

Sayornis phoebe, Eatern Phoebe

The Eastern Phoebe inhabits rather open woods, woods borders, clearings, roadsides, and the vicinity of farms and other homes, especially near water. It is a common and widely-distributed, permanent resident north of the Coastal Plain, and common on migration and in winter in the rest of both states. It breeds north of the Fall Line.

This species eats large quantities of ants, wasps , bees, sawflies, beetles, leafhoppers, bugs, flies and mosquitoes. In lesser amounts it takes grasshoppers, crickets, moths, catepillars, dragonflies, spiders, ticks, millipedes, and a great variety of wild fruit, especially sumac.

Empidonax virescenus, Acadian Flycatcher

The Acadian Flycatcher is a common, breeding, summer resident. It occurs in deep, shady, deciduous woods, especially along streams or in swamps. It has a special liking for beeches and hornbeams. It occupies the lower limbs and branches, generally not more than twenty feet from the ground. In the Coastal Plain the nest is often composed entirely of Spanish moss. The two to four creamy-white to buffy-white eggs are marked with minute brown dots around the larger end and can usually be seen from below through the nest.

The cankerworm is probably the bird's main item of food. It also eats wasps, bees, ants, catepillars, moths, beetles, flies, crickets, grasshoppers, spiders, millipedes and small amounts of wild fruit.

Contopus virens, Eastern Wood Pewee

The Eastern Wood Pewee is a common, breeding, summer resident which shares with the Great Crested Flycatcher almost every patch of woods in both states. It may be partial to deciduous woods, but it will reside in the almost pure forests of longleaf and slash pines.

The nest is small and dainty, shaped like shallow cup, well camouflaged, and licken-covered. Usually it it built in the level fork of a small limb well out from the trunk of a large tree. The bird lays two or three whitish or cream-colored eggs, marked with various shades of brown and lavender.

This flycatcher feeds mainly on flies, but it also takes wasps, bees, ants, beetles, catepillars, moths, grasshoppers, and bugs. Occasionally it eats spiders, millipedes, and wild berries.

Iridoprocne bicolor , Tree Swallow

This is the only swallow on Alabama list not known to breed in the state. On migration it is common, especially in river valleys. The bird feeds largely on flying insects and will eat berries during the fall and winter.

Riparia riparia, Bank Swallow

On migration the Bank Swallow is fairly common in the Coastal Plain but does not breed in that section. This species occurs over most open areas with other swallows on migration. Its food habits are similar to the tree swallow.

Stelgidopteryx ruficollis , Rough-winged Swallow

The Rough-winged Swallow is a common to abundant, breeding, summer resident. It frequents the rivers, creeks, and ponds, especially near exposed banks and on migration flocks over such open areas as cultivated fields, lakes, rivers, and marshes.

The nest is usually in a burrow in an exposed bank, but this species uses almost any other reasonable substitute. The nest proper is usually a bulky, loose affair of pine straw and dead leaves, but when it is built outside a cavity, it is more sturdy. This swallow usually lays five to seven white eggs.

Flies made up a large part of the diet of this swallow along with other flying insects.

Hirundo rustica, Barn Swallow

The Barn Swallow is common to abundant on migration and a fairly common but local, breeding, summer resident in the Tennessee Valley and the Gulf Coast. This species usually occurs near water, but from time to time it frequents open crop or pasture land, especially in the vicinity of barns or bridges, dams, piers, and other structures built over water.

This species subsists almost entirely on flying insects.

Petrochelidon pyrrhonota , Cliff Swallow

Throughout Alabama, except for the Tennessee Valley where it breeds, this swallow is uncommon on migration, but sometimes it occurs in fair-sized flocks. It frequents the same habitat as other swallows near water. Food habits are similar to other swallows.

Progne subis, Purple Martin

This is the most widespread swallow, for it is a common to abundant, breeding, summer resident throughout both states. It is one of the earliest of the migrant birds to arrive and depart. It occurs over the same open areas as other swallows, but seems to prefer farmland more than areas near water, for it feeds frequently over row crops and pastures.

The Purple Martin habitually nests in hollow gourds, bird houses, hollow trees, woodpecker holes, mail boxes, traffic lights, and other cavities. Inside the box or cavity selected, the female lays three to six pure white eggs in a nest of grass, twigs, leaves, mud and trash.

Except for a few spiders, this martin eats only insects.

Cyanocitta cristata, Blue Jay

This species is an abundant resident of Alabama and Georgia. The Blue Jay is widespread in all woodlands and near houses. It nests in all parts of both states. This is a bold, noisy, active, strong and hardy bird, but during the nesting season it is less active. It harasses hawks, owls, and other predators and by screaming and pecking, it forces them to leave its territory.

Generally the Blue Jay builds a large nest, using small twigs, bark, moss, paper, rags, wool, leaves, string, or dry grass. Sometimes it cements its nest with mud and lines it with finer materials, usually rootlets. This nest is often hidden by foliage in a crotch from four to forty feet up in an evergreen or hardwood, particularly on oak. Ordinarily this species lay three to five olive or buff eggs spotted with dashes of olive and brown.

The nuts of oak, hickory, pecan, and beech trees are the principal foods of this jay. Prominent among a great variety of other dietary items are grains, wild fruits, insects, molluscs, crustaceans, mice, fish, small amphibians, and occasionally eggs and young of other birds.

Corvus brachyrhynchos, Common Crow

The Common Crow is an abundant, breeding, permanent resident, but it seems to shun the deeper woods and to be partial to farming areas. Like the Blue Jay, the Common Crow harasses hawks, owls, and other large birds. This species is extremely wary, highly reasourceful, and probably more intelligent than most birds.

Usually this crow builds a nest of sticks lined compactly with soft, finer material such as hair and bark strips. The nest is ordinarily constructed in the crown of a pine tree from 10 to 70 feet above the ground. This bird lays from four to six eggs, bluish-green to olive-buff with irregular blotches of browns and grays.

The Common Crow eats any kind of food, dependent on local availability. Items include cultivated grains, fruits and seeds. Lesser items include animal matter and even carrion.

Corvus ossifragus, Fish Crow

The Fish Crow is a breeding, permanent resident in the Coastal Plain, abundant on the Gulf Coast and common farther inland in river valleys. This crow generally frequents the vicinity of water and often forages on beaches and mudflats. Inland it also occurs frequently on farms. It has been sighted in Henry and Houston Counties.

The nesting habits are similar to those of the Common Crow, but the Fish Crow nests in smaller groups, closer to water, later in the year, and generally in pines or cedars, sometimes at a great height. Frequently the nest contains feathers of water birds, and although the Fish Crow nests in conifers, hardwood twigs are often used exclusively for nest contruction. The usual clutch is three to five eggs colored bluish-green to olive-buff like those of the Common Crow.

The food habits are similar to those of the Common Crow, with main emphasis on aquatic and marine life.

Parus carolinensis, Carolina Chickadee

The Carolina Chickadee is a common, permanent resident and breeder in nearly all woodlands. It is equally common in pines and hardwoods, in the wildest areas and around houses. It is commonly found in partially-wooded residential areas. Outside the breeding season, it forms flocks with the Tufted Titmouse and many other insect-eating, woodland birds.

This bird usually excavates its own nest hole from four to fifteen feet above ground in a dead or decaying stump or fence post. It often uses nest boxes. The nest itself has a foundation of moss with strips of bark and grass and is lined with plant downs, feathers, and hair. The eggs are white, dotted with reddish-brown, and number five to eight, commonly six. A parent chickadee disturbed on the nest gives a realistic imitation of the hiss of a copperhead.

The bird is insectivorous, and eats lesser amounts of seeds, wild fruits, and miscellaneous items placed in feeding stations.

Parus bicolor, Tufted Titmouse

The Tufted Titmouse is a breeder and is about as common and widespread as the Carolina Chickadee, except that it seems to be more common in oaks and less common in pines. It has the same feeding habits, trustful ways, and family traits as the titmice.

The nest is a hollow tree, stump, fence post or nest box. The Titmouse builds its nest with leaves, sometimes also snake's skin, and lines it with inner bark, Spanish moss and mammal hairs. The hairs are often collected from living animals, including in one instance those of a human. The four to six white eggs are finely spotted with shades of brown.

This species is chiefly insectivorous. During fall and winter, plant matter, nuts and miscellaneous feeds in feeding stations are consumed.

Sitta carolinensis, White-brested Nuthatch

This species is uncommon and local in the Lower Coastal Plain. It spends most of its time in hardwoods and generally frequents the bigger trees, especially oaks. Quite a tame bird, this nuthatch allows close approach and frequently visits feeding stations. During wintertime, it occasionally associates with titmice flocks.

Usually this nuthatch nests in a knot-hole, an abandoned woodpecker hole, or another natural cavity, but occasionally it selects a nest box. Inside the chosen cavity, this bird assembles a foundation of bark strips, then fine plant materials such as rootlets, inner bark, and grass, and finally a lining of fur and feathers. The four to six white eggs are heavily marked with reddish-brown.

The principal food is nuts, seeds and wild fruits. Also it feeds on insects. This nuthatch often takes particles of food and stores them in cracks in wood or wedges nuts there for more convenient cracking with the bill. This hacking of nuts probably inspired the name nuthatch.

Sitta pusilla, Brown-headed Nuthatch

The Brown-headed Nuthatch is a common, breeding, permanent resident. Usually occuring in small flocks in more open woods, this bird spends most of its time clambering around the outer twigs of the tall pine trees which are its favorite habitat.

For the nest, this bird usually digs a hole in a dead pine tree or in a fence post, but occasionally selects a natural cavity or a nest box. The nest is frequently over water, and usually in less than 12 feet in elevation. The nest is lined with pine seed coats, but sometimes bark shells and grass are used. A clutch consists of four to six white eggs, usually marked with reddish-brown.

This nuthatch feeds on beetles, cockroaches, caterpillars, ants, scale insects and pine seeds.

Certhia familiaris, Brown Creeper

This bird is usually fairly common in winter in all types of woodlands. It is not known to nest in either Alabama or Georgia. The Brown Creeper spends most of its time circling a tree trunk from the base upward in search of food and then moving onto the next tree and repeating the procedure. Although solitary, it sometimes joins small flocks of its own species or remains on the fringes of the titmice groups. Except during the breeding season, it rarely pays attention to anything except the perpetual search for food.

This bird feeds on variety of injurious woodland insects and other insects, and varies its diet with nuts.

Troglodytes aldon, House Wren

The House Wren is a common transient. In winter it is fairly common in the Coastal Plain, and lives in dense tangles near the ground, especially in bottomlands. Such places as brush piles, fallen trees, thick vines, palmetto clumps, and heavy brush of any sort are ideal for habitation. The species is very localized as a breeder in either state.

This wren naturally nests in tree cavities, but through adaptation it uses almost any available cavity near houses. This cavity, regardless of size, is filled with sticks and grass, leaving only a passageway for nesting. This cup is lined with feathers, hair, wool, or other fine materials. The five to eight whitish eggs are very heavily marked with fine reddish-brown dots.

This species is primarily insectivorous.

Thryothorus ludovicianus, Carolina Wren

This bird is the most common and widespread wren in both states. It occurs here throughout the year and usually nests wherever found. It frequents habitats near houses, and like other woodland wrens, prefers thick cover near the ground. Although the House Wren and Bewick's Wren cannot get along together, the Carolina Wren seems to associate amicably with either species.

This wren nests any sort of cavity or receptacle left undisturbed, and lines it with any fine material available. Woodland nests are usually constructed as a ball with a side entrance in upturned roots, tree holes, stumps, crotibes, stream bands, vine tangles, and often on the ground on slopes. The three to six white eggs are marked with shades of brown, often in rather large spots.

This species is primarily insectivorous, but, surprisingly, occasionally feeds on lizards, treefrogs, berries and seeds.

Telmatodytes palustris, Long-billed Marsh Wren

This wren is a common, sometimes locally abundant, breeding, permanent resident in coastal marshes. This species is also fairly common on migration and it winters in fresh water marshes. Although the Short-billed Marsh Wren often occurs on the periphery and the drier parts of marshes, the Long-billed Marsh Wren is normally the only wren that frequents the deeper sections.

This species is insectivorous and also feeds on small molluscs and smails.

Cistothorus platensis, Short-billed March Wren

This wren inhabits grassy areas drier than the marsh of the Long-billed Wren. In Alabama the Short-billed Marsh Wren winters abundantly on the coast, commonly in the remainder of the Coastal Plain. August records of singing birds suggest that this bird may possibly breed in the state, but no positive breeding evidence has yet been found. It frequents the grassy edges of marshes, boggy areas in pine flats, damp broomsedge and sometimes dry, grassy places, as long as the cover is at least two or three feet tall. This species is crepuscular during its activity period and is insectivorous.

Mimus ployglottos, Mockingbird

A remarkable songbird, the Mockingbird, frequently sings on spring and summer nights, especially when the moon is full. Frequently the Mockingbird goes through its repertoire of songs of local birds, repeating each imitation five or six times and often singing more than one song for each species. In early spring, it even imitates summer resident birds that have not yet returned from their winter quarters. This bird is a widespread and abundant resident throughout the year. It seems to be most abundant around houses, particularly farms, and least abundant in deep woods. It usually nests wherever found.

The typical nest is durably made of dead twigs lined with grasses or rootlets. It is commonly three to ten feet above ground in a thick shrub, often near a house, but a great variety of other materials and locations are often selected. The clutch consists of three to five bluish or greenish eggs heavily marked with shades of brown.

Wild fruit forms more than half of the yearly diet of the Mockingbird. It occasionally may eat cultivated fruit and the remainder of its diet includes insects and small lizards.

Dumetella carolinensis, Catbird

The Catbird is a common, breeding, summer resident in most of Alabama, but it breeds in only a few places south of the Black Belt. On migration it is common throughout both states. It frequents hedgerows, woods borders, and other shrubby or brushy places.

The nest is a deep cup made of twigs, sticks and leaves, lined almost exclusively with rootlets. It is usually well concealed in dense shrubbery close to the ground. The female lays three to four deep greenish-blue eggs.

More than half of the Catbird's food consists of berries and other fruits with the remainder in insects.

Toxostoma rufum, Brown Thrasher

The Brown Thrasher is a common to abundant, permanent resident. During the winter this species is common in the Coastal Plain. It breeds in both states in woodland borders, shrubbery around houses and other bushy places.

The nest is generally two to ten feet above the ground in hedgerows, vine tangles, shrubbery, or low trees, especially in hawthorn, osage orange, honeylocust and young oaks. It is built of twigs, dead leaves, and grass, and lined with rootlets. The three to five pale bluish-white eggs are evenly and heavily covered with very fine, reddish-brown dots.

Most of this bird's diet consists of acorns, small berries, cherries, grapes and beetles.

Turdus migratorius, Robin

In the Lower Coastal Plain of Alabama, the Robin is an uncommon and local resident, mostly around towns. For breeding it seems to require a lawn and at least one shade tree. In winter, its numbers are reinforced by northern birds. It occurs at this time in flocks in many habitats, but seems to favor swamps, farmland, and open woodland, especially where berries are available. The Robin has not been reported to breed in Henry and Houston Counties.

Most of this bird's food is fruit and insects.

Hylocichla mustelina, Wood Thrush

The Wood Thrush is a common and well-distributed summer resident. It frequents primarily the lower parts of low, moist, shaded hardwoods, but it also occurs in mixed woods and rarely in pure pine.

The nest is a deep cup of mud, dead leaves, and moss, reinforced with grass and lined with rootlets. The average nest is in a crotch of a sapling or shrub, or on a horizontal limb of a tree about 10 feet above the ground. The two to four eggs are greenish-blue, smaller and darker than those of the robin.

In spring the thrush feeds on insects, in fall the wild fruits, and a list of other assorted berries when ripened.

Hylocichla guttata, Hermit Thrush

The Hermit Thrush is common to abundant on migration and in winter, but is not known to nest in either state. It occurs in all types of wooded areas but especially in moist places and shrubby or brushy spots. Like other thrushes, it lives near the ground.

This species eats more insects than the other brown thrushes. In fall and winter it consumes wild fruits and some seeds.

Hylocichla ustulatus, Swainson's Thrush

Swainson's Thrush is a common, often abundant, transient which is not known to nest here. It occurs in spring and fall in almost all the wooded areas of both states. Like other thrushes it usually occurs on or near the ground, but Swainson's Thrush occasionally ranges higher in the trees. Migrating birds are usually silent and retiring.

In spring and summer, this thrush subsists principally on insects, and in fall or winter, on fruits.

Hylocichla minima, Gray-checked Thrush

This species is uncommon to common on migration and casual in winter but is not known to nest here. Usually it occurs with Swainson's Thrush at the same season and in the same habitat. Occasionally it sings on migration. Insects in spring and summer, and wild fruit when available, are consumed.

Hylocichla fuscescens, Veery

In both states, the Veery is uncommon to fairly common on migration. It appears to be the least common of the brown thrushes, but this may be due to its shorter stay here. Usually it occurs in the hardwoods with other brown thrushes, and it reputed to be the tamest of them. Its food habits are similar to other brown thrushes.

Sialia sialis, Eastern Bluebird

The Eastern Bluebird is a well-distributed, abundant, permanent resident. In winter it is abundant in southern counties. This bird is scarce in deep woods and in cities, but occupies nearly all other dry-land habitats, especially in farming areas and along roads. It breeds throughout both Alabama and Georgia.

Since 1957, the species has become reduced in numbers and the winter population of Alabama has likewise suffered a decline. There seems to be four causes for the decline: (1) the natural habitat is being destroyed by the conversion of rural areas to suburban areas; (2) the Starling has been introduced, and this hole-nesting bird competes for breeding sites; (3) many bluebirds have not survived the winter in the South during periods of prolonged freezes; (4) insecticides are being dispersed indiscriminately on an area-wide basis, blanketing large sections of both wintering and breeding grounds.

The Eastern Bluebird nests in cavities such as natural holes in trees, deserted woodpecker holes, nest boxes and abandoned mail boxes. The bluebird's clutch usually consists of three to five, very pale blue eggs.

Insects, are eaten mainly in spring and summer. Wild fruit, especially berries, make up most of the vegetable foods during fall and winter.

Polioptila caerulea, Blue-gray Gnatcatcher

This gnatchatcher is a common, breeding, summer resident which also winters rarely inland in the Coastal Plains. It occurs in all types of woodland except pure pine and seems to prefer white oak, especially post oak. In winter it usually associates with flocks of titmice, kinglets, and other insectivores.

The beautiful nest is a well constructed cup of various plant downs, bound together by spider and caterpillar silk and covered with lichen. It usually straddles a horizontal limb of a hardwood and occasionally a pine. This gnatcatcher often completes the nest about ten days before the first egg is laid. The four or five pale bluish eggs are rather sparingly marked with fine, reddish-brown or dark brown dots. This species is predominantly insectivorous.

Regulus satrapa, Golden-crowned Kinglet

In winter this kinglet is abundant in wooded areas throughout Alabama and Georgia, but it is not known to nest here. It frequently associates with wooded titmice bands, often forming the major portion of such flocks. This species feeds extensively on small crawling insects. It rarely eats vegetable matter.

Regulus calendula, Ruby-crowned Kinglet

This kinglet is abundant in winter in all types of woodland but is not known to breed in either state. It prefers hardwoods to pines, and it often occurs in weeds or brushy border areas such as ragweed growths. Small groups of these birds usually associate with the titmice flock in winter. This species is insectivorous.

Anthus spinoletta, Water Pipit

In winter the Water Pipit is common, often abundant and widespread, but is not known to breed here. It frequents open country such as farmland, especially where the ground is bare. Beaches, mudflats, plowed fields and barren shorelines are favored places. This species is insectivorous.

Bombycilla cedrorum, Cedar Waxwing

This species is common to abundant in winter, and in certain years, when it is especially numerous, it breeds rarely in a few northern counties of Alabama. It travels in flocks, usually seen in berry bearing trees and shrubs.

Lanius ludovicianus, Loggerhead Shrike

This species is common and well distributed throughout the year and more abundant in winter and possibly most abundant in the Black Belt of Alabama. It occupies exposed perches usually on wires and fences, along roadsides, in open country around farmlands, and meadows.

The nest is built of heavy twigs or grass and is lined with rootlets and plant fibers, often padded with cotton or feathers. Usually it is found in the dense part of a tall shrub or small tree, frequently an oak or hawthorn. The four to six white to light gray eggs are variously marked with gray, yellow and brown.

This bird is predaceous, eating insects in the summer and mostly smaller birds and mammals in winter.

Sturnus vulgaris, Starling

The Starling is an abundant, widespread, introduced exotic that resides and breeds throughout both states. It is equally common around cities and farms, and seems to be least common in heavy woods. In fall and winter it often joins flocks of blackbirds, and usually it roosts with them by the thousands on public building, groves of trees and bamboo, and in other protected places.

This bird will nest in any cavity, but it prefers natural tree holes or fresh woodpecker holes. Starlings often wait for a woodpecker to complete an excavation and then gang up on the owner and evict it. The cavity is lined with grasses, twigs, feathers and many other materials.

The female lays three to five bluish-white or greenish-white eggs. Most of this bird's food is animal matter, a major portion being insects.

Vireo griseus, White-eyed Vireo

This vireo is a common, breeding, summer resident which winters rarely farther inland along the Coastal Plain. It lives in bushy or shrubby places, especially along woods borders.

The nest is a deep cup shaped like an inverted cone and is about one to eight feet above ground in a fork in shrubs or saplings. The nest is constructed of grasses, leaves, and inner bark; it is lined with fine plant fibers, and is ornamented on the outside with bark, paper, mosses, and spider webbs. The usual clutch consists of three to five white eggs with a few small dark brown or black spots around the larger end.

This species is insectivorous.

Vireo flavifrons, Yellow-throated Vireo

This vireo is a common, breeding, summer resident. It is a woodland bird which usually frequents large deciduous trees and occasionally pines.

The nest is a very well-made, handsome, deep cup decorated on the outside with lichens and lined with fine grass tops on the inside. It is constructed over 20 feet above the ground in forks of branches. The female lays three or four white eggs rather heavily spotted with various shades of brown around the larger end. This vireo is insectivorous.

Vireo solitarius, Solitary Vireo

The Solitary Vireo is common on migration throughout both states, and it winters commonly in the Coastal Plain. It is not known to nest in Alabama but does breed far south in Georgia. It is a woodland bird that is common in pines or hardwoods. In winter it rarely joins the loose bands of titmice and other small insectivores, but it may associate with Myrtle and Orange-crowned Warblers. This bird is insectivorous.

Vireo olivaceus, Red-eyed Vireo

The Red-eyed Vireo is probably the most abundant bird in eastern deciduous forests. It is an abundant, breeding, summer resident wherever hardwoods are dominant.

The nest is a well woven, dainty cup suspended from a horizontal fork at almost any height from the ground in a hardwood. The three or four white eggs are sparingly marked with brown spots around the larger end. This bird is insectivorous.

Vireo philadelphicus , Philadelphia Vireo

The Philadelphia Vireo is a quiet, shy and retiring bird which frequents the middle and upper parts of hardwoods. Because it is difficult to identify, it probably is more common than the records indicate. As a migrant during fall, it is uncommon in the Coastal Plain. This species has been sighted in Houston County. It is not known to breed here. This vireo is an insectivore, but during fall it consumes wild fruits.

Mircotilta varia , Black-and white Warbler

This warbler is a common migrant. It breeds in summer and is fairly common in hardwoods or mixed woods north of the Fall Line but rare south of it. Often hopping with its head down, it forages on the trunks and larger branches of trees, rarely in pines. Although other warblers may occasionally perch or even forage on trunks, this species consistently feeds there. This bird is an insectivore.

Prothonotaris citrea, Prothonotary Warbler

This warbler is a common to abundant, breeding, summer resident in the Coastal Plain. It inhabits river swamps, swampy ponds and lakes, and occurs in all Coastal Plain bottomlands. On migration the Prothonotary Warbler occasionally frequents uplands with other warblers.

This species is the only warbler in the eastern United States that habitually nests in cavities. It is not particular as to species of tree or size or condition of the hole, although it often chooses a dead stump five to ten feet above the ground or water. It often uses a nest box. The bird fills the cavity with moss, which it uses in the cup and lining, along with other fine materials. The three to six eggs are rich creamy to rose-colored and are boldly and handsomely marked with browns, grays and purples. This species is an insectivore.

Limnothlypis swainsonii, Swainson's Warbler

Swainson's Warbler is an uncommon and local summer resident in the Coastal Plain. It has been sighted in Houston County and breeds in Early County. Elsewhere it is a rare migrant. In the breeding season it inhabits river swamps, usually where cane (*Arrundinaria*) grows. This plainly colored species lives in dense thickets and is often motionless or quiet for long periods of time. Hence bird watchers often fail to record it even when making a special search.

The bulky, loosely built nest is usually in a clump of cane from three to ten feet above the ground and often looks like bunch of leaves lodged there by high water. The two or three eggs are very round and usually dull white but, on rare occasions, they are spotted. This species is insectivorous.

Vermivora chrysoptera, Golden-winged Warbler

The Golden-winged Warbler is fairly common on migration in nearly all parts of both states. It is seen generally in saplings or in the lower branches of large deciduous trees. This species is not known to nest here. This warbler feeds mainly on small, hairless caterpillars, spiders and butterflies.

Vermivora pinus , Blue-winged Warbler

As a migrant, this species is uncommon to fairly common. It has not been reported to breed in the Lower Coastal Plain. This species prefers long abandoned fields near water which have usually a scattered growth of saplings about six to eight feet tall. After a few years, when sapling growth becomes too tall, the bird deserts its former habitat for another less overgrown field. It is insectivorous.

Vermivora bachmanii, Bachman's Warbler

This small warbler was last reported in Alabama in 1959. It was considered common throughout its range in the early 1900's but was considered quite rare by the 1920's. Small numbers frequented swamps near Tuscaloosa and Montgomery until 1940. By 1950 the species appeared to be nearing extinction and none have been reported in the United States since 1965. The rapid decrease of Bachman's Warbler defies explanation. It is listed as endangered by the U.S. Department of Interior and the Alabama Department of Conservation and Natural Resources (See Section 4.2).

Vermivora peregrina, Tennessee Warbler

This warbler is a common spring and abundant fall migrant. It is not known to breed in Alabama and Georgia. Except for the Myrtle Warbler during fall migration, the Tennessee Warbler is often the most abundant warbler in these states. It occurs in almost any woodland, pine or hardwood, dense or thin. Although it is seen frequently on shrubs, it usually forages in the upper half of the taller trees, particularly in the spring. Primarily an insectivore, it feeds on wild fruits and berries during fall and winter.

Vermivora celata, Orange-crowned Warbler

In winter, this warbler is fairly common in most of the Coastal Plain. On migration it is uncommon to fairly common throughout these states. This species is not known to breed in Alabama and Georgia. It is partial to evergreen oaks, especially live oaks, and it frequents magnolias. Transients may be found anywhere, often in tall weeds such as ragweeds, but these warblers avoid pine trees. This warbler is an insectivore.

Parula americana, Parula Warbler

In the Coastal Plain this warbler is a common to abundant summer resident in swampy woods wherever Spanish moss grows. As a transient it is uncommon to fairly common in spring and common to abundant in fall throughout both states. It breeds generally wherever found in early June, including Early County.

This species prefers to build its nest with Spanish moss. In regions where moss is not available, the nest is often constructed in a cluster of leaves and is a hanging affair made of local, fine plant materials. The four to five white eggs are normally marked with various shades of reddish-brown.

This species is an insectivore and during winter occasionally eats seeds.

Dendroica petechia , Yellow Warbler

As a migrant this species is common and occasionally abundant throughout both states. Usually it occurs in small trees and shrubs in relatively open areas, around houses, in orchards, and streamside thickets. The Yellow Warbler breeds near water in willow thickets along creeks and rivers.

This bird constructs its neat, well built nest in a fork of a shrub or tree. It uses various plant materials for the outer cup and lines it with finer plant material. The two to four whitish eggs are spotted and blotched around the larger end with shades of brown, olive, and gray. Like other warblers, this species is an insectivore.

Dendroica magnolia, Magnolia Warbler

The Magnolia Warbler is a migrant. In spring it is rare to uncommon in the Coastal Plain, and in fall it is common and sometimes locally abundant throughout both states. It has been sighted in Houston County. It is not known to breed here. This species frequents young evergreen growth, especially spruce, in the breeding season and on migration usually occurs in hardwoods. This warbler is a insectivore.

Dendroica coronota, Myrtle Warbler

The Myrtle Warbler is the most numerous of its family, but it is not known to breed here. It is abundant on migration and in winter throughout both states in all wooded and brushy habitats. Often if feeds over water, especially in trees and shrubs which grow in flooded lakes and bottomlands. It feeds in both hardwoods and pines, and although it sometimes associates with titmouse flocks, it seems to have a flock organization of its own. This species is insectivorous. Its ability to survive on fruits is undoubtedly the reason why large numbers can winter farther north than other warblers.

Dendroica dominica, Yellow-throated Warbler

The Yellow-throated Warbler is a common, breeding, summer resident. It is a common migrant throughout both states. This warbler frequents pines, especially tall ones near water, and also cypress. Much of the time it forages on and around the trunks of large trees, seeking insects.

The nest is usually in a clump of Spanish moss when it is available. It is built 15 to 55 feet above the ground, and generally away from the trunk of the tree. When no moss is available, this bird hides its nest in a cluster of leaves, usually in a pine. Into the basic frame it weaves fine grasses, bark strips, other plant fibers, and silk of caterpillars or spiders. The nest is lined with plant down, feathers, or hair. Four or five whitish eggs are laid which are heavily marked around the larger end with reddish-brown, lavender or gray.

Dendroica pennsylvanica, Chestnut-sided Warbler

On migration this warbler is fairly common to common in spring and common to abundant in fall. In the breeding season it frequents the borders of second-growth woods and shrubby pastures and forages for leaf-eating insects between the ground and the lower branches of tall trees. It occurs in similar places on migration, including Houston County. Thus far it is not known to breed in Alabama but does breed in Georgia 60 miles from the Alabama Line.

Usually built close to the ground in a shrub, the rather flimsy nest is a deep cup of bark strips, fine grasses and other plant fibers lined with very fine grasses and hair. The four whitish eggs are speckled with brown.

Dendroica castanea, Bay-breasted Warbler

The Bay-breasted Warbler is common on migration in Alabama, particularly in the northern half of Alabama, but it is not known to breed here. It usually is found in flocks of other migrant warblers that forage for insects through hardwoods.

Dendroica striata, Blackpoll Warbler

This warbler is a common spring transient, often abundant north of the Fall Line. Although it is not known to breed in either Alabama or Georgia, it has been recorded once in summer in the Mountain Region. On migration the the species mixes with other insectivorous warblers in hardwoods.

Dendroica pinus, Pine Warbler

This warbler is an abundant, breeding, permanent resident in pines throughout both states. In winter it is more numerous in the southern counties and less so in the northernmost areas. During this season it often flocks with other insectivorous woodland birds. Rarely does it occur at any season in hardwoods or in dense pine plantations.

The nest, usually 10 to 50 feet above the ground, may be saddled on a horizontal limb of a pine or hidden in a cluster of needles or cones. The female lays three to five whitish eggs spotted and blotched with various shades of reddish-brown and gray.

Dendroica palmarum, Palm Warbler

This species is a migrant, abundant in spring and uncommon in fall, and it is not known to breed here.

The Palm Warbler forages on or near the ground in open shubby woods or woodland borders. These open, second growth, piney and mixed oak-pine woods with an abundance of saplings and shrubs resemble the stunted subarctic spruce woods of the far north where it breeds. It is insectivorous.

Seirvus aurocapillus, Ovenbird

This species is a common migrant and is slightly more numerous in the northern half of Alabama. It is also a common summer resident on the higher ridges of the Mountain Region and Tennessee Valley, usually at an elevation above 1,000 feet, and it breeds there. This bird lives on the ground in decicuous woods both in summer and on migration and is heard more often than seen. This bird is an insectivore.

Seiurus noveboracensis, Northern Waterthrush

This ground warbler is uncommon in spring and common in fall. It is not known to breed in Alabama or Georgia. On migration, as on the breeding grounds, it occurs close to water, in swamps, bogs, along streams, and on the shores of lakes and ponds. It feeds on insects and small aquatic life.

Seiurus notacilla, Louisiana Waterthrush

The Louisiana Waterthrush is a common, breeding, summer resident south to the Lower Coastal Plain. It frequents streams and creeks, particularly those flowing with a noticeable current through well developed woodlands.

This waterthrush builds its nest in the roots of a tree usually upturned, on the side of a bank or occasionally in a stump or on a rock ledge but always close to water. Shades of gray and brown variously mark its four to six white eggs.

This species subsists mainly on aquatic insect larvae.

Opornis formosus, Kentucky Warbler

The Kentucky Warbler is a common, breeding, summer resident. It lives on or near the ground in shaded shrubs and saplings in deciduous woods, often bottomlands. The nest of the Kentucky Warbler is very well concealed either on the ground or close to it in shrubby woods, usually in rather open places, such as near paths or a road. The white eggs, usually marked finely with reddish-brown and grays, generally number three to five in a clutch. This bird is an insectivore.

Geothlypis trichas, Yellowthroat

This species is a common, sometimes locally abundant, summer resident. It winters commonly throughout the Coastal Plain. This bird nests in almost any type of sunlit thicket that is in or near water. In winter it retires to a similar habitat such as cattails and shrubby or grassy wet areas that are either evergreen or contain sufficient dead vegetation to provide protection from the weather.

The well-hidden nest is on or near the ground in dense vegetation, often near a shrub or small tree, and is very difficult to locate. The clutch consists of three to five white eggs, lightly marked around the larger end with brown, gray and black. This bird is an insectivore.

Icteria virens, Yellow-breasted Chat

The Yellow-breasted Chat is a common to abundant summer resident. The species usually breeds in rather dense, sunlit thickets such as those along ecotones, hedgerows, and shrubby pastures. The nest is rather loosely attached to a thick shrub or small tree. This species lays three or four white eggs usually heavily marked with reddish-brown and grayish-brown.

Wilsonia citrina, Hooded Warbler

Few shrubby bottomland deciduous woods are without breeding Hooded Warblers, for this species is a common summer resident throughout both states. Occasionally it visits dry, unshaded, or shrubless woodlands, especially during migration. The well camouflaged and often well hidden nest is a neat compact structure usually one to four feet above the ground in a shrub or sapling. The clutch includes three to four white eggs, marked variously with reddish-brown and grayish-brown. This warbler prefers flying insects.

Setophaga ruticilla, American Redstart

In Alabama the American Redstart is a common summer resident within five miles of the city of Mobile. As a breeder in Early County, it inhabits rich deciduous woods, especially bottomland hardwoods and swamps. Foraging often on the outermost twigs of tall hardwoods, it darts downwards in long loops in pursuit of insects. On migration, it occurs in all wooded habitats except pines.

The beautifully constructed, thin walled nest is usually in an upright fork of a hardwood, often a sapling, from four to twenty feet above the ground. The three or four whitish eggs are variously marked with browns and grays.

Passer domesticus, House Sparrow

This introduced species is abundant and breeds throughout the year. It occurs around houses or other buildings and seems to prosper well in cities, small towns or farms.

The usual nest is a disorderly pile of grass, straw, feathers, rags, paper, etc. The four to seven eggs are whitish, marked with olive and brown. It raises two to five broods each year.

The natural diet includes grains, seeds, fruits and insects.

Dolichonyx oryzivorus, Bobolink

This bird is a common to abundant spring migrant. In fall it is uncommon and it is not known to breed in either state. The Bobolink has been sighted in Houston County. It occurs around lakes where fields of luxuriant growth such as oats, wild rice and legumes are predominant. In summer this species is insectivorous, but eats grains and seeds during the rest of the year. In some areas it is destructive to these cultivated grains.

Sturnella magna, Eastern Meadowlark

The Eastern Meadowlark occurs throughout the year in almost any field and high vegetation along country roads. This species is a common breeder. It occupies all types of fields from broomsedge openings in piney woods to active and abandoned farmland.

The nest is a loosely made, arched over cup of grass and weed stems, well concealed in the grass, often at the base of a trunk. The three to five eggs are whitish, marked with reddish brown.

This bird is primarily insectivorous while weed seeds and waste grain dominate the diet of winter and spring.

Agelaius phoeniceus, Redwinged Blackbird

The Redwinged Blackbird prefers freshwater marshes, but it is a highly adaptable species and will live in any habitat where grass or bushes and a little water occur together. Hence it breeds commonly almost everywhere except in woodlands and on mountains. Its numbers bolstered by northern birds, the species becomes abundant throughout in winter, and often occurs in flocks of a thousand or more. It usually feeds on farmlands, particularly grain fields, and frequently associates with Starlings and other blackbirds.

This species builds a loosely-woven cup of various grasses and lines it with finer grasses and roots. Whenever possible, it is built over water in marsh grass, in a shrub or small tree, or even built on the ground in dense grass. The female lays two to five bluish eggs marked with dark purple or reddish-brown. Large numbers of these blackbirds breed close to one another when the available habitat is limited.

This species feeds mainly on waste grain supplemented with insects, small molluscs and crustaceans.

Icterus spurius, Orchard Oriole

This oriole is a common to abundant, breeding, summer resident. This bird occurs in orchards and wherever low trees grow rather far apart, particularly about houses and in hedgerows.

The Orchard Oriole builds a rather deep basket of woven grasses and weed stems from an outer branch or the uppermost fork of a shade tree, orchard tree, tall shrub, or slender sapling, usually 10 to 20 feet from the ground.

It lines the nest with plant down and feathers and lays three to five pale bluish eggs marked with shades of brown and purple. This species is an insectivore.

Icterus galbula , Baltimore Oriole

This oriole is an uncommon to fairly common migrant, uncommon and local in summer and rare in winter. It breeds in a few restricted places within Alabama and Georgia. Like other orioles, it is an insectivore.

Euphagus carolinus, Rusty Blackbird

The Rusty Blackbird is common and often locally abundant in winter, but uncommon near the coast. It is not known to breed in either state. This species sometimes frequents grain fields and feeds with other blackbirds, but it often occurs near water where it feeds on grains, seeds, wild fruit and invertebrates along the margins of streams, ponds, and small pools, especially in or near woods.

Euphagus cyanocephalus, Brewer's Blackbird

In the Coastal Plain, Brewer's Blackbird is a common migrant and somewhat local. It is not known to breed in either state. This species frequents barnyards, city parks, golf courses, grain fields, and freshly plowed fields, but especially likes pastures where it often feeds on or around domestic animals. It rarely flocks with other blackbirds except in the roosts.

Quiscalus quiscula, Common Grackle

The Common Grackle is a common summer resident. In winter it becomes abundant, often occurring in flocks of several thousand, and during this season it roosts in large numbers, frequently with the Redwinged Blackbird and the Starling. It spreads out over a large area; often a whole county, to feed during the day. This bird usually breeds in small colonies in tall trees, especially conifers, and in towns, in parks, or around farms.

Small colonies breed preferably in tall evergreens near water, but any one of a variety of other places, including willows and cavities in trees and buildings, is acceptable. The bulky nest is usually close to a tree trunk and is made of twigs, grasses, weed stems and often mud and lined with fine grasses. The four to six eggs are pale greenish, bluish, or brownish boldly marked with brown or black.

This blackbird subsists on a great variety of food items, chiefly grains and insects.

Molothrus ater , Brown-headed Cowbird

The Brown-headed Cowbird is abundant in winter. This bird breeds throughout both states. It feeds at all seasons in open grain fields but prefers the vicinity of livestock where it forages in feed lots or at the feet of grazing animals.

This and other cowbirds in the Western Hemisphere lay their eggs in the nests of other birds. The female seeks out the unguarded open nests of small land birds and deposits a white, evenly brown-spotted egg. So far as is known, the number of eggs is four or five and they are laid a day apart, usually in different nests.

Piranga olivacea, Scarlet Tanager

This tanager is a locally common, breeding, summer resident, in the northern half of both states. The species is a common migrant in both states but appears to be more numerous in the northern half. It occurs in the upper levels of hardwood timber, most often in oaks and hickories. This tanager feeds primarily on leaf-eating insects and has been sighted in Houston County.

Piranga rubra, Summer Tanager

The Summer Tanager is a common, breeding, summer resident. Like the Scarlet, the Summer Tanager frequents hardwoods and prefers oaks.

This Tanager is a rather poor builder, but it contrives a shallow nest of weed stems, inner bark, grasses and other plant fibers. Usually it builds in a hardwood five to thirty feet above ground and far out from the trunk on a horizontal limb. The female lays two to four eggs which are pale greenish or pale bluish and marked variously with brownish and purplish colors. This tanager is insectivorous and frugivorous in feeding habits.

Richmondena cardinali, Cardinal

The Cardinal is a common to abundant, permanent resident. It nests here in hedgerows, shrubbery around houses, thickets in woods, and in a great variety of places as long as they provide a reasonable amount of cover within 10 feet of the ground. In winter they often occur in loose flocks.

The nest is generally found less than eight feet above the ground, in dense shrubbery or a vine tangle. The two to four eggs are whitish, greenish, or bluish, variously marked with brown, reddish-brown or purple.

This bird feeds on seeds, wild fruit, insects and grains.

Pheucticus ludovicianus, Rose-breasted Grosbeak

This grosbeak is common on migration in both states. It is not known to breed here. It occurs generally in upper and middle levels of hardwoods. This bird eats blossoms and buds of forest and orchard trees, wild fruits, weed seeds, and noxious insects.

Guiraca caerulea, Blue Grosbeak

The Blue Grosbeak is a common summer resident. It is common in the center of Alabama, particularly the Black Belt. The species breeds in field borders, shrubby fields, roadsides, and other brushy areas in the vicinity of grain and legume fields, and sometimes also in openings in woods.

The nest is usually in a shrub or sapling, often in blackberry bushes, within 10 feet above ground, but it may be on the ground or as high as 30 feet up a tree. The two to four eggs are pale blue. This bird is insectivorous and also consumes seeds and grains.

Passerina cyanea, Indigo Bunting

The Indigo Bunting is an abundant, breeding, summer resident. This bird frequents brushy areas, roadsides, woods borders and openings in deciduous woods.

The nest is built in a crotch of a shrub or sapling about three or four feet above ground in dense cover. The female lays two to four pale blue eggs.

Seeds, berries and other small fruits are its major foods.

Passerina ciris, Painted Bunting

In the Coastal Plain the Painting Bunting is a rare spring migrant. It has been sighted in Houston County. Although more secretive than the Indigo Bunting, it inhabits the same type of woods borders and other bushy areas, although it usually prefers those close to streams and often in or near towns. Most of this bird's feed is seeds.

Spiza americana, Dickissel

This species is a rare transient south of the Black Belt. It has been sighted in Houston County. This bird is very erratic in its summer distribution and often may appear or disappear from a locality without apparent cause. Changes in land use such as mowing, grazing, and crop rotation are probably responsible. It occurs mainly in fields planted with legumes, especially clover and alfalfa, but sometimes it also frequents weedy or grassy fields.

The nest is usually on the ground in dense grass, often in a hedge tussock, but it may be in a small tree or shrub as high as 15 feet from the ground. The three to five eggs are pale blue. This species is an insectivore and seed eater.

Carpodacus purpureus, Purple Finch

The finch, not known to nest in either Alabama or Georgia, is common in winter. It occurs in nearly all woodlands except the densest and those of nearly pure pine. This species is seen frequently around openings, along edges, and in the tops of budding or fruiting trees. The main foods are seeds and small fruits.

Spinus pinus, Pine Siskin

About every third or fourth winter this species occurs uncommonly to abundantly throughout both the states. Sometimes in pure flocks, but often with American Goldfinches, it ranges throughout all the more open woodlands and often visits feeding stations. It is not known to breed in either Alabama or Georgia.

The species subsists on buds, tender leaves, insects, and seeds.

Spinus tristis, American Goldfinch

As a breeder, the American Goldfinch is common in summer in the Mountain Regions and uncommon in the remainder of the states south at least to the Upper Coastal Plain. This bird is rare in summer in Houston County. In winter this species is abundant, frequenting open woods and their edges, but not pure pine stands. It feeds in any woodland opening where composits grow. In spring, flocks, often in the hundreds, forage for seeds or lawns and about houses.

Pipilo erythropthalmus, Rufous-sided Towhee

This bird is a permanent resident, common in summer and abundant in winter. It breeds in brushy and scrubby areas, usually in dry and rather open woods. Most often it is active on or near the ground but, when singing, it often chooses a rather high perch.

The early nest is built on the ground or very close to it, and generally well concealed in the shelter of a shrub, grass clump, or other ground cover. Later in the season it is usually seen in a shrub or small tree about two to seven feet above ground. This bird lays two to four whitish or pale pinkish-white eggs variously marked with chestnut-brown.

This species feeds mainly on the ground where it scratches vigorously among fallen leaves and other litter from insects and seeds.

Passerculus sandwichensis, Savannah Sparrow

The Savannah Sparrow is abundant in winter, but is not known to breed here. It occurs on almost any grass field in sparse or tall cover, so long as it can feed on the ground and woody plants are far apart. The bird generally feeds in short grass, and roosts during bad weather in tall grass, which makes partially-mowed field or weedy fields especially attractive. Usually it flushes close at hand and bounds away often at right angles, dropping back into the grass a short distance away.

Most of the food consists of grass seed, weed seed, grass dwelling, insects and a small amount of waste grain.

Ammodramus savannarum, Grasshopper Sparrow

This species as a breeder is common but local in summer as far south as the Black Belt. It has been sighted in Houston County. In winter it is uncommon to common south of the Fall Line. This bird habitually skulks in tall grass and is often difficult to flush.

The nest is well hidden, usually in a slight depression on the ground or in a clump of grass. It is made of grass, lined with rootlet and hair, and arched over so that the inside cannot be seen from above. The three to five whitish eggs are sparingly marked with reddish-brown.

This sparrow probably eats more insects than any other sparrow in Alabama and it takes grasshoppers in quantity.

Passerherbulus candacutus, Le Conte's Sparrow

LeConte's Sparrow is rare to uncommon in winter and on migration. Because of its secretive habits, it is probably more common than records thus far indicate. It frequents damp, weedy, or grassy fields, especially those near water. This sparrow is not know to nest in Alabama, for it breeds in prairie marshes. This bird feeds chiefly on weed and grass seeds.

Pooectes gramineus, Vesper Sparrow

In the Coastal Plain this species is common to abundant in winter and on migration. It is not known to breed in either state. It inhabits short grass or even bare fields, especially recently plowed or fallow fields or pastures. During warm seasons it feeds on insects while in migration it consumes seeds and waste grain.

Chondestes grammarus , Lark Sparrow

The Lark Sparrow is a permanent resident in the Lower Coastal Plain. It inhabits prairie and open farming areas such as poor pastures, corn fields, edges and hedgerows. This sparrow requires some bare earth in its breeding habitat.

This bird usually conceals its nest in a slight depression on the ground in the shade of a weed or cornstalk but sometimes it selects a low bush. The female lays three to six whitish eggs marked with dark brown and black.

Most of the food this sparrow eats consists of weed seeds, grass seeds, grain and grasshoppers.

Aimophila aestivalis, Bachman's Sparrow

This sparrow is a common permanent resident in suitable habitat. It breeds in dry piney and scrub oak woods, particularly the drier ridge tops with few shrubs. It forages on the ground for insects, often near stumps or fallen logs. In summer this bird is easily located by its song, but in winter it is silent and difficult to find. The nest, which has a dome shaped top, is located on the ground in clumps of grass, palmetto, or vine tangle. The usual clutch is four pure white eggs.

Junco hyemalis , Slate-colored Juneo

This species is abundant in winter and recorded in summer, yet no evidence of nesting has been noted. It occurs on the ground in woods, or edges usually in flocks of 10 to 100 birds. During most of the year this junco eats seeds of weeds and grasses, supplemented with insects.

Spizella passerina, Chipping Sparrow

This sparrow is a common, permanent resident of the Lower Coastal Plain. In winter, it is abundant while on migration it is common. In breeding season this species frequents evergreen, near short grass, especially lawns, while in winter it occupies modest sized, short grass near such as lawns, small pastures, golf courses, and borders of cultivated fields.

Usually the nest is built in a shrub or low in an evergreen. The female lays three or four bluish-green eggs marked around the larger end with dark brown spots.

In summer this sparrow feeds exclusively on insects, while in cold weather it consumes weed seeds.

Sprizella pusilla, Field Sparrow

This sparrow is common as a breeder in the Lower Coastal Plain. In winter it is abundant and widespread throughout both Alabama and Georgia. Usually this bird occurs in brushy fields, old overgrown pastures, and wood borders. It is the most common sparrow of broomsedge fields.

The nest is a well-built structure, usually on the ground in a tuft of grass or in a low thick bush. The female lays three to five pale greenish-white or bluish eggs scratched with reddish-brown.

The diet of this bird consists of insects and seeds in almost equal amounts; insects are consumed mainly in the summer and seeds primarily in winter.

Zonotrichia leucophrys, White-crowned Sparrow

This sparrow during winter is uncommon and local. It is not known to breed here. Since this bird seems to require open weedy or grassy areas for feeding on seeds, and thick shrubs for cover, it occurs most often in roadside thickets, hedgerow edges and streamside thickets close to fields. In Alabama flocks of about 20 occur in these places and apparently return each winter, unless changes in land use alter the habitat.

Zonotrichia albicollis, White-throated Sparrow

This species is abundant in winter, and it has summered in Alabama several times, although it is not known to breed here. Frequenting thickets in or near woods, and feeding on the ground near cover, it is especially common in shrubbery around houses. This sparrow is probably the best winter customer at most feeding stations. It is decidedly more active at dark than most sparrows.

Seeds and wild berries are prominent in its diet.

Passerella iliaca, Fox Sparrow

In the Lower Coastal Plain this sparrow is a rare to uncommon migrant but in severe, snowy winters it is seen commonly throughout both states. It frequents the same general areas as does the White-throated Sparrow, but the Fox Sparrow usually chooses more open places. After a snowfall it often appears in places from which it is normally absent. It is primarily a seed eater also consumer of insects.

Melospiza geogiana, Swamp Sparrow

This species is abundant in winter, but it is not known to breed here. It is most numerous in fresh water marshes, and pond borders but generally occurs wherever shrubs, grasses, and weeds grow in or near water. These places are often dry in summer, but when flooded by winter rains, they adequently fit the requirements of this sparrow. On migration birds often frequent borders or other grassy or weedy places far from water.

Most of this bird's diet consists of seeds and insects.

Melospiza melodia, Song Sparrow

In winter this species is abundant. Since it is an adaptable species which breeds abundantly in disturbed habitants, it will probably follow the patterns of the Eastern Phoebe, Horned Lark, Robin, Loggerhead Shrike, Brown-headed Cowbirds and others that have recently extended their breeding ranges in both states. The Song Sparrow occupies sunlit, brushy, weedy, or shrubby places near water, although on migration and in winter it often frequents thickets far from the water.

The nest is well hidden on the ground or, usually later in the season, a few feet up in the dense cover of a conifer, thick shrub, or in matted grass or weeds. The four or five greenish eggs are usually marked heavily with various shades of brown.

Most of the food of this sparrow consists of seeds and insects.

The following summary sheets of the Breeding Bird Survey for the Grangeburg route were provided by the U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. The Grangeburg route runs north of Highway 78 in Houston County, junctions with Highway 52 and terminates in Columbia, Alabama. Much of this data would be applicable to the Farley Nuclear Plant Site.

REFERENCES

1. Alabama Department of Conservation and Natural Resources. Rare and Endangered Vertebrates of Alabama. 1972.

2. Bateman, D. L. Movement-behavior in Three Species of Colonial-Nesting Wading Birds: a Radio-telemetric Study. Unpublished Ph. D. dissertation. Auburn University. 1970.

3. Burleigh, T. D. Georgia Birds. University of Oklahoma Press, Norman. 1958.

4. Dusi, J. L. "Mortality of the Little Blue Heron". Alabama Birdlife. Vol. II. 1963.

5. Dusi, J. L. and R. L. Dusi. "Ecological Factors Contributing to Nesting Failure in a Heron Colony." Wilson Bulletin. Vol. 80. 1968.

6. Dusi, J. L. et. al. Ecological Impact of Wading Birds on the Aquatic Environment. Auburn University Water Resourses Research Institute Bulietin 5. 1971.

7. Imhof, T. A. Alabama Birds. University of Alabama Press, Tuscaloosa. 1962.

C ach

UL12 968
Distribution and Migration
FISH AND WILDLIFE SERVICE

MIGRATORY NON-GAME BIRD STUDIES
MIGRATORY BIRD POPULATIONS STATION
LAUREL, MARYLAND 20810

3

SUMMARY SHEET, BREEDING BIRD SURVEY

State Prov. 02 | 3 Route No. 031 | 6 Route Name Grangeburg | 18 Lat.-Long. 31 00 ~~[illegible]~~ -08512

Counties (stop numbers in each) Houston

27 Observer (please print) DUSI (LAST NAME) Julian (FIRST NAME) L (INITIAL) [✓ Dr.] Mr, Mrs, Miss (CIRCLE ONE)

Mailing Address P.O. Box 742 Auburn, Ala ZIP: 36830

39 1 | 40 04 OFFICIAL USE ONLY | Weather: Start & Finish | 42 Temp. (F.) 72° - 86° | 46 Wind Speed Beaufort 0 - 2 | 48 Sky Code 0 - 0

50 Date 06 08 / 68 MO DAY YEAR | 51 Total Species 46 | 64 Name Assistant, if any Rosemary T. Dusi

0502-0745 | 1

Species	AOU 65	Page Totals 69	72	75	78	81	84 Total Indiv	Stops 88 Spec.
Brown Pelican	126							
Anhinga	118							
Gt. Blue Heron	194							
Green Heron	201							
Little Blue Heron	200	1	1	1	1		4	4
Cattle Egret	2001	8	14	31	12	7	72	19
Common Egret	196	2			1		3	1
Snowy Egret	197							
Louisiana Heron	199							
Yel-cr Night Heron	203							
White Ibis	184		1	2			3	2
Wood Duck	144							
Turkey Vulture	325							
Black Vulture	326							
Cooper's Hawk	333							
Red-tailed Hawk	337							
Red-shouldered Hawk	339							
Broad-winged Hawk	343							
Osprey	364							
Sparrow Hawk	360							
Bobwhite	289	12	9	3	8	10	42	33
Turkey	310							
Sandhill Crane	206							
Clapper Rail	211							
Common Gallinule	219							
American Coot	221							
Killdeer	273			2			2	1
Willet	258							
Laughing Gull	058							
Least Tern	074							
Black Skimmer	080							
Rock Dove	3131			12			12	1
Mourning Dove	316	9	13	7	10	6	45	31
Ground Dove	320	1	5			1	7	5
Yellow-bill Cuckoo	387	1					1	1
Screech Owl	373							
Great Horned Owl	375							
Barred Owl	368							
Chuck-will's-widow	416	1					1	1
Whip-poor-will	417							
Common Nighthawk	420							
Chimney Swift	423	3		1		15	19	7
Ruby-t Hummingbird	428	1					1	1
Belted Kingfisher	390							
Yel-shaft. Flicker	412			1			1	[illegible]
Pileated Woodpeckr	405							
Red-bellied Wdpkr	409	2	9	2	4	6	23	17
Red-hd Woodpecker	406		2		2	2	6	4
Hairy Woodpecker	393							
Downy Woodpecker	394	1	1				2	2
Red-cockaded Wdpkr	395							
E. Kingbird	444		3		1	1	5	5
Gt. Crest Flycatcher	452	2		2	1	1	6	5
E. Phoebe	456							
Acadian Flycatcher	465			1			1	1
E. Wood Pewee	461							
Horned Lark	474							
Tree Swallow	614							
Rough-wing Swallow	617							
Barn Swallow	613							
Purple Martin	611	3		6	2	6	17	7
Blue Jay	477	14	6	13	16	8	57	26
Common Crow	488	11	11	9	9	3	43	22
Fish Crow	490	7	1	2	6		16	10
Carolina Chickadee	736					2	2	1
Tufted Titmouse	731		1		1	1	3	3

Species	AOU 65	Page Totals 69	72	75	78	81	84 Total Indiv	Stops 88 Spec.
White-br. Nuthatch	727							
Brown-hd. Nuthatch	729							
House Wren	721							
Bewick's Wren	719							
Carolina Wren	718			2	1	5	8	7
Mockingbird	703	26	23	36	30	22	137	45
Catbird	704							
Brown Thrasher	705	1	1	3	1	1	7	6
Robin	761							
Wood Thrush	755	1					1	1
E. Bluebird	766		3				3	2
Blue-gr Gnatcatcher	751							
Loggerhead Shrike	622	1	4	1	5		11	8
Starling	493		7		1		8	4
White-eyed Vireo	631		1		1		2	2
Yellow-thr. Vireo	628							
Red-eyed Vireo	624							
Blk-and-wht Warb	636							
Prothonotary Warb	637							
Worm-eating Warb	639							
Blue-winged Warb	641							
Parula Warbler	648					1	1	1
Yellow Warbler	652							
Blk-thr. Gr. Warbler	667							
Cerulean Warbler	658							
Yellow-thr. Warb	663							
Pine Warbler	671							
Prairie Warbler	673							
Ovenbird	674							
La. Waterthrush	676							
Kentucky Warbler	677							
Yellowthroat	681	1	1				2	2
Yellow-br. Chat	683							
Hooded Warbler	684							
American Redstart	687							
House Sparrow	6882	14		38	2		54	7
E. Meadowlark	501		10	3	2	1	16	8
Red-wing Blackbird	498	1	1	8	3	8	21	11
Orchard Oriole	506	2				1	3	3
Baltimore Oriole	507							
Boat-tail Grackle	513							
Common Grackle	511	2	5	37	3	6	53	18
Brown-hd Cowbird	495							
Scarlet Tanager	608							
Summer Tanager	610							
Cardinal	593	21	12	1	3	11	48	21
Blue Grosbeak	597			1	3	2	6	5
Indigo Bunting	598	4	2	2	1	4	13	9
Painted Bunting	601							
Dickcissel	604							
American Goldfinch	529							
Rufous-side Towhee	587	6	5	5	1	7	24	17
Grasshopper Spar	546							
Bachman's Sparrow	575							
Chipping Sparrow	560							
Field Sparrow	563		1	1	3	1	6	5
Song Sparrow	581							
....								
....								
....								
....								
....								
....								
....								
....								
....								

10

ack 711 + 203

Bureau of Sport Fisheries and Wildlife
U.S. Department of the Interior

SOUTHEASTERN SUMMARY SHEET, BREEDING BIRD SURVEY

State 1 ~~A/A~~ 02 Route No. 3 ~~12~~ 031 Starting Locality 6 Grangeburg Lat.-Long. 18 ~~3100-8552~~ 3100-8512

Counties (Stop numbers in each) Houston (50)

Observer (Last name, then initials) 27 Baker, M.F.

Mailing Address Wildlife Research, AU., Auburn, Alabama 36830

Weather (start & finish): Temp. 42 68°-79° Wind Speed, Beaufort 44 1-3 Sky Code 48 2-0

Date 50 06/23/66 Total Species 39 Name of Assistant, if any

SPECIES	65 AOU	19 PAGE TOTALS 1	2	3	4	5	84 TOTAL INDIV	88 NO. OF STOPS
ANHINGA	118							
GREEN HERON	201	2		1			3	2
LITTLE BLUE HERON	200	25	10	1			36	9
CATTLE EGRET	2001		2				2	1
COMMON EGRET	196							
SNOWY EGRET	197							
LOUISIANA HERON	199							
YEL-CR NIGHT HERON	203							
WOOD DUCK	144	1					1	1
TURKEY VULTURE	325							
BLACK VULTURE	326							
COOPER'S HAWK	333							
RED-TAILED HAWK	337							
RED-SHOULDERED HAWK	339							
BROAD-WINGED HAWK	343	1					1	1
OSPREY	364							
SPARROW HAWK	360							
BOBWHITE	289	15	19	14	28	10	86	40
COMMON GALLINULE	219							
AMERICAN COOT	221							
KILLDEER	273			3			3	1
WOODCOCK	228							
WILLET	258							
LAUGHING GULL	058							
COMMON TERN	070							
LEAST TERN	074							
BLACK SKIMMER	080							
ROCK DOVE	3131					1	1	5
MOURNING DOVE	316	26	26	9	14	6	81	32
GROUND DOVE	320	2			2		4	3
YELLOW-BILL CUCKOO	387							
SCREECH OWL	373							
GREAT HORNED OWL	375							
BARRED OWL	368							
CHUCK-WILL'S-WIDOW	416	1					1	1
WHIP-POOR-WILL	417							
COMMON NIGHTHAWK	420							
CHIMNEY SWIFT	423		2			5	7	2
RUBY-T HUMMINGBIRD	428							
BELTED KINGFISHER	390							
YELLOW-SHAFT FLICKER	412			1			1	1
PILEATED WOODPECKR	405							
RED-BELLIED WDPKR	409		1	3	6	2	12	10
RED-HEADED WOODPKR	406		1	1			2	2
HAIRY WOODPECKER	393							
DOWNY WOODPECKER	394							
RED-COCKADED WDPKR	395							
E. KINGBIRD	444		1	3	3		7	7
GT CREST FLYCATCHER	452		1				1	1
E. PHOEBE	456							
ACADIAN FLYCATCHER	465							
E. WOOD PEWEE	461							
TREE SWALLOW	614							
ROUGH-WING SWALLOW	617							
BARN SWALLOW	613							
PURPLE MARTIN	611		9	1		7	17	5
BLUE JAY	477	4	2	12	2	17	37	19
COMMON CROW	488	4		4	12	4	24	8
FISH CROW	490	14		2		3	19	6
CAROLINA CHICKADEE	736							
TUFTED T.MOUSE	731							
WHITE-BR. NUTHATCH	727							
BROWN-HEADED NUT	729							
HOUSE WREN	721							
BEWICK'S WREN	719							
CAROLINA WREN	718		1				1	1
LONG-BIL MARSH WREN	725							

SPECIES	AOU	PAGE TOTALS 1	2	3	4	5	TOTAL INDIV	NO. OF STOPS
MOCKINGBIRD	703	23	26	27	27	19	122	42
CATBIRD	704							
BROWN THRASHER	705		3	2	3		8	8
ROBIN	761							
WOOD THRUSH	755							
E BLUEBIRD	766							
BLUE-GR GNATCATCHR	751							
LOGGERHEAD SHRIKE	622	4	3	3	5	2	17	15
STARLING	493		10	11	1		22	7
WHITE-EYED VIREO	631		2				2	1
YELLOW-THR. VIREO	628							
RED-EYED VIREO	624							
WARBLING VIREO	627							
BLK-AND-WHT WARB	636							
PROTHONOTARY WARB	637							
WORM-EATING WARBLR	639							
BLUE-WINGED WARB	641							
PARULA WARBLER	648							
YELLOW WARBLER	652							
BLK-THR.GREEN WARB	667							
CERULEAN WARBLER	658							
YELLOW-THR. WARB	663							
PINE WARBLER	671							
PRAIRIE WARBLER	673							
OVENBIRD	674							
LA.WATERTHRUSH	676							
KENTUCKY WARBLER	677							
YELLOWTHROAT	681							
YELLOW-BR. CHAT	683					1	1	1
HOODED WARBLER	684							
AMERICAN REDSTART	687							
HOUSE SPARROW	6882	1	1	3	11	5	21	7
E. MEADOWLARK	501	1	5	7	2		15	9
RED-WINGED BLKBRD	498			5	2	7	14	7
ORCHARD ORIOLE	506		1	1			2	2
BALTIMORE ORIOLE	507							
BOAT-TAIL GRACKLE	513							
COMMON GRACKLE	511		14	13	2		29	10
BROWN-HD COWBIRD	495							
SUMMER TANAGER	610							
CARDINAL	593	22	8	6	8	10	54	28
BLUE GROSBEAK	597			1	4	1	6	5
INDIGO BUNTING	598	1		2			3	2
PAINTED BUNTING	601							
DICKCISSEL	604							
AMERICAN GOLDFINCH	529							
RUFOUS-SID. TOWHEE	587		1			2	3	3
GRASSHOPPER SPAR	546							
HENSLOW'S SPARROW	547							
BACHMAN'S SPARROW	575							
CHIPPING SPARROW	560							
FIELD SPARROW	563							
SONG SPARROW	581							
White Ibis	184	1	1				2	2
GREAT BLUE HERON	194	1					1	1

MIGRATORY NON-GAME BIRD STUDIES
MIGRATORY BIRD POPULATIONS STATION
LAUREL, MARYLAND 20810

18 SUMMARY SHEET, BREEDING BIRD SURVEY 3

State 02 Route No. ~~12-2~~ 031 Route Name GRANGEBURG Lat.-Long. 3100 ~~8528~~ -08512

Counties (Number of stops in each) Houston - 50

Observer (Last name, then initials) Baker, M.F. 2- 04

Mailing Address Wildlife Res., A.U., Auburn, Ala. 36830

Weather (start - finish): Temp. 70° - 98° Wind Speed, Beaufort 1 - 3 Sky Code 0 - 0

Date 06/16/67 Total Species 33 Name of Assistant, if any ——

64= 1

SPECIES	AOU	PAGE TOTALS 1	2	3	4	5	TOTAL INDIV	STOPS PER SPEC.
ANHINGA	118							
GT. BLUE HERON	194							
GREEN HERON	201							
LITTLE BLUE HERON	200		4				4	1
CATTLE EGRET	2001		27				27	3
COMMON EGRET	196							
SNOWY EGRET	197							
LOUISIANA HERON	199							
YEL-CR NIGHT HERON	203							
WHITE IBIS	184							
WOOD DUCK	144							
TURKEY VULTURE	325							
BLACK VULTURE	326							
COOPER'S HAWK	333							
RED-TAILED HAWK	337							
RED-SHOULDERED HAWK	339							
BROAD-WINGED HAWK	343							
OSPREY	364							
SPARROW HAWK	360	2					2	1
BOBWHITE	289	10	19	18	9	15	71	39
COMMON GALLINULE	219							
AMERICAN COOT	221							
KILLDEER	273							
WOODCOCK	228							
WILLET	258							
LAUGHING GULL	058							
COMMON TERN	070							
LEAST TERN	074							
BLACK SKIMMER	080							
ROCK DOVE	3131							
MOURNING DOVE	316	20	31	17	9	8	85	37
GROUND DOVE	320	1	4		3		8	5
YELLOW-BILL CUCKOO	387			2			2	2
SCREECH OWL	373							
GREAT HORNED OWL	375							
BARRED OWL	368							
CHUCK-WILL'S WIDOW	416	2					2	2
WHIP-POOR-WILL	417							
COMMON NIGHTHAWK	420							
CHIMNEY SWIFT	423	0	2	0	0	22	24	2
RUBY-T HUMMINGBIRD	428							
BELTED KINGFISHER	390							
YEL-SHAFT. FLICKER	412	1		1			2	2
PILEATED WOODPECKER	405							
RED-BELLIED WDPKR	409	7	4	2	5	3	22	19
RED-HD WOODPECKER	406		1	1	1	2	5	5
HAIRY WOODPECKER	393							
DOWNY WOODPECKER	394							
RED-COCKADED WDPKR	395							
E. KINGBIRD	444	1	1	1	4	1	8	7
GT. CREST FLYCATCHER	452			1		1	2	2
E. PHOEBE	456							
ACADIAN FLYCATCHER	465							
E. WOOD PEWEE	461							
HORNED LARK	474							
TREE SWALLOW	614							
ROUGH-WING SWALLOW	617							
BARN SWALLOW	613							
PURPLE MARTIN	611		1				1	1
BLUE JAY	477	2	5	6	6	8	27	13
COMMON CROW	488	13	8	6	6	4	37	15
FISH CROW	490							
CAROLINA CHICKADEE	736							
TUFTED TITMOUSE	731							
WHITE-BR. NUTHATCH	727							
BROWN-HD. NUTHATCH	729							
HOUSE WREN	721							

SPECIES	AOU	PAGE TOTALS 1	2	3	4	5	TOTAL INDIV	STOPS PER SPEC.
BEWICK'S WREN	719							
CAROLINA WREN	718	1	1				2	2
LONG-BIL MRSH WREN	725							
MOCKINGBIRD	703	16	18	29	22	14	99	43
CATBIRD	704							
BROWN THRASHER	705	6	2	5		1	14	11
ROBIN	761							
WOOD THRUSH	755							
E. BLUEBIRD	766							
BLUE-GR GNATCATCHER	751							
LOGGERHEAD SHRIKE	622	5	4	2	3	1	15	4
STARLING	493		2	[illegible]	5	2	9	5
WHITE-EYED VIREO	631		1				1	1
YELLOW-THR. VIREO	628							
RED-EYED VIREO	624							
WARBLING VIREO	627							
BLK-AND-WHT WARB	636							
PROTHONOTARY WARB	637							
WORM-EATING WARB	639							
BLUE-WINGED WARB	641							
PARULA WARBLER	648							
YELLOW WARBLER	652							
BLK-THR. GR. WARB	667							
CERULEAN WARBLER	658							
YELLOW-THR. WARB	663							
PINE WARBLER	671							
PRAIRIE WARBLER	673							
OVENBIRD	674							
LA. WATERTHRUSH	676							
KENTUCKY WARBLER	677							
YELLOWTHROAT	681							
YELLOW-BR. CHAT	683		1				1	1
HOODED WARBLER	684							
AMERICAN REDSTART	687							
HOUSE SPARROW	6882	2		6		1	9	4
E. MEADOWLARK	501	2	8		2	3	17	13
RED-WING BLACKBIRD	498	2	[illegible]	4		8	14	7
ORCHARD ORIOLE	506	2	2	1			5	[illegible]
BALTIMORE ORIOLE	507							
BOAT-TAIL GRACKLE	513							
COMMON GRACKLE	511		8	18	2	1	29	11
BROWN-HD COWBIRD	495							
SUMMER TANAGER	610							
CARDINAL	593	15	9	10	5	3	42	27
BLUE GROSBEAK	597		2			1	3	3
INDIGO BUNTING	598	3	2				5	3
PAINTED BUNTING	601							
DICKCISSEL	604							
AMERICAN GOLDFINCH	529							
RUFOUS-SIDE TOWHEE	587	1	2		1		4	4
GRASSHOPPER SPAR	546							
HENSLOW'S SPARROW	547							
BACHMAN'S SPARROW	575							
CHIPPING SPARROW	560							
FIELD SPARROW	563							
SONG SPARROW	581							
....								
....								
....								
....								
....								
....								
....								
....								
....								
....								
....								

C

BUREAU OF SPORT FISHERIES AND WILDLIFE
MIGRATORY BIRD POPULATIONS STATION
LAUREL, MARYLAND 20810

(6)

DIV. RECEIVED OR
AUG 5 1969
Distribution and Migration
FISH AND WILDLIFE SERVICE

SUMMARY SHEET, BREEDING BIRD SURVEY

(1) STATE-PROV. 02
(3) ROUTE NO. 031
(6) ROUTE NAME GRANGEBURG
(18) COORDINATES ~~3100-08620~~ 3100-08512
STRATUM 04

		Start	Finish
(42)	TEMP. (F)	65	85
(46)	WIND SPEED	0	3
(48)	SKY	0	0

C 1 (39)

(50) DATE 06 01 69
Month Day Year

OBSERVER (please print) Dr. [✓ Mr.] Mrs. Miss (circle one)
YOUNG B. F.
Last Name First Initial

(56) TIME Start 0507 Finish 0924

MAILING ADDRESS 1320 - WARREN Williams ROAD
COLUMBUS, GEORGIA

(65) (69) (72) (75) (78) (81) (84) (88)

Species	AOU	Page Totals					Total Indiv.	Stops per Spec.
		1	2	3	4	5		
Brown Pelican	126							
Anhinga	118							
Gt. Blue Heron	194							
Green Heron	201							
Little Blue Heron	200							
Cattle Egret	2001							
Common Egret	196			10	5		15	2
Snowy Egret	197							
Louisiana Heron	199							
Black-cr. Night Heron	202							
Yel-cr. Night Heron	203							
White Ibis	184							
Wood Duck	144							
Turkey Vulture	325							
Black Vulture	326			2			2	1
Cooper's Hawk	333							
Red-tailed Hawk	337							
Red-shouldered Hawk	339							
Broad-winged Hawk	343							
Osprey	364							
Sparrow Hawk	360							
Bobwhite	289	23	20	7	8	9	67	32
Turkey	310							
Sandhill Crane	206							
Clapper Rail	211							
Common Gallinule	219							
American Coot	221							
Killdeer	273			1			1	1
Willet	258							
Laughing Gull	058							
Least Tern	074							
Black Skimmer	080							
~~Rock Dove~~	~~3131~~							
Mourning Dove	316	9	13	3	2	7	34	20
Ground Dove	320			1			1	1
Yellow-billed Cuckoo	387					1	1	1
Screech Owl	373							
Great Horned Owl	375							
Barred Owl	368							
Chuck-will's-widow	416	2					2	2
Whip-poor-will	417							
Common Nighthawk	420							
Chimney Swift	423	4	7			5	16	4
Ruby-thr. Hummingbird	428							
Belted Kingfisher	390							
Yellow-shafted Flicker	412	1	1				2	2
Pileated Woodpecker	405	1					1	1
Red-bellied Woodpecker	409	2	2			2	6	6
Red-headed Woodpecker	406		1	3		1	5	4
Hairy Woodpecker	393							
Downy Woodpecker	394							
Red-cockaded Wdpkr	395							
E. Kingbird	444	4	7	2	3	2	18	14
Gt. Crested Flycatcher	452	3					3	3
E. Phoebe	456							
Acadian Flycatcher	465							
E. Wood Pewee	461							
Tree Swallow	614							
Rough-winged Swallow	617							
Barn Swallow	613							
Purple Martin	611	3	3	5		9	20	4
Blue Jay	477	2	20	10	8	16	56	29
Common Crow	488	13	6	1	7	1	28	17
Fish Crow	490							
Carolina Chickadee	736	1			1		2	2
Tufted Titmouse	731			1			1	1

(65) (69) (72) (75) (78) (81) (84) (88)

Species	AOU	Page Totals					Total Indiv.	Stops per Spec.
		1	2	3	4	5		
White-breasted Nuthatch	727							
Brown-headed Nuthatch	729							
House Wren	721	1						
Bewick's Wren	719							
Carolina Wren	718	2	3			1	6	6
Mockingbird	703	7	16	10	13	11	57	13
Catbird	704							
Brown Thrasher	705	4					4	4
Robin	761							
Wood Thrush	755	2					2	2
E. Bluebird	766							
Blue-gray Gnatcatcher	751							
Loggerhead Shrike	622		3	1		3	7	3
Starling	493	5	7	7	5	5	29	16
White-eyed Vireo	631			1				1
Yellow-throated Vireo	628							
Red-eyed Vireo	624							
Black-and-wht. Warbler	636							
Prothonotary Warbler	637							
Worm-eating Warbler	639							
Blue-winged Warbler	641							
Parula Warbler	648							
Yellow Warbler	652							
Blk-thr. Green Warbler	667							
Cerulean Warbler	658							
Yellow-thr. Warbler	663							
Pine Warbler	671							
Prairie Warbler	673							
Ovenbird	674							
La. Waterthrush	675							
Kentucky Warbler	677							
Yellowthroat	681							
Yellow-breasted Chat	683							
Hooded Warbler	684							
American Redstart	687							
House Sparrow	6882	11	8	11	5	25	60	13
E. Meadowlark	501	5	10	5	2		22	16
Red-winged Blackbird	498	9		8	1	2	20	10
Orchard Oriole	506	1	2				3	3
Baltimore Oriole	507							
Boat-tail Grackle	513							
Common Grackle	511			11	15	3	29	11
Brown-headed Cowbird	495							
Scarlet Tanager	608							
Summer Tanager	610	2	1			2	5	5
Cardinal	593	11	11	3	2	2	29	24
Blue Grosbeak	597	4	1	2		1	8	8
Indigo Bunting	598	5	6	3			14	9
Painted Bunting	601							
Dickcissel	604							
American Goldfinch	529							
Rufous-sided Towhee	587	7	6	1	3	2	19	14
Grasshopper Sparrow	546							
Bachman's Sparrow	575							
Chipping Sparrow	560							
Field Sparrow	563	2		1		1	4	4
Song Sparrow	581							

Form 3 - 3
(1969)

BUREAU OF SPORT FISHERIES AND WILDLIFE
MIGRATORY BIRD POPULATIONS STATION
LAUREL, MARYLAND 20810

3

SUMMARY SHEET, BREEDING BIRD SURVEY

(1) STATE-PROV. 02
(3) ROUTE NO. 031
(6) ROUTE NAME GRANGEBURG
(18 COORDINATES 3100-08512
STRATUM 04 (0)

TOTAL SPECIES: 46

C 2 (39)

ASSISTANT: Mrs FLORENCE LYNN

		Start	Finish
(42)	TEMP. (F)	67	85
(46)	WIND SPEED	2	0
(48)	SKY	2	1

(50) DATE 05 31 70 (Month Day Year)

OBSERVER (please print) Dr. [✓ Mr.] Mrs. Miss (circle one)
(27) YOUNG (Last Name) B (First) F (Initial)

(56) TIME Start 0502 Finish 0920

(64) 1 T

MAILING ADDRESS 1621-17TH STREET Columbus, Georgia Zip Code 31901

	(65)	(69)	(72)	(75)	(78)	(81)	(84)	(88)
Species	AOU	Page Totals					Total Indiv.	Stops per Spec.
		1	2	3	4	5		
Brown Pelican	126							
Anhinga	118							
Gt. Blue Heron	194							
Green Heron	201							
Little Blue Heron	200		2	1	3	2	8	7
Cattle Egret	2001		7	15	23	3	48	10
Common Egret	196							
Snowy Egret	197							
Louisiana Heron	199							
Black-cr. Night Heron	202							
Yel-cr. Night Heron	203							
White Ibis	184		24	8			32	3
Wood Duck	144							
Turkey Vulture	325							
Black Vulture	326			5			5	2
Cooper's Hawk	333							
Red-tailed Hawk	337							
Red-shouldered Hawk	339							
Broad-winged Hawk	343							
Osprey	364							
Sparrow Hawk	360							
Bobwhite	289	7	17	17	8	13	62	41
Turkey	310							
Sandhill Crane	206							
Clapper Rail	211							
Common Gallinule	219							
American Coot	221							
Killdeer	273							
Willet	258							
Laughing Gull	058							
Least Tern	074							
Black Skimmer	080							
Rock Dove	3131							
Mourning Dove	316	14	7	17	12	4	54	28
Ground Dove	320				2		2	1
Yellow-billed Cuckoo	387				1		1	1
Screech Owl	373							
Great Horned Owl	375							
Barred Owl	368							
Chuck-will's-widow	416	2					2	2
Whip-poor-will	417							
Common Nighthawk	420	1					1	1
Chimney Swift	423	6		3	7	3	19	5
Ruby-thr. Hummingbird	428			1			1	1
Belted Kingfisher	390			1			1	1
Yellow-shafted Flicker	412					2	2	2
Pileated Woodpecker	405	1					1	1
Red-bellied Woodpecker	409	5	6	1	2	1	15	14
Red-headed Woodpecker	406		1		1		2	2
Hairy Woodpecker	393							
Downy Woodpecker	394					1	1	1
Red-cockaded Wdpkr	395							
E. Kingbird	444	4	12	4	4	1	25	14
Gt. Crested Flycatcher	452	2	2	2		1	7	7
E. Phoebe	456							
Acadian Flycatcher	465							
E. Wood Pewee	461							
Tree Swallow	614							
Rough-winged Swallow	617							
Barn Swallow	613							
Purple Martin	611	15				10	25	3
Blue Jay	477	11	14	14	7	8	54	29
Common Crow	488	13	14	7	11	2	52	23
Fish Crow	490							
Carolina Chickadee	736	1					1	1
Tufted Titmouse	731		1				1	1

	(65)	(69)	(72)	(75)	(78)	(81)	(84)	(88)
Species	AOU	Page Totals					Total Indiv.	Stops per Spec.
		1	2	3	4	5		
White-breasted Nuthatch	727							
Brown-headed Nuthatch	729							
House Wren	721							
Bewick's Wren	719							
Carolina Wren	718	1		1	1		3	3
Mockingbird	703	15	12	8	8	9	52	37
Catbird	704							
Brown Thrasher	705	5	1		2	2	10	10
Robin	761							
Wood Thrush	755	1			1	1	3	3
E. Bluebird	766							
Blue-gray Gnatcatcher	751							
Loggerhead Shrike	622	2	6	6	3	1	18	13
Starling	493	2	5	2	16	9	38	9
White-eyed Vireo	631		1				1	1
Yellow-throated Vireo	628							
Red-eyed Vireo	624							
Black-and-wht. Warbler	636							
Prothonotary Warbler	637							
Worm-eating Warbler	639							
Blue-winged Warbler	641							
Parula Warbler	648							
Yellow Warbler	652							
Blk-thr. Green Warbler	667							
Cerulean Warbler	658							
Yellow-thr. Warbler	663							
Pine Warbler	671							
Prairie Warbler	673							
Ovenbird	674							
La. Waterthrush	676							
Kentucky Warbler	677							
Yellowthroat	681					1	1	1
Yellow-breasted Chat	683			1			1	1
Hooded Warbler	684							
American Redstart	687							
House Sparrow	6882	22	8	6	8	25	69	13
E. Meadowlark	501	3	6	5	14	12	40	16
Red-winged Blackbird	498	9	6	5	1	19	40	18
Orchard Oriole	506	2	5	2	2	1	12	12
Baltimore Oriole	507							
Boat-tail Grackle	513							
Common Grackle	511	11	12	5	8	4	40	20
Brown-headed Cowbird	495			2		1	3	3
Scarlet Tanager	608							
Summer Tanager	610			1			1	1
Cardinal	593	24	11	7	13	7	62	31
Blue Grosbeak	597	3	1	2	2		8	7
Indigo Bunting	598	3	5	5	3	1	17	17
Painted Bunting	601							
Dickcissel	604							
American Goldfinch	529							
Rufous-sided Towhee	587	3	1	2	2	9	17	13
Grasshopper Sparrow	546							
Bachman's Sparrow	575							
Chipping Sparrow	560							
Field Sparrow	563	1		1			2	2
Song Sparrow	581							

Form 3 - 3
(1969)

a/e

AUG 3 1972

x0

BUREAU OF SPORT FISHERIES AND WILDLIFE
MIGRATORY BIRD POPULATIONS STATION
LAUREL, MARYLAND 20810 /

SUMMARY SHEET, BREEDING BIRD SURVEY

(1) STATE-PROV. 02
(3) ROUTE NO. 031
(6) ROUTE NAME GRANGEBURG
(18 COORDINATES 3100-08512
STRATUM 04 (40)

		Start	Finish
(42)	TEMP. (F)	66	82
(46)	WIND SPEED	0	0
(48)	SKY	0	1

TOTAL SPECIES: 45

C 1 (39)

(50) DATE 06 04 72
Month Day Year

ASSISTANT: B. F. YOUNG

OBSERVER (please print) Dr. [✓ Mr.] Mrs. Miss (circle one)

(27) PATE SAM
Last Name First Initial

(56) TIME Start 0507 Finish 0929

(64) 1 T

MAILING ADDRESS 1621-17TH St. Columbus, Georgia Zip Code 31701

(65)		(69)	(72)	(75)	(78)	(81)	(84)	(88)
Species	AOU	Page Totals 1	2	3	4	5	Total Indiv.	Stops per Spec.
PIED-BILLED GREBE . .	006							
BROWN PELICAN . . .	126							
DBL-CR, CORMORANT	120							
ANHINGA	118							
GT. BLUE HERON . . .	194							
GREEN HERON	201		1	1		1	3	3
LITTLE BLUE HERON .	200	6			2		8	6
CATTLE EGRET	2001	72	21	10	14	3	120	16
COMMON EGRET . . .	196			1			1	1
SNOWY EGRET	197							
LOUISIANA HERON . .	199							
BLK-CR, NIGHT HERON	202	2					2	2
YEL-CR, NIGHT HERON	203							
WOOD IBIS	188							
WHITE IBIS	184							
MOTTLED DUCK . . .	134							
WOOD DUCK	144							
TURKEY VULTURE . .	325							
BLACK VULTURE . . .	326							
RED-TAILED HAWK . .	337							
RED-SHOULDER HAWK	339							
BROAD-WG, HAWK . .	343							
OSPREY	364							
SPARROW HAWK . . .	360							
BOBWHITE	289	20	24	16	26	5	94	37
TURKEY	310							
SANDHILL CRANE . . .	206							
LIMPKIN	207							
CLAPPER RAIL	211							
COMMON GALLINULE .	219							
AM. COOT	221							
KILLDEER	273				2		2	1
WILLET	258							
LAUGHING GULL . . .	058							
LEAST TERN	074							
ROYAL TERN	065							
ROCK DOVE	3131							
MOURNING DOVE . . .	316	76	37	12	14	14	153	31
GROUND DOVE	320		1	2			3	3
YELLOW-BIL. CUCKOO	387	4	4	1	2		11	11
GREAT HORNED OWL .	375							
BARRED OWL	368							
CHUCK-WILL'S WIDOW	416							
WHIP-POOR-WILL . . .	417							
COMMON NIGHTHAWK	420							
CHIMNEY SWIFT . . .	423	5	11	1		34	51	8
RUBY-T. HUMMINGBIRD	428							
BELTED KINGFISHER .	390		1			1	2	2
YEL-SHAFT FLICKER .	412	1			2	4	7	6
PILEATED WOODPECKR	405				1		1	1
RED-BELL. WOODPECKR	409	6	13	6	7	7	39	26
RED-HD. WOODPECKER	406		2	1		3	7	5
HAIRY WOODPECKER .	393							
DOWNY WOODPECKER	394		1		1	1	3	3
RED-COCKADED WDP'R	395							
E. KINGBIRD	444	6	6	9	2	1	24	14
GT. CREST FLYCATCHR	452		6	4		3	13	11
E. PHOEBE	456							
ACADIAN FLYCATCHR	465							
E. WOOD PEWEE . . .	461							
HORNED LARK	474							
ROUGH-WG. SWALLOW	617			2			2	1
BARN SWALLOW . . .	613							
PURPLE MARTIN . . .	611	6	12		21	30	69	8
BLUE JAY	477	5	15	35	20	7	82	28
COMMON CROW . . .	488	10	21	19	10		60	22

(65)		(69)	(72)	(75)	(78)	(81)	(84)	(88)
Species	AOU	Page Totals 1	2	3	4	5	Total Indiv.	Stops per Spec.
FISH CROW	490							
CAROLINA CHICKADEE	736							
TUFTED TITMOUSE . .	731	1	1		3	1	6	6
WHITE-BR. NUTHATCH	727							
BROWN-HD. NUTHATCH	729							
HOUSE WREN	721							
BEWICK'S WREN . . .	719							
CAROLINA WREN . . .	718	1	4	1	3	2	11	9
MOCKINGBIRD	703	9	11	13	25	5	71	36
CATBIRD	704							
BROWN THRASHER . .	705		5	10	8	5	28	17
ROBIN	761							
WOOD THRUSH	755	1	3				4	4
E. BLUEBIRD	766		2				2	2
BL-GR. GNATCATCHER	751							
LOGGERHEAD SHRIKE .	622	1		10	10	2	23	10
STARLING	493	5	22	3	5	1	36	7
WHITE-EYED VIREO . .	631		1				1	1
YELLOW-THR. VIREO .	628							
RED-EYED VIREO . . .	624							
BLK-&-WHT WARBLER	636							
PROTHONOTARY WARB	637							
WORM-EATING WARBLR	639							
BLUE-WG. WARBLER .	641							
PARULA WARBLER . . .	648							
YELLOW WARBLER . .	652							
BLK-THR. GREEN WARB	667							
YELLOW-THR. WARB .	663					2	2	2
PINE WARBLER	671							
PRAIRIE WARBLER . . .	673							
OVENBIRD	674							
LA. WATERTHRUSH . .	676							
KENTUCKY WARBLER .	677		1				1	1
YELLOWTHROAT . . .	681							
YELLOW-BR. CHAT . .	683					1	1	1
HOODED WARBLER . .	684							
AM. REDSTART	687							
HOUSE SPARROW . . .	6882	10		2	44	50	138	10
E. MEADOWLARK . . .	501	7	9	16	2	1	35	20
RED-WG. BLACKBIRD .	498	2	2	24	21	9	58	17
ORCHARD ORIOLE . . .	506	8	2	3	1	3	17	14
BALTIMORE ORIOLE . .	507							
BOAT-TAIL GRACKLE .	513							
COMMON GRACKLE . .	511	4	15	28	24	6	77	19
BROWN-HD. COWBIRD	495							
SCARLET TANAGER . .	608							
SUMMER TANAGER . .	610	1					1	1
CARDINAL	593	10	4	5	7	7	33	21
BLUE GROSBEAK . . .	597	2	2	2	2	1	9	8
INDIGO BUNTING . . .	598	1	2	3	5		11	8
PAINTED BUNTING . .	601							
DICKCISSEL	604							
AM. GOLDFINCH . . .	529							
RUFOUS-SIDE TOWHEE	587	4	3	8	8	6	29	20
GRASSHOPPER SPARROW	546							
BACHMAN'S SPARROW	575							
CHIPPING SPARROW . .	560							
FIELD SPARROW	563							
SONG SPARROW	581							
. . . .								
. . . .								
. . . .								
. . . .								
. . . .								
. . . .								
. . . .								

Form 3-3 (1972)

1.6 MAMMALS

Forty-seven species of mammals have been found in the three counties that surround the Farley Nuclear Plant. These include: one marsupial, four insectivores, twelve bats, three lagomorphs, seventeen rodents, nine carnivores and one undulate. (Table 1.6-1)

The narrative on the status, abundance, distribution and biology of each species was obtained from several references listed at the end of this section.

Didelphis marsupialis, Opossum

The opossum is an abundant animal throughout the area and is found in a diversity of habitats. It appears to be successful living in association with man. This mammal is primarily nocturnal but will venture from its den during the day if adverse weather conditions prevent foraging at night. The opossum is omnivorous, but a food habit study in Alabama revealed the following stomach contents from 95 animals: 60 percent insects, 9 percent vegetable food, with birds, mammals and reptiles, each being approximately 5 percent of the diet. It has a fondness for carrion and will occasionally kill and eat poultry. The opossum makes its den in ditch banks, hollow stumps and trees, in rocky crevices, among wind falls and will frequently inhabit abandoned structures.

The reproductive biology of the opossum is of special interest. The young at birth, after a short gestation period of 12 to 13 days, are embryo-like, with poorly developed head, body and limbs. In this immature state the young crawl from the vaginal orifice to the marsupial pouch on the mother's belly. Once in the pouch, they grasp a teat and remain in the pouch or marsupium until they are about two months old. They then begin to leave the pouch, but remain near the mother, often climbing about over

Table 1.6-1 - Mammals Found in Henry & Houston Counties, Alabama and Early County, Georgia

Species	Status*	Species	Status*
Opossum	F, G	Gray Squirrel	G
Southeastern Shrew	R-1	Fox Squirrel	G
Short-tailed Shrew	N	Flying Squirrel	N
Least Shrew	N	Southeastern Pocket Gopher	N
Eastern Mole	N	Beaver	F, G
Little Brown Myotis	N	Rice Rat	N
Southeastern Myotis	R-2	Harvest Mouse	N
Gray Myotis	N	Old-field Mouse	N
Indiana Myotis	E	Cotton Mouse	N
Eastern Pipistrelle	N	Golden Mouse	N
Big Brown Bat	N	Cotton Rat	N
Red Bat	N	Eastern Wood Rat	N
Seminole Bat	N	Pine Mouse	N
Hoary Bat	R-2	Muskrat	F
Florida Yellow Bat	R-1	Red Fox	F, G
Evening Bat	N	Raccoon	F, G
Big-eared Bat	N	Gray Fox	F, G
Brazilian Free-tailed Bat	N	Long-tail Weasel	F
		Mink	F
Cottontail Rabbit	G	Spotted Skunk	F
		Striped Skunk	F
Swamp Rabbit	G	River Otter	F
		Bobcat	G
Marsh Rabbit	U, G	White-tailed Deer	G

*Status: E - Endangered; F - Fur bearing; G - game; N - No; U - Undetermined
R - Rare

her body. Only a small percentage of the 13 to 16 offspring survive to a juvenile stage for many fall from the marsupium or mother's back and are left to perish. The litter begins to disperse near the third month after birth. Two breeding periods may occur per year, from mid-January to early March, and from early April to mid-June.

The opossum has a habit of feining death when approached by a potential enemy and will assume such a pose until the danger passes. However, when faced by a threat, it will attempt to escape by climbing a tree or bush. Although the prehensile tail and opposable rear toe indicate that the opossum is arboreal, it is often seen on the ground away from trees.

This mammal is a source of food to rural people in the South and is a protected game animal. Although a small percentage is trapped for skins, the opossum pelt is of little commercial value.

Sorex longirostris, Southeastern Shrew

This species is probably found throughout both Alabama and Georgia but is so rare and elusive that it appears only seldom in collections. In Alabama, none of the shrews are abundant and therefore this least collected species has been placed in a rare-1 status (1)*. The few records may indicate low population densities and discontinuous distribution or they may mean that the trapping techniques used by mammalogists for collecting small mammals are not effective for this species. Man probably has had little effect on its present position. Based on records of captures of this shrew throughout the southeast, it appears to inhabit moist situations near swamps, as well as woods and open fields. The few specimens collected in Alabama were obtained in mixed hardwood forests. Little is known about the habits or life history of the Southeastern Shrew. Four or five young comprise a litter.

---

* See Bibliography at end of section for references.

Blarina brevicauda, Short-tail Shrew

The Short-tail Shrew is found in a wide variety of habitats, but prefers mixed deciduous hardwood forests and peat soils. It has been collected in Early County. It makes its burrows and dens under fallen logs and decaying stumps and quite often is found near back water and inlets of water bodies. It frequently uses the burrows of other small fossorial animals. This shrew usually makes a four to five inch diameter nest composed of bits of grass and shredded leaves at the distal end of an extensive burrow system. This intricate burrow system meanders one to five inches below the surface of the ground in a complex pattern. Each burrow, which is less than 40.0 millimeters in diameter, has more than one entrance with each entrance well hidden. Caches of food may be found stored in chambers along this burrow system.

Although its sense of hearing, smell and touch are well-developed, its eyesight is poor and restricted. It has a ferocious appetite and requires the equivalent of its own weight in food per day. Members of this group possess a poison substance produced by the submaxillary glands and are able to inflict painful and lethal wounds on its prey. The food of the Short-tailed Shrew generally consists of small invertebrates, snails and insects. It will, however, kill and devour vertebrates twice its size such as other small burrowing rodents. Due to its carnivorous nature, small trapped mammals may be found completely or partially devoured with both trap and specimen dragged to the entrance of the shrew's den.

The females may have several litters of one to eight young per year. Two Georgia specimens had two and three embryos in April and October. The gestation period averages 21 days.

The Short-tailed Shrew is of economic significance because it consumes large quantities of noxious insects and maintains a balance in nature. It is preyed upon by small carnivores, raptorial birds and certain snakes.

Cryptotis parva, Least Shrew

The Least Shrew is generally found throughout Alabama and Georgia but is most abundant in the Coastal Plain Region. It seems to prefer open grasslands near agricultural areas rather than deciduous forests. This mammal is not common in museum collections and only small numbers have been taken in extensive trap sets. Actually this shrew is probably more common than trapping records indicate, since owl pellets found under roosting trees in grasslands bordering agricultural areas contain large numbers of skulls of this species. This small mammal is active in the twilight and evening hours. It constructs an extensive burrow system along ditch banks and hedgerows where the drainage is good. Each burrow is less than 25.0 millimeters in diameter and enters the ground separately at well-spaced intervals. Usually each burrow entrance is concealed and opens out onto a slope. A small hollow nest constructed of leaves and bits of sticks usually is found in a separate chamber.

The food habits of this species are similar to those of other shrews. Insects, earthworms, centipedes, snails and vegetable matter have all been recorded from the stomachs of wild specimens. In captivity this shrew may eat more than its body weight in food daily.

The breeding season is not known for the Short-tailed Shrew in the Southeastern portion of its range. In more northern latitudes and in Texas, breeding extends from March to November. Litter size is approximately five to six young. The gestation period is 21 to 23 days, and in the southern extension of its range more than one litter may be born each year.

Scant information is available on other aspects of this species' biology in the southernmost extension of its range.

Scalopus aquatius, Eastern Mole

The Eastern Mole is commonly found throughout Alabama and Georgia in a diversity of habitats. Normally it prefers sandy to sandy-loam soils rather than clay or hard soils. Its presence is noted in gardens, woodlands, lawns and cultivated areas where burrows barely run under the surface of the soil. The two central facts of this mammal's existence are that it lives beneath the ground and is insectivorous. The mole actually "swims" through the soil in its search for insects and earthworms. Approximately a foot beneath the soil surface is a more permanent tunnel system, to which the mole retreats during dry or cold weather. A nest of grass and leaves is connected to the tunnels and may be entered from below.

Since the mole is fossorial, it has relatively few of the enemies which prey on other similar-sized mammals which live above ground. Even though moles are active at all hours and at all seasons of the year, their burrow systems generally protect them from avian and mammalian predators. Snakes probably take their toll of moles by entering the burrow system. This relative freedom from predation may be reflected in the rather low capacity for increase of the mole population. One litter is born per year and contains two to five young. Growth of the young is quite rapid, and they leave the nest at approximately four weeks of age.

Moles cause extensive damage to lawns and agricultural areas where plants are uprooted by their burrows. The insectivorous mole has been blamed, however, for eating roots of food plants. Much of this food plant damage is attributable to the Vole, Microtus spp. These burrowing rodents utilize the tunnels of the mole by an access to the roots of food plants.

Myotis lucifugus, Little Brown Myotis

The Little Brown Bat is probably found throughout Alabama and Georgia, even though there is a lack of specimens in museums. This bat favors heavily wooded habitats but may also be found in caves and in crevices in rocks or in holes in trees. Occasionally, specimens may be found behind shutters in houses. It is crepuscular and may be seen very early in the evening. They are known to travel for hundreds of miles to find suitable caves where they congregate for hibernation.

Little is known concerning the breeding habits of this species. Although ovulation occurs in spring, both fall and spring breeding occur. One Georgia specimen collected June 10 contained two embryos rather than one (2). Data are too limited to determine if the reproductive behavior of this species is similar throughout its range. The young bat is able to fly and fend for itself when about one month old.

The Little Brown Myotis feeds almost entirely on insects captured on the wing. It has radar sensing apparatus which it uses during the evening flights over fields and bodies of water. Economically, this bat is useful as an insect destroyer. Body parasites include fleas, which do not favor men as a host, and several species of ticks and mites of medical significance. Since bats roost in inaccessible places and have flight, they probably have few predators such as birds of prey or possible snakes and small carnivorous mammals.

Myotis austroriparius, Southeastern Myotis

The Southeastern Myotis has not been collected in Alabama but has been found in the southwestern portion of Georgia. The Miller and Thomas County specimens are part of the west Florida, Alabama and Georgia populations. The finding of studies of the west Florida population applies to the Georgia colonies of this species (2).

This bat is restricted to the cavernous Karst region. It hibernates in caves during the winter, from about late October to early March, and also uses caves for summer roosts. They are seldom found in buildings. Breeding usually occurs in the fall and, as in other Myotis, sperm are stored in the female until ova are released. Spring breeding may also occur. In the spring and summer, females congregate in maternity colonies. By late March and early April maternity colonies may contain from 2,000 to 90,000 adult bats. Male and non-breeding females roost in separate colonies in other caves during this period. Young are born in May and these are two young per litter. The young are able to fly in five to six weeks after birth.

A study (2) of this species in Florida estimates that the annual birth rate is 116 percent (61 percent females, 1.90 young per female) and the annual survival rate, assuming stable population is about 46 percent. Survival may be somewhat higher in southwestern Georgia because the bats are active and exposed to predation for a shorter period.

In Alabama this species has been placed in a Rare-2 status (1). It is assumed to have a statewide distribution in suitable habitat but in small numbers. Man's collecting and disturbances in caves affect its abundance.

Myotis grisescens, Gray Myotis

The Gray Bat is found commonly throughout Alabama but only one specimen has been recorded from Georgia. It can be assumed that this species exists in southwestern Georgia. It frequents caves and crevices among rocks where it generally lines the ceilings. In one Alabama cave, several large colonies were studied (5). It was also observed to associate with the Indiana and the Keen's Myotis in this and a distant cave. Both males and females used the same roost in all the Alabama caves where they were found; however, there was either an obviously larger number of females or an obviously larger number of males present.

These bats are most active just after dark on summer nights when they hunt for food among trees lining creeks and rivers. A single young is born between early June and July. These bats are of economic significance because they consume huge quantities of noxious insects. A large number of external parasites are also carried by these small mammals.

Myotis sodalis, Indiana Myotis

The Indiana Myotis probably has a statewide distribution in Alabama, while it is recorded from only one county in northwestern Georgia. This species is listed as endangered by the U. S. Department of the Interior (1). This bat has been collected together with the Keen's Myotis and the Eastern Pipistrelle. The Indiana Myotis hibernates in caves, especially those which contain large bodies of water. The hibernating colonies may be very large with the bats clustered in close compact groups. There appears to be no sexual segregation in the roosts of this species and at no time have great concentrations of these bats been found in Alabama. Solitary specimens of this species have been seen in an Alabama cave (5). Very little is known about the breeding, feeding and summer habits of this species.

Pipistrellus subflavus, Eastern Pipistrelle

The Eastern Pipistrelle is one of the smallest and most easily recognized bats. It has a statewide distribution in Alabama and Georgia. This species is a weak and erratic flyer, and leaves its retreat in buildings, caves and rock cliffs to hunt for food early in the evening. In an Alabama cave, dozens of these bats have been observed roosting on the ceilings and along the walls. They shared roosts with the Keene's Myotis and the Indiana Myotis. The Eastern Pipistrelle apparently do not segregate themselves sexually on these roosts for both sexes have been collected in equal numbers.

The food consists of flying insects. In a food study of this species (2), two specimens weighing 5.3 and 6.7 grams collected a total of 2.7 and 3.3 grams of food per hour respectively. In the Coastal Plains this species probably remains active throughout the year. One or two young are born each year from May to July.

Eptesicus fuscus, Big Brown Bat

The Big Brown Bat is found in a variety of habitats throughout Alabama (including Houston County) and Georgia. This bat is a hardy species commonly found in urban areas. It inhabits caves as well as buildings. In an early study (5), four specimens were collected from a porch under a wooden brace of a dewlling in Ashford, Houston County, along with two adult specimens of the Brazelian Free-tailed Bat. This bat leaves its daytime retreat later in the evening than the smaller bats and has only one activity period before midnight. It prefers to hunt its insect prey over old fields, surrounded by mixed hardwood forests. It is reported that the rate of feeding in this species averaged 1.2 grams per hour for young of the year and 2.7 grams per hour for adults.

Young are usually born in late May. Litter size may range from one to four offspring, but is most commonly two. Spermatozoa are definitely known to remain viable in the uterus of the female over the winter (140 to 150 days). These bats are entirely insectivorous and carry large number of external parasites.

Lasiurus borealis, Red Bat

The Red Bat is found statewide in Alabama (including Houston County) and Georgia. It prefers to roost in trees and shrubs and occasionally specimens have been found under the loose bark of trees. The Red Bat commonly leaves its roost before darkness, foraging among the branches, and is active during the daytime in migration. Not more than three specimens have been collected at one time from one locality, and usually they are found singly or in pairs. In northern states the Red Bat begins to migrate, often in groups, in September. It is more common in the south from December to March than at other times of the year.

This species is unusual in that it bears two to four offspring. Juveniles associated with females have been observed in Alabama on August 12 and in Georgia on June 29. A study (2) showed that the average number of embryos per female was 3.0. This species is reported to mate in August and bear offspring the following May or June. This genus is valuable for its ability to consume large quantities of insects.

Lasiurus seminolus, Seminole Bat

The Seminole Bat is probably found statewide in Alabama and Georgia along the Coastal Plain. This species roost in trees and in Spanish Moss. In southwestern Georgia it is found in clumps of moss in oak forests from February through April, but not in May and June. Selected sites are on the west and southwest exposures of trees. It begins its flight in the evening, not flying when the temperature falls below 70°F., and seeks its prey over water, cleared land, and pine barrens. It is known to eat flying insects and the feeding rate of one 8.6 gram adult was 1.5 grams of insects per hour. The Seminole Bat is active throughout the year in the South and may be a migratory species. An average of three offspring are born in late May. It has been suggested that this species is solitary until April.

Lasiurus cinereus , Hoary Bat

The Hoary Bat is a Rare-2 (1), status species in Alabama and is an assumed statewide resident in Georgia. Like other lasiurine bats, this species is solitary and roosts in trees and shrubs, shuns caves, and is migratory. The Hoary Bat is probably a winter transient in Alabama and Georgia, summering far to the North in the U. S. and Canada. In the North, the two young are usually born about mid-June. Scant data is available concerning the habits of this bat in the Southeast.

Dasypterus floridanus, Florida Yellow Bat

The Florida Yellow Bat is classified in the Rare-1, status in Alabama and may be present in the southern counties. In Georgia the few specimens collected were obtained on the Coastal Plain. This species is most likely to be found in caves. Scant information is available on the biology of this species. It has been reported that two offspring are born in May or June. This species feeds on flying insects.

Nycticeius humeralis, Evening Bat

The Evening Bat is common and well distributed throughout both Alabama and Georgia. This bat roosts in trees, buildings, or under bridges. This species has been noted flying in congregations in evening during the fall. It flies early and hunts its insect prey well into the night. A high degree of sexual segregation is noticed in roosts with females being more common than males in the same roost. When males were found, they usually were single or in pairs.

Breeding probably occurs in August and the two offspring are born in May or early June.

Corynorhinus macrotis, Big-eared Bat

The Big-eared Bat has not been collected in southern Alabama and only a few specimens have been collected from the Coastal Plain of Georgia. In one Alabama cave a group of five were observed while in a northeast Alabama cave a large colony of 75 was observed (5). In both sightings the bats were roosting in the twilight zone of the cave. Their flight is strong and erratic and usually begins after dark.

It is known to consume large quantities of insects and hunts along waterways bordering hardwood forests.

Tadarida brasiliensis, Brazilian Free-tailed Bat

This bat is found throughout Alabama (including Houston County) and is moderately common. In Georgia, this species is restricted to the Coastal Plain. This species is most often found in houses, stables, or other buildings, but may also occur in caves and under bridges. These bats leave their roosts in early evening or late afternoon and may travel long distances to the feeding grounds. It feeds along water courses and along the edge of lakes and small ponds where it seeks out its main prey, moths. Their flight is unusually rapid and erratic. It is reported to eat an amount equal to one-half of its body weight per meal.

Breeding occurs in February and March. Usually a single offspring is born in late May to late June, after a gestation period of 11 to 12 weeks.

Sylvilagus floridanus, Cottontail Rabbit

The Cottontail Rabbit is an abundant animal statewide in both Alabama and Georgia. This species is usually found on the uplands, both in wooded and open areas. It may border swamp and marsh rabbit habitat during the drier seasons of the year, but there is little overlap in the range of the upland and semiaquatic species. Perhpas the optimum habitat for cottontails is an old-field community with abundant green forage for food, adjacent to honeysuckle or blackberry thickets, which afford cover. Forms are found in thickets, as well as in dense broomsedge. Grass-lined nests are usually well concealed in thickets, along logs or in dense grass. Cottontail Rabbits consume a large variety of barks, twigs, leaves, seeds, and roots of plants. Plants such as bluegrass, orchard grass, timothy, wild rye grass, red clover, and lespedeza are important seasonally. During periods when herbaceous plants are unavailable, woody material is utilized.

In Georgia the first litters are usually conceived in February. Breeding synchrony is also exhibited by cottontail populations in that state. The above phenomenon, combined with nearly 100 percent pregnancy among females, results in the potential production of five litters per female per year. An additional litter in August is also indicated among approximately 50 percent of the females. Since the average litter size for Georgia cottontails is approximately three, the theoretical maximum number of young that could be produced by an adult female is 15 to 20. One factor that has received some attention in the literature is the relationship between soil fertility and cottontail reproduction (4, 8). Evidence reveals that cottontails from the Coastal Plain region of Georgia come from a better soil regime than Mountain or Piedmont region rabbits (8). However, there was a lack of concomitant change in litter size between areas. The gestation period is 30 days. The young rabbits weigh about 30 grams at birth and are covered with fine hair. The eyes open at about the seventh day. The young leave the nest at about two weeks of age.

Apparently the home range is quite variable. One study (2) reported from .15 to 4.9 acres, while another study reported 1.4 acres for adult males and 1.2 acres for adult females. The Cottontail Rabbit is both diurnal and nocturnal. It provides sport and food for hunters and rural inhabitants. Tremendous numbers of road kills reveal the results from the increased activity during breeding season. Besides hosting numerous external moxious parasites, a large number of internal parasites may be found. Rabbits are preyed upon by all carnivores, large snakes and raptorial birds. Rabbit fur once was considered to be of economic importance for use in linings of various garments but has since lost its value with the advent of cheaper and more practical synthetics.

Sylvilagus aquaticus, Swamp Rabbit

The Swamp Rabbit is quite common in the creek and river bottoms in all of Alabama's 67 counties. In Georgia it is found throughout the Piedmont and Ridge Valley provinces and on the upper Coastal Plain at the western border of the state where it inhabits similar habitat. Water is generally included within the rabbit's home range and it readily takes to water when pursued. Two types of shelter are required by this mammal. Adults require a resting place, called forms, which are often located on tops of old stumps, in low crotches of trees, in honeysuckle tangles, and in cane patches. The second type of shelter is the nest, which is constructed of rabbit fur and grass and is concealed under honeysuckle or in some other suitable location.

The gestation period is 39 to 40 days and the litter size ranges from 4 to 6. Two litters are produced per year. The young weigh about 56 grams at birth and have a well developed pelage. The eyes are open and the young rabbit is able to walk by the second or third day after birth.

This rabbit eats emergent aquatic vegetation and succulent herbaceous vegetation, such as grass, sedges and cane. At the Oconee River near Athens, Georgia, the home range was 18.9 acres (2). During the fall and winter the population density was about 5.6 rabbits per 100 acres of cottonland. Typical of rabbits, this species carries numerous external and internal parasites and harbors rabbit fever, Tularemia. The Swamp Rabbit ranks second to the Cottontail as a game animal in Alabama. It is preyed upon by raptorial birds, large snakes and all carnivores.

Sylvilagus palustris, Marsh Rabbit

The Marsh Rabbit is usually found in areas with an elevation less than 500 feet above sea level in a broad belt east of Mobile extending into Houston County and western Georgia (including Early County). The Marsh Rabbit's status is undetermined in the southern counties of Alabama (1). This species is found in coastal lowlands, brackish marshes, and in flood plain habitat throughout the Coastal Plain. Like the Swamp Rabbit it is seldom encountered far from a source of water. The forms of the Marsh Rabbit are located under thickets, in fallen logs, or in other sheltered locations, while the nest of grass and rabbit fur is concealed under similar cover. Marsh Rabbits eat a variety of herbaceous foods, including marsh grass, cane, forb leaves of deciduous trees and shrubs, and even woody materials when more desirable foods are not available.

Like other members of this family, it gives birth to four through six young usually twice a year, depending upon weather conditions. Its nest is a shallow depression from four to six inches in diameter covered with marsh grass and located in a well-drained, high location at the edge of a marsh. This species is not hunted extensively as its coastal habitat is very dense and difficult to traverse. It is reported that in the coastal areas alligators attack and consume these animals (5).

Sciursus carolinensis, Gray Squirrel

The Gray Squirrel is an abundant animal throughout Alabama and Georgia wherever there are substantial stands of hardwoods. In the southwestern portion of Georgia the Gray Squirrel is generally restricted to the hardwood bottomlands, while the Fox Squirrel is most common in the pine uplands. This species is particularly common in cities, where they are often killed by automobiles.

Gray squirrel shelters are of two types, the den tree and the temporary leaf nest. Cavities in den trees are used for reproduction, shelter and escape. Blackgum, beech and maple often contain cavities suitable for gray squirrels, but those in oaks are preferred.

Two breeding seasons exist for this species and these are influenced by the food supply and the weather. Generally, breeding reaches peaks in mid-January and early June. The gestation period is 42 to 45 days and the average litter size is two to three offspring. The young squirrels remain confined to the nest for about two months after birth and are weaned when they are about seven weeks old. Although two breeding seasons would indicate a high reproductive potential, only 20 to 30 percent of the females actually bear two litters. Yearlings, which make up a large part of the population, only bear one litter per year. Early spring-born juveniles may also breed and bear a litter in their first summer. If each yearling bears two young and each two-year-old bears six young in two litters per year, the increment and growth of the population would be four young per female per year.

Food habits of the grey squirrel are fairly well known. Hickory nuts are a preferred food item, and the squirrels congregate at hickory trees to gather the harvest in season. Acorns, pecans, beechnuts, buds, roots, fruits, leaves, and insects are also consumed. Food consumption of adult squirrels ranges from 63 to 81 grams of hickory nuts per day; the highest rate being for lactating females.

Population density may vary greatly from local area to area within a state. In West Virginia the density per 100 acres of woodland ranged from 21 to 148, with averages of 31, 55, 74 and 75 for four study areas (2). From these same studies the following population data are available: the percent mortality by hunting was 15 percent, natural mortality was 44 percent, and average survival rate was 41 percent.

The Grey Squirrel is exceeded in popularity as a game animal only by the Cottontail Rabbit. Its meat is highly palatable and furnishes a major portion of the diet of many rural residents. The squirrel hosts a large number of endo- and ectoparasites which serve as vectors for many blood borne disease. It is preyed upon by carnivores and large raptorial birds.

Sciurus niger, Fox Squirrel

The Fox Squirrel is commonly found throughout Alabama and Georgia where its preferred habitat is found. This species occurs in both hard and pine woodlands where it appears to be more tolerant of open conditions than the Grey Squirrel. It finds most congenial conditions where there is an abundance of den and nest producing trees, as well as corn and soybean fields, to supply supplementary feeds. Therefore, in the sandhills and flatwoods where these conditions are limited, distribution of the fox squirrel is irregular.

The den of the Fox Squirrel, like that of the Grey Squirrel, may be in tree cavities or leaf nests. A variety of different types of leaf nests are built 10 to 20 feet above ground during the summer. Wildlife managers have used leaf nest counts to estimate squirrel abundance and have reported that in hardwood areas one squirrel has about seven nests; in Florida flatwoods, seven usable nests is the average number per squirrel. In the sand hills, where tree cavities are scarce, Fox Squirrels may take refuge in the burrow of a gopher tortoise. Spanish moss clumps may also be used for nesting.

Fox Squirrels are most active in early morning to several hours after sunrise, and then again before sunset. There are two breeding seasons. The first begins at the end of November in the southern counties, when the live oak acorns are at the greatest abundance, extending into December through March in the northern counties. During this period most two-year-old females and yearlings breed. The second breeding season extends from May to October. During this period, adult females bearing the second litter, and young born in early winter, will breed. The gestation period is approximately 44 to 45 days and the litter size ranges from one to four and averages two to three offspring. The young nurse for two to two and one-half months before they are weaned and leave the brood nests. By five months they are subadults and weigh from 750 to 900 grams.

Population density of Fox Squirrels varies widely in Georgia. On the Coastal Plain, populations are high (greater than one per 30 acres) and on the Satilla Terrace may reach one per acre. Population density of Fox Squirrels in a Florida study area of pine and turkey oak was one per 6.5 acres (2). These rodents are highly desirable as both food and game animals and are rigidly protected by state hunting regulations.

Glaucomys volans, Flying Squirrel

The Flying Squirrel is found throughout both states in hardwood habitats. In turkey oak sandhills it is often more abundant than in hardwood forests where its larger relatives dominate. This species is mainly nocturnal and is seldom seen. The den is a tree cavity, abandoned woodpecker hole, bird houses or attics of houses and barns. The species is sociable, and many times three or more individuals will be discovered in one den.

The Flying Squirrel cannot actually fly but rather moves from tree to tree by gliding through the air. When the squirrel glides from a branch, the lateral membranes are stretched out and the tail is used as a rudder. It usually glides to the base of another tree.

There are two breeding periods; one in late winter and the other in late spring. After a gestation period of 40 days, an average of three to six young are born.

Flying squirrels are more carnivorous than are the tree squirrels. They consume acorns, hickory nuts, seeds, and fruit, as well as insects and small birds. Populations vary in Georgia. As many as six families of squirrels were found in a line of six nest boxes along one mile of road in a turkey oak-pine sandhill on the Coastal Plain in September (2). This species is preyed upon by owls and domestic house cats.

Geomys pinetis, Southeastern Pocket Gopher

The Pocket Gophers are associated with the longleaf pine forests of the sandy Coastal Plain and also with post-forest fire conditions in Alabama and Georgia. Presumably fire encourages the growth of succulent herbs utilized by the Pocket Gopher as food. Water forms a barrier to the migration of this species, as do heavy soils, so that populations are distributed irregularly over areas where the species is found.

Burrows of the Pocket Gopher are commonly recognized and generally consist of a series of sand mounds over underground tunnels. The colloquial name "salamander" is probably a contraction of sandy-mounder, which refers to these characteristic signs of the Pocket Gopher. The tunnel system consists of a nest cavity, storage cavities and many exploratory tunnels. These are seldom deeper than four feet in the ground. The Pocket Gopher lives almost all its life alone in the tunnel system. Only during the breeding season is there any congregation and this lasts until breeding is completed. This animal is pugnacious and solitary by nature.

Pocket Gophers eat a variety of roots & herbaceous plants, as well as leaves of various species. This animal may be considered noxious in agricultural areas and in pastures. It is a serious pest where sweet potatoes are cultivated. It cuts up suitable roots into pieces and transports these in the cheek pouches to the storage chamber.

Breeding occurs throughout the year with peaks in March and July-August. Some females may produce two litters per year, and the average number of embryos per pregnant female is about 1.5. Sexual maturity is probably reached at approximately six months of age. Probably the only natural enemies of this animal are foxes, bobcats and certain large snakes.

Castor canadensis, Beaver

The Beaver is now found throughout Alabama and Georgia and its rapid expansion is due to reintroduction and protection. This large rodent may be found along rivers, streams or in lakes, wherever suitable water and food conditions prevail. In large rivers this species generally lives in burrows dug into the river bank while, in small streams and in lakes, the dens are typically beaver lodges of a conical shape protruding above the surface of the water. These lodges are constructed of small sticks and mud, and may be large enough inside to accommodate a man. In areas of sandy soil beavers are rare, since mud is not available for construction of the lodges and dams.

Sweet gum seems to be the preferred food item in most areas, with pine of secondary importance. Sweet gum trees are often cut down by the beaver, while the pine bark is usually stripped from standing trees. Tree bark and twigs are the winter food of the beaver. This animal will utilize almost any woody vegetation, herbaceous food, roots of water lilies or other aquatic macrophytes.

Alabama beavers breed from October through March and older females may bear two litters per year. The gestation period is about three months and the litter size averages two to eight young. The young weigh about one pound at birth and grow in the first year to about 15 to 25 pounds. Average weight of 71 adult males was 38 pounds, and of 80 females, 36 pounds (2). The young beaver stays in the den for approximately one month after birth and does not begin to breed until two years of age.

In Georgia, heaviest population densities are in the Flint River drainage. From records of the trapping-restocking program in Georgia (2), it was found that there is an average of 5.3 beavers per colony; these include an adult male and female, and young of the past two years. Beavers are trapped commercially for their pelts. Inhabitants in rural areas often kill these animals as sources of food. In some suburban areas this animal has become a nuisance with its dam building and subsequent flooding. Also, its affinity for girdling trees, and dam building, with resulting flooding, has caused problems to the forestry industry. Since this animal is so large and possesses a large set of continuous growing incisors, it has few natural enemies, resulting in its high population densities in certain areas.

Oryzomys palustris, Rice Rat

This rat is found statewide in Alabama and Georgia. This species prefers wet, marsh habitats. They require a dense cover of grass or sedges and so may be occasionally encountered in dry, upland, broomsedge fields. In salt marshes the Rice Rat may build a loosely constructed nest of Spartina leaves and stems in the tall Spartina bordering the tidewater channels. On land, nests are constructed of leaves and are placed on the ground surface or may be in shallow burrows.

These rodents feed on seeds of Tripsicum, Ehymus, Spartina and rice when available. Insects, young marsh wrens, small crustaceans and molluscs are also eaten.

Breeding occurs in Alabama in March through May with three to five offspring being born. The estrous cycle is 7.6 days and the gestation period is 25 days. A post-partum heat period is present in this species. Young develop rapidly; they are weaned at about 11 days and are sexually mature at 50 to 60 days of age.

Population of this rodent varies within fairly wide limits (2). Severe winter weather reduced populations on Breton Island, Louisiana, from a high of 7.2 mice per acre to 0.5 mice per acre in 1957 to 1958, and from 4.0 to 0.2 per acre in 1959 to 1960. Home range on Breton Island averaged 0.81 acres per male and 0.51 acres for females when determined by the inclusive boundary method. These rodents are preyed upon by hawks, owls, foxes and bobcats. They are not considered to be major economic pests because they are not found commonly in drier agricultural areas. However, in some localities they may burrow in dikes, dams and escarpments.

<u>Reithrodrontomys</u> <u>humulis</u>, Harvest Mouse

The habitat of the harvest mouse in Alabama and Georgia is abandoned fields in the late herbaceous and early broomsedge stages of old-field succession, roadside ditches and thickets, honeysuckle thickets, or wet meadows. The nest is generally a small globular clump of shredded leaves and plant fibers, usually placed in the ground or sometimes several inches above ground in a clump of grass. They are often captured in the same fields as cotton rats but, when the captures of cotton rats are high, the captures of harvest mice are low and vice versa, suggesting an antagonistic relationship.

Food habits of this species are poorly known. They eat small grass and herb seeds, and green sprouts of plants. Their ability to store food is limited.

Breeding probably does not occur during the winter in North Carolina, while in Florida breeding occurs throughout the year. The gestation period is about

21 to 22 days and litter size ranges from two to five young with a mean of three. Weaning occurs between the second and fourth week and females may become pregnant for the first time at 11 weeks of age.

There is no definite estimate of density of harvest mice over a year's time. Heavy trapping for this species in the Black Belt and in southeastern Alabama has been unproductive. This suggests that this small rodent is not a serious economic pest in these agricultural areas.

Peromyscus polionotus, Oldfield Mouse

This species occurs in dry, sandy habitat in Alabama and Georgia. It may be found on beaches, or sandy floodplains in the foothills. but is most common in the herbaceous stage of old-field succession, in sandy areas. The old-field mouse is an able digger and constructs a burrow system which may be quite extensive. The entrance tunnel is often marked by a mound of sand and is closed by a plug of sand approximately four inches from the opening when the mouse is in the nest. Besides these burrows, surface holes and tunnels may be used by these mice. Oldfield mice are nocturnal, spending the hot period of the day in the cool burrow.

The food of this species is primarily seeds of grass, herb and domestic grass, although insects may be utilized during periods when this food type is available. Seeds of Lespedeza, Diodia teres and Rumex acetosella are commonly utilized.

Breeding occurs throughout the year but reaches a peak in early winter (December to January). In the summer months, breeding is reduced. Females become sexually mature at about 30 days of age. After a gestation period of 22 days they bear an average of three young per litter. A post-partum breeding period may occur in this year.

Populations of oldfield mice vary considerably from habitat to habitat. At the Savannah River Project near Augusta, Georgia, densities ranged from 3.8 to 5.2 mice per acre (2). Numbers of mice were greatest from November to March and least in June and July.

The high reproductive rate and preference for agricultural region makes this species a serious economic pest. Carnivores, particularly the domestic cat, raptorial birds and certain large snakes serve to keep their population in check.

Peromyscus gossypinus, Cotton Mouse

The cotton mouse is found primarily in the Coastal Plain of Alabama and Georgia. It inhabits river-bottom woodlands, often living in areas subject to periodic inundation, and may be taken in upland hardwood forests. In dry woodlands they may be present in moist ravines. Nests are commonly built under fallen logs, in caves or crevices, in hollow cavities and under the decaying bark of windfalls. The name cotton mouse apparently comes from its propensity to use cotton as nesting material.

The cotton mouse feeds extensively on snails and insects. They also feed on seeds and nuts and during the winter this type of food probably assumes greater importance.

Breeding occurs throughout the year but is at a low ebb during the late spring and summer. Greatest reproductive activity is found in November through January. Females are polyestrous and have an estrous cycle of 5.26 days. There is a post-partum heat period in this species, so that gestation may extend from 23 days in non-nursing females to 30 days in nursing females. Litter size ranges from one to seven and averages four. Weaning occurs from

20 to 35 days after birth. Both males and females appear to be sexually mature at about 70 days of age.

The promiscuous mating habits and abundant food supply result in tremendous populations of this small rodent. Their numbers are kept in check by raptorial birds, snakes and carnivores. Population densities also follow the same trends as shown in other southeastern Peromyscus. Peak densities are reached in January and February and low densities occur in July and August. In east Texas population densities ranged from 0.3 per acre in September to 2.7 per acre in February (2).

Peromyscus nuttalli, Golden Mouse

The golden mouse is found in Alabama and Georgia in its preferred habitat of swampy woodlands, thick canebrakes and bottomlands with thick undergrowth. This species builds a globular nest in a fork of a shrub or tree several feet above the ground. Two nests may be constructed; the first is a tree nest used for shelter and for reproduction and the second is used as a feeding platform. This species is gregarious. Typical nests are constructed of tightly woven tree leaves on the outside, and animal hair, bird feathers, and shedded bark and leaves inside. The feeding platform may have only a shallow covering over the top and is often filled with shells of seeds.

Preferred food includes the seeds of sumac, wild cherry, dogwood, and greenbrier. Other seeds, fruits, and herbaceous materials are eaten. Golden mice have cheek pouches and can transport seeds readily.

The breeding season of golden mice is probably like that of other Peromyscus in the southeast. Females have a post-partum heat period and gestation period of 29 to 30 days when lactating. The litter averages two or three. The young are weaned at about three weeks of age and growth in weight and linear measurements level off at about five weeks. Mice born in October and November may reach maturity within one or two months and produce at least one litter before the summer.

Population densities vary considerably from area to area and from season to season. In Texas a high density of 2.2 mice per acre occurs in spring and a low of 0.3 mice per acre in summer (2). Peak densities occur in winter and harvest densities occur in summer. The average length of life of the golden mouse in the wild is about 6.5 months. The home range size, determined by the strip method, was about 1.42 acres for both sexes in Texas. It is not considered an economic pest because of its preference for heavily wooded areas. Raptorial birds, carnivores and snakes prey upon this small rodent.

Sigmodon hispidus, Cotton Rat

The cotton rat is the most abundant rodent statewide in Alabama and Georgia; yet it has definite habitat requirements. It is found only where the cover is sufficiently dense to provide it with some security against overhead predators and where succulent grasses and forbes are abundant. It is particularly common in thickets of honeysuckle or blackberries growing on field contours, in marshy areas, and in well developed broomsedge fields. The nest is usually constructed of grass and herbs and is placed in a hollow on the surface of the ground. These nests are actually a light ball of leaves, with an entrance to a soft, central chamber. Shallow burrow systems are also used, particularly along field contours and roadsides. From these nests a system of runways and piles of grass and herb cuttings are useful signs of cotton rat activity. Where cotton rats are very abundant all of the bare ground surface between grass clumps may be converted into runways.

The food habits and requirements of the cotton rat have been intensively studied in Georgia (2). In March, July and November, herbaceous plants (such as Lespedeza) were most commonly eaten, with grasses, such as purple-top and broomsedge, of second importance. Insects were important only during November. In addition, this species digs for roots and tubes.

This species has an estrous cycle averaging 9 days, but ranged from 4 to 20 days. The cotton rat is a post-partum breeder and copulation usually occurs three to six hours after partuition. The gestation period is about 27 days. The breeding season in northern and mid-Georgia extends from March to December. Samples from south Georgia are not sufficient to tell if the breeding season differs from that in the Piedmont (2). The average litter size is about five young. During times of low population densities, females carry an average of 4.1 embryos and during periods of high populations, the average is 5.7. Cotton rats wean their young between the ages of 15 and 25 days of age. The young appear in the runways when a week or less old (10 to 20 days) and begin to breed when two months or less in age.

Population densities of this species fluctuates widely, depending on the habitat, time of year, and environmental conditions (2 to 59 per acre). In high density years 76% of individuals trapped were juveniles, 18% were young adults, and 6% were old adults; while, in low density years, 55% were juveniles, 30% young adults, and 15% old adults. Peak densities are observed in the fall while low densities occur in the spring. Cotton rats live only a short time in the wild. In a Georgia study (2) only 13.2 percent of the individuals lived over six months; the oldest animal in this study was 9½ months old. A complete population turnover occurs in this species about every six months. In addition to seasonal changes in density and breeding, the size of home range also changes. Female home ranges are smallest during periods of reproductive activity (5,850 square feet to 0.13 acres) and male home ranges are at their maximum size during this period (17,380 square feet to 0.40 acres). The females appear to maintain a territory during the breeding season. The average home range size for adult males over the entire year was 0.28 acres and, for females 0.21 acres.

Cotton rats are of considerable economic importance since they may destroy quail eggs and chicks, and damage truck crops and pine plantations. Also, this species is a useful laboratory animal, particularly in research on typhus. Predatory birds, carnivores and large snakes prey upon these rodents.

Neotoma floridana, Eastern Wood Rat

This rat occurs in the Coastal Plain of Alabama and Georgia. The preferred habitat of the wood rat living on the Coastal Plain is dense vegetation bordering lowland swamps along rivers. Proper shelter is of very great importance to this species, since it has neither special arboreal nor fossorial adaptations. Its nest is generally made in the middle of a large cluster of sticks, leaves, and trash which may be six feet in diameter and four feet high. These clusters may be on the ground where they are often supported by a log, in a subterranean location under a stump, in a hollow log, in buildings, or even several feet in the air in a grapevine tangle. The wood rat also has stores of food near the nest and toilet areas, where the feces are deposited. All kinds of trash such as old tin, paper, and glass may be collected and stored.

In the Coastal Plain populations, breeding occurs throughout the year. Females are polyestrous with a cycle of four to six days and have a post-partum heat period. Gestation period varies from 33 to 42 days. Litter size is two or three. Weaning occurs at about 26 days. Females probably do not breed until one year old. In Kansas, populations vary considerably in density from year to year (2). In a declining Kansas population survival in juvenile to adult age classes was 11 percent and survival of adults from one year to the next was 64 percent. Raptorial birds, carnivores and large snakes are its predators. This species is not considered an economic pest.

Pitymys pinetorum, Pine Mouse

The pine mouse is found statewide in Alabama and Georgia. This rodent is fossorial, and lives in underground nests or in nests built beneath stumps, logs or stones. It occurs most commonly in wooded areas, in hardwood as well as pine forests. In Alabama it prefers agricultural areas to pine woodlands, being encountered in field terraces overgrown with honeysuckle or green brier and in old-fields covered with broomsedge. Many burrows or runways lead from the nest site. These may be as much as a foot below the soil surface or, more commonly, are immediately below the leaf litter. Small dirt piles may also be found outside the entrance to the burrows. Light soils or clay houses are necessary for this species, unless burrows of other mammals in heavy soils can be utilized.

The pine mouse is largely herbivorous. Bulbs, roots, and timbers are commonly used and may be stored in underground storerooms. Seeds, leaves and fruit are also utilized. Pine mice may be a severe pest in orchards, since they eat the bark off roots, and may girdle trees completely. Animal food, including other rodents, is also taken, but is less important.

Breeding occurs throughout the year. After a gestation period of about 20 days, a litter of two to four young is born. The young begin leaving the nest at about two weeks of age. The home range is fairly small (average diameter range 21 to 38 yards). In Georgia, populations of pine mice seem to be very low in most areas studied compared to a high of 250 mice per acre removed from an orchard in New York (2). The natural enemies of this species include foxes, weasels, the domestic house cat and owls.

Ordatra zibethica, Muskrat

The muskrat occurs abundantly along the waterways and marshes of Alabama and is less abundant in the Coastal Plain of Georgia. The muskrat requires water with an abundance of aquatic plants and molluscs, such as ponds, rivers and streams. Marsh habitat is optimum for this species. Typically, muskrats construct large lodges of cattails and sedges in marsh habitat. In flowing water situations, this dwelling is uncommon and the muskrat relies on bank burrows to provide shelter and nesting sites. These burrows may have several entrances and penetrate into the ground about five feet. The entrances are 6 to 12 inches below the water level and the tunnel rises above the water level into two or more nest cavities. Several muskrats may live in one of these burrow systems.

The food habits of muskrats are quite variable. In summer, roots, stems, leaves, and fruit of aquatic plants, together with vegetable crops in adjoining fields and plant materials from woodlands, are important. In winter, roots of aquatic plants and clams, fish, crayfish, and other animal foods may be used.

In Alabama and Georgia, the muskrat breeds throughout the year, although breeding probably is diminished in December and January. Two or more litters may be produced in one year, after a gestation period of 29 to 30 days. The average litter size is six to seven young and varies from one to eleven. The young grow rapidly and are able to take care of themselves when over one month old.

Populations of muskrats vary greatly and are dependent upon environmental conditions, food supply, and predators. Greatest densities are reached in marsh habitat and lowest densities in streams. In Alabama farm ponds, captures of as many as nine muskrats per acre of pond are reported which compares favorably with some of the best natural muskrat marshes (2). During the trapping season 70 percent of these Alabama populations were young-of-the-year. Muskrats do not move much during the summer and winter periods; the average distance between points of capture of farm pond muskrats was 50 yards, and the maximum 500 yards in Alabama. In the spring and fall, movement occurs between ponds and between streams.

Economically, the species is valuable for its pelage and the important role it plays in marshland ecology. Mink, weasel, fox, bobcat, marsh hawk, and owls, and man prey upon this rodent.

Vulpes fulva, Red Fox

The red fox is found commonly in all of Alabama's 67 counties, with a spotty occurrence on the Coastal Plain of Georgia. The red fox prefers more open habitat than does the gray fox. However, both species may occur together. The red fox has been widely introduced by sportsmen.

This species usually dens in a ground burrow, which has an entrance approximately 15 inches high and may be as much as 75 feet long and as much as 14 feet beneath the ground surface. The red fox generally chooses a sandy soil, or other soft material such as sawdust, to dig its den. The main dens are dug in late winter, before the young are born, and are situated near open areas. It is common for more than one family to den together.

The home range of the red fox varies with the season. In the spring there may be local movements to denning sites and during the time the young remain with the parents. Until October, the range is about two miles in diameter. In the fall the adult males and the pups disperse and may travel 15 or more miles from the den site.

The red fox is monestrous, with one breeding period a year; most breeding occurs from January to February. This species breeds the first year after their birth. The gestation period is 49 to 55 days and the litter size ranges from one to ten pups.

The red fox is more carnivorous than the gray fox, feeding primarily on rabbits, mice and rats, poultry and other birds. It is a major vector of rabies and also carries numerous external parasites.

Uroyon cinereoargenteus , Gray Fox

The gray fox is found commonly throughout Alabama and Georgia. It reaches its greatest abundance in areas having a diversity of fields and woods. Areas supporting cultivation and woods had greatest gray fox populations; Savannah pine lands were next important, and wooded areas with dense underbrush were the least used habitat types. The dens are usually located in dense cover and near water. Slash piles are a favorite den site, but hollow logs, rock cavities, and dense brush may be used.

In Georgia the population structure and dynamics of the gray fox was studied on the Coastal Plain (2). Population levels were relatively constant throughout the Coastal Plain from year to year - 14% of the traps in spring were successful, 12% in summer, 23% in fall, and 22% in winter. The age structure determined by tooth wear was also relatively constant - 61% less than one year old, 28% one year, 7% two years, 2% three years, and 2% four years old.

Sexual maturity is reached during the first year. Breeding extends from December to March, with a peak in breeding occurring in late January and early February. The gestation period is 53 days, so that whelping occurs from late March through May. An average of 4.5 embryos are carried per female. Juveniles reach adult weight by 5 to 6 months of age.

Rodents and birds, primarily Galliformes are the main foods. The gray fox has no natural enemies except man and feral dogs. Like the red fox it is an important vector for rabies and blood borne diseases.

Procyon lotor, Raccoon

The raccoon is found abundantly statewide in Alabama and Georgia. It occurs in many different habitats. In farm land and mixed woodlands, they prefer the bottomlands, where plentiful den trees are available, and range over the uplands for food. However, they are also common where den trees are not available, utilizing rock cliffs, caves, or ground burrows for dens. They are extremely common in fresh or salt marshes. Generally the raccoon will den singly; however, during the breeding season, males and females will be found together and, of course, the young will be with the mother during their early life.

At nightfall the raccoon leaves its den to range for food. Ranges of individual raccoons may overlap, and these mammals seem to be tolerant of others and do not defend territories. Home range of 87 Michigan raccoons were 503 acres for adult males, 268 acres for adult females and juvenile males, and 111 acres for juvenile females (2). Densities vary from one per 16 acres to 46 acres.

The food habits of the raccoon are varied. Important plant foods are persimmon, pecans, grapes, and corn. Animal food includes crayfish, insects, birds, snails, fish and small mammals.

In the southeast the breeding season extends from February to August. The gestation period is 63 days and the average litter size is about three. The young are born within a period from April to October. Females produce one litter per year.

Raccoons are valuable for their pelts and are trapped by the thousands each year by local trappers. Their flesh is palatable but usually not desired; however, it furnishes a staple part of the diet of many rural residents.

Sportsmen value the raccoon for its ability to evade hounds, as it is a strong runner and is quick to rely on running to lose its pursuers.

Mustelo frenata, Long-tailed Weasel

The long-tailed weasel is found statewide in Alabama and Georgia. Due to its highly secretive behavior, it is rarely seen or captured. This weasel prefers to live in the drier parts of the timbered swamps and bottomlands. The den is generally located in a shallow burrow in the ground, under a stump, or in a burrow made by another mammal. Mouse fur, leaves and dry grass are used for nesting material.

This species ranges out into grassfields and brushland for its food during the evening. Small mammals such as cotton rats, wood rats, chipmunks, shrews, and rabbits form the major food items. In addition, small birds, snakes, and insects are eaten. Weasels are well adapted to the carnivorous habit since they are very quick and nervous, have a long narrow body capable of entering small holes and have an instinct to kill wherever a prey animal is encountered. Their mode of killing is to bite the prey animal at the base of the skull or at the throat. The weasel generally proceeds to eat the brains first and then works backwards, leaving the skin and larger bones.

The females of this species mate when three to four months old, while the males do not become sexually mature until they are about one year old. Breeding occurs in April and May and the fertilized embryos remain as blastocysts in the uterus for 205 to 337 days until they become implanted 21 to 28 days before birth. Parturition occurs in mid-April. The four to eight young per litter are weaned when five to six weeks old and remain with the parents until mid-summer.

Population estimates of weasels are rarely made. In Iowa, on typical farmland, densities ranged from two per 5.5 acres in weed patches, one per 10 acres in oat stubble and ragweed, and two per 28 acres in sweet clover fields (2). Commercially, the weasel is important for its fur, which is exceeded in value only by that of the mink.

Mustela vison, Mink

The mink occurs statewide in Alabama and Georgia in thick, bushy banks along creeks and rivers. It makes its den among the roots of a tree or in muskrat lodges or burrows.

For food the mink consumes animals such as rodents, rabbits, fish, frogs, aquatic insects, snakes and birds. Where muskrats occur these may also form an important part of the mink's diet.

The breeding season occurs in March and there may be three heat periods lasting about two days and occurring at intervals of eight to nine days. Ovulation is induced by coitus and occurs 42 to 50 hours afterwards. The gestation period averages about 50 days. The litter of 4 to 10 young are weaned in five weeks and remain with the parents until mid-summer.

In Georgia, mink populations are low in the Piedmont and mountain regions but increase on the Coastal Plain. Populations are especially high on the lower Coastal Plain and in the salt marshes. The harm that minks may do in destroying other forms of wildlife is offset greatly by their valuable pelts.

Spilogal putorius, Spotted Skunk

This skunk occurs statewide in Alabama and Georgia. This common carnivore occurs in the vicinity of farms and wastelands, where it often dens beneath buildings or in deserted mammal or gopher tortoise burrows. Since the spotted skunk climbs well, it may sometimes be found dening in trees. It is primarily nocturnal and is noticeably active on cold winter evenings. Its small tracks often are observed in the stream beds and around cultivated fields.

This skunk is an omnivore and may eat small mammals, insects, fruit, nuts, birds and reptiles.

Skunks are polygamous and one male usually mates with many females each year. The spotted skunk breeds in early spring and the four to five young are born in early summer. Skunks are trapped commercially for their pelts.

Mephitis mephitis, Striped Skunk

This skunk is found statewide in Alabama and Georgia. It is abundant in agricultural land and in open wasteland rather than in dense forest. This species builds a nest of dried grass in old mammal burrows, under buildings, or in other sanctuaries. Several skunks may congregate in one nest. At nightfall they emerge to hunt for food. The striped skunk is omnivorous and eats small mammals, insects, and fruit. In summer the diet is mainly composed of fruit and insects, while in winter small mammals and carrion are important.

Breeding occurs in early spring and the four to seven young born in late May, after a gestation of 62 days. This species is valuable for its pelts and ability to destroy agricultural pests.

Lutra canadensis, River Otter

The otter is fairly common on the Coastal Plain in the salt marshes. This aquatic mammal is an expert swimmer and diver and can travel for long distances beneath the water. Usually they travel in families or mating pairs. The den is located in the banks of a stream and generally has more than one entrance, usually beneath the water line.

The diet of these otter consists of any animal that can be caught. Carp, suckers, sunfish and catfish are the fish most commonly eaten.

Crustaceans, molluscs, small snakes and water birds are also consumed. This animal is a rigidly protected fur bearer.

Lynx rufus, Bobcat

The bobcat is found statewide in Alabama and Georgia. It is a secretive mammal and is seldom seen. This cat travels in river bottom swamps and brush and dens in hollow logs, under rock ledges, and in thickets. In a study in west central South Carolina (7), the home ranges for three bobcats were as follows: (1) an adult female had an approximate range of 1,142 acres; (2) a young male had an approximate range of 886 acres; (3) a young female had an approximate range of 610 acres.

Breeding may occur throughout the year, but a peak probably occurs in the spring. Females, which do not breed in the first heat period, come into heat a second time. After a gestation period of from 50 to 60 days, one to four young are born. The kittens nurse for about two months before going on a meat diet.

The food of the bobcat is almost exclusively meat, primarily rabbits and rodents. This animal is an economic benefit since it takes a high toll of these pests. The bobcat is a very good climber and is more than a good match for a dog in a fair fight.

Odocoileus virginianus, White-tailed Deer

This deer is common to abundant statewide in Alabama and Georgia. This remarkably, adaptable animal is capable of living in deep forests, swamps, and open farm land with scattered woodlots. The optimum habitat is the brushy stage of forest reproduction, where young trees and shrubs provide a variety of food and cover. However, if small woodlots are available to provide shelter during the day, deer can survive in close proximity to man. This assumes, of course, that hunting and wild-running dogs are controlled. Deer are most active during the early evening and early morning and usually bed down in a sheltered place during the day and middle of the night.

White-tailed deer are primarily browse feeders; that is, they bite off the leaves and tips of twigs from shrubs and trees. Besides these woody plants, they also graze on grass and forbes and relish mushroom, fruit and berries. Preferred food types include greenbrier, black gum, flowering dogwood, maple, white oak, sumac, and sweet gum.

The breeding season of Alabama and Georgia deer ranges from November to February, with a peak occurring in December. After a gestation period of 196 - 203 days, fawning occurs. In Alabama peak fawning occurs in August. By one to two weeks a fawn is able to outrun and evade capture by man. Weaning occurs at three and one-half years old; however, there are numerous reports of fawns breeding their first winter. Since most of the deer are in the young age classes, the average production for the herd is often less than 2.0 fawns per acre. Deer seldom live longer than 10 years in the wild.

In Henry and Houston Counties, particularly along the Chattahoochee River, deer population level is below the environmental capacity (9). This phenomenon is also prevalent in Early County only along the river floodplain. The major mortality factors appear to be predation by wild-running dogs and illegal hunting. Screwworm (Cochliomyia americana) may have reduced population in extreme southern counties of Alabama and Georgia, but this parasite is presently under control. The gene pool of the native whitetail deer has been diluted with stocked animals primarily from the Lake States and North Carolina.

REFERENCES (MAMMALS)

1. Alabama Department of Conservation and Natural Resources, Rare and Endangered Vertebrates of Alabama. 1972.

2. Golly, F. B. Mammals of Georgia. University of Georgia Press, Athens. 1962.

3. Hamilton, W. J. The Mammals of Eastern United States. Comstock Publishing Co., Ithaca, N.Y. 1943.

4. Hill, E.P. III. The Cottontail Rabbit in Alabama. Alabama Agricultural Experiment Station, Auburn University Bulletin 440. 1972.

5. Hollimon, D.C. The Mammals of Alabama. unpublished Ph.D. dissertation. University of Alabama, Tuscaloosa. 1963.

6. Johnson, A.S. Biology of the Raccoon (Procyon lotor) in Alabama. Alabama Agricultural Experiment Station, Auburn University Bulletin 402. 1970.

7. Marshall, A.D. and J.H. Jenkins. "Movements and Home Ranges of Bobcats as Determined by Radio-tracking in the Upper Coastal Plain of West-central South Carolina". Proceedings of the 20th Annual Conference Southeastern Association of Game and Fish Commissioners. 1966.

8. Pelton, M.R. and J.H. Jenkins. "Productivity of Georgia Cottontails." Proceedings of the 25th Annual Conference Southeastern Association of Game and Fish Commissioners. 1970.

9. Southeastern Cooperative Wildlife Disease Study. Map of Deer Density Relative to Environmental Capacity. University of Georgia, School of Veterinary Medicine, Athens. 1970-71.

APPENDIX 2

1.0 INTRODUCTION

A mathematical model has been developed to estimate environmental distribution of radioactive effluents and resultant doses to man and other organisms. Figures 1, 2 and 3 of this appendix are schematic representations of this model. In the figures, and in subsequent descriptions in this appendix, the model is divided into three parts. They are the distribution of radioactive materials in atmospheric effluents and resultant doses to man, and doses to organisms other than man. Dashed lines in the figures indicate that calculations are too complex to be included in the figure. These more complex calculations are thoroughly described in the text of this appendix.

2.0 DOSE TO MAN FROM ATMOSPHERIC EFFLUENTS

2.1 Pathways Evaluated

The model estimates dose to man from each of the following atmospheric effluent pathways:

1. exposure to direct radiation from airborne radioactive materials
2. inhalation of airborne radioactive materials
3. exposure to direct radiation from radioactive material deposited on soil
4. ingestion of radioactive materials in milk
5. ingestion of radioactive materials in vegetation

2.2 Concentration of Radioactive Materials in Air

Meteorological models are used to determine the atmospheric dispersion coefficient, X/Q ($\sec/m^3$) for each of 160 points within a 50 mile radius of the reactors. The ground-level air concentration of an isotope at any point is calculated by using the value of X/Q for that point in the following equation:

$$C_a = 3.17 \times 10^{-8} (Q_a) (X/Q) \tag{1}$$

where:

C_a = ground-level air concentration of an isotope (uCi/cc)

3.17×10^{-8} = units conversion constant (yr/sec)

Q_a = atmospheric release rate of an isotope (Ci/yr)

X/Q = atmospheric dispersion coefficient ($\sec/m^3$)

2.3 Rate of Deposition of Airborne Radioactive Material on Vegetation

The deposition velocity, V_d (m/sec), is an empirically derived term which relates long-term ground-level air concentration to the rate of deposition on vegetation (per unit area basis). Although the deposition velocity varies with a number of factors, such as chemical activity of the isotope, wind speed, and vegetation density, a value of 0.01 m/sec has been used for all iodine isotopes in atmospheric effluent.(1) Radioactive noble gases are presumed not to deposit on vegetation. The equation used to calculate deposition rate is:

$$R_d = 1.0 \times 10^6 \ (Q_a)(X/Q)(V_d) \qquad (2)$$

where:

R_d = rate of deposition on pasture, crops and other vegetation (uCi/m^2-yr)

1.0×10^6 = units conversion constant (uCi/Ci)

V_d = deposition velocity (m/sec)

and other terms as previously defined.

2.4 Accumulated Deposition on Pasture and Crops

The estimate of accumulated deposition on crops and pasture assumes constant rate of deposition and a first-order loss process due both to radioactive decay and field loss. The field loss process includes all variables that reduce deposition as a function of time except radioactive decay. These include weathering, dilution by new growth and other factors. This process has been found to be a first-order rate process with a half-time of approximately 14 days which appears to be relatively independent of chemical form, mode of deposition, and other factors.(2) The rate of change of accumulated deposition is described by the following equation:

$$\frac{d(D_v)}{dt} = R_d - (\lambda_r + \lambda_f) \ D_v \qquad (3)$$

The solution to this equation for accumulated deposition at the end of the life of the power plant is:

$$D_v = \frac{R_d}{\lambda_f + \lambda_r} \quad 1 - \exp\ (-(\lambda_f + \lambda_r)\ L) \qquad (4)$$

where:

D_v = accumulated deposition on pasture and crops at the end of the life of the power plant (uCi/m^2)

λ_f = field loss constant (yr^{-1}) equivalent to a field loss half-time of 14 days

λ_r = radiological decay constant (yr^{-1})

L = power plant life (yr)

and other terms remain as defined previously. In these evaluations, L is arbitrarily assumed to be 40 years.

2.5 Accumulated Deposition on Soil

The estimate of accumulated deposition on soil assumes that all radioactive material linitially deposited on crops soon moves to the soil from which it is lost only by radioactive decay. By analogy with the development in the preceeding paragraph, the equation for accumulated deposition after a reactor life of L years is:

$$D_s = \frac{R_d}{\lambda_r} \quad 1 - \exp(-\lambda_r L) \qquad (6)$$

where:

D_s = accumulated deposition on soil ($\mu Ci/m^2$)

and other terms remain as previously defined.

2.6 Concentration of Deposited Radioactive Material in Vegetation Eaten by Humans

The calculation assumes that concentration in edible vegetation derives partly from direct deposition and partly from uptake from soil. The direct deposition part of the calculation assumes that only a fraction, F_r, of the accumulated deposition is retained on edible portions of the vegetation. The value of F_r is taken to be 0.25.(3) The concentration in vegetation is then calculated by assuming that the accumulated deposition on edible vegetation, expressed in unit area terms, is distributed in the wet weight yield of edible vegetation from the same unit area. A representative value for wet weight vegetation yield, 800 grams/m^2, was selected.(4) The soil uptake part of the calculation assumes that the accumulated soil deposition in one m^2 area is distributed through a plow layer 10 cm deep with a density of 2.2 grams dry soil/cm^3 This gives an areal soil density, K_{soil}, of 2.2×10^5 grams/m^2. Concentration factors relating the concentration of a nuclide in vegetation to the concentration in soil are available.(5) These factors are based upon stable element analyses for most isotopes. The value of the concentration factor, F_v, used for iodine isotopes is 2.0×10^{-2} gm dry soil/gm wet vegetation.(6) The equation used to calculate concentration in edible vegetation is:

$$C_v = \frac{(F_r)\ (D_v)}{Y} + \frac{(F_v)\ (D_s)}{K_{soil}} \qquad (6)$$

where:

C_v = concentration in edible vegetation (μCi/gm wet wt)

F_r = fraction of accumulated deposition retained on edible tissues (dimensionless)

Y = yield of edible vegetation (gm wet wt/m^2)

F_v = uptake from soil to edible vegetation (gm dry soil/gm wet vegetation)

K_{soil} = areal density of soil in a 10 cm plow layer (gm dry soil/m^2)

and other terms remain as previously described.

2.7 Concentration of Deposited Radioactive Material in Milk

For iodine isotopes, uptake from soil to pasture grass is not significant. For these isotopes, literature values of constants relating accumulated deposition on pasture to concentration in milk are used. The value for iodine isotopes is $9.0 \times 10^{-5} \mu Ci/cm^3$ per $\mu Ci/m^2$.(7)

$$C_m = (F_{md})(D_v) \tag{7}$$

where:

C_m = concentration in milk ($\mu Ci/cm^3$)

F_{md} = factor relating accumulated deposition to concentration in milk ($\mu Ci/cm^3$ per $\mu Ci/m^2$)

and other terms remain as previously defined.

2.8 Diet and Living Habits

Diet and living habit assumptions affecting estimates of individual and population dose estimates are presented in Section 4.5. These factors include breathing rates, food consumption rates, and occupation times.

2.9 Dose Estimates

Preceding sections describe the distribution of atmospheric effluents in the environment in terms on concentration ($\mu Ci/cm^3$ or $\mu Ci/gm$) in materials inhaled or ingested by humans or in terms of areal deposition ($\mu Ci/m^2$) on surfaces occupied by humans. The discussion relating these quantities to dose is presented in three sections, each corresponding to one exposure mode: direct radiation, ingestion, and inhalation.

The annual direct radiation dose from an isotope deposited on soil is calculated using the following equation:

$$\text{Dose} = (D_s)(F_{dd})(T_o) \tag{8}$$

where:

Dose = annual dose (mrem/yr)

F_{dd} = factor relating dose rate to accumulated deposition on soil (mrem/hr per $\mu Ci/m^2$)

T_o = occupation time (hr/yr)

and D_s has been defined previously.

Values used by Soldat to estimate the total body dose rate one-meter above the surface are used for F_{dd}.(8) The values assume a surface roughness factor of 0.5. F_{dd} is taken to be the value for sodium-24 if Soldat does not list a value for an isotope in question. The value for sodium-24 is selected because it is unusually high and would be likely to overestimate the dose. In this report, it is assumed that the dose to individual organs from deposition on soil will be the same as total body dose.

A semi-infinite plume model is used to calculate direct gamma radiation dose from nuclides in gaseous effluent, and an infinite cloud model is used to calculate beta dose to the skin.(9) Total direct dose for the total body and each internal organ is considered to be the same as the gamma whole body dose. Total skin dose is taken to be the sum of the skin beta dose and the whole body gamma dose.

The annual radiation dose from ingestion of radioactive material is estimated by the following equation:

$$\text{Dose} - 365(C_i)(R_c)(F_{di}) \tag{9}$$

where:

365 = units conversion constant (days/yr)

C_i = concentration in ingested material C_b, C_m, C_v, etc. (μCi/gm wet wt or μCi/cm^3).

R_c = rate of ingestion (gm/day or cm^3/day)

F_{di} = factor relating annual dose to annual isotope intake by ingestion (merm/yr per μCi/yr)

and Dose remain as defined previously.

Values for F_{di} are based upon ICRP recommendations.(10) ICRP 2 lists concentrations in water which will result maximum permissible occupational organ doses in the 50th year of consumption of 2,200 cm^3/day. Concentrations are listed for each of several important organs for each reactor effluent isotope likely to be a significant contributor to dose to man and other organisms. The following equation is used to calculate F_{di}:

$$F_{di} = \frac{D_{ref}}{(C_{ref})\ (2,200)\ (365)} \tag{10}$$

where:

D_{ref} = ICRP recommended maximum permissible dose to a specified organ of an adult exposed occupational (mrem/yr)

C_{ref} = ICRP recommended concentration of an isotope in water which, if consumed by an adult at the rate of 2,200 cm^3/day for 50 years, will result in a 50th-year dose of D_{ref}mrem to the specified organ ($\mu Ci/cm^3$)

2,200 = Adults water consumption rate used by the ICPP (cm^3/day)

365 = units conversion constant (days/year)

The ICRP gives values of C_{ref} for the thyroid and skin for only a few isotopes. For other isotopes, values of F_{di} for the thyroid and skin are assumed to be equal to the value of F_{di} for the total body. For some isotopes, ICRP 2 may give values of C_{ref} for certain organs, but not for all of the organs to be considered in this evaluation. For these organs, the lowest value of C_{ref} listed for other organs is taken as C_{ref} for the unlisted organs. For some isotopes, ICRP 2 lists no values for C_{ref}. These isotopes are usually extremely short-lived and are expected to be present in reactor effluents only in low concentrations. Thus, they are not likely to contribute significantly to the dose to man or other organisms. For these isotopes C_{ref} was taken as $3.0 \times 10^{-5} \mu Ci/cm^3$, the ICRP recommendation for the maximum permissible concentration in drinking water consumed by adult radiation workers at the rate of 2,200 cm^3/day. Use of this value assures that dose contributions from these isotopes will be overestimated.

The description thus far has been limited to doses to adults. This evaluation assumes that doses to children will not differ significantly except for thyroid doses from iodine isotopes. USAEC 10CFR20 maximum permissible concentrations of soluble iodine isotope concentrations in water are based upon recommendations of the Federal Radiation Council (FRC).(11) An infant consuming 1,000 cm^3/day of water containing any one soluble iodine isotope at a concentration equal to the 10CFR20, Appendix B, Table II, Column 2 maximum permissible concentration for that isotope would receive 500 mrem/year to his thyroid. Values of F_{di} for the infant thyroid dose from ingestion of iodine isotopes are calculated by the following equation:

$$F_{di} = \frac{500}{(PMPC_w)\ (1,000)\ (365)} \qquad (11)$$

where:

500 = FRC population dose limit for the thyroid (mrem/yr)

$PMPC_w$ = 10CFR20, Appendix B, Table II, Column 2 maximum permissible concentration of soluble iodine isotopes in water consumed by the public ($\mu Ci/cm^3$)

1000 = infant consumption rate used by USAEC to derive $PMPC_w$ for iodine isotopes (cm^3/day)

365 = units conversion constant (days/yr)

The annual radiation dose to a specified organ from inhalation of an isotope is calculated in a manner analogous to that used for ingestion:

$$\text{Dose} = 365\ (C_a)(R_b)(F_{db}) \qquad (12)$$

where:

Dose = annual dose (mrem/yr)

365 = units conversion contant (day/yr)

C_a = concentration of an isotope in air (μCi/cm^3)

R_b = breathing rate (cm^3/day)

F_{db} = factor relating annual organ dose to annual intake of an isotope by inhalation (mrem/yr per μCi/yr)

Values for F_{db} are, as before, based on ICRP recommendations.$^{(12)}$ Values are calculated using the following equation:

$$F_{db} = \frac{D_{ref}}{(C_{ref})(2.0 \times 10^{-7})(365)} \qquad (13)$$

where:

D_{ref} = ICRP recommended maximum permissible dose to a specified organ of an adult occupationally exposed to radiation (mrem/yr)

C_{ref} = ICRP recommended concentration of an isotope in air which, if breathed by an adult at the rate of 2.0×10^7 cm^3/day for 50 years, will result in a 50th-year dose of D_{ref}mrem to the specified organ (μ Ci/cm^3)

$2.0\text{x}10^7$ = adult breathing rate assumed in ICRP calculations (cm^3/day)

365 = units conversion constant (days/year)

As before, if ICRP 2 gives no values of C_{ref} for the thyroid and skin, values of F_{db} are assumed equal to the value of F_{db} for the total body. If ICRP 2 gives no values of C_{ref} for other organs, the lowest value of C_{ref} listed for other organs is taken as the value of C_{ref} for the unlisted organs.

As with ingestion, inhalation doses to children are assumed not to differ substantially from inhalation doses to adults except for thyroid doses from iodine isotopes. USAEC 10 CFR20 maximum permissible concentrations of soluble iodine isotopes in air are also based upon recommendations of the FRC.$^{(12)}$ The AEC evaluations estimate than an infant breathing 3.0×10^6 cm^3/day of air containing any one soluble iodine isotope at a concentration equal to the 10CFR20, Appendix B, Table II, Column 1 maximum permissible concentration for that isotope would receive 1,500 mrem/year to his thyroid.$^{(13)}$ Values of F_{db} for the infant thyroid dose from inhalation of iodine isotopes are calculated by the following equation:

$$F_{db} = \frac{1500}{(PMPC_a)(3.0 \times 10^6)(365)}$$

where:

1500 = FRC individual dose limit for the thyroid (mrem/yr)

$PMPC_a$ = 10CFR20, Appendix B, Table II, Column 2 maximum permissible concentration of an isotope in air breathed by individuals in the public ($\mu Ci/cm^3$)

$3.0x10^6$ = infant's breathing rate used by USAEC to derive $PMPC_a$ for iodine isotopes (cm^3/day)

365 = units conversion constant (days/yr)

3.0 DOSE TO MAN FROM LIQUID EFFLUENTS

3.1 Pathways Evaluated

The model estimates dose to man from each of the following liquid effluent pathways:

1. exposure to direct radiation from waterborne radioactive materials (boating and swimming)
2. ingestion of radioactive materials in drinking water
3. ingestion of radioactive materials in aquatic organisms (fish, molluscs, crustacea, plants)
4. exposure to direct radiation from radioactive materials deposited on sediments

3.2 Concentration of Radioactive Material in Receiving Water

For sites located on rivers with small mixing zones out of the influence of tidal effects, instantaneous and complete dilution of liquid effluents in the river is assumed. The following equation is used to calculate concentration in receiving water:

$$Cw = \frac{Qw}{Rw} \quad (15)$$

where:

Cw = concentration of an isotope in receiving water ($\mu Ci/cm^3$)

Qw = release rate of the isotope to receiving water ($\mu Ci/yr$)

Rw = annual average river flow rate (cm^3/yr)

3.3 Concentration of Radioactive Materials in Organisms Inhabiting Receiving Water

The following equation is used to calculate concentrations in aquatic organisms:

$$C_w = (C_w)(F_{ao}) \qquad (16)$$

where:

C_{ao} = concentration of an isotope in aquatic organism (μCi/gm wet wt)

F_{ao} = factor relating concentration of an isotope in an organism class to concentration of the isotope in water (μCi/gm wet wt per μCi/cm^3)

and C_w remains as previously defined.

This calculation is performed for a number of organism classes including fresh water fish, plants, crustacea and molluscs, and salt water fish, plants, crustacea, and molluscs. Values of F_{ao} differ with organism class and isotope. Values are listed in Section 5.2.

3.4 Accumulated Deposition on Receiving Water Sediments

The method of Fletcher and Dotson is used to calculate sediment concentration.(14) The equation is:

$$C_{sed} \quad \frac{Q_W}{R_s + R_W/F_{dist}} \qquad (17)$$

where:

C_{sed} = concentration in sediment (μCi/gm)
Q_W = average annual rate of discharge to receiving water (μCi/yr)
R_s = annual average rate of sediment transport (gm/yr)
R_W = average annual river flow rate (cm^3/yr)
F_{dist} = distribution coefficient relating concentration in sediment to concentration in water (μCi/gm per μCi/cm^3)

Values selected for F_{dist} are those used in the USAEC "Year 2000" study.(15) The study lists values for all important isotopes in reactor effluents. If the study lists no value for an isotope in question, the value for cobalt-60, an unusually high value, is used.

The development thus far gives concentrations in sediments. It is desirable to convert this to accumulated deposition on an activity per unit area basis. For an isotope emitting 1.2 Mev gamma radiation, the exposure rate at a point above a 20 cm thick slab of sediment containing uniformly distributed isotope is approximately the same as the exposure rate at the same point before an infinity thick sediment slab, assuming a sediment density, K_{sed}, equal to 2.4 g/cm^3, the value for concrete. Thus, any radioactive material below a depth of 20 cm will not contribute appreciably to the dose at or above the surface of the slab. Concentration is converted to deposition by assuming that all of the activity in a 20-cm thickness of sediment is concentrated in a thin layer at the surface. Deposition on sediment is calculated by the following equation:

$$D_{sed} = 2.0 \times 10^5 (C_{sed})(K_{sed}) \tag{18}$$

where:

D_{sed} = accumulated deposition of an isotope on receiving sediment (μCi/m^2)

2.0×10^5 = volume per unit area in a 20 cm sediment slab (cm^3/m^2)

C_{sed} = sediment concentration (μCi/gm)

K_{sed} = sediment density (gm/cm^3)

For sites not located on simple river systems, it is assumed that the accumulated inventory of isotopes released to receiving water is distributed over an area in which sedimentation processes are most likely to be significant. This area is determined by site-specific conditions such as receiving water concentration isotopes.

3.5 Diet and Living Habits

Values used for consumption rates and occupation times for people exposed to radiation in certain pathways are listed in Section 4.5 of the ER.

3.6 Dose Estimates

For liquid effluents there are dose calculations for three modes of exposure; direct radiation from water (swimming or boating), direct radiation from deposited radioactive material, and ingestion of water or food. The dose calculations for direct radiation from deposited radioactive material and for ingestion of water or food are described in Section 2.10 of this appendix.

The following equation is used to calculate annual dose due to direct radiation from water-borne materials:

$$\text{Dose} = (C_w)(T_o)(F_{dw}) \tag{19}$$

where:

Dose = annual dose (mrem/yr)

C_w = water concentration μCi/cm^3

T_o = occupation time (hr/yr)

F_{dw} = factor relating organ dose rate from complete submersion in water to concentration of an isotope in water (mrem/hr per μCi/cm^3)

Values for F_{dw} for the skin and total body are available for most important isotopes in reactor effluents.(16) The atypically high values for sodium-24 are used for isotopes not listed. This evaluation assumes that doses to internal organs are the same as total body dose. In calculating dose to a boater, the total body dose rate is assumed to be one-half that received by a swimmer since the boater is exposed to a semi-infinite source. The dose to a boater's internal organs and skin is assumed to be equal to his total body dose. The boat's structural materials are assumed to absorb all beta radiation from the water, but no gamma radiation.

4.0 DOSES TO ORGANISMS OTHER THAN MAN

This section describes calculations used to estimate doses to organisms other than man. Methods used for aquatic organisms differ from those used for terrestrial organisms, so each is described separately.

4.1 Doses to Aquatic Organisms

Aquatic organisms are exposed to direct radiation from water-borne isotopes. Estimates of external dose to aquatic organisms are derived from estimates of whole body dose to swimmers. Dose rates are assumed to be the same for both. The estimate of dose to the aquatic organism assumes that the organism is fully submerged 8,760 hours per year.

Internal doses to aquatic organisms are calculated from the isotope concentrations in the organism. The calculation of isotope concentration in the aquatic organism is described in part 3.3 of this appendix. The dose to an organism is given by the equation:

$$\text{Dose} = 1.87 \times 10^4\ C_{ao}\ \ E_{eff} \qquad (20)$$

where:

Dose = annual internal dose (rads/year)

1.87×10^4 = units conversion constant

$$\frac{\text{gm - disintegration - rad}}{\text{Mev - } \mu\text{Ci - yr}}$$

C_{ao} = isotope concentration in the aquatic organism (μCi/gm wet wt)

E_{eff} = average energy deposited in the organism for each disintegration (Mev/disintegration)

The value of E_{eff} depends upon the size of the organism if the organism is small. For this reason, values of E_{eff} for a one-kilogram spherical mass of tissue were used to assure that doses would not be underestimated. Values used were values listed by the ICRP as absorbed energy per disintegration for the human lung.(18)

In calculating values for the human lung, the ICRP assumed the lung could be represented by a 1,000 gm spherical mass of tissue with a diameter of ten centimeters. The ICRP does not list values of E_{eff} for some short-lived isotopes in reactor effluents. For these isotopes, the decay scheme was examined and a suitable conservative value, such as the maximum beta energy per disintegration, was selected as E_{eff}.

4.2 Doses to Terrestrial Organisms

Terrestrial organisms are exposed to direct radiation from radioisotopes in the gaseous effluent plume and from radioisotopes deposited on soil. It is assumed that the external dose to a terrestrial organism will be the same as the total body dose to the man receiving the highest off-site doses from these sources.

The estimate of isotope concentration in the terrestrial organism assumes that the organism has reached an equilibrium concentration of each isotope determined by a constant rate of intake and a rate of decay proportional to the accumulated burden. The following equation is used to estimate concentration in the terrestrial organism:

$$C_{to} = 3.65x10^2 \; \frac{C_{ao} \times R_{cao} \times F_u}{\lambda_t \times M} \qquad (21)$$

where:

C_{to} = isotope concentration in the terrestrial organism (μCi/gm wet wt)

3.65×10^2 = units conversion constant (days/yr)

C_{ao} = isotope concentration in aquatic organism eaten by the terrestrial organism (μCi/gm wet wt)

R_{cao} = rate at which terrestrial organism consumes aquatic organism (gm/day)

F_u = fraction of ingested isotope initially retained in the terrestrial organism (dimensionless)

λ_t = removal constant for an isotope in the terrestrial organism (yr^{-1})

M = mass of terrestrial organism (gm)

The values of M and R_{cao} are taken as 1,000 gm and 100 gm/day. Since $\lambda_t = 0.693/T_t$, where T_t is the removal half-time of an isotope in the terrestrial organism in years, equation (21) is rewritten:

$$C_{to} = 5.1 \times 10^1 \times C_{ao} - F_u - T_t$$

The value of T_t is assumed to be the radiological half-life or 50 years, whichever is less, for all isotopes except Cs 134 and Cs 137. A more realistic value of 0.049 years (18 day) for Cs 134 and Cs 137 is taken from Reichle, et al.(19) Values of F_u are 0.01, 0.5, or 1.0, depending upon the element. Values were selected from work by Reichle, et al.(18)

The dose to the terrestrial organism is calculated using equation (20) after substituting C_{to} for C_{ao}.

APPENDIX 2 REFERENCES

1. Slade, D. H., ed., Meteorology and Atomic Energy, 1968, U.S. Atomic Energy Commission, TID-24190, 1968, p. 207.

2. Russell, R. Scott, ed., Radioactivity and the Human Diet, London: Pergamon Press, 1966, pp. 92, 195, 460.

3. Russell, R. Scott, ed., Radioactivity and the Human Diet, London: Pergamon Press, 1966, pp. 90, 91.

4. Fletcher, J. F. and Dotson, W. L., compilers, HERMES--A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, U.S. Atomic Energy Commission, HEDI-TME-71-168, 1971, p. 112.

5. Fletcher, J. F. and Dotson, W. L., compilers, HERMES--A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, U.S. Atomic Energy Commission, HEDI-TME-71-168, 1971, pp. 101, 112.

6. Fletcher, J. F. and Dotson, W. L., compilers, HERMES--A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, U.S. Atomic Energy Commission, HEDI-TME-71-168, 1971, p. 101.

7. Dunster, H. J., Howells, H. and Templeton, W. L., "District Surveys Following the Windscale Incident, October 1957," in Proceedings of the Second U.N. International Conference on the Peaceful Uses of Atomic Energy, Geneva: United Nations, 1958, XVIII

8. Soldat, J. K., "Conversion of Survey Meter REadings to Concentration (μCi/m^2), "Item 04.3.4 in Emergency Radiological Plans and Procedures: K. R. Heid (ed.), USAEC Report HW-70935, Hanford Laboratories, Richland, Washington, 1962.

9. Slade, D. H. ed., Meteorology and Atomic Energy, 1968, US Atomic Energy Commission, TID-24190, 1968, pp. 330, 339.

10. International Commission on Radiological Protection, Recommendations of the International Commission on Radiological Protection, Report of Committee 2 on Permissible Dose for Internal Radiation, ICRP Publication 2, London: Pergamon Press, 1959.

11. Federal Radiation Council, Background Material for the Development of Radiation Protection Standards, FRC Report No. 2, Washington, D.C., US Government Printing Office, 1961.

12. International Commission on Radiological Protection, Recommendations of the International Commission on Radiological Protection, Report of Committee 2 on Permissible Dose for Internal Radiation, ICRP Publication 2, London: Pergamon Press, 1959.

13. Notice of Proposed Rulemaking, "Standards for Protection Against Radiation," (10CFR20) Atomic Energy Commission, Federal Register, 28 FR 10170, September 17, 1973.

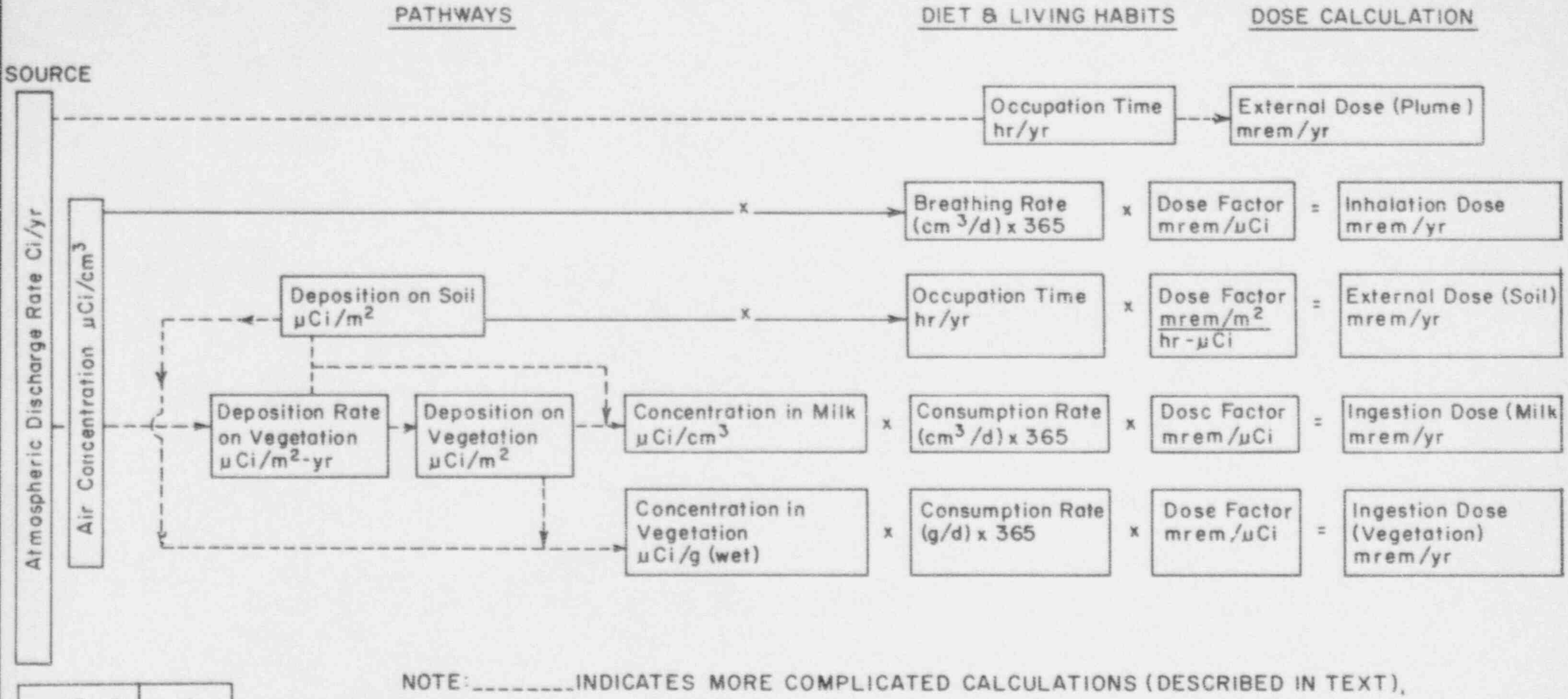
14. Fletcher, J. F. and Dotson, W. L., compilers, HERMES--A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, U.S. Atomic Energy Commission, HEDI-TME-71-168, 1971.

15. United States Stomic Energy Commission, The Potential Radiological Implications of Nuclear Facilities in a Large Region in the U.S. in the Year 2000, U.S. Atomic Energy Commission. WASH-1209 (DRAFI), 1972.

16. Fletcher, J. F. and Dotson, W. L., compilers, HERMES--A Digital Computer Code for Estimating Regional Radiological Effects from the Nuclear Power Industry, U.S. Atomic Energy Commission, HEDI-TME-71-168, 1971, p. 154.

17. International Commission on Radiological Protection, Recommendations of the International Commission on Radiological Protection, Report of Committee 2 on Permissible Dose for Internal Radiation, ICRP Publication 2, London: Pergamon Press, 1959.

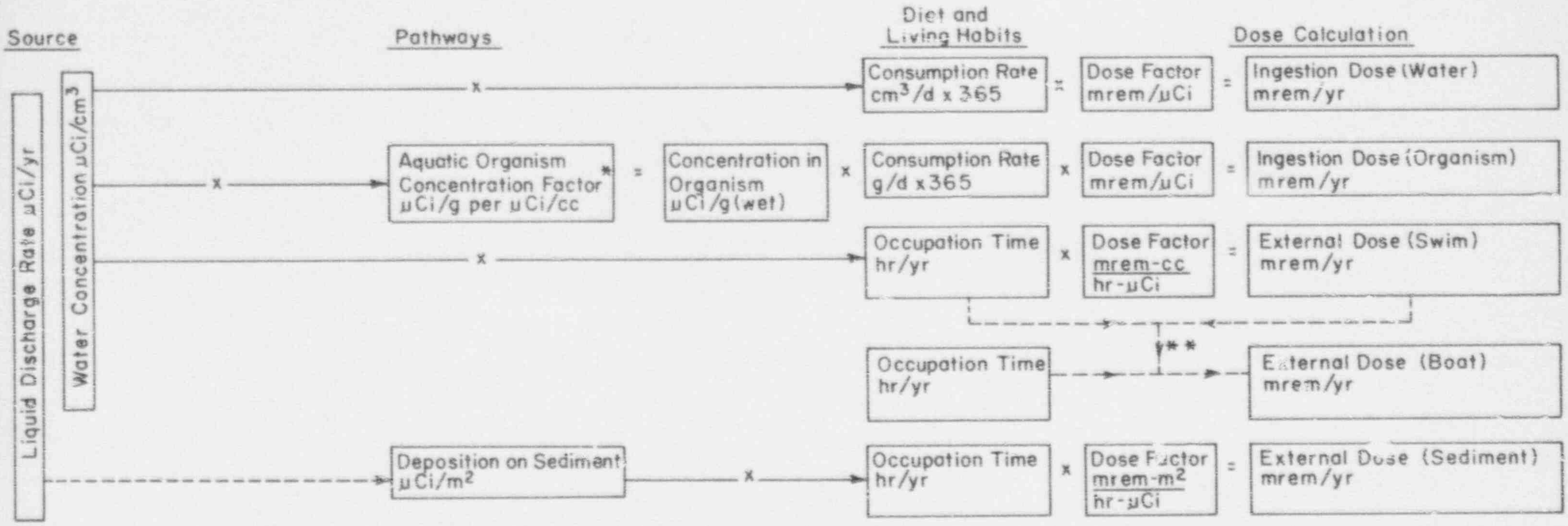
18. Reichle, D. E., Dunaway, P. B., and Nelson, D. J., "Turnover and Concentration of Radionuclides in Food Chains", Nuclear Safety, Volume 11, No. 1, January-February, 1970.



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

CALCULATION OF DOSE TO MAN FROM ATMOSPHERIC EFFLUENTS SCHEMATIC REPRESENTATION

FIGURE 1



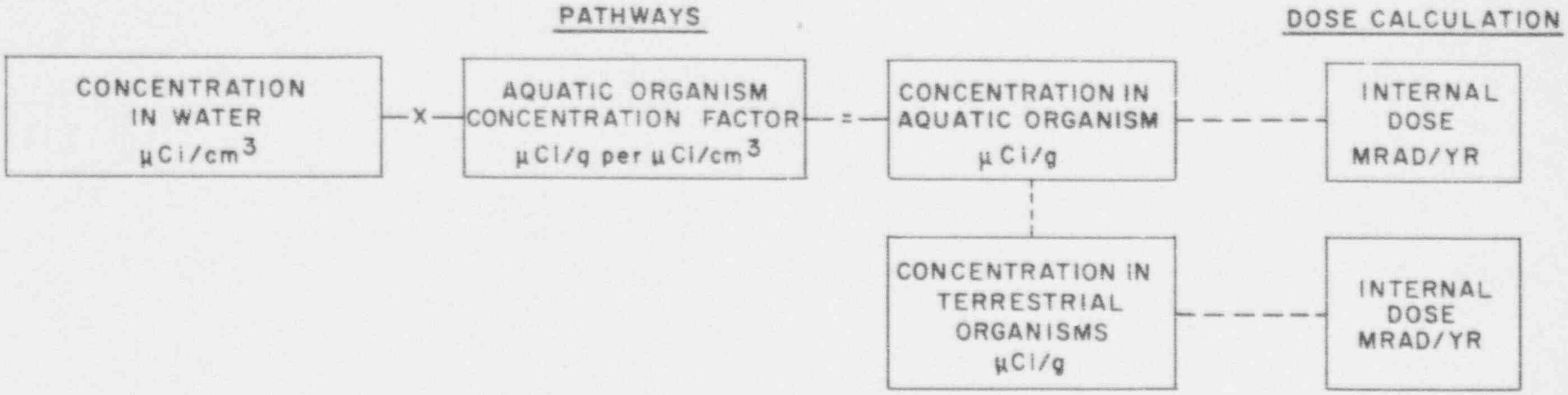
* THIS PATHWAY TO BE EVALUATED FOR EACH OF SEVERAL ORGANISM TYPES: FRESHWATER FISH, SALT WATER CRUSTACEA, ETC.

** BOATING DOSE = 0.5 $\frac{\text{(Occupation Time) BOATING}}{\text{(Occupation Time) SWIMMING}}$ x (TOTAL BODY DOSE FROM SWIMMING)

ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

CALCULATION OF DOSE TO MAN FROM AQUATIC EFFLUENTS SCHEMATIC REPRESENTATION

FIGURE 2



ALABAMA POWER COMPANY
JOSEPH M. FARLEY NUCLEAR PLANT
ENVIRONMENTAL REPORT
OPERATING LICENSE STAGE

CALCULATION OF INTERNAL DOSE TO ORGANISMS OTHER THAN MAN
SCHEMATIC REPRESENTATION

FIGURE 3