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SUBJECT: Provides adequate info to show that no unmonitored pathway for radioactive releases exists at plant. Dose assessment models adequatly predict exposures to individuals. Viewgraphs encl.

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April 17, 1987

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287

Dear Sir:

By a letter dated November 20, 1986, the NRC transmitted to Duke Power Company (Duke) an evaluation of elevated levels of radionuclides in fish samples collected in the vicinity of Oconee Nuclear Station (ONS). This evaluation was in response to a June 13, 1984 Anomalous Radiological Environmental Sample Report from Duke to the NRC which concerned the elevated levels. The NRC evaluation reexamined the ODCM methodology and reviewed the monitoring and sampling program associated with ONS including Chemical Treatment Pond 3 (CTP-3). The three major concerns resulting from the evaluation follow:

(1) Oconee may have a potential for significant unmonitored normal releases of radioactive materials to occur resulting in higher than expected levels of radioactive materials in the environment.

(2) Oconee's ODCM calculation model appears to have a significant unanalyzed dose contribution from the consumption of bottom-feeding organisms and buildup of radionuclides over the operating life of the station resulting in higher than expected levels of radioactive materials in the environment.

(3) Oconee's technical specifications appear to limit the radioactive material inventory only in Chemical Treatment Ponds 1 and 2, and not CTP-3. Also it appears unclear as to whether the limits apply to individual ponds or to both ponds.

As discussed in the evaluation, the NRC suggests that a potential for significant unmonitored releases of radioactive material exists. The pathway for release would be from the chemical treatment ponds through the ground water to nearby waterbodies. This does not occur at Oconee as evidenced by groundwater sampling which is performed quarterly. Attachment 1 is a map displaying the locations of groundwater and sediment sampling locations.* Although the Technical Specifications require environmental samples for drinking water, surface water, shoreline sediment and fish (catfish, bass), the station samples the following as additional checks for the liquid effluent program.

*A discussion of groundwater is included in the ONS FSAR Section 2.4.7.

- Well/ground water: 3 samples are collected downstream of the liquid flowpath and 2 are collected upstream. The samples are collected on a quarterly frequency and the distance from the plant ranges from about 1/4 mile to 1 1/2 miles.

- Sediment: 5 samples are collected annually in the CTP-3 area at a maximum distance from the plant of 1 mile.

Attachment 2 shows groundwater sampling activities resulting from environmental monitoring for radionuclide migration into the groundwater. The results indicate only insignificant activity over a seventeen month period. These samples had been discontinued upon implementation of Appendix I Technical Specifications, but were returned to the program in the second half of 1985 based on an American Nuclear Insurers recommendation.

Prior to the implementation of Appendix I Technical Specifications, bottom sediment and aquatic vegetation were also sampled at the tailrace and Highway 183 bridge. The station has approximately 8 years of trended data for these samples which do not demonstrate any positive trends for activity. Also, included as Attachment 3 is a Summary of Effluent Releases which demonstrates a decreasing trend. Based on past and present data of groundwater and sediment samples, Duke maintains that there are no unmonitored release pathways at Oconee.

The next identified NRC concerns involved the ODCM calculations and model. In the evaluation, the NRC calculated doses using activities reported in a catfish that was analyzed in May 1984. The catfish caught on May 2, 1984 was analyzed and showed a concentration exceeding the reporting levels, as stated in Technical Specifications, for Cs-134 and Cs-137. Another catfish was caught on May 18, 1984 at the same location (063 -- Hwy 183 Bridge, 0.8 mile ESE) and analyzed; the concentration in the second catfish was below the reporting levels for the two radiocesiums. A bass and a carp were also caught on May 2, 1984; their analyses showed radiocesium concentrations well below the reporting levels.

In October and November 1984, a number of fish were caught in both Lake Keowee and Lake Hartwell to determine if the radiocesiums were being concentrated in the edible portion of the fish. Since the indicator location for fish collection had changed from the previous year, samples of fish were collected at both the new location (063) and the old location (013, then renumbered to 067 -- Lawrence Ramsey Bridge, Hwy 27, 4.2 miles SSE). Both of these locations are in Lake Hartwell. Extra fish were also caught at the control location (064 -- Seneca, 6.7 miles SW) which is in Lake Keowee. For fish that could be filleted, both the fillets and the viscera (internals + bones) were analyzed. One (1) of the bass caught during this test showed elevated concentrations of both radiocesiums exceeding the reporting levels; two (2) other bass caught in the same area showed radiocesium concentrations well below the reporting levels. The results of all of the fish sampled during 1984 are listed in Attachment 4. In general, there is a slight increase in the fillet concentration over the viscera concentration.

Throughout 1985 and 1986, locations 063 and 067 were used as indicator locations for fish. The control location was changed beginning in late 1985 because of the difficulty in catching catfish at location 064. The new location is 060 (New Greenville Water Intake Road, 2.5 miles NNE) and is located in Lake Keowee. All fish data for 1984, 1985, and 1986 are included as Attachments 4, 5, and 6.

Shoreline sediment samples were taken at location 063 and 067 in 1984, 1985, and 1986. At location 063, shoreline sediment samples were started in 1985 but they were not included as part of the environmental program as given in Technical Specifications; therefore, their results were not included in the annual report. Ground (or well) water samples were also taken both upstream and downstream of the groundwater flow; these samples have been collected quarterly since the middle of 1985. Bottom sediment samples have been collected in the CTP-3 area since 1985. The ground water and the CTP-3 sediment samples are both considered to be part of the station environmental monitoring program but are not Technical Specification requirements. Bottom sediment samples had been taken in the Keowee Hydro Tailrace area from 1971 through 1983, and a special sample was taken in January 1987. The groundwater results are given in Attachment 2. The results of all other samples are included as Attachment 7.

Duke has performed a review of the liquid effluent dose assessment models applicable to the fish pathway and the effects of radiocesium buildup. The review identified several factors which may have contributed to the discrepancies observed between the currently used dose assessment model and environmental measurements.

The dose calculation models used by Duke in calculating fish pathway doses for reporting purposes are based on Regulatory Guide 1.109 methods and generic assumptions. Regulatory Guide 1.109 uses the concentration factor approach in calculating radionuclide uptake by fish. Before addressing possible model weaknesses, it will be necessary to review the technical basis for the Regulatory Guide 1.109 model and the uncertainties associated with parameters used in that model. A detailed discussion of concentration factor radionuclide uptake models and parameters can be found in NUREG/CR-3332, "Radiological Assessment - A Textbook on Environmental Dose Analysis" (Reference 1). A brief discussion is provided below.

Concentration factor radionuclide uptake models are derived from the following differential equation:

$$dC/dt = Iw * Cw / m - (r + \lambda) * C \qquad (1)$$

Where:

- C = Radionuclide concentration in the organism (pCi/kg)
- Cw = Radionuclide concentration in water (pCi/L)
- Iw = Intake rate of the organism (L/day)
- m = Mass of the organism (kg)
- r = Biological elimination rate of the radionuclide by the organism (1/day)
- λ = Radioactive decay constant of the radionuclide (1/day)

This differential equation has the solution:

$$C(t) = CF * Cw * [1 - \exp [- (r + \lambda) * t]] \quad (2)$$

Where:

$$CF = \text{Concentration factor of the radionuclide (L/kg)}$$
$$= Iw / [m * (r + \lambda)]$$
$$= \text{(Equilibrium concentration in organism)/(Cw)}$$

The Regulatory Guide 1.109 model conservatively assumes equilibrium buildup of radionuclides in the organism (i.e., $t \rightarrow \infty$) resulting in the following dose model:

$$C(t) = CF * Cw \quad (3)$$

Concentration factors are a function of biological assimilation and elimination rate, which are highly variable and cannot be considered equivalent for all organisms or elements. Concentration factors for numerous varieties of freshwater and marine species have been established based on empirical data (References 1, 2 and 3). Freshwater fish concentration factors referenced for cesium range from 40 to 15,000 L/kg. The high variability in concentration factors is explained by the number of factors which influence radionuclide uptake and elimination by aquatic animals and plants. These factors include dietary patterns, radionuclide turnover rate through the food chain, trophic level of the organism, stable element concentrations in the water, temperature, pH, and organism size, age, and metabolic rate.

Radiocesium uptake by freshwater organisms was the subject of a comprehensive study performed on Finnish lakes in order to determine the cause of large variations observed in the Cs-137 content of fish (References 1 and 4).

"It was determined that the main factors contributing to these differences were:

(1) The potassium content of water affected 10- to 100-fold differences between lakes studied and resulted in very high Cs-137 levels in the entire biota in the most oligotrophic lakes.

(2) The biological half-time for cesium in the fish was a major factor. The biological half-life varied from 20 -200 days and caused up to a 10-fold difference in cesium levels.

(3) The Cs-137 concentration in water was a minor factor - observed concentrations varied only by factors of 2 or 3 between lakes studied.

(4) The type of food eaten by the fish was also a minor factor resulting in only 2- to 3-fold differences (Reference 1)."

Sensitivity calculations were performed to determine whether the anomalous samples taken in 1984 at Oconee (i.e., 1 catfish sample taken May 2, 1984 with a Cs-137

concentration of 7570 pCi/kg and 1 bass sample taken October 4, 1984 with a Cs-134 concentration of 3600 pCi/kg) could be predicted by 1) accounting for radiocesium buildup in the fish from previous years releases, and 2) using a range of concentration factors, intake rates and biological elimination rates.

The results of the sensitivity calculations are plotted on Attachments 8 and 9 for Cs-134 and on Attachments 10 and 11 for Cs-137. All four figures include mean and maximum sample data, and Regulatory Guide 1.109 calculated fish concentrations for the years listed. The Regulatory Guide 1.109 data was calculated using equation (3) and a concentration factor value of 2000 L/kg. The Regulatory Guide 1.109 method only considers releases occurring in the year indicated. Other data plotted considers radiocesium buildup in fish from previous years releases: 1) Attachment 8 and 10 include equation (2) predictions using a concentration factor of 2000 L/kg and two biological elimination half-lives (R = 100 days and R = 1000 days), and 2) Attachments 9 and 11 include equation (2) predictions using a concentration factor of 20,000 L/kg and two biological half-lives (R = 100 days and R = 1000 days). Tables are included in Attachment 12 which provide the calculated numerical valves for the equation (2) predictions plotted in Attachments 8 through 11.

As demonstrated by the results plotted in Attachments 9 and 11, even the maximum sample concentrations can be predicted by the concentration factor model by using a long biological elimination half-life of 1000 days and a high concentration factor of 20,000 L/kg.

Although the anomalous samples can be predicted by equation (2) simply by varying the biological elimination rate (r) and the concentration factor (CF), there are other possible explanations. For example, acute releases of radionuclides or periods of low dilution have been shown to be followed by transient peaks of radioactivity along the food chain pathways (Reference 3).

Other explanations put forward previously include: 1) Possible non-applicability of concentration factor models to bottom-feeding fish, and 2) The buildup of radiocesiums in the aquatic environment over the life of the station. Given the limited site-specific survey data presently available, neither of these explanations can presently be ruled out. However, the high radiocesium levels measured in a 1984 bass sample indicates that the anomalities are not solely bottom-feeder related, and sediments survey data, that is presently available, does not support the radiocesium buildup theory. In addition, studies performed on carp (a bottom-feeder) have shown that as little as 7% of radiocesium in organic detritus, associated with lake-bottom sediments consumed is assimilated by that species while as much as 80% of radiocesium on algae is assimilated.

The obvious conclusion to be drawn from the data presented in Attachments 8 through 11 is that none of the concentration factor models presented predict the sample data very well. For most years both the mean and maximum sample data are well below the values predicted by the models. Only in 1984 are the model predictions lower than the environmental sampling results. However, using calculated long-term integrated exposures to a hypothetical maximum individual as a basis for determining model acceptability, it can be shown that the Regulatory Guide 1.109 model with a concentration factor of 2000 L/kg (i.e., the method presently used by Duke Power in calculating maximum individual exposures for reporting purposes) provides adequate results.

Attachment 13 is a table which summarizes maximum exposed individual integrated doses for all years with sample data available (i.e., 1977, 1979-1985). The doses are calculated using sample data and the various concentration factor models presented above. The table summary demonstrates that the fish pathway dose model presently used by Duke Power produces results which, in the long-term, agree well with environmental sample results. The present Duke Power method calculates whole body and maximum organ integrated doses from Cs-134 and Cs-137 well above what is calculated based on mean sample data and just slightly below the doses calculated based on maximum sample data.

Although the Regulatory Guide 1.109 fish pathway model lacks the sophistication to account for all variables existing in the aquatic environment, it does an acceptable job in predicting the long-term total integrated fish pathway exposures to the hypothetical maximum exposed individual. It is unlikely that any site specific model could assure that future anomalies will not occur (given the complexity of the ecosystem involved and the statistical nature of sampling programs, anomalies will be inevitable).

Duke Power will continue to use the Regulatory Guide 1.109 model with a concentration factor of 2000 L/kg. It is true that the Regulatory Guide 1.109 assumptions, as provided, do not estimate the "hot" fish concentration; however, the need for a more site specific concentration factor for radiocesiums in catfish is unjustified. Based on the creel surveys performed on both Lake Keowee and Lake Hartwell, catfish are not significant contributors to the fish eaten in the Oconee area (see attachment 14 for Creel Survey Data). The catfish that are eaten in the Oconee area are usually grown in fish farms that are located in the southeasterly part of South Carolina. Since the catfish grown in these fish farms do not forage along the bottom of Lake Hartwell, the expected radiocesium concentrations in the actual catfish consumed would be at background levels.

The NRC's final concern involved technical specification control of CTP-1, CTP-2, and CTP-3. Oconee has technical specification limits on activity in CTP-1 and CTP-2, but not on CTP-3. This due, primarily, to the way the ponds have been used. CTP-1 and CTP-2 have been used as part of the powdex resin processing system. When steam generator tube leaks occurred, contaminated powdex resin was sluiced from the turbine building to CTP-1 and CTP-2 where it was processed for disposal. Realizing that these ponds are radioactive materials storage areas, limits were placed on the total activity stored in the ponds and the maximum activity per batch sluiced to the ponds. The total inventory limit of the ponds were to limit the consequences of an uncontrolled release of the pond inventory. The batch limit provides assurance that activity input to the CTP would be minimized.

CTP-3 is not part of the powdex processing system. It is a separate pond at a lower elevation on the plant site. It collects run-off from the plant site, including the storm drainage system, sewage treatment pond effluent, turbine building sump effluents, CTP-1 and CTP-2 discharge, and other normally non-contaminated sources. CTP-3 was originally called the "Waste Oil Collection Basin" and was used to cleanup oil spills which occured onsite prior to reaching Lake Hartwell. Following steam generator tube leaks, powdex decant water from CTP-1 and CTP-2 and turbine building sump water was discharged through CTP-3. These effluents, containing only slightly contaminated water, are not held up for

any appreciable time in CTP-3. CTP-3 continuously discharges due to the number of inputs to it. Conservatively it is assumed that all contaminated effluents entiring CTP-3 are assumed to pass directly to Lake Hartwell, although slight amounts of activity are deposited in the pond sediment. All slightly contaminated water is analyzed prior to being discharged to CTP-3 and, thus, any activity deposited in the sediment there is accounted for in the effluent release program and is assumed to have passed into Lake Hartwell. All activity discharged to CTP-3 is used in the dose calculations to the unrestricted area.

Due to the addition of the Oconee Radwaste Treatment Facility, all known contaminated effluents will be processed and monitored prior to release to CTP-3. The upper ponds (CTP-1 and CTP-2) will no longer be routinely used for processing of contaminated powdex resin. This work will be done primarily in the new facility. The additional processing should decrease the total radionuclide activity directed through CTP-3.

Sediment samples taken from CTP-3 and composite sampling of discharged effluents verifies that CTP-3 actually contains most of the radionuclide activity discharged to it from CTP-1 and CTP-2 and probably from other smaller sources. Any potential discharge of sediment solids from CTP-3 must comply with state NPDES permits.

Daily grab samples obtained from the CTP-3 discharge point during August 1986 while the composite sampler was out of service, indicate that the majority of the sample data are less than the detectable limits. The average concentration (Geometric means) from 10 positive samples for Cs-137 is 1.20 E-7 μCi/ml (measured Cs-137 concentrations range from 6.66E-8 μCi/ml to 2.60E-7 μCi/ml). Among these 10 samples, only one sample shows Cs-134 present at a concentration of 9.6E-08 μCi/ml.

It is reasonable to assume that the radionuclide inventory of CTP-3 has reached equilibrium and that the daily grab sample concentration should be the same as the concentrations in the pond. This is because the sampled discharge path is the only release point for the pond, because the sampled discharge stream is monitored on a continuous basis and because the daily grab samples indicate radionuclide concentrations are consistently steady. The total curies inventory in the pond liquids are determined to be:

Cs-134 = (9.60E-8 μCi/ml) X (3.8 X 10^6 gallon) X (3785.4 ml/gallon) = 1381 μci

Cs-137 = (1.20E-7 μCi/ml) X (3.8 X 10^6 gallon) X (3785.4 ml/gallon) = 1726 μci

There are no established inventory limits for CTP-3, however compared to the limit values provided in the Technical Specifications for CTP-1 and CTP-2, CTP-3 contains only about 0.11% of Cs-134 and 0.05% of Cs-137.

In conclusion, the above discussion should provide adequate information to show that there is not an unmonitored pathway for radioactive releases at Oconee. Also the dose assessment models are adequate in predicting exposures to individuals. Furthermore, the CTP's at Oconee are satisfactorily maintained and monitored in accordance with technical specifications.

Please feel free to contact us if additional information is required.

Very truly yours,

Hal B. Tucker

WHM/29/sbn

Attachments

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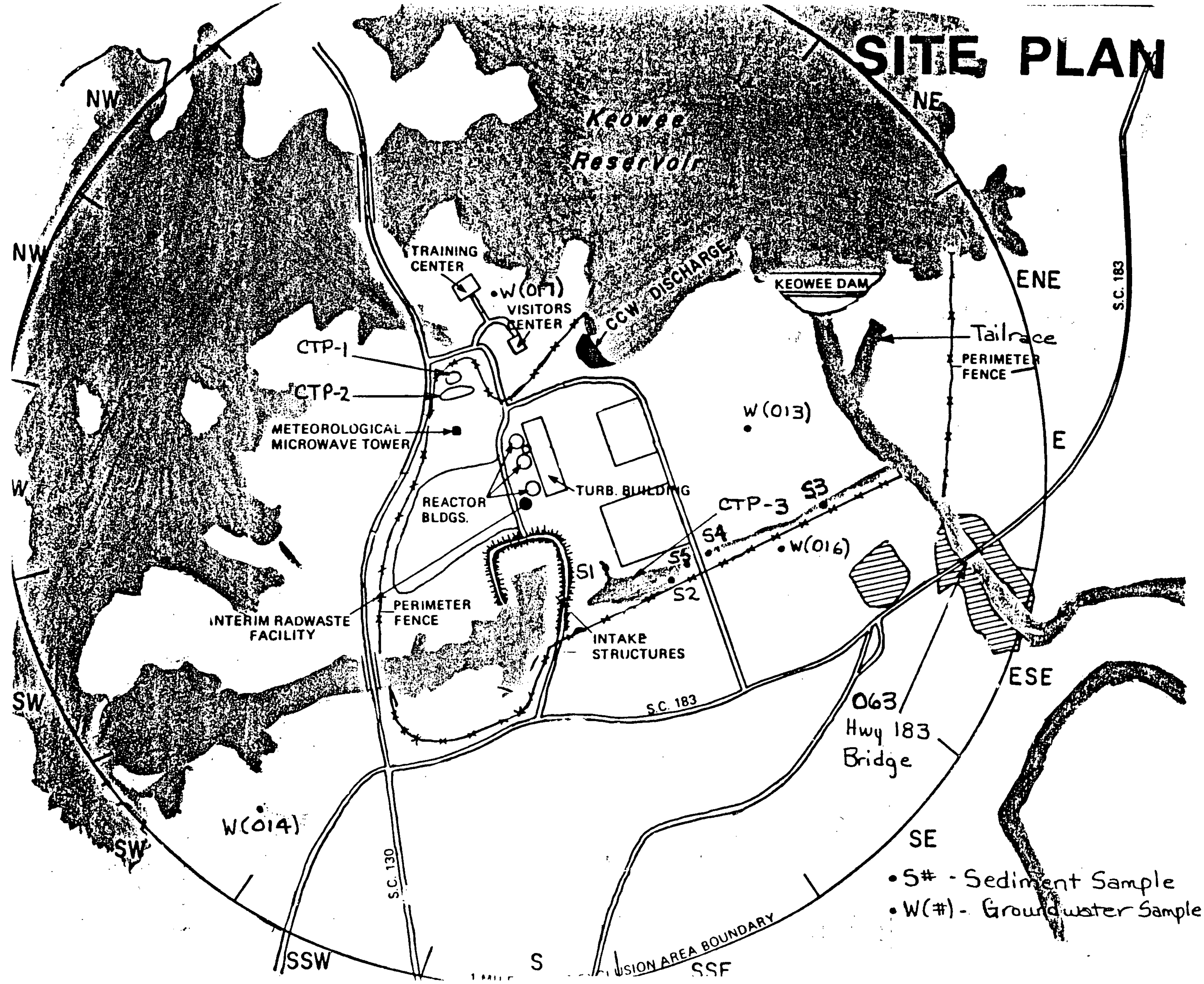
REFERENCES:

(1) Till, J. E., and Meyer, W. R., "Radiological Assessment - A Textbook on Environmental Dose Analysis," U.S.N.R.C., NUREG/CR-3332, September 1983.

(2) Thompson, S. E., et. al., "Concentration Factors of Chemical Elements in Edible Aquatic Organisms," U.S.A.E.C., UCRL-50564, Revision 1, October 1972.

(3) Reichle, D. E., et. al., "Turnover and Concentration of Radionuclides in Food Chains," Nuclear Safety 11:43-55 (1970).

(4) Kolehmainen, S. E., "White Oak Lake Studies," pp. 128-136 in Health Physics Division Annual Progress Report for Period Ending July 31, 1969, Oak Ridge National Laboratory, U.S.A.E.C. Rpt. ORNL-446 (October 1969).



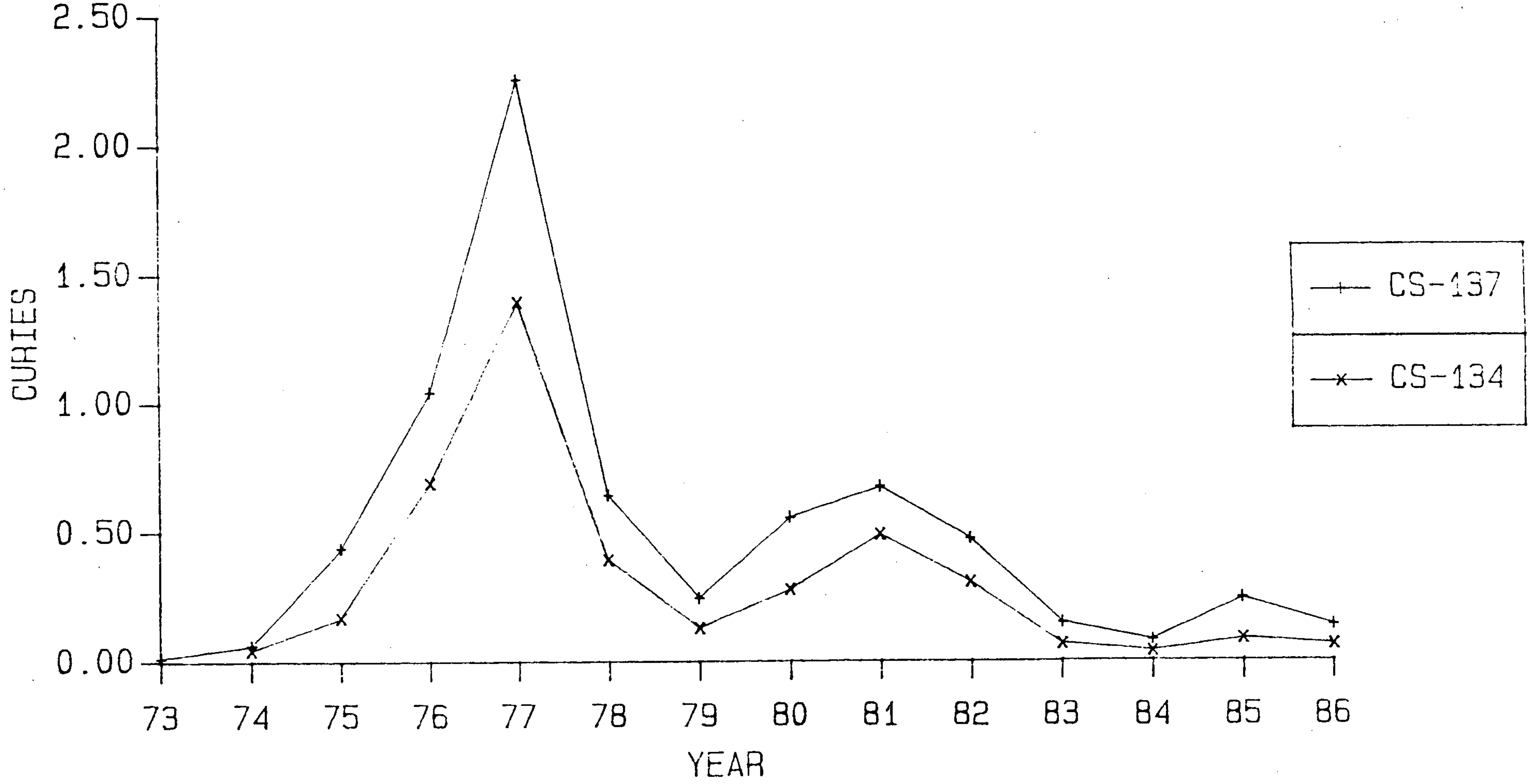
ATTACHMENT 1

ATTACHMENT 2

OCONEE NUCLEAR STATION -- GROUNDWATER SAMPLE DATA

Sample ID	Sample Date	Radionuclide	Concentration in Water (pCi/L)
013 -- Warehouse #7 -- downstream	7/16/85	Nb-95	18.30
	9/24/85	Nb-95	6.36
	12/26/85	Nb-95	10.20
	3/25/86	--	--
	6/24/86	Nb-95	4.22
	9/23/86	--	--
	12/23/86	--	--
014 -- Duke Power Environmental Health (control) -- upstream	6/25/85	Cs-134	8.29
	8/06/85	Co-58	5.51
	9/24/85	Nb-95	6.43
	12/26/85	Cs-134	6.45
	3/25/86	Mn-54	3.73
	6/24/86	Nb-95	4.22
	9/23/86	--	--
	12/23/86	--	--
015 -- Brown's Bottom -- downstream (1.7 mi SSE)	6/25/85	--	--
	9/24/85	--	--
	12/26/85	--	--
	1/09/86	Nb-95	6.00
	3/25/86	--	--
	6/24/86	Co-60	4.66
	9/23/86	--	--
	12/23/86	--	--
016 -- Firing Range -- downstream	6/25/85	--	--
	9/24/85	--	--
	12/26/85	(sample unavailable — line closed during winter)	
	3/25/86	Nb-95	7.84
	6/24/86	--	--
	9/23/86	--	--
	12/23/86	--	--
017 -- Training Center -- upstream	6/25/85	--	--
	9/24/85	--	--
	12/26/85	Zr-95	3.51
	3/25/86	Nb-95	11.40
	5/6/86	--	--
	6/24/86	BaLa-140	5.50
	9/23/86	--	--
	12/23/86	--	--

CURIES RELEASED AT OCONEE



ATTACHMENT 3

Summary of Oconee Fish Samples — 1984

Date	Location	Fish Type	Fish Weight (kg)	Results of Analysis (Conc. +/- 1 sigma pCi/kg) Cs-134	Cs-137
27-Jan-84	063	Bass	0.474	* 173.00 +/- 33.00	454.90 +/- 43.57
27-Jan-84	063	Catfish	2.535	261.10 +/- 23.06	618.60 +/- 31.37
02-May-84	063	Bass	1.390	218.60 +/- 18.86	688.40 +/- 28.27
02-May-84	063	Carp	1.439	102.70 +/- 19.33	367.30 +/- 23.35
02-May-84	063	Catfish	0.187	1275.00 +/- 97.10	7567.00 +/- 195.80
18-May-84	063	Catfish (Resample)	0.121	370.40 +/- 91.24	1956.00 +/- 130.20
02-Oct-84	063	Bass Filets	0.259	* 158.00 +/- 50.00	432.10 +/- 88.91
02-Oct-84	063	Bass Internals+Bone	0.170	* 106.00 +/- 44.00	397.80 +/- 56.40
02-Oct-84	063	Catfish Filets	0.579		275.30 +/- 47.91
02-Oct-84	063	Catfish Int.+Bone	0.234	* 68.70 +/- 38.00	* 64.60 +/- 42.00
03-Oct-84	063	Bass Filets	0.446	* 50.70 +/- 14.00	137.70 +/- 16.48
03-Oct-84	063	Bass Internals+Bone	0.444	* 40.80 +/- 13.00	132.20 +/- 14.84
03-Oct-84	063	Catfish Filets	0.221	* 161.00 +/- 41.00	556.60 +/- 56.34
03-Oct-84	063	Catfish Int.+Bone	0.127	* 73.90 +/- 41.00	404.80 +/- 53.14
04-Oct-84	063	Bass	0.085	3662.00 +/- 104.50	3596.00 +/- 96.66
04-Oct-84	063	Catfish	0.963	* 63.40 +/- 20.00	374.10 +/- 34.47
09-Nov-84	063	Bass #1	0.162		330.80 +/- 51.58
09-Nov-84	063	Bass #2	0.591	* 39.50 +/- 21.00	303.80 +/- 36.44
		Average for the year		379.16	1036.56
03-Feb-84	064	Bass	0.801		
03-Feb-84	064	Carp	0.390		
26-Apr-84	064	Bass	0.967		
26-Apr-84	064	Carp	1.599		* 18.60 +/- 12.00
26-Apr-84	064	Catfish	0.098		
23-Oct-84	064	Catfish	0.075		
24-Oct-84	064	Bass Filets	0.744		* 29.40 +/- 18.00
24-Oct-84	064	Bass Internals+Bone	1.017		
26-Oct-84	064	Bass	1.806		29.19 +/- 8.09
30-Oct-84	064	Catfish Filets	0.105		* 71.90 +/- 40.00
30-Oct-84	064	Catfish Int.+Bone	0.120		
		Average for the year		0.00	13.55
08-May-84	013 (067)	Bass (StCC)	0.832		54.62 +/- 13.34
08-May-84	013 (067)	Catfish (StCC)	0.818		80.35 +/- 9.49
10-Oct-84	013 (067)	Bass Filets	0.086	* 72.40 +/- 32.00	303.20 +/- 34.68
10-Oct-84	013 (067)	Bass Internals+Bone	0.108	* 134.00 +/- 45.00	95.36 +/- 35.76
10-Oct-84	013 (067)	Carp Filets	0.157	* 70.30 +/- 50.00	* 73.30 +/- 50.00
10-Oct-84	013 (067)	Carp Internals+Bone	0.249		
12-Oct-84	013 (067)	Bass Filets	0.246		118.90 +/- 24.12
12-Oct-84	013 (067)	Bass Internals+Bone	0.495		* 72.40 +/- 30.00
12-Oct-84	013 (067)	Carp Filets	0.156	* 142.00 +/- 53.00	* 226.00 +/- 53.00
12-Oct-84	013 (067)	Carp Internals+Bone	0.240	* 76.40 +/- 45.00	* 154.40 +/- 44.35
16-Oct-84	013 (067)	Bass	0.834		71.39 +/- 24.86
16-Oct-84	013 (067)	Carp	0.814		* 120.00 +/- 32.00
17-Oct-84	013 (067)	Catfish Filets	0.454		188.40 +/- 24.82
17-Oct-84	013 (067)	Catfish Int.+Bone	0.331	* 49.60 +/- 24.00	103.50 +/- 28.16

* MDA value given for MDA > Critical Level

ATTACHMENT 4

Summary of Oconee Fish Samples -- 1984

		Average for the year		38.91	118.70
24-Oct-84	073	Crappie (whole)	0.059		* 59.70 +/- 32.00

* MDA value given for MDA > Critical Level

ATTACHMENT 4

[redacted] Summary of Oconee Fish Samples — 1985

Date	Location	Fish Type	Fish Weight (kg)	Results of Analysis (Conc. +/- 1 sigma pCi/kg) Cs-134	Cs-137
13-Dec-85	060	Bass Filets	0.454		26.70 +/- 7.73
13-Dec-85	060	Catfish Filets	0.159		35.71 +/- 7.88
		Average for the year			31.21
26-Mar-85	063	Bass Filets	0.211	* 69.40 +/- 27.00	184.10 +/- 30.68
27-Mar-85	063	Bass Filets	1.737	* 17.40 +/- 7.10	143.50 +/- 12.06
11-Apr-85	063	Catfish Filets	0.108		249.90 +/- 43.07
11-Apr-85	063	Catfish Filets (StCC)	0.132	* 115.00 +/- 45.00	281.90 +/- 51.55
16-Apr-85	063	Catfish Filets	0.292	* 46.00 +/- 19.00	156.70 +/- 22.28
09-Oct-85	063	Catfish Filets	0.631	196.70 +/- 18.88	543.70 +/- 24.36
11-Oct-85	063	Bass Filets	0.610	118.60 +/- 13.42	431.10 +/- 21.29
11-Oct-85	063	Bass Filets (StCC)	0.319	152.60 +/- 30.90	349.40 +/- 30.46
		Average for the year		89.46	292.54
23-Apr-85	064	Bass Filets	0.502		37.68 +/- 15.96
18-May-85	064	Catfish Filets	0.338		
06-Nov-85	064	Bass Filets	0.715	* 13.00 +/- 8.22	* 15.50 +/- 8.01
06-Nov-85	064	Catfish Filets	0.288		77.89 +/- 6.91
		Average for the year		3.25	32.77
17-Apr-85	067	Bass Filets	1.101	* 16.90 +/- 7.70	59.35 +/- 9.50
17-Apr-85	067	Carp Filets	0.516		122.80 +/- 19.75
15-Oct-85	067	Bass Filets	0.515	* 15.30 +/- 7.76	26.89 +/- 7.69
15-Oct-85	067	Catfish Filets	0.471	* 13.50 +/- 8.29	84.20 +/- 10.81
16-Oct-85	067	Carp Filets	0.520	* 40.80 +/- 9.90	121.50 +/- 12.61
18-Oct-85	067	Carp Filets	0.541		34.36 +/- 8.46
22-Oct-85	067	Bass Filets	0.625	* 17.90 +/- 7.08	123.50 +/- 11.72
23-Oct-85	067	Carp Filets	0.514		112.70 +/- 11.34
23-Oct-85	067	Catfish Filets	0.535		98.00 +/- 9.69
		Average for the year		11.60	87.03

* MDA value given for MDA > Critical Level

ATTACHMENT 5

Summary of Oconee Fish Samples — 1986

Date	Location	Fish Type	Fish Weight (kg)	Results of Analysis (Conc. +/- 1 sigma pCi/kg) Cs-134	Cs-137
27-Mar-86	060	Bass Filets	0.398		26.63 +/- 11.28
13-May-86	060	Catfish Filets (Sp.)	0.313		41.39 +/- 4.13
09-Oct-86	060	Bass Filets	0.467		26.02 +/- 9.76
02-Oct-86	060	Catfish Filets	0.354		34.87 +/- 11.64
		Average for the year			32.23
06-Mar-86	063	Bass Filets	0.613		119.20 +/- 24.94
07-Mar-86	063	Catfish Filets	0.411	720.60 +/- 36.88	1977.00 +/- 56.32
18-Dec-86	063	Bass Filets	0.712	* 31.70 +/- 8.86	165.90 +/- 13.37
18-Dec-86	063	Catfish Filets	0.288	216.60 +/- 20.99	682.80 +/- 31.12
		Average for the year		242.23	736.23
17-Mar-86	067	Bass Filets	0.747	* 9.45 +/- 3.74	55.02 +/- 4.53
17-Mar-86	067	Carp Filets	0.214	* 24.90 +/- 8.01	173.80 +/- 11.02
18-Mar-86	067	Carp Filets	0.195	* 36.00 +/- 9.58	163.60 +/- 13.22
05-Dec-86	067	Bass Filets	0.986	17.02 +/- 5.60	71.07 +/- 6.72
05-Dec-86	067	Carp Filets	1.014		70.37 +/- 6.65
		Average for the year		17.47	106.77

ATTACHMENT 6

* MDA value given for MDA > Critical Level

ATTACHMENT 7

OCONEE NUCLEAR STATION -- SEDIMENT SAMPLE DATA FROM 063 AND 067

Sample ID	Sample Date	Concentration in Sediment (pCi/kg) Cs-134	Cs-137
063 -- Hwy 183 Bridge, 0.8 mile ESE	6/25/85	77.5	67.8
	12/17/85	35.1	< 12.2
	6/17/86	54.3	40.2
	12/09/86	48.2	59.1
067 -- Lawrence Ramsey Bridge, Hwy 27, 4.2 miles SSE)	1/03/84	59.3	< 16.6
	7/03/84	< 33.1	55.4
	12/26/84	141	82.8
	6/25/85	95.9	144
	12/17/85	56.8	45.2
	6/17/86	162	837
	12/09/86	119	587

ATTACHMENT 7

OCONEE NUCLEAR STATION -- SEDIMENT SAMPLE DATA IN THE CTP-3 AREA

Sample ID	Sample Date	Concentration in Sediment (pCi/kg) Cs-134	Cs-137
1 -- outfall of concrete into CTP-3	8/02/85	1570	6770
	8/27/86	6400	33900
2 -- southwest end of CTP-3 dam	8/02/85	<LLD	31.5
	8/27/86	72.1	392
3 -- before outfall of CTP-3 weir	8/02/85	5690	28600
	8/27/86	185	1410
4 -- east side of plant entrance road culvert	8/02/85	1590	6360
	8/27/86	6420	51200
5 -- west side of plant entrance road culvert	8/02/85	1290	6510
	8/27/86	1740	9050

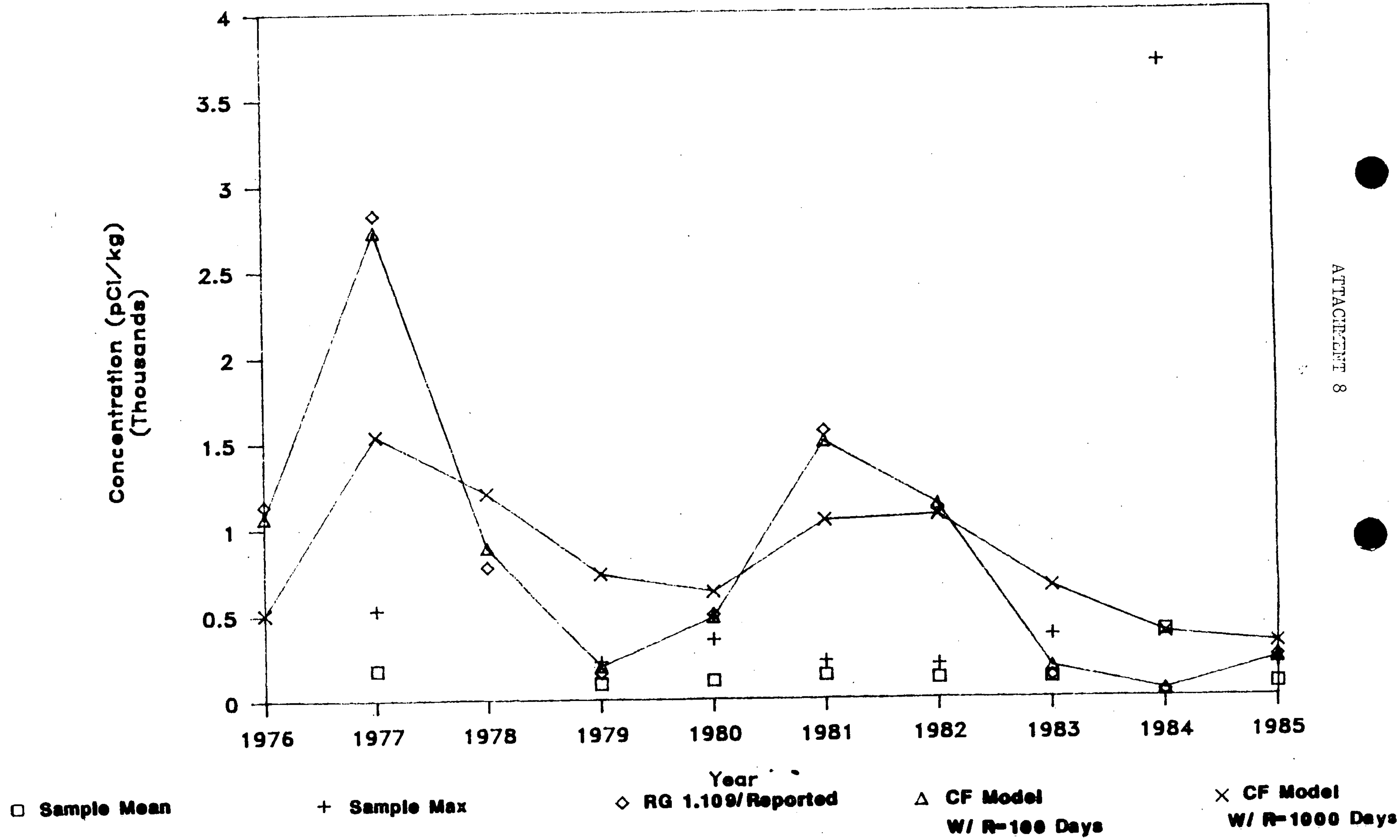
ATTACHMENT 7

OCONEE NUCLEAR STATION -- SEDIMENT SAMPLE
FROM TAILRACE (000.4)

Sample Date	Concentration in Sediment (pCi/kg) Cs-134	Cs-137
1971-1974	No Cs-134 nor Cs-137 detected	
8/08/75	200	400
7/13/76	2,930	5,560
1/05/77	4,380	11,000
7/05/77	22,000	39,100
Spec 8/25/77	4,280	8,090
1/04/78	8,560	20,200
7/05/78	2,160	5,520
1/04/79	4,550	11,180
8/06/79	4,414	12,420
2/05/80	1,719	6,509
8/12/80	4,011	12,240
2/10/81	2,868	8,941
8/03/81	1,969	6,969
2/22/82	1,960	5,913
8/10/82	1,664	6,445
2/04/83	1,422	5,706
8/30/83	665	3,509
Spec 1/30/87	290	2,820

OCONEE FISH CONCENTRATION: Cs−134

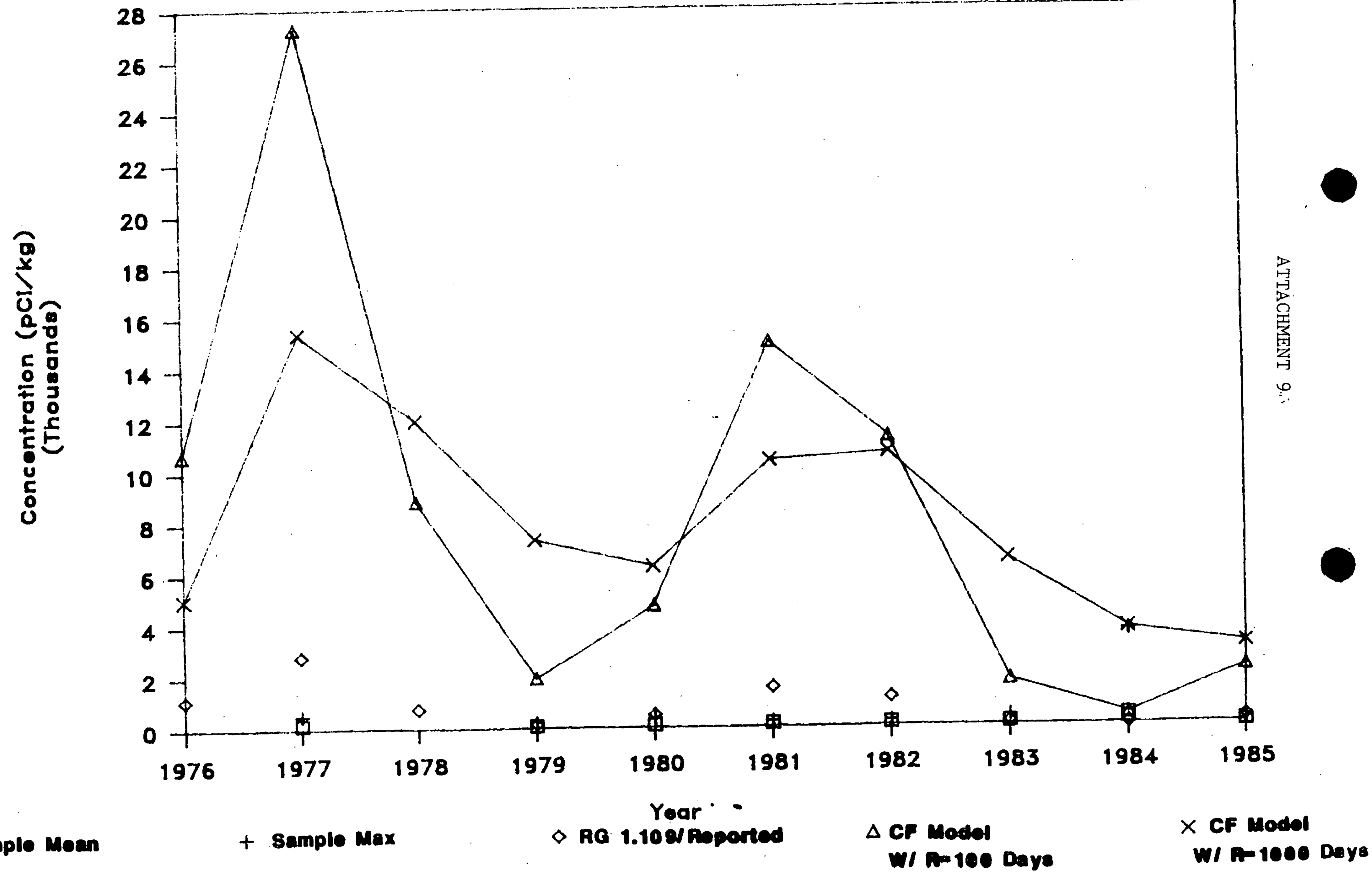
COMPARISON OF DATA AND MODELS (CF=2E3)



ATTACHMENT 8

OCONEE FISH CONCENTRATION: Cs−134

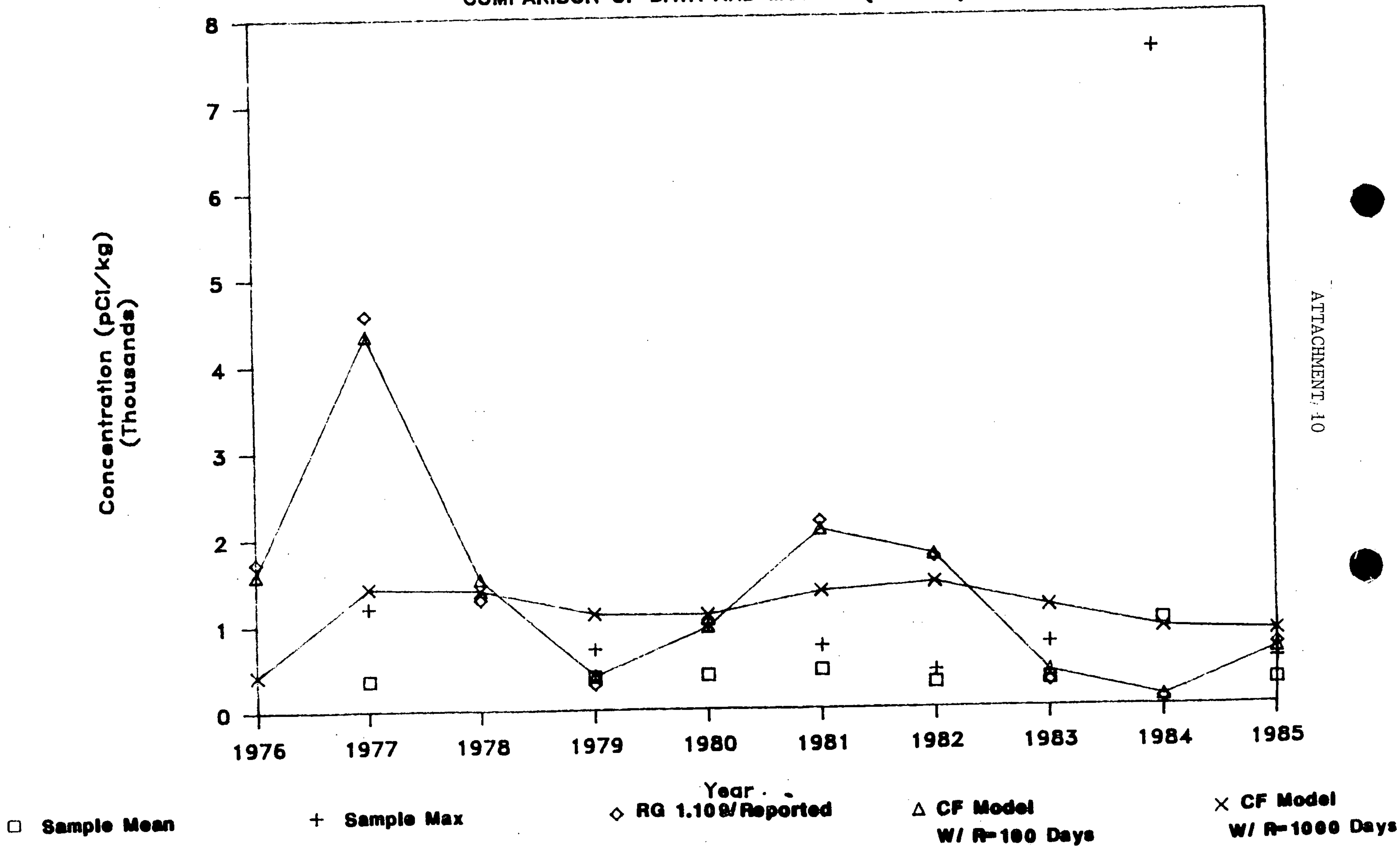
COMPARISON OF DATA AND MODELS (CF=2E4)



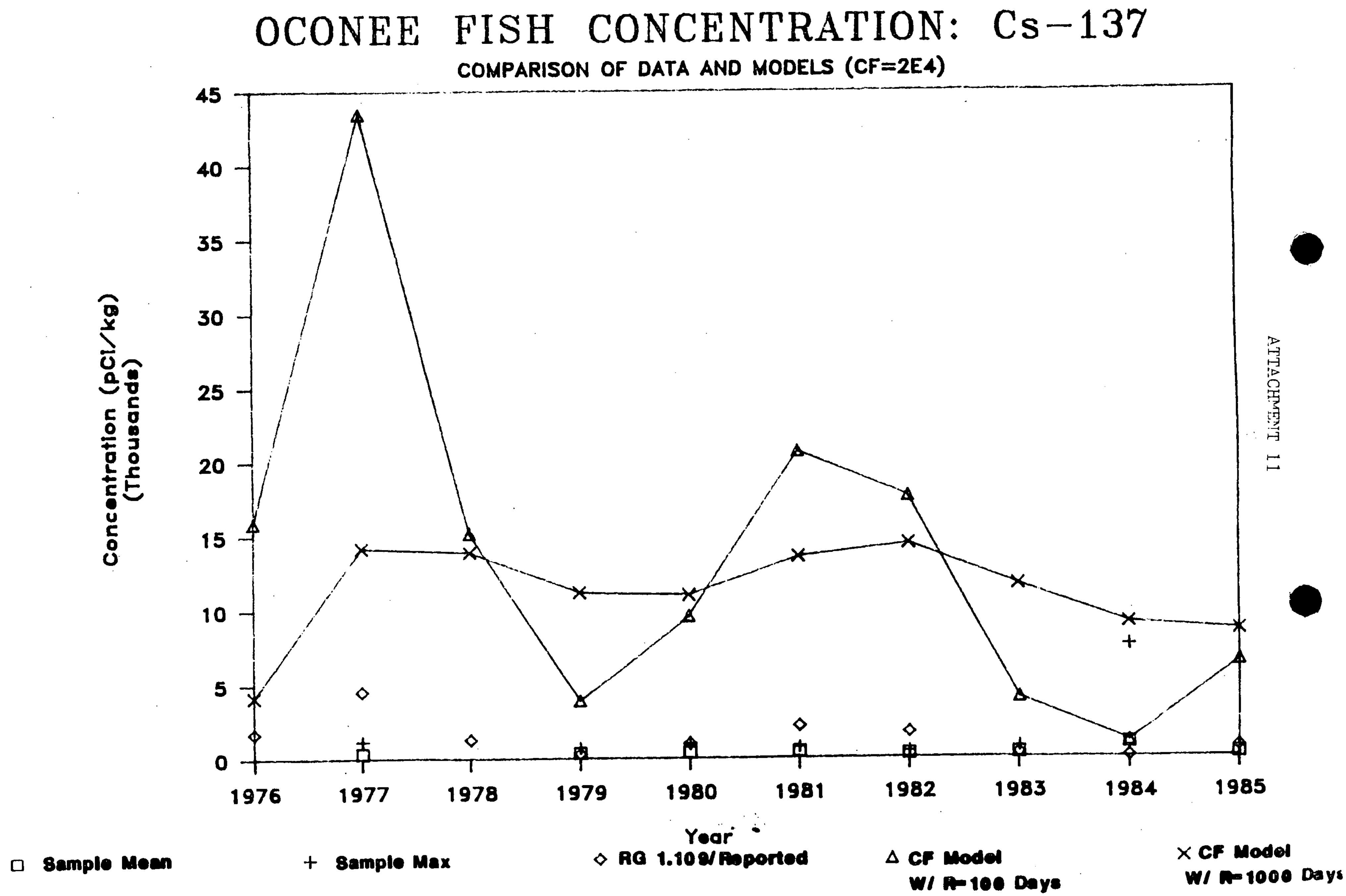
ATTACHMENT 9.

OCONEE FISH CONCENTRATION: Cs-137

COMPARISON OF DATA AND MODELS (CF=2E3)



ATTACHMENT 10



ATTACHMENT 11

Attachment 12

TABLE 1 - Cs-134 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs134 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	6.86E-01	1.35E+03	5.69E-01	1.07E+03
1977	1.39E+00	1.10E+03	1.42E+00	2.73E+03
1978	3.87E-01	1.12E+03	3.87E-01	8.85E+02
1979	1.24E-01	1.80E+03	7.72E-02	1.96E+02
1980	2.73E-01	1.23E+03	2.49E-01	4.80E+02
1981	4.85E-01	6.95E+02	7.82E-01	1.50E+03
1982	2.99E-01	6.03E+02	5.55E-01	1.13E+03
1983	6.08E-02	1.10E+03	6.19E-02	1.81E+02
1984	2.95E-02	1.93E+03	1.71E-02	4.26E+01
1985	7.98E-02	7.56E+02	1.18E-01	2.25E+02

T-half[Cs134] (days) = 7.53E+02
T-half[metal] (days) = 1.00E+02
Concentration factor = 2.00E+03
({pCi/kg}/{pCi/l})

TABLE 2 - Cs-137 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs137 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	1.04E+00	1.35E+03	8.63E-01	1.59E+03
1977	2.25E+00	1.10E+03	2.29E+00	4.35E+03
1978	6.40E-01	1.12E+03	6.40E-01	1.52E+03
1979	2.40E-01	1.80E+03	1.49E-01	3.94E+02
1980	5.54E-01	1.23E+03	5.04E-01	9.61E+02
1981	6.73E-01	6.95E+02	1.08E+00	2.07E+03
1982	4.69E-01	6.03E+02	8.71E-01	1.77E+03
1983	1.46E-01	1.10E+03	1.49E-01	4.12E+02
1984	7.45E-02	1.93E+03	4.32E-02	1.12E+02
1985	2.37E-01	7.56E+02	3.51E-01	6.56E+02

T-half[Cs137] (days) = 1.10E+04
T-half[metal] (days) = 1.00E+02
Concentration factor = 2.00E+03
({pCi/kg}/{pCi/l})

(1) Total calculated fish concentration at end of year including contributions from all previous years.

TABLE 1.A - Cs-134 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.07E+03	6.11E+01	3.48E+00	1.98E-01	1.13E-02	6.43E-04	3.66E-05	2.09E-06	1.19E-07	6.77E-09
	2.67E+03	1.52E+02	8.66E+00	4.93E-01	2.81E-02	1.60E-03	9.11E-05	5.19E-06	2.95E-07
		7.30E+02	4.16E+01	2.37E+00	1.35E-01	7.68E-03	4.37E-04	2.49E-05	1.42E-06
			1.46E+02	8.29E+00	4.72E-01	2.69E-02	1.53E-03	8.72E-05	4.97E-06
				4.69E+02	2.67E+01	1.52E+00	8.66E-02	4.93E-03	2.81E-04
					1.47E+03	8.40E+01	4.78E+00	2.72E-01	1.55E-02
						1.05E+03	5.97E+01	3.40E+00	1.94E-01
							1.17E+02	6.65E+00	3.79E-01
								3.23E+01	1.84E+00
									2.23E+02

T-half[meta] (days) = 1.00E+02
Concentration factor = 2.00E+03

TABLE 2.A - Cs137 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.59E+03	1.24E+02	9.65E+00	7.52E-01	5.86E-02	4.56E-03	3.55E-04	2.77E-05	2.16E-06	1.68E-07
	4.22E+03	3.29E+02	2.56E+01	2.00E+00	1.56E-01	1.21E-02	9.44E-04	7.35E-05	5.73E-06
		1.18E+03	9.19E+01	7.16E+00	5.58E-01	4.34E-02	3.38E-03	2.64E-04	2.05E-05
			2.75E+02	2.15E+01	1.67E+00	1.30E-01	1.01E-02	7.90E-04	6.15E-05
				9.30E+02	7.25E+01	5.64E+00	4.40E-01	3.42E-02	2.67E-03
					2.00E+03	1.56E+02	1.21E+01	9.45E-01	7.36E-02
						1.61E+03	1.25E+02	9.75E+00	7.59E-01
							2.74E+02	2.14E+01	1.66E+00
								7.97E+01	6.21E+00
									6.48E+02

T-half[meta] (days) = 1.00E+02
Concentration factor = 2.00E+03

TABLE 3 - Cs-134 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs134 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	6.86E-01	1.35E+03	5.69E-01	5.07E+02
1977	1.39E+00	1.10E+03	1.42E+00	1.54E+03
1978	3.87E-01	1.12E+03	3.87E-01	1.20E+03
1979	1.24E-01	1.80E+03	7.72E-02	7.34E+02
1980	2.73E-01	1.23E+03	2.49E-01	6.29E+02
1981	4.85E-01	6.95E+02	7.82E-01	1.04E+03
1982	2.99E-01	6.03E+02	5.55E-01	1.07E+03
1983	6.08E-02	1.10E+03	6.19E-02	6.51E+02
1984	2.95E-02	1.93E+03	1.71E-02	3.77E+02
1985	7.98E-02	7.56E+02	1.18E-01	3.14E+02

T-half[Cs134] (days) = 7.53E+02
T-half[metal] (days) = 1.00E+03
Concentration factor = 2.00E+03
({pCi/kg}/{pCi/l})

TABLE 4 - Cs-137 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs137 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	1.04E+00	1.35E+03	8.63E-01	4.16E+02
1977	2.25E+00	1.10E+03	2.29E+00	1.42E+03
1978	6.40E-01	1.12E+03	6.40E-01	1.39E+03
1979	2.40E-01	1.80E+03	1.49E-01	1.12E+03
1980	5.54E-01	1.23E+03	5.04E-01	1.10E+03
1981	6.73E-01	6.95E+02	1.08E+00	1.36E+03
1982	4.69E-01	6.03E+02	8.71E-01	1.45E+03
1983	1.46E-01	1.10E+03	1.49E-01	1.17E+03
1984	7.45E-02	1.93E+03	4.32E-02	9.09E+02
1985	2.37E-01	7.56E+02	3.51E-01	8.59E+02

T-half[Cs137] (days) = 1.10E+04
T-half[metal] (days) = 1.00E+03
Concentration factor = 2.00E+03
({pCi/kg}/{pCi/l})

(1) Total calculated fish concentration at end of year including contributions from all previous years.

TABLE 3.A - Cs-134 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
5.07E+02	2.81E+02	1.56E+02	8.66E+01	4.80E+01	2.66E+01	1.48E+01	8.20E+00	4.55E+00	2.53E+00
	1.26E+03	6.99E+02	3.88E+02	2.15E+02	1.19E+02	6.63E+01	3.68E+01	2.04E+01	1.13E+01
		3.45E+02	1.91E+02	1.06E+02	5.89E+01	3.27E+01	1.81E+01	1.01E+01	5.58E+00
			6.87E+01	3.81E+01	2.11E+01	1.17E+01	6.51E+00	3.61E+00	2.00E+00
				2.21E+02	1.23E+02	6.81E+01	3.78E+01	2.10E+01	1.16E+01
					6.96E+02	3.86E+02	2.14E+02	1.19E+02	6.60E+01
						4.94E+02	2.74E+02	1.52E+02	8.45E+01
							5.51E+01	3.06E+01	1.70E+01
								1.52E+01	8.46E+00
									1.05E+02

T-half[metal] (days) = 1.00E+03
Concentration factor = 2.00E+03

TABLE 4.A - Cs137 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
4.16E+02	3.16E+02	2.40E+02	1.82E+02	1.38E+02	1.05E+02	7.95E+01	6.03E+01	4.58E+01	3.47E+01
	1.10E+03	8.38E+02	6.36E+02	4.83E+02	3.66E+02	2.78E+02	2.11E+02	1.60E+02	1.22E+02
		3.09E+02	2.34E+02	1.78E+02	1.35E+02	1.02E+02	7.77E+01	5.89E+01	4.47E+01
			7.20E+01	5.47E+01	4.15E+01	3.15E+01	2.39E+01	1.81E+01	1.38E+01
				2.43E+02	1.85E+02	1.40E+02	1.06E+02	8.07E+01	6.12E+01
					5.23E+02	3.97E+02	3.01E+02	2.29E+02	1.73E+02
						4.20E+02	3.19E+02	2.42E+02	1.84E+02
							7.17E+01	5.44E+01	4.13E+01
								2.08E+01	1.58E+01
									1.69E+02

T-half[metal] (days) = 1.00E+03
Concentration factor = 2.00E+03

TABLE 5 - Cs-134 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs134 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	6.86E-01	1.35E+03	5.69E-01	1.07E+04
1977	1.39E+00	1.10E+03	1.42E+00	2.73E+04
1978	3.87E-01	1.12E+03	3.87E-01	8.85E+03
1979	1.24E-01	1.80E+03	7.72E-02	1.96E+03
1980	2.73E-01	1.23E+03	2.49E-01	4.80E+03
1981	4.85E-01	6.95E+02	7.82E-01	1.50E+04
1982	2.99E-01	6.03E+02	5.55E-01	1.13E+04
1983	6.08E-02	1.10E+03	6.19E-02	1.81E+03
1984	2.95E-02	1.93E+03	1.71E-02	4.26E+02
1985	7.98E-02	7.56E+02	1.18E-01	2.25E+03

T-half[Cs134] (days) = 7.53E+02
T-half[meta] (days) = 1.00E+02
Concentration factor = 2.00E+04
((pCi/kg)/(pCi/l))

TABLE 6 - Cs-137 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs137 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	1.04E+00	1.35E+03	8.63E-01	1.59E+04
1977	2.25E+00	1.10E+03	2.29E+00	4.35E+04
1978	6.40E-01	1.12E+03	6.40E-01	1.52E+04
1979	2.40E-01	1.80E+03	1.49E-01	3.94E+03
1980	5.54E-01	1.23E+03	5.04E-01	9.61E+03
1981	6.73E-01	6.95E+02	1.08E+00	2.07E+04
1982	4.69E-01	6.03E+02	8.71E-01	1.77E+04
1983	1.46E-01	1.10E+03	1.49E-01	4.12E+03
1984	7.45E-02	1.93E+03	4.32E-02	1.12E+03
1985	2.37E-01	7.56E+02	3.51E-01	6.56E+03

T-half[Cs137] (days) = 1.10E+04
T-half[meta] (days) = 1.00E+02
Concentration factor = 2.00E+04
((pCi/kg)/(pCi/l))

(1) Total calculated fish concentration at end of year including contributions from all previous years.

ATTACHMENT 12

TABLE 5.A - Cs-134 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.07E+04	6.11E+02	3.48E+01	1.98E+00	1.13E-01	6.43E-03	3.66E-04	2.09E-05	1.19E-06	6.77E-08
	2.67E+04	1.52E+03	8.66E+01	4.93E+00	2.81E-01	1.60E-02	9.11E-04	5.19E-05	2.95E-06
		7.30E+03	4.16E+02	2.37E+01	1.35E+00	7.68E-02	4.37E-03	2.49E-04	1.42E-05
			1.46E+03	8.29E+01	4.72E+00	2.69E-01	1.53E-02	8.72E-04	4.97E-05
				4.69E+03	2.67E+02	1.52E+01	8.66E-01	4.93E-02	2.81E-03
					1.47E+04	8.40E+02	4.78E+01	2.72E+00	1.55E-01
						1.05E+04	5.97E+02	3.40E+01	1.94E+00
							1.17E+03	6.65E+01	3.79E+00
								3.23E+02	1.84E+01
									2.23E+03

T-half[metal] (days) = 1.00E+02
Concentration factor = 2.00E+04

TABLE 6.A - Cs137 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1.59E+04	1.24E+03	9.65E+01	7.52E+00	5.86E-01	4.56E-02	3.55E-03	2.77E-04	2.16E-05	1.68E-06
	4.22E+04	3.29E+03	2.56E+02	2.00E+01	1.56E+00	1.21E-01	9.44E-03	7.35E-04	5.73E-05
		1.18E+04	9.19E+02	7.16E+01	5.58E+00	4.34E-01	3.38E-02	2.64E-03	2.05E-04
			2.75E+03	2.15E+02	1.67E+01	1.30E+00	1.01E-01	7.90E-03	6.15E-04
				9.30E+03	7.25E+02	5.64E+01	4.40E+00	3.42E-01	2.67E-02
					2.00E+04	1.56E+03	1.21E+02	9.45E+00	7.36E-01
						1.61E+04	1.25E+03	9.75E+01	7.59E+00
							2.74E+03	2.14E+02	1.66E+01
								7.97E+02	6.21E+01
									6.48E+03

T-half[metal] (days) = 1.00E+02
Concentration factor = 2.00E+04

TABLE 7 - Cs-134 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs134 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	6.86E-01	1.35E+03	5.69E-01	5.07E+03
1977	1.39E+00	1.10E+03	1.42E+00	1.54E+04
1978	3.87E-01	1.12E+03	3.87E-01	1.20E+04
1979	1.24E-01	1.80E+03	7.72E-02	7.34E+03
1980	2.73E-01	1.23E+03	2.49E-01	6.29E+03
1981	4.85E-01	6.95E+02	7.82E-01	1.04E+04
1982	2.99E-01	6.03E+02	5.55E-01	1.07E+04
1983	6.08E-02	1.10E+03	6.19E-02	6.51E+03
1984	2.95E-02	1.93E+03	1.71E-02	3.77E+03
1985	7.98E-02	7.56E+02	1.18E-01	3.14E+03

T-half[Cs134] (days) = 7.53E+02
T-half[meta] (days) = 1.00E+03
Concentration factor = 2.00E+04
((pCi/kg)/(pCi/l))

TABLE 8 - Cs-137 CONCENTRATION IN FISH AT OCONEE - 1976 THROUGH 1985
NUREG/CR-3332 MODEL - CONCENTRATION FACTOR METHOD

YEAR	Cs137 Releases (Ci/yr)	Dilution (CFS)	Ave Water Conc (pCi/l)	EOY Fish Conc (1) (pCi/kg)
1976	1.04E+00	1.35E+03	8.63E-01	4.16E+03
1977	2.25E+00	1.10E+03	2.29E+00	1.42E+04
1978	6.40E-01	1.12E+03	6.40E-01	1.39E+04
1979	2.40E-01	1.80E+03	1.49E-01	1.12E+04
1980	5.54E-01	1.23E+03	5.04E-01	1.10E+04
1981	6.73E-01	6.95E+02	1.08E+00	1.36E+04
1982	4.69E-01	6.03E+02	8.71E-01	1.45E+04
1983	1.46E-01	1.10E+03	1.49E-01	1.17E+04
1984	7.45E-02	1.93E+03	4.32E-02	9.09E+03
1985	2.37E-01	7.56E+02	3.51E-01	8.59E+03

T-half[Cs137] (days) = 1.10E+04
T-half[meta] (days) = 1.00E+03
Concentration factor = 2.00E+04
((pCi/kg)/(pCi/l))

(1) Total calculated fish concentration at end of year including contributions from all previous years.

ATTACHMENT 12

TABLE 7.A - Cs-134 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
5.07E+03	2.81E+03	1.56E+03	8.66E+02	4.80E+02	2.66E+02	1.48E+02	8.20E+01	4.55E+01	2.53E+01
	1.26E+04	6.99E+03	3.88E+03	2.15E+03	1.19E+03	6.63E+02	3.68E+02	2.04E+02	1.13E+02
		3.45E+03	1.91E+03	1.06E+03	5.89E+02	3.27E+02	1.81E+02	1.01E+02	5.58E+01
			6.87E+02	3.81E+02	2.11E+02	1.17E+02	6.51E+01	3.61E+01	2.00E+01
				2.21E+03	1.23E+03	6.81E+02	3.78E+02	2.10E+02	1.16E+02
					6.96E+03	3.86E+03	2.14E+03	1.19E+03	6.60E+02
						4.94E+03	2.74E+03	1.52E+03	8.45E+02
							5.51E+02	3.06E+02	1.70E+02
								1.52E+02	8.46E+01
									1.05E+03

T-half[meta] (days) = 1.00E+03
Concentration factor = 2.00E+04

TABLE 8.A - Cs137 Decayed Yearly Contributions To Total EOY Fish Concentrations

1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
4.16E+03	3.16E+03	2.40E+03	1.82E+03	1.38E+03	1.05E+03	7.95E+02	6.03E+02	4.58E+02	3.47E+02
	1.10E+04	8.38E+03	6.36E+03	4.83E+03	3.66E+03	2.78E+03	2.11E+03	1.60E+03	1.22E+03
		3.09E+03	2.34E+03	1.78E+03	1.35E+03	1.02E+03	7.77E+02	5.89E+02	4.47E+02
			7.20E+02	5.47E+02	4.15E+02	3.15E+02	2.39E+02	1.81E+02	1.38E+02
				2.43E+03	1.85E+03	1.40E+03	1.06E+03	8.07E+02	6.12E+02
					5.23E+03	3.97E+03	3.01E+03	2.29E+03	1.73E+03
						4.20E+03	3.19E+03	2.42E+03	1.84E+03
							7.17E+02	5.44E+02	4.13E+02
								2.08E+02	1.58E+02
									1.69E+03

T-half[meta] (days) = 1.00E+03
Concentration factor = 2.00E+04

TOTAL INTEGRATED DOSES CALCULATED USING SAMPLE DATA AND CONCENTRATION FACTOR FISH PATHWAY MODELS FOR YEARS WITH SAMPLE DATA AVAILABLE (1)
(mRem)

SAMPLE DATA / FISH PATHWAY MODEL	ADULT WB DOSE	TEEN LIVER DOSE
MEAN SAMPLE DATA	8.39E+00	1.23E+01
MAXIMUM SAMPLE DATA	3.41E+01	4.91E+01
R.G. 1.109 (AS REPORTED) CF = 2000 L/KG	3.29E+01	4.66E+01
NUREG/CR-3332 CF=2000 L/KG R=100 DAYS	3.26E+01	4.60E+01
NUREG/CR-3332 CF=2000 L/KG R=1000 DAYS	3.02E+01	4.24E+01
NUREG/CR-3332 CF=20,000 L/KG R=100 DAYS	3.26E+02	4.60E+02
NUREG/CR-3332 CF=20,000 L/KG R=1000 DAYS	3.02E+02	4.24E+02

(1) Doses listed are total integrated values calculated based on Cs-134 and Cs-137 sample data or releases for the years 1977, 1979-1985.

ATTACHMENT 14

CREEL DATA FOR LAKES AROUND OCONEE NUCLEAR STATION

Lake Keowee (approx. 18,000 acres) 1985 data

Fish Type	Total Catch (number of fish)	Percent of Total Catch (%)	Total Weight (kg)	Percent of Total Weight (%)	Type of Food the Fish Normally Eats
Large Mouth Bass	49,182	26.19	34,266	49.20	Other Fish
Crappie	117,158	62.40	32,423	46.55	Plankton & Insects (Other fish if crappie > 0.25 kg)
Bream	19,285	10.27	2,124	3.05	Omnivorous
Catfish or Bullhead	17	0.01	2	2.87E-03	Bottom Feeders (Other fish if catfish > 1 kg)
White Bass	1,216	0.65	603	0.87	Other Fish
Yellow Perch	856	0.46	182	0.26	Plankton & Insects (Other fish if perch > 0.5 kg)
Others	41	0.02	46	0.07	
	187,755	100.00	69,646	100.00	

Lake Hartwell (approx. 60,000 acres) 1982 data

Fish Type	Total Catch (number of fish)	Percent of Total Catch (%)	Total Weight (kg)	Percent of Total Weight (%)	Type of Food the Fish Normally Eats
Large Mouth Bass	67,003	24.03	60,101	29.83	Other Fish
Crappie	110,494	39.63	23,095	11.46	Plankton & Insects (Other fish if crappie > 0.25 kg)
Bream	16,020	5.75	1,878	0.93	Omnivorous
Hybrid Bass	64,969	23.30	99,030	49.16	Other Fish
White Bass	6,339	2.27	2,841	1.41	Other Fish
Striped Bass	1,046	0.38	6,994	3.47	Other Fish
Catfishes	4,889	1.75	1,814	0.90	Bottom Feeders (Other fish if catfish > 1 kg)
Walleye	1,842	0.66	2,823	1.40	Other Fish
Coosae Bass	4,782	1.72	1,280	0.64	Other Fish
Others	1,437	0.52	1,595	0.79	
	278,821	100.00	201,451	100.00	