SEQUOYAH NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL
DATES OF REVISIONS

Original ODCM	02/29/80*
Revision 1	04/15/80**
Revision 2	10/07/80**
Revision 3	11/03/80,
02/10/81	
	04/08/81,
06/04/81**	
Revision 4	11/22/82
(10/22/81,	
	11/28/81,
04/29/82**)	
Revision 5	10/21/82**
Revision 6	01/20/83**
Revision 7	03/23/83**
Revision 8	12/16/83**
Revision 9	03/07/84**
Revision 10	04/24/84**
Revision 11	08/21/84**
Revision 12	02/19/85**
Revision 13	12/02/85
Revision 14	04/14/86
Revision 15	11/05/86***
Revision 16	01/16/87**
Revision 17	10/28/87**
Revision 18	01/05/88**
Revision 19	03/30/88**

Approved by _____ Date 5/3/88
RARC Chairman

Approved by _____ Date 5/13/88
Manager, RADCON

* Low Power license for Sequoyah unit 1
** RARC Meeting date
*** Date approved by RARC Chairman

SEQUOYAH NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL
LIST OF TABLES
REVISION 19

SEQUOYAH NUCLEAR PLANT
OFFSITE DOSE CALCULATION MANUAL
LIST OF FIGURES
REVISION 19

3.0 Radiological Environmental Monitoring

3.1 Monitoring Program

An environmental radiological monitoring program shall be conducted in accordance with Technical Specification 3.12.1. The monitoring program described in Tables 3.1, 3.2, and 3.3, and in Figures 3.1, 3.2 and 3.3 shall be conducted. Results of this program shall be reported in accordance with Technical Specifications 6.9.1.6 and 6.9.1.7.

The atmospheric environmental radiological monitoring program shall consist of monitoring stations from which samples of air particulates and atmospheric radioiodine shall be collected.

The terrestrial monitoring program shall consist of the collection of vegetation, milk, soil, ground water, drinking water, and food crops. In addition, direct gamma radiation levels will be measured in the vicinity of the plant.

The reservoir sampling program shall consist of the collection of samples of surface water, sediment, clams, and fish.

Deviations are permitted from the required sampling schedule if specimens are unobtainable due to hazardous conditions, sample unavailability, or to malfunction of sampling equipment. If the latter, every effort shall be made to complete corrective action prior to the end of the next sampling period.

3.2 Detection Capabilities

Analytical techniques shall be such that the detection capabilities listed in Table 3.4 are achieved.

3.3 Interlaboratory Comparison Program

Analyses shall be performed on radioactive materials supplied as part of an Interlaboratory Comparison Program which has been approved by the NRC. A summary of the results obtained in the intercomparison shall be included in the Annual Radiological Environmental Operating Report (or the EPA program code designation may be provided).

If analyses are not performed as required corrective actions taken to prevent a recurrence shall be reported in the Annual Radiological Environmental Operating Report.

Table 1.4
SQN - OFFSITE RECEPTOR LOCATION DATA

POINT	SECTOR	DIST (m)	ELEV (m)	χ/Q (s/m³)	D/Q (1/m²)
1 Land Site Boundary	N	950	-6.	5.12E-06	1.29E-08
2 Land Site Boundary	NNE	2260	-6	1.93E-06	5.28E-09
3 Land Site Boundary	NE	1910	-6.	2.32E-06	6.33E-09
4 Land Site Boundary	ENE	1680	-6.	1.12E-06	2.64E-09
5 Land Site Boundary	E	1570	-6.	7.10E-07	1.46E-09
6 Land Site Boundary	ESE	1460	-6.	7.91E-07	1.58E-09
7 Land Site Boundary	SE	1460	-6.	9.14E-07	2.41E-09
8 Land Site Boundary	SSE	1550	-6.	1.34E-06	3.23E-09
9 Land Site Boundary	S	1570	-6.	2.37E-06	4.18E-09
10 Land Site Boundary	SSW	1840	-6.	4.51E-06	9.26E-09
11 Land Site Boundary	SW	2470	-6.	1.38E-06	2.63E-09
12 Land Site Boundary	WSW	910	-6.	2.93E-06	3.86E-09
13 Land Site Boundary	W	670	-6	3.63E-06	3.74E-09
14 Land Site Boundary	WNW	660	-6.	2.49E-06	2.44E-09
15 Land Site Boundary	NW	660	-6.	2.25E-06	3.67E-09
16 Land Site Boundary	NNW	730	-6.	3.95E-06	6.59E-09
17 Resident	N	1370	0.	2.93E-06	7.10E-09
18 Resident	NNE	2710	0.	1.49E-06	3.88E-09
19 Resident, Garden	NE	2140	15.	1.98E-06	5.21E-09
20 Resident	ENE	2290	0.	7.13E-07	1.57E-09
21 Resident	E	1790	8.	5.85E-07	1.18E-09
22 Resident	ESE	1790	46.	5.86E-07	1.14E-09
23 Resident	SE	1680	0.	7.42E-07	1.92E-09
24 Resident, Garden	SSE	2210	46.	7.99E-07	1.79E-09
25 Resident	S	2020	0.	1.65E-06	2.75E-09
26 Resident, Garden	SSW	2290	0.	3.31E-06	6.38E-09
27 Resident	SW	3010	0.	1.04E-06	1.88E-09
28 Resident	WSW	1140	8.	2.09E-06	2.67E-09
29 Resident	W	1750	47.	8.53E-07	7.82E-10
30 Resident, Garden	WNW	1750	12.	5.71E-07	4.98E-10
31 Resident	NW	1140	11.	1.25E-06	1.50E-09
32 Resident, Garden	NNW	800	0.	3.42E-06	5.67E-09
33 Garden	N	1680	0.	2.20E-06	5.10E-09
34 Garden	NNE	3010	0.	1.28E-06	3.24E-09
35 Garden	E	2630	9.	3.38E-07	6.14E-10
36 Garden	ESE	1980	29.	5.08E-07	9.57E-10
37 Garden	SE	3010	47.	3.19E-07	7.16E-10
38 Garden	S	2290	0.	1.38E-06	2.22E-09
39 Garden	SW	3660	24.	7.96E-07	1.34E-09
40 Garden	WSW	1680	0.	1.16E-06	1.43E-09
41 Garden	W	1830	0.	8.02E-07	7.26E-10
42 Garden	NW	1180	11	1.19E-06	1.42E-09
43 Milk Cow Adult	N	4120	0.	6.18E-07	1.10E-09
44 Milk Cow Adult	NE	6750	47.	3.94E-07	7.03E-10
45 Milk Cow Adult	WNW	1750	12.	5.71E-07	4.98E-10
46 Milk Cow Adult	NW	1980	5.	5.61E-07	6.09E-10

TABLE 3.1 (Sheet 1 of 4)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGR

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
1. AIRBORNE			
a. Particulates	4 samples from locations (in different sectors) at or near the site boundary (LM 2, 3, 4, and 5)	Continuous sampler operation with sample collection once per 7 days (more frequently if required by dust loading)	Analyze for gross beta radioactivity ≥ 24 hours following filter change. Perform gamma isotopic analysis on each sample if gross beta > 10 times yearly mean of control sample. Composite at least once per 31 days (by location for gamma scan)
	4 samples from communities approximately 6-10 miles distance from the plant (PM 2, 3, 8, and 9)		
	4 samples from control locations greater than 10 miles from the plant (RM 1, 2, 3, and 4)		
b. Radioiodine	Samples from same locations as air particulates	Continuous sampler operation with filter collection once per 7 days	^{131}I at least once per 7 days
c. Soil	Samples from same locations as air particulates	Once per year	Gamma scan, ^{89}Sr, ^{90}Sr once each year
2. DIRECT RADIATION	2 or more dosimeters placed at 11 of the air particulate sampling stations (LM-3, LM-4, LM-5, PM-2, PM-3, PM-8, PM-9, RM-1, RM-2, RM-3, and RM-4)	Once per 92 days	Gamma dose at least once per 92 days
	2 or more dosimeters placed at each of at least 30 other locations. (Figures 3.1, 3.2, and 3.3)		

*Sample locations are listed in Tables 3.2 and 3.3 and shown on Figures 3.1, 3.2, and 3.3.

TABLE 3.1 (Sheet 2 of 4)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
3. WATERBORNE			
a. Surface	TRM 497.0 TRM 483.4 TRM 473.2	Collected by automatic sequential-type sampler** with composite samples collected over a period of ≤ 32 days	Gamma scan of each composite sample. Composite for tritium analysis at least once per 92 days
b. Ground	1 sample adjacent to plant (location W-6)	At least once per 92 days	Gross beta, gamma scan and tritium analysis at least once per 92 days
	1 sample from ground water source upgradient		
c. Drinking	1 sample at the first potable surface water supply downstream from the plant (TRM 473.0)	Collected by automatic sequential-type sampler** with composite sample collected over a period of ≤ 31 days	Gross beta and gamma scan of each composite sample. Composite for tritium, ^{89}Sr, ^{90}Sr at least once per 92 days
	1 sample at the next 2 downstream potable surface water suppliers (greater than 10 miles downstream) (TRM 470.5 and 465.3)	Grab sample once per 31 days	
	2 samples at control locations (TRM 497.0 and TRM 503.8)	Samples collected by automatic sequential-type sampler with composite sample collected over a period of ≤ 31 days	
d. Sediment	TRM 496.5 TRM 483.4 TRM 480.8 TRM 472.8	At least once per 184 days	Gamma scan of each sample

*Sample locations are listed in Tables 3.2 and 3.3 and shown on Figures 3.1, 3.2, and 3.3.
**Samples shall be collected by collecting an aliquot at intervals not exceeding 2 hours.

TABLE 3.1 (Sheet 3 of 4)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
e. Shoreline Sediment	TRM 485 TRM 478 TRM 477	At least once per 184 days	Gamma scan of each sample
4. INGESTION			
a. Milk	1 sample from milk producing animals in each of 1-3 areas indicated by the cow census where doses are calculated to be highest. If samples are not available from a milk animal location, doses to that area will be estimated by projecting the doses from concentrations detected in milk from other sectors or by sampling vegetation where milk is not available (Table 3.1, 4.d) At least 1 sample from a control location.	At least once per 15 days	Gamma isotopic and ^{131}I analysis of each sample. ^{89}Sr, ^{90}Sr once per quarter
b. Fish	1 sample each for Nickajack, Chickamauga, and Watts Bar Reservoirs	At least once per 184 days. One sample of each of the following species: Channel Catfish Crappie Smallmouth Buffalo	Gamma scan on edible portion

*Sample locations are listed in Tables 3.2 and 3.3 and shown on Figures 3.1, 3.2, and 3.3.

TABLE 3.1 (Sheet 4 of 4)

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Exposure Pathway and/or Sample	Sample Locations*	Sampling and Collection Frequency	Type and Frequency of Analysis
c. Invertebrates (Asiatic Clams)	TRM 496.5 TRM 483.4 TRM 480.8	At least once per 184 days.	Gamma scan on edible portion
d. Food Products	1 sample each of principal food products grown at private gardens and/or farms in the immediate vicinity of the plant.	At least once per 365 days at time of harvest. The types of foods available for sampling will vary. Following is a list of typical foods which may be available: Cabbage and/or Lettuce Corn Green Beans Potatoes Tomatoes	Gamma scan on edible portion
e. Vegetation	1 sample from up to three locations of milk-producing animals where a sample of milk is not available and at each air particulate station	At least once per 31 days	Gamma scan at least once per 31 days. ^{89}Sr and ^{90}Sr analysis and least once per 92 days

*Sample locations are listed in Tables 3.2 and 3.3 and shown on Figures 3.1, 3.2, and 3.3.

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TABLE 3.2

SEQUOYAH NUCLEAR PLANT

Environmental Radiological Monitoring Program
Sampling Locations

Map Location Number [a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected[b]
2	LM-2	N	0.8	I	AP, CF, S, V
3	LM-3	SSW	1.2	I	AP, CF, S, V
4	LM-4	NE	1.5	I	AP, CF, S, V
5	LM-5	NNE	1.8	I	AP, CF, S, V
7	PM-2	SW	3.8	I	AP, CF, S, V
8	PM-3	W	5.6	I	AP, CF, S, V
9	PM-8	SSW	8.7	I	AP, CF, S, V
10	PM-9	WSW	2.6	I	AP, CF, S, V
11	RM-1	SW	16.7	C	AP, CF, S, V
12	RM-2	NNE	17.8	C	AP, CF, S, V
13	RM-3	ESE	11.3	C	AP, CF, S, V
14	RM-4	WNW	18.9	C	AP, CF, S, V
15	Farm B	NE	43.0	C	M, V
16	Farm C	NE	16.0	C	M, V
17	Farm S	NNE	12.0	C	M, V
18	Farm J	WNW	1.1	I	M, V
19	Farm HW	NW	1.2	I	M, V, W[c]
20	Farm EM	N	2.6	I	V
21	Farm Br	SSW	2.2	I	V
24	Well No. 6	NNE	0.15	I	W
31	TRM[d] 473.0 (C.F. Industries)	--	11.5[e]	I	PW
32	TRM 470.5 (E.I. DuPont)	--	14.0[e]	I	PW
33	TRM 465.3 (Chattanooga)	--	19.2[e]	I	PW
34	TRM 497.0	--	12.5[e]	C[d]	SW
35	TRM 503.8 (Dayton)	--	19.3[e]	C	PW
36	TRM 496.5	--	12.0[e]	C	CL, SD
37	TRM 485.0	--	0.5[e]	C	SS
38	TRM 483.4	--	1.1[e]	I	CL, SD, SW
39	TRM 480.8	--	3.7[e]	I	CL, SD
40	TRM 477.0	--	7.5[e]	I	SS
41	TRM 473.2	--	11.3[e]	I	SW
42	TRM 472.8	--	11.7[e]	I	SD
44	TRM 478.8	--	6.5[e]	I	SS

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TABLE 3.2 (Continued)

SEQUOYAH NUCLEAR PLANT

Environmental Radiological Monitoring Program
Sampling Locations

Map Location Number [a]	Station	Sector	Approximate Distance (Miles)	Indicator (I) or Control (C)	Samples Collected [b]
45	TRM 425-471 (Nickajack Reservoir)	--	--	I	F
46	TRM 471-530 (Chickamauga Reservoir)	--	--	I	F
47	TRM 530-602 (Watts Bar Reservoir)	--	--	C	F

a. See figures 3.1, 3.2, and 3.3

b. Sample Codes
AP = Air particulate filter
CF = Charcoal filter
CL = Clams
F = Fish
M = Milk
PW = Public water
R = Rainwater
S = Soil
SD = Sediment
SS = Shoreline sediment
SW = Surface water
V = Vegetation
W = Well water

c. A control for well water.

d. TRM = Tennessee River Mile.

e. Distance from plant discharge (TRM 484.5)

f. Surface water sample also used as a control for public water.

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Table 3.3

SEQUOYAH NUCLEAR PLANT

Thermoluminescent Dosimeter Locations

Map Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[a] or Offsite (Off)
3	SSW-1A	SSW	1.2	On
4	NE-1A	NE	1.5	On
5	NNE-1	NNE	1.8	On
7	SW-2	SW	3.8	Off
8	W-3	W	5.6	Off
9	SSW-3	SSW	8.7	Off
10	WSW-2A	WSW	2.6	Off
11	SW-3	SW	16.7	Off
12	NNE-4	NNE	17.8	Off
13	ESE-3	ESE	11.3	Off
14	WNW-3	WNW	18.9	Off
49	N-1	N	0.6	On
50	N-2	N	2.1	Off
51	N-3	N	5.2	Off
52	N-4	N	10.0	Off
53	NNE-2	NNE	4.5	Off
54	NNE-3	NNE	12.1	Off
55	NE-1	NE	2.4	Off
56	NE-2	NE	4.1	Off
57	ENE-1	ENE	0.4	On
58	ENE-2	ENE	5.1	Off
59	E-1	E	1.2	On
60	E-2	E	5.2	Off
61	ESE-A	ESE	0.4	On
62	ESE-1	ESE	1.2	On
63	ESE-2	ESE	4.9	Off
64	SE-A	SE	0.4	On
65	SE-B	SE	0.4	On
66	SE-1	SE	1.4	On
67	SE-2	SE	1.9	On
68	SE-4	SE	5.2	Off
69	SSE-1	SSE	1.6	On
70	SSE-2	SSE	4.6	Off
71	S-1	S	1.5	On
72	S-2	S	4.7	Off
73	SSW-1	SSW	0.6	On
74	SSW-2	SSW	4.0	Off

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Table 3.3 (Continued)

SEQUOYAH NUCLEAR PLANT

Thermoluminescent Dosimeter Locations

Map Location Number	Station	Sector	Approximate Distance (Miles)	Onsite (On)[a] or Offsite (Off)
75	SW-1	SW	0.9	On
76	WSW-1	WSW	0.9	On
77	WSW-2	WSW	2.5	Off
78	WSW-3	WSW	5.7	Off
79	WSW-4	WSW	7.8	Off
80	WSW-5	WSW	10.1	Off
81	W-1	W	0.8	On
82	W-2	W	4.3	Off
83	WNW-1	WNW	0.4	On
84	WNW-2	WNW	5.3	Off
85	NW-1	NW	0.4	On
86	NW-2	NW	5.2	Off
87	NNW-1	NNW	0.6	On
88	NNW-2	NNW	1.7	On
89	NNW-3	NNW	5.3	Off

a. TLDs designated onsite are those located two miles or less from the plant. TLDs designated offsite are those located more than two miles from the plant.

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Table 3.4 (1 of 2)
MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)[a,c]

Analysis (pCi/L)	Water (pCi/L)	Airborne Particulate or Gas (pCi/m^3)	Fish (pCi/kg,wet)	Milk (pCi/L)	Food Products (pCi/kg,wet)	Sediment (pCi/kg,dry)
gross beta	4	1×10^{-2}	N.A.	N.A.	N.A.	N.A.
H-3	2000	N.A.	N.A.	N.A.	N.A.	N.A.
Mn-54	15	N.A.	130	N.A.	N.A.	N.A.
Fe-59	30	N.A.	260	N.A.	N.A.	N.A.
Co-58,60	15	N.A.	130	N.A.	N.A.	N.A.
Zn-65	30	N.A.	260	N.A.	N.A.	N.A.
Zr-95	30	N.A.	N.A.	N.A.	N.A.	N.A.
Nb-95	15	N.A.	N.A.	N.A.	N.A.	N.A.
I-131	1[b]	7×10^{-2}	N.A.	1	60	N.A.
Cs-134	15	5×10^{-2}	130	15	60	150
Cs-137	18	6×10^{-2}	150	18	80	180
Ba-140	60	N.A.	N.A.	60	N.A.	N.A.
La-140	15	N.A.	N.A.	15	N.A.	N.A.

TABLE NOTATION

[a] The LLD is the smallest concentration of radioactive material in a sample that will be detected with 95% probability with 5% probability of falsely concluding that a blank observation represents a "real" signal.

For a particular measurement system (which may include radiochemical separation):

$$LLD = \frac{4.66\ s_b}{E\ V\ 2.22\ Y\ \exp(-\lambda \Delta t)}$$

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Table 3.4 (1 of 2)
MAXIMUM VALUES FOR THE LOWER LIMITS OF DETECTION (LLD)[a,c]

TABLE NOTATION (continued)

Where:

LLD is the "a priori" lower limit of detection as defined above (picocurie per unit mass or volume),

s_b is the standard deviation of the background counting rate or of the counting rate of a blank sample as appropriate (counts per minute),

E is the counting efficiency (counts per transformation),

V is the sample size (units of mass or volume),

2.22 is the number of transformations per minute per picocurie,

Y is the fractional radiochemical yield (when applicable),

λ is the radioactive decay constant for the particular radionuclide, and

Δt is the elapsed time between sample collection (or end of the sample collection period) and time of counting (for environmental samples, not plant effluent samples).

The value of s_b used in the calculation of the LLD for a detection system shall be based on the actual observed variance of the background counting rate or of the counting rate of the blank samples (as appropriate) rather than on an unverified theoretically predicted variance. In calculating the LLD for a radionuclide determined by gamma-ray spectrometry, the background shall include the typical contributions of other radionuclides normally present in the samples (e.g., potassium-40 in milk samples). Typical values of E, V, Y, and Δt shall be used in the calculations.

b The LLD for analysis of drinking water and surface water samples shall be performed by gamma spectroscopy at approximately 15 pCi/L. If levels greater than 15 pCi/L are identified in surface water samples downstream from the plant, or in the event of an unanticipated release of I-131, drinking water samples will be analyzed at a LLD of 1.0 pCi/L for I-131.

c Other peaks which are measurable and identifiable, together with the radionuclides in Table 4.12-1, shall be identified and reported.

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(All Stability Classes)

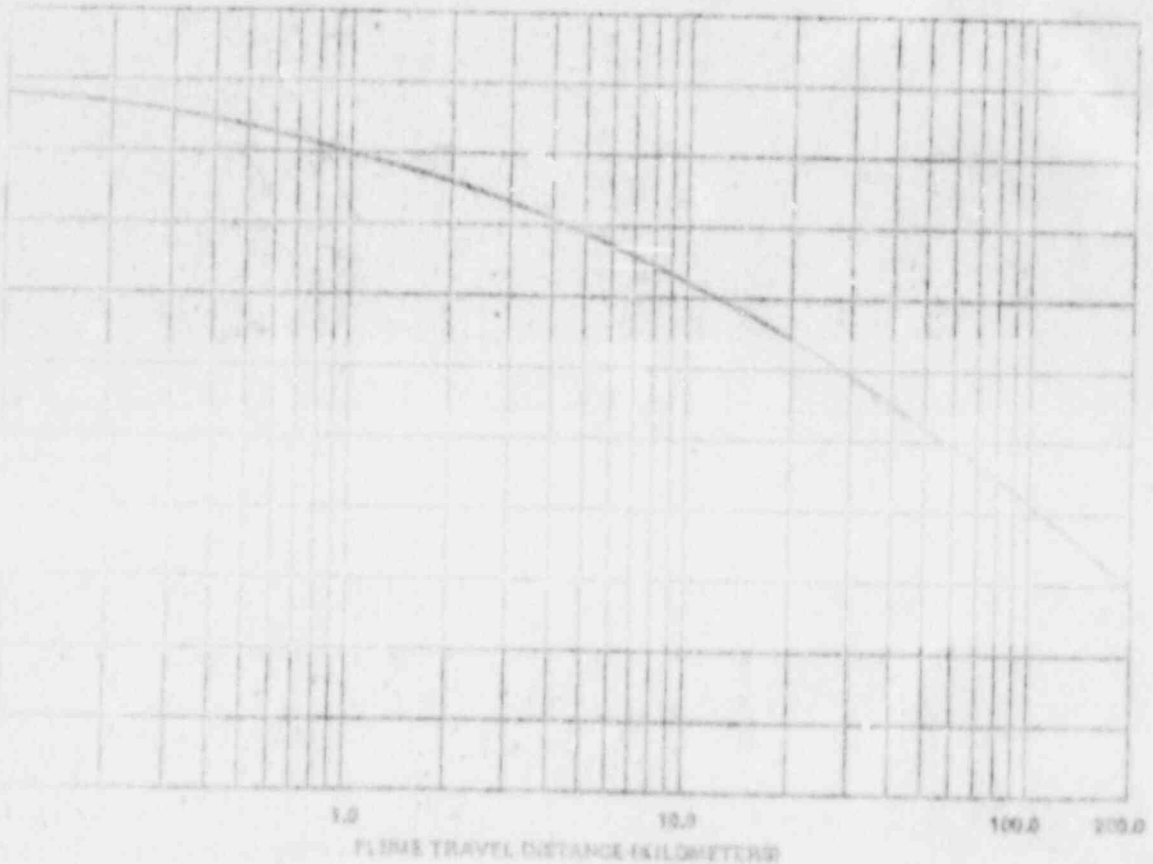

Figure 1.2
RELATIVE DEPOSITION FOR GROUND LEVEL RELEASES
(All Stability Classes)

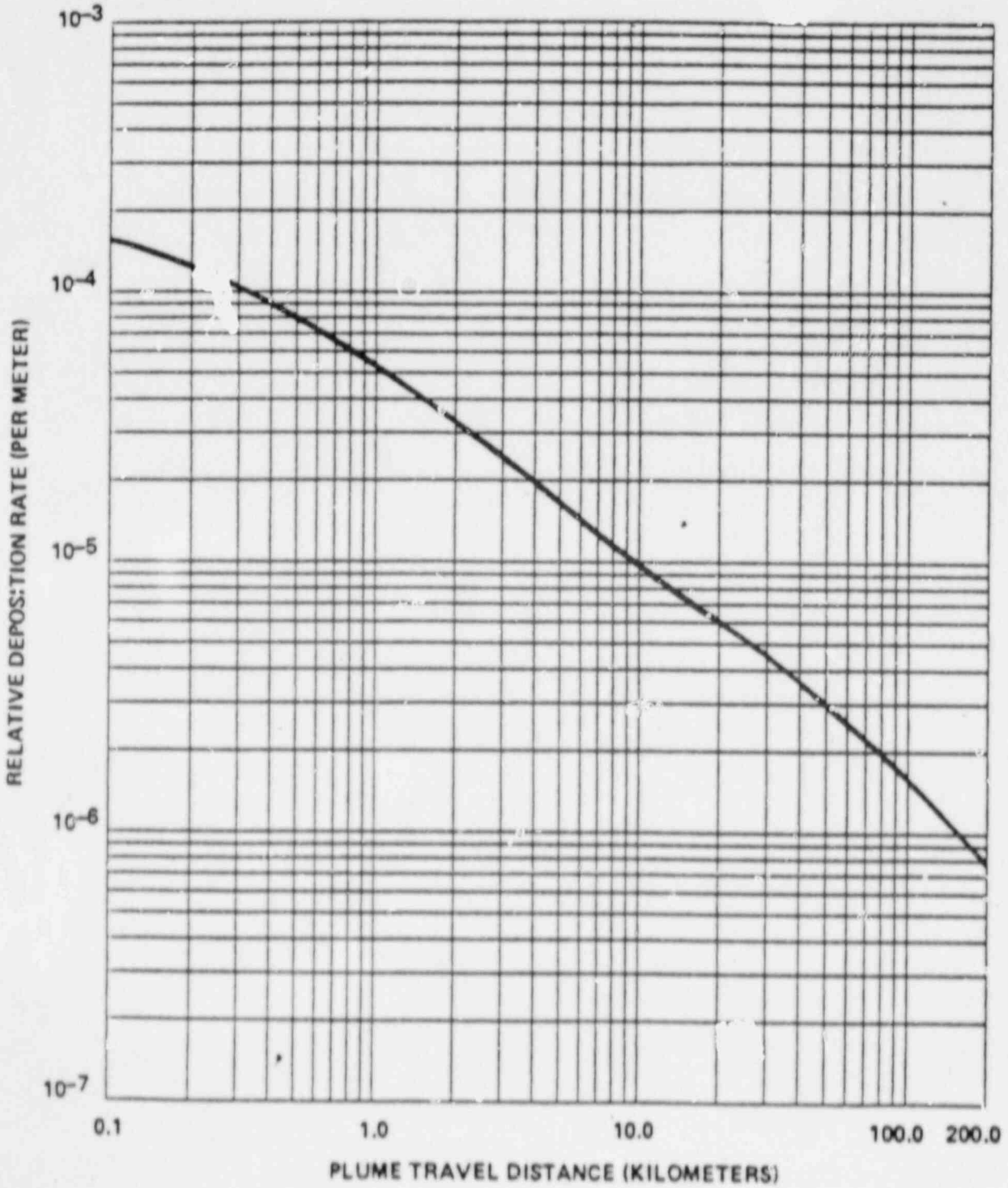

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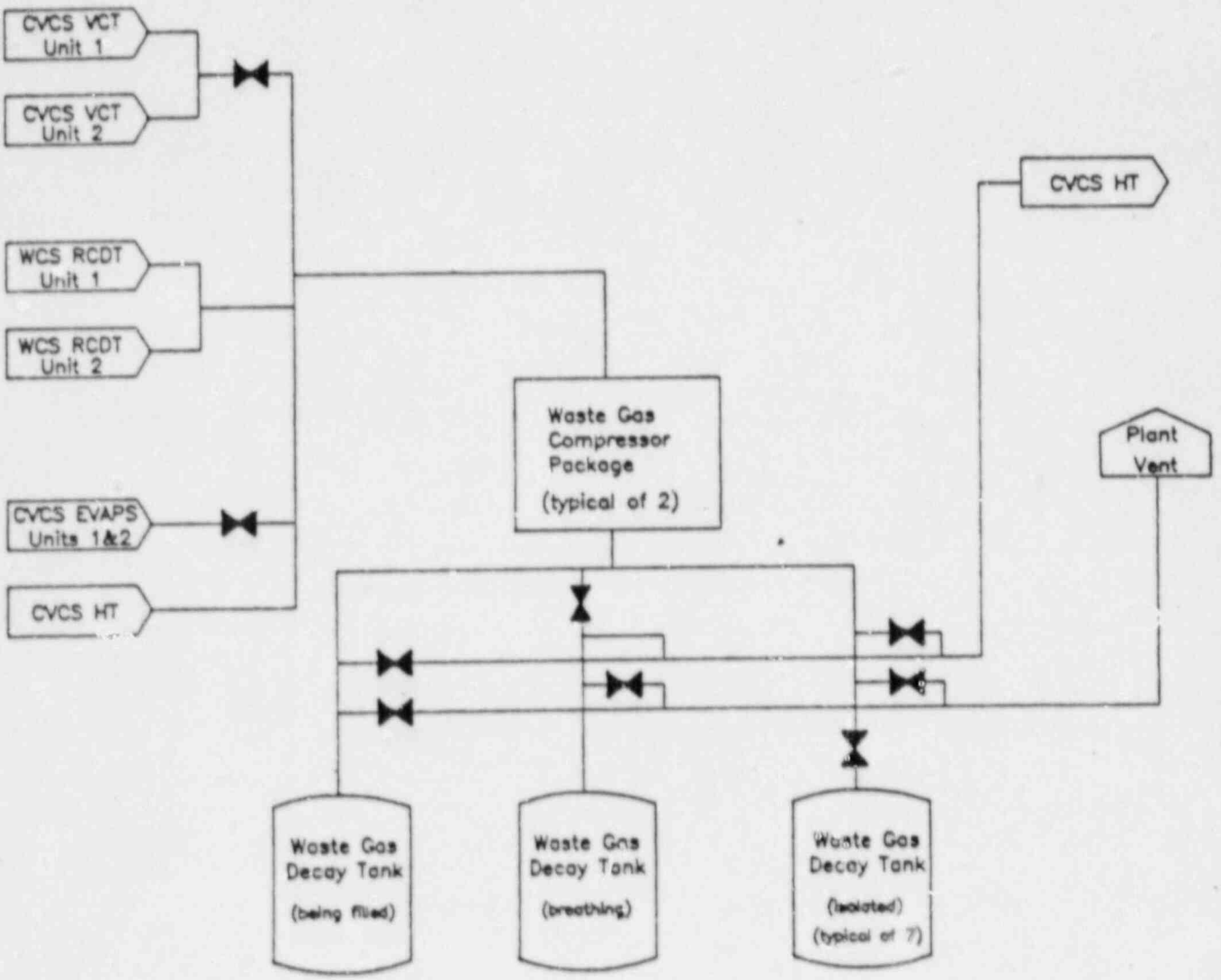
Figure 1.3
GASEOUS RADWASTE TREATMENT SYSTEM



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Figu e 3.1

Environmental Radiological Sampling Locations

Within 1 Mile of Plant

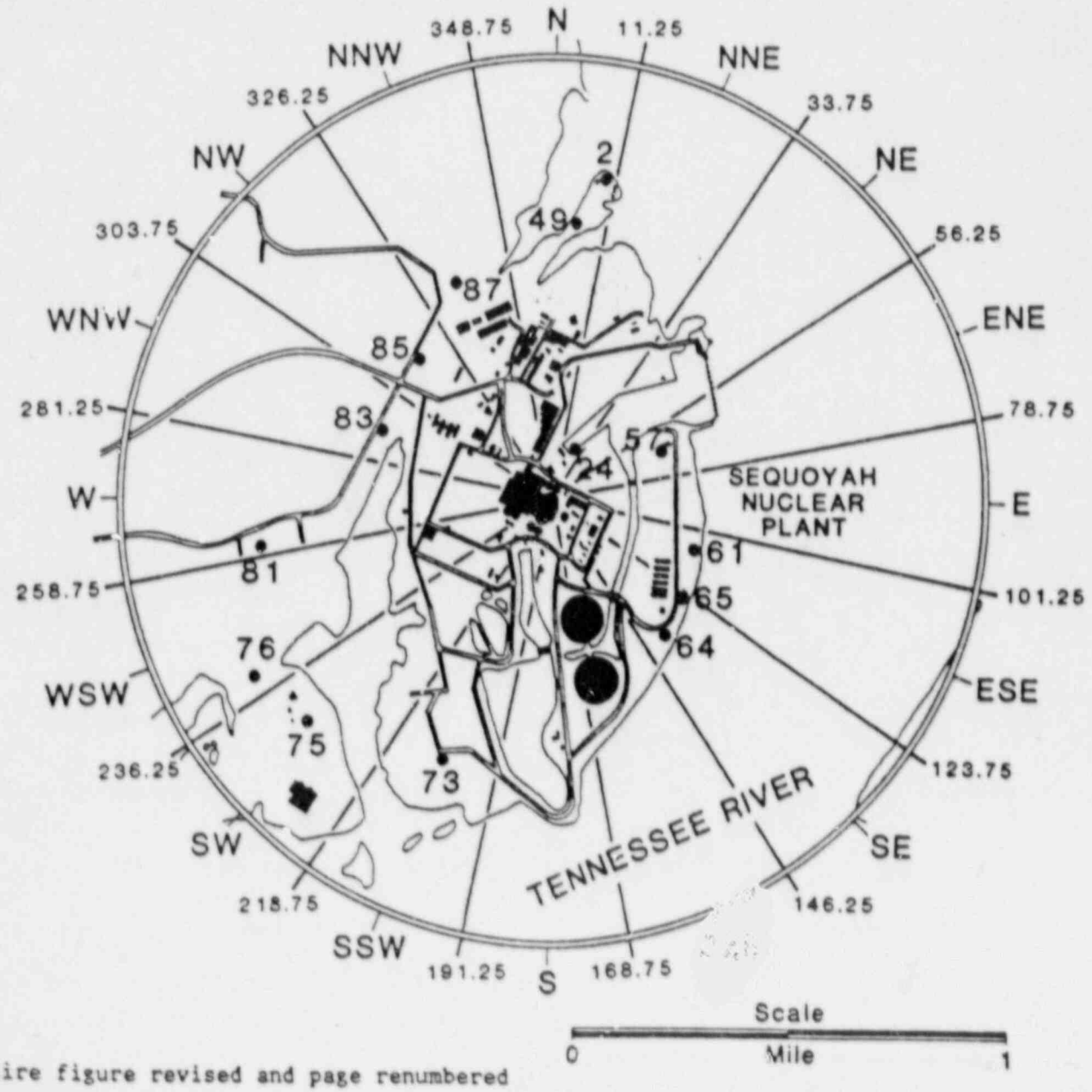

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Figure 3.2

Environmental Radiological Sampling Locations From 1 to 5 Miles From The Plant

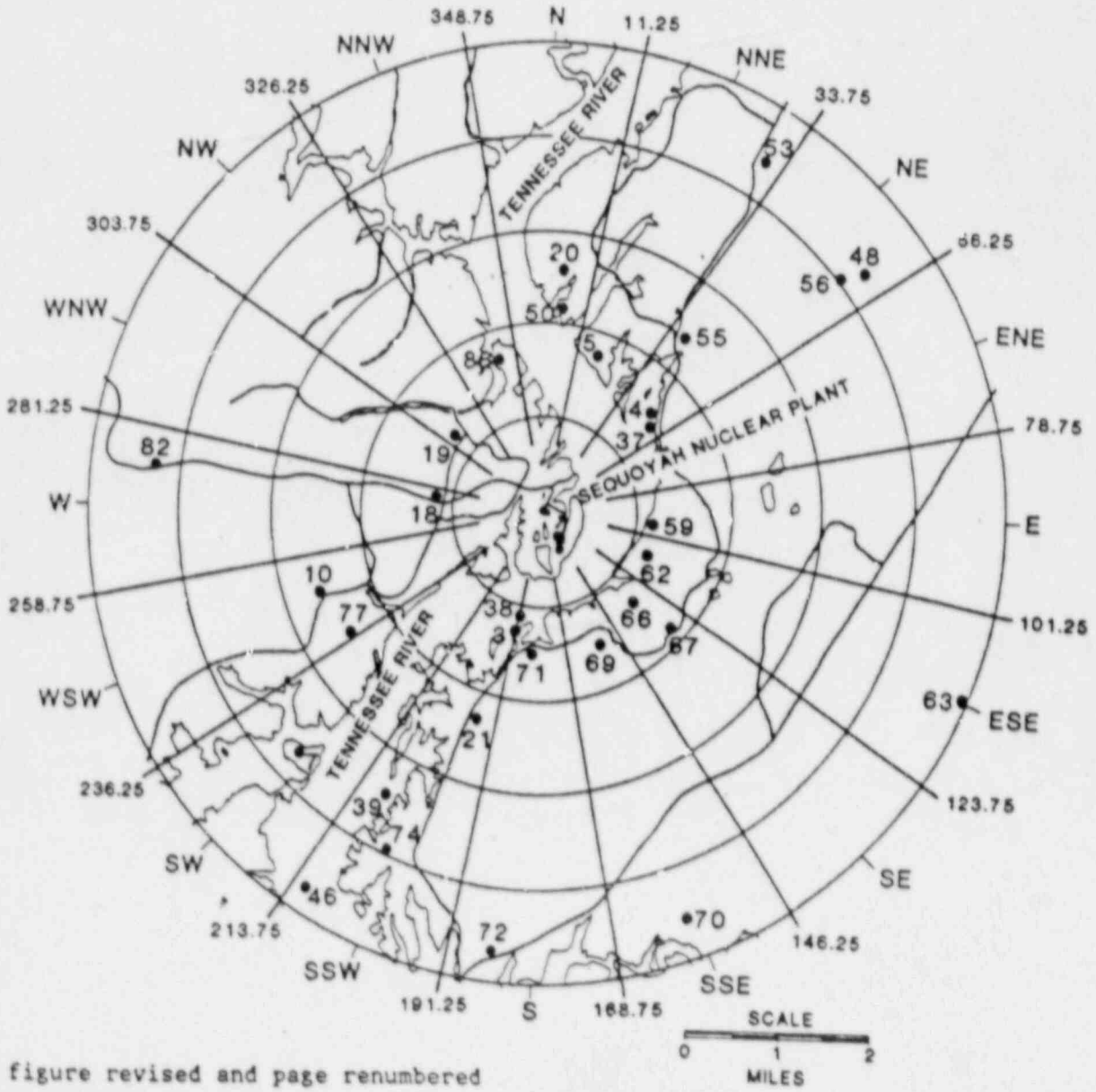

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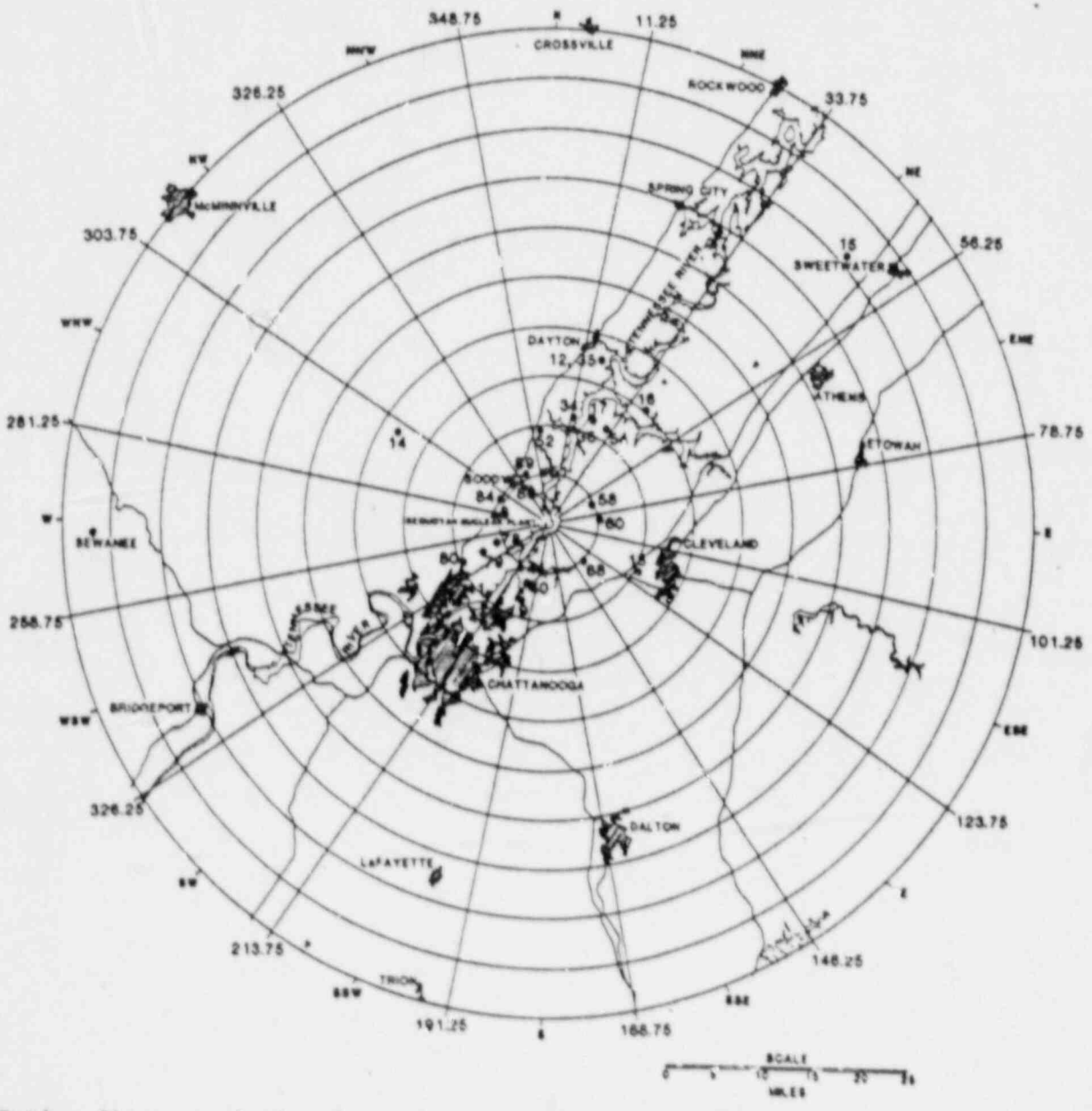
Figure 3.3

Environmental Radiological Sampling Locations

Greater Than 5 Miles From The Plant



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