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REACTOR OPERATION ENVIRONMENTAL INFORMATION DOCUMENT

VOLUME III

METEOROLOGY, SURFACE HYDROLOGY, TRANSPORT AND IMPACTS (U)

L. R. Bauer
D. W. Hayes
C. H. Hunter
W. L. Marter
R. A. Moyer

SRL
RECORD COPY

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Savannah River Site
Aiken, SC 29808

Prepared for the U. S. Department of Energy under Contract No. DE-AC09-88SR18035

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1.0 METEOROLOGY AND AIR QUALITY

1.1 REGIONAL CLIMATOLOGY SUMMARY

The climate of the southeastern United States, including the Savannah River Site (SRS) area, is classified as humid subtropical (Oliver et al., 1987). This climate is characterized by relatively short, mild winters and long, warm, and humid summers.

Summer weather usually lasts from May through September, when the area is strongly influenced by the semi-permanent Atlantic subtropical anti-cyclone (the "Bermuda high" pressure system). Winds are relatively light and weather associated with migratory low pressure systems and fronts usually remains well to the north of the area. Daytime temperatures are frequently above 90°F, and temperatures of 100°F or greater occur once per year on the average (NOAA, 1987). The relatively hot and humid conditions frequently result in scattered afternoon and evening thunderstorms.

The influence of the "Bermuda high" begins to diminish during the fall, resulting in relatively dry weather and moderate temperatures. Fall days are frequently characterized by cool, clear mornings and warm, sunny afternoons.

During the winter, low pressure systems and associated fronts frequently affect the SRS area. Conditions often alternate between warm, moist subtropical air from the Gulf of Mexico region and cool, dry polar air. The Appalachian Mountains to the north and northwest of the SRS moderate the extremely cold temperatures associated with occasional outbreaks of arctic air masses. Consequently, less than one-third of all winter days have minimum temperatures below freezing. Frozen precipitation occurs less than once per year on the average (NOAA, 1987).

Outbreaks of severe thunderstorms and tornadoes occur more frequently during the spring than during the other seasons. Although spring weather is changeable and relatively windy, temperatures are usually mild.

1.2 LOCAL METEOROLOGY

Sources of data used to describe the local meteorological conditions include an onsite meteorological tower network, an instrumented television tower near the SRS, an onsite standard meteorological instrument shelter, and the National Weather Service (NWS) office located at Bush Field Airport in Augusta, Georgia approximately 15 miles west-northwest of the SRS. The onsite instrument shelter, located in A Area, is equipped with instrumentation to measure temperature, precipitation, and relative humidity. These instruments are maintained in accordance with manufacturers specifications. The data collection program for the television tower and the onsite tower network is described in subsection 1.2.1.

1.2.1 Onsite Meteorological Monitoring Program

An extensive meteorological data base has been collected from instrumentation on an onsite network of eight 200-foot towers, one located near each major production facility at SRS, and on the 1,000-ft WJBF-TV tower located about nine miles northwest of the site boundary. The location of these towers are shown in Figure 1-1. The onsite meteorological monitoring program is conducted in a manner generally consistent with guidance given in Nuclear Regulatory Commission Regulatory Guide 1.23 (NRC, 1980).

The tower data that are summarized and discussed in Section 1.2 were collected during the five-year period from 1982 through 1986. During this five-year period, the onsite towers were instrumented with wind vector vanes located 200 feet above ground. The TV tower was instrumented at seven levels with bivanes and fast-response cup anemometers to provide the same information collected from the onsite towers. In addition, temperature sensors were located on the TV tower at eight levels. More detailed summaries of the meteorological instrumentation, including performance specifications, are given in Table 1-1.

Data from the K- and P-Area towers are used to characterize the wind and atmospheric dispersion climatology of the three reactor facilities. Data from the L-Area tower are not provided since this tower was not operational during all of the 1982-1986 period. However, the K- and P-Area data are considered reasonably representative of conditions at L Area.

The K- and P-Area towers were each located about 0.5 miles southeast of their respective reactor facility. Tower base elevation was approximately the same elevation as reactor building grade. To collect data representative of local dispersion, the towers were sited within the surrounding forest. Trees surrounding the monitoring sites were generally no more than 100 feet tall; therefore, the vegetation was not an obstruction to the wind sensors.

A Digital Equipment Corporation (DEC) VAX 11/750 microcomputer, located in the Weather Center Analysis Laboratory (WCAL) at the Savannah River Laboratory (SRL), was used for data acquisition and storage. A signal from each instrument was transmitted to the computer every 1.5 seconds. These signals were processed and used to compute 15-minute and hourly averages of wind speed and wind direction (vector and scalar) and to calculate fifteen minute and hourly values of sigma-a and sigma-e (the standard deviation of the fluctuations of the horizontal and vertical component of wind direction, respectively). Scalar hourly average winds were used for summaries reported in this chapter.

The data collected from the SRS meteorological tower system are used primarily for real-time emergency response. Since good data must be reliably available, instrument technicians visited the site each work day to inspect the data and equipment, and perform needed maintenance. Furthermore, the data were frequently inspected by SRL meteorologists.

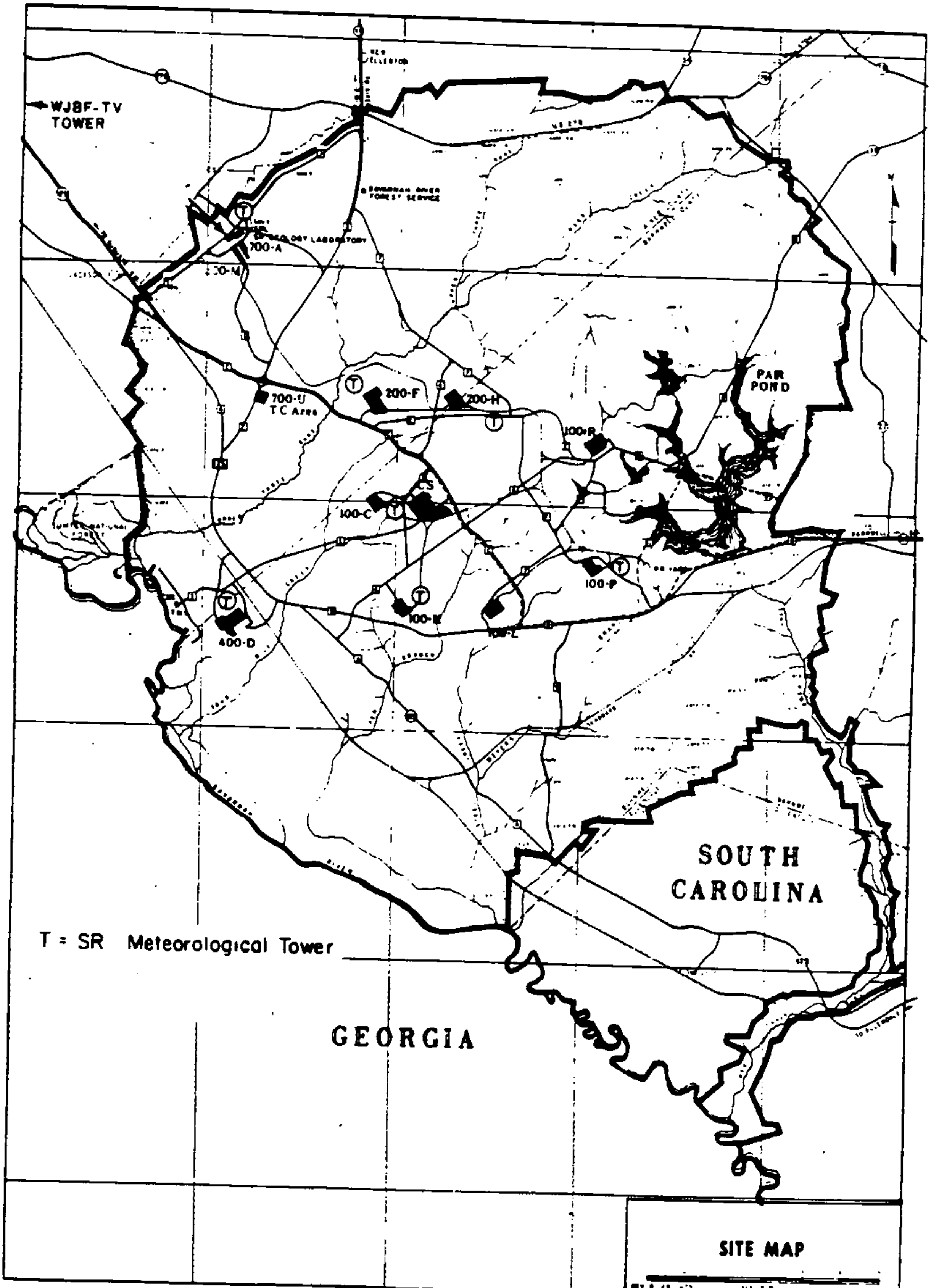


FIGURE 1-1. Approximate Locations of Onsite Meteorological Towers

TABLE 1-1

Descriptions of SRS Meteorological Instrumentation

Sensor	Measurement	Height (ft)	Description
	SRS Area Towers A, C, D, F, H, K, and P		
MRI (Meteorological Research Institute) Mark II Vector Vane, Model 1053 III-2	Azimuth	200	Accuracy, ±3°; starting threshold, 0.75 mph; damping ratio, 0.4-0.6; operating range, 0-540°; linearity, ±1%; delay distance, 2-3 feet.
	Elevation	200	Accuracy, ±2°; starting threshold, 0.75 mph; damping ratio, 0.4-0.6; operating range, ±60°; linearity, ±1%.
	Wind speed	200	Accuracy, ±0.35 mph; starting threshold, 0.75 mph; operating range, 0-100 mph; linearity, ±1%; response distance, 2-3 feet.
	WJBF-TV Tower		
Climet Model 012-8A Bivane	Azimuth	60,120,300, 450,600,800, 1000	Accuracy, ±3°; starting threshold, 0.75 mph; damping ratio, 0.6; range, 0-540° delay distance, 3 feet; linearity, ±0.5%.
	Elevation	60,120,300, 450,600,800 1000	Accuracy, ±3°; starting threshold, 0.75 mph; damping ratio, 0.6; operating range, ±60°; linearity, ±0.5%.
Climet Model 011-1 Cup Anemometer	Wind speed	60,120,300 450,600,800, 1000	Accuracy, ±1% or 0.15 mph whichever is greater; starting threshold, 0.6 mph; range, 0.6-90 mph.
Rosemont Model T-200 Platinum Resistance Thermometer	Temperature	7,60,120,300 450,600,800 1000	Accuracy, ±1.8°F

The instrumentation was calibrated, as needed, at the SRL by trained instrument mechanics. A wind tunnel at SRL was used for calibrations of the wind sensors. All calibrations were conducted according to manufacturers' specifications using procedures that met or exceeded ASTM calibration methods (Addis, 1986).

Quality control of the data was performed by combining a real-time screening algorithm with statistical checks. The real-time screening consisted of instrument voltage range checks and a check that sufficient instantaneous data were received during a fifteen-minute period. Subsequently, the Dixon ratio test with a 99% confidence level was used to check for statistical outliers. A final screening consisted of comparisons of the components of the wind turbulence. Valid data recovery was 80% and 72% of the total number of hours during the five-year period for the K- and P-Area towers, respectively (Laurinat, 1987).

1.2.2 Temperature, Humidity, and Fog

Monthly and annual average temperatures for SRS (period of record, 1961-1986) and for Augusta (1942-1986) are given in Tables 1-2 and 1-3, respectively. At the SRS, the annual average temperature was 64°F. July was the warmest month with an average maximum temperature of 91.5°F and an average minimum of 70.5°F. January was the coldest month with an average maximum temperature of 55°F and an average minimum temperature of 35°F. Monthly and annual extreme temperatures for both locations are also listed in Tables 1-2 and 1-3. Observed temperature extremes for SRS ranged from 107°F to -3°F. Average and extreme temperatures for Augusta differ little from the SRS data.

Table 1-4 shows the average number of days in each month that Augusta's maximum and minimum temperatures were above and below specified values. These data indicate that prolonged periods of cold weather seldom occur. Daytime high temperatures during the winter months are rarely less than 32°F. Conversely, high temperatures in the summer months are greater than 90°F on more than half of all days. The average dates of the first and last freeze are November 12 and March 16, respectively (NOAA, 1987).

Monthly and annual average values of relative humidity for Augusta (1965-1986) and for SRS (1964-1986) are given in Table 1-5. The data for the SRS are averages of the observed relative humidity at the time of occurrence of the minimum and maximum temperatures, respectively. Consequently, the SRS and Augusta data are not directly comparable because of differences in the time of day that the data are recorded. In general, average relative humidities are greatest during the summer months and least during the spring months. Annually, relative humidity ranges from about 90% in the early morning to around 43% in the afternoon.

TABLE 1-2

Monthly Average and Extreme Temperatures for the SRS[a]

Month	Average Daily Temperature (°F) Maximum	Average Daily Temperature (°F) Minimum	Average Daily Temperature (°F) Monthly	Extreme Temperature (°F) Maximum	Extreme Temperature (°F) Minimum
January	55.0	35.0	45.0	86	-3
February	60.0	37.5	49.5	81	4
March	68.5	44.0	56.5	91	11
April	77.0	52.5	65.0	99	29
May	83.5	60.0	72.0	102	40
June	89.5	67.0	78.5	105	48
July	91.5	70.5	81.0	107	56
August	90.5	69.5	80.0	107	56
September	85.0	64.0	75.0	102	41
October	76.5	55.0	66.0	96	28
November	67.5	45.0	56.5	89	18
December	59.5	38.5	49.5	82	5
Annual	75.5	53.0	64.0	107	-3

[a] Period of record, 1961-1986.

TABLE 1-3

Monthly Average and Extreme Temperatures for Augusta, Georgia

Month	Average Daily Temperature[a] (°F) Maximum	Minimum	Monthly	Extreme Temperatures[b] (°F) High[c]	Low[c]
January	57.0	36.6	46.8	80 (1985)	-1 (1985)
February	60.0	38.4	49.2	86 (1962)	9 (1973)
March	67.5	45.2	56.4	88 (1985)	12 (1980)
April	75.7	51.9	63.8	96 (1986)	26 (1982)
May	83.5	60.6	72.1	99 (1964)	35 (1971)
June	89.4	67.9	78.7	105 (1952)	47 (1984)
July	91.1	71.3	81.2	107 (1980)	55 (1951)
August	90.0	70.5	80.3	108 (1983)	54 (1968)
September	85.6	65.5	75.6	101 (1957)	36 (1967)
October	76.4	53.6	65.0	97 (1954)	22 (1952)
November	66.4	43.3	54.9	90 (1961)	15 (1970)
December	58.3	37.4	47.9	82 (1982)	5 (1981)
Annual	75.1	53.5	64.3	108 (1983)	-1 (1985)

[a] Period of record, 1942-1986
[b] Period of record, 1950-1986
[c] Year of occurrence shown in parentheses

Source: NOAA (1987)

TABLE 1-4

Average Number of Days Maximum and Minimum Temperatures for Augusta, GA Exceed Indicated Values

	Number of Days			
	Maximum Temperature		Minimum Temperature	
Month	90°F and Above	32°F and Below	32°F and Below	0°F and Below
January	0	0.6	17.1	<0.5
February	0	<0.5	13.4	0
March	0	<0.5	5.5	0
April	1	0	0.6	0
May	4.8	0	0	0
June	14.4	0	0	0
July	21.6	0	0	0
August	17.7	0	0	0
September	8.5	0	0	0
October	0.8	0	0.5	0
November	0	0	7.2	0
December	0	0	13.8	0
Annual	68.7	0.7	58.2	<0.5

Source: NOAA (1987)

TABLE 1-5

Average Daily Relative Humidities, in Percent, at Augusta, GA, and at the SRS

Month	Augusta, GA[a]				SRS[b]	
	1 a.m.	7 a.m.	1 p.m.	7 p.m.	Minimum	Maximum
January	78	82	54	66	49	81
February	76	81	49	59	43	80
March	76	83	47	55	38	83
April	79	85	45	54	36	87
May	85	87	49	61	39	92
June	86	86	52	62	41	95
July	87	87	55	67	45	97
August	89	91	56	72	46	98
September	89	91	55	75	45	96
October	87	89	58	76	41	92
November	84	87	51	72	42	89
December	81	85	53	70	49	85
Annual	83	86	51	66	43	90

[a] Period of record, 1965-1986
[b] Period of record, 1964-1986

Source (for Augusta): NOAA (1987)

Heavy fog, defined as fog that reduces visibility to less than 1/4 mile, occurred at Augusta on an average of about 28 days per year during the period from 1951 through 1986. Monthly occurrence frequencies ranged from an average of about three days per month during the fall and winter months to slightly more than one day per month during the spring and summer months (NOAA, 1987). Frequently, the heavy fog observed at Augusta is due to the proximity of the Savannah River. The frequency of naturally occurring fog at the SRS reactor areas would be expected to be lower because these facilities are located higher above river elevation than the Augusta NWS station.

1.2.3 Precipitation

The annual average precipitation for the SRS (1952-1987) and for Augusta (1951-1986) was 48.2 inches and 43.1 inches, respectively. Monthly average and extreme precipitation amounts for both locations are shown in Tables 1-6 and 1-7. Precipitation is fairly well distributed throughout the year. Average precipitation during the fall months (September, October, and November) was slightly less than during the other seasons, accounting for about 18% of the average annual total. For Augusta, precipitation totals greater than 0.01 inches occurred on an average of 107 days per year. The number of days per month with measurable precipitation ranged from an average of about 6 days in October to about 12 days in July (NOAA, 1987).

Monthly precipitation extremes for Augusta ranged from a maximum of 11.92 inches, recorded in March 1980, to a trace, observed in October 1959. The greatest observed rainfall for a 24-hour period was 5.98 inches in August 1964. Hourly observations from Augusta indicate that rainfall rates are usually less than 0.5 inch/hour, although rates greater than 0.5 inch/hour can be expected during spring and summer thunderstorms. Extreme rainfall events are discussed in subsection 1.3.5.

A summary of snowfall statistics for Augusta (1951-1986) is shown in Table 1-8. The average annual snowfall is 1.2 inches per year and the average number of days per year with snow is 0.5 days. Significant snowfall is most likely to occur in February. For the reported period of record, snow has been observed in the months of November through March.

1.2.4 Winds

Hourly average wind data from the K- and P-Area meteorological towers were used to describe the local wind climatology. Joint frequency distributions (JFD's) based on these data are shown in Figures 1-2 and 1-3 for the K and P Areas, respectively. These figures show the joint occurrence of each of sixteen 22.5° wind direction sectors for six wind speed categories.

TABLE 1-6

Precipitation for SRS[a,b]

Month	Average	Maximum[c]	Minimum[c]
January	4.17	10.02 (1978)	0.89 (1981)
February	4.61	7.94 (1956)	0.94 (1968)
March	5.02	10.96 (1980)	1.31 (1985)
April	3.49	8.20 (1961)	0.57 (1972)
May	4.23	10.90 (1976)	1.33 (1965)
June	4.36	10.89 (1973)	1.54 (1979)
July	5.02	11.48 (1982)	0.90 (1980)
August	4.85	12.34 (1964)	1.04 (1963)
September	3.74	8.71 (1959)	0.49 (1985)
October	2.49	10.86 (1959)	0.00 (1963)
November	2.60	6.46 (1957)	0.21 (1958)
December	3.63	9.55 (1981)	0.46 (1955)
Annual	48.19	73.47 (1964)	28.82 (1954)

[a] Total inches, water equivalent
[b] Period of record, 1952-1987
[c] Year of occurrence shown in parentheses

TABLE 1-7

Precipitation for Augusta, GA[a,b]

Month	Average	Maximum[c]	Minimum[c]
January	3.99	8.48 (1960)	0.75 (1981)
February	4.04	7.67 (1961)	0.69 (1968)
March	4.92	11.92 (1980)	0.88 (1968)
April	3.31	8.43 (1961)	0.60 (1970)
May	3.73	9.61 (1979)	0.48 (1951)
June	3.88	7.28 (1973)	0.68 (1984)
July	4.04	11.43 (1967)	1.44 (1983)
August	3.98	11.34 (1986)	0.65 (1980)
September	3.53	9.51 (1975)	0.31 (1984)
October	2.02	6.90 (1959)	Trace (1953)
November	2.07	7.76 (1985)	0.09 (1960)
December	3.20	8.65 (1981)	0.32 (1955)
Annual	43.07	66.04 (1964)	31.53 (1954)

[a] Total inches, water equivalent
[b] Period of record, 1951-1986
[c] Year of occurrence shown in parentheses

Source: NOAA (1987)

TABLE 1-8

Total Accumulation of Snow and Ice Pellets at Augusta, GA[a]

Month	Average (in.)	Maximum[b] (in.)
January	0.2	1.5 (1982)
February	0.9	14.0 (1973)
March	0.1	1.1 (1980)
April	0.0	0
May	0.0	0
June	0.0	0
July	0.0	0
August	0.0	0
September	0.0	0
October	0.0	0
November	Trace	Trace (1968)
December	Trace	0.9 (1958)
Annual	1.2	

[a] Period of record, 1951-1986
[b] Year of occurrence indicated in parentheses

Source: NOAA (1987)

The JFD's indicate that observed wind directions at both locations are fairly well distributed among the 16 wind direction sectors. Winds from the northeast, east-northeast, and south clockwise through the west sectors occurred with relatively high frequency, generally 7 to 10% of the time. Small differences in actual occurrence frequencies for the two tower locations are believed to be primarily due to nonconcurrent periods of unavailable data during the five-year period of record. The topography of the SRS consists of gently rolling hills. Consequently, terrain does not have a significant effect on local winds.

Seasonal JFD's used for this evaluation were based on tower data collected from 1975-1979, since similar summaries for 1982-1986 were not readily available. The summaries generated from these earlier data are considered reasonably representative of the later five year period.

An annual JFD of K-Area tower winds for 1975-1979 is shown in Figure 1-4. The seasonal distributions for K Area are shown in Figures 1-5 through 1-8. Seasonal percent occurrence frequencies for any of the 16 sectors generally differ by no more than a few percent. Northeasterly winds occurred slightly more frequently than the other wind directions in the fall and summer seasons. The winter and spring seasons were characterized by relatively high frequencies of winds from the west-northwest, southwest through west, and southeast sectors.

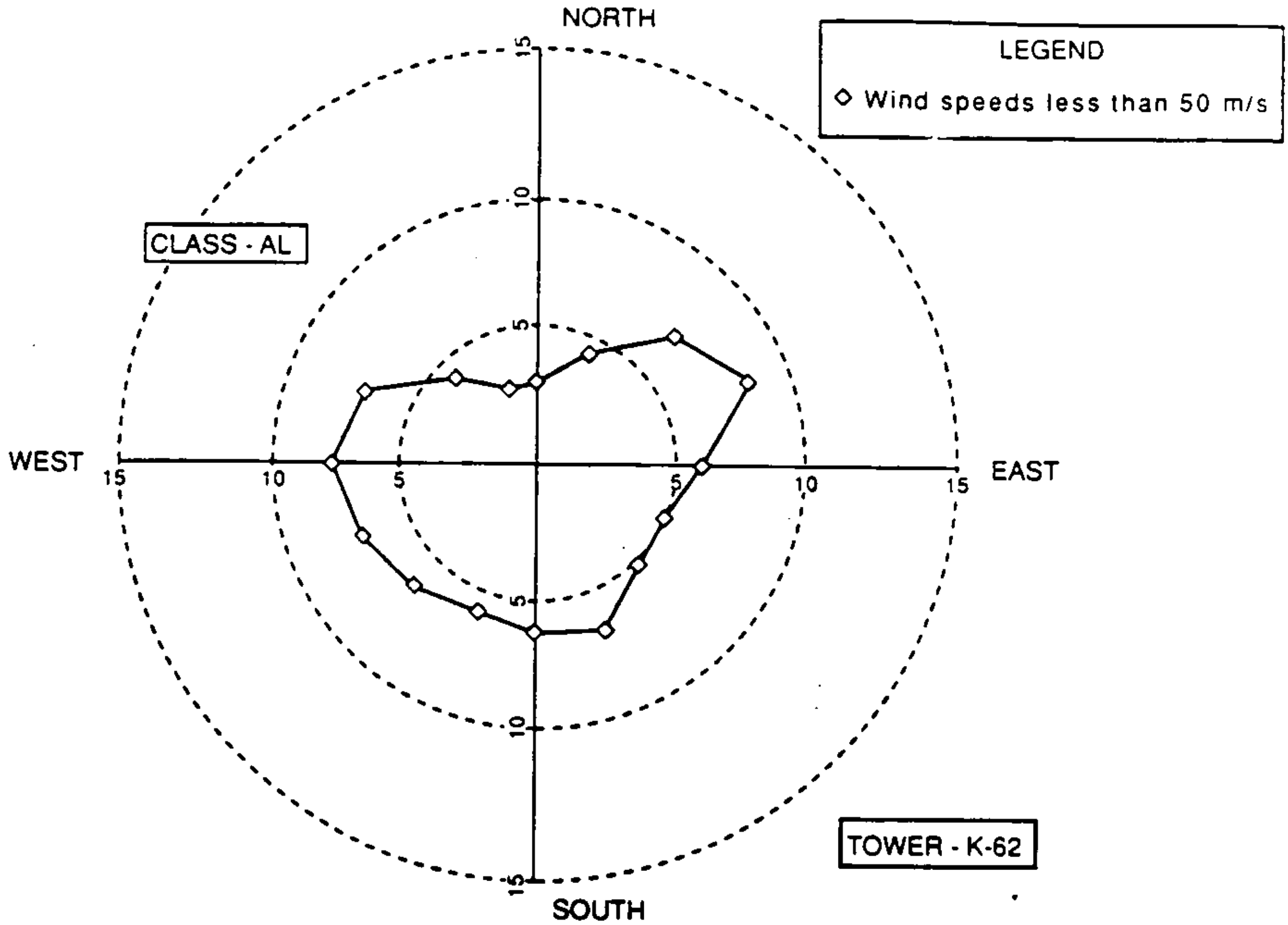
Wind direction persistence summaries are also available for the 1975-1979 data. Table 1-9 shows occurrence frequencies for consecutive hours that an average of hourly wind directions over all seven onsite towers differed by no more than the indicated ranges. For the difference range most closely approximating a 22.5° sector (±15°), the wind direction persisted no longer than one hour for about half of the time. Persistence events lasting more than six hours accounted for about 13% of the hours.

The annual average wind speed for the 1982-1986 period was 6.5 and 7.4 mph at the K and P Areas, respectively. Hourly wind speeds less than 4.5 mph occurred around 10% of the time. For about half of the time, wind speeds were less than 9 mph. For the 1975-1979 period, the average speed was greatest during the winter season, 8.1 mph, and least during the summer season, 6.3 mph. The average wind speed at the Augusta NWS site for data collected from 1951 through 1986 was 6.5 mph. The highest monthly average wind speed occurred in March, 8.1 mph, and the lowest monthly average speed occurred in August and September, 5.6 mph. Augusta wind data were collected at 20 feet above ground during this period (NOAA, 1987).

1.3 SEVERE WEATHER

1.3.1 Tornadoes

Tornado statistics given by Ramsdell and Andrews (1986) show that a total of 37 tornadoes were reported during a 30-year period (1954-1983) for a one degree square of latitude and longitude that includes the SRS. Based on these data, the average frequency of a tornado striking any given

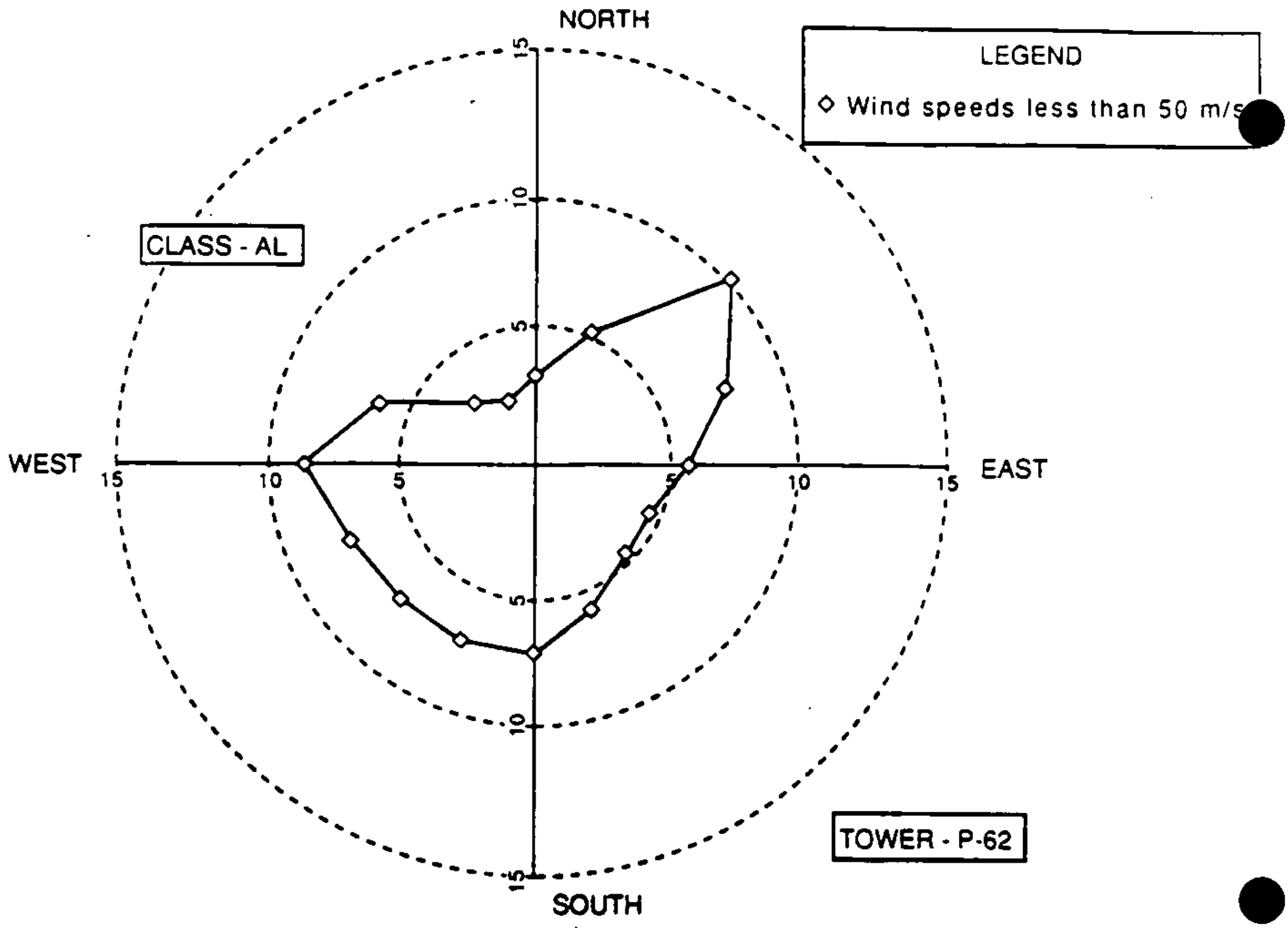


JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	197	457	412	86	7	0	2.67	1159	0.55	1.28	1.15	0.24	0.02	0.00	3.23
NNE	221	673	651	155	10	1	2.96	1711	0.62	1.88	1.58	0.43	0.03	0.00	4.77
NE	297	1073	1065	201	12	0	3.06	2648	0.83	2.99	2.97	0.56	0.03	0.00	7.39
ENE	329	1525	1265	153	9	0	3.07	3281	0.92	4.25	3.53	0.43	0.03	0.00	9.15
E	272	1107	811	122	3	0	2.90	2315	0.76	3.09	2.26	0.34	0.01	0.00	6.46
ESE	288	802	625	75	3	0	2.66	1793	0.80	2.24	1.74	0.21	0.01	0.00	5.00
SE	277	830	751	78	3	0	2.90	1939	0.77	2.32	2.10	0.22	0.01	0.00	5.41
SSE	270	1032	1080	128	12	0	3.04	2522	0.75	2.88	3.01	0.36	0.03	0.00	7.04
S	287	1160	887	92	10	0	2.86	2436	0.80	3.24	2.47	0.26	0.03	0.00	6.80
SSW	316	1026	763	135	19	0	2.77	2259	0.88	2.86	2.13	0.38	0.05	0.00	6.30
SW	324	1133	834	173	32	1	2.82	2497	0.90	3.16	2.33	0.48	0.09	0.00	6.97
WSW	349	1111	977	221	52	2	2.93	2712	0.97	3.10	2.73	0.62	0.15	0.01	7.57
W	323	1131	1032	393	136	2	3.17	3017	0.90	3.16	2.88	1.10	0.38	0.01	8.42
WNW	296	876	1021	389	133	3	3.33	2698	0.83	2.44	2.85	1.03	0.37	0.01	7.53
NW	249	681	586	166	45	1	2.92	1728	0.69	1.90	1.63	0.46	0.13	0.00	4.82
NNW	218	470	374	58	6	0	2.60	1126	0.61	1.31	1.04	0.16	0.02	0.00	3.14
NO DIRECT	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVG SPEED	1.16	2.95	4.80	6.61	9.03	13.32	2.94								
TOT ENTRY	4513	15087	13134	2605	492	10		35841							

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-2. Annual Windrose for K-Area Meteorological Tower, 1982-1986, All Stabilities, Laurinat (1987)



JOINT FREQUENCY DATA

OCCURRENCE FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
	SPEED IN METERS/SECOND							
N	149	434	352	74	8	1	2.96	1018.00
NNE	151	624	737	225	32	0	3.32	1769.00
NE	238	1141	1467	380	38	0	3.54	3264.00
ENE	258	1230	989	105	2	0	3.14	2584.00
E	226	925	581	51	2	0	2.91	1785.00
ESE	192	723	449	49	8	0	2.93	1421.00
SE	221	640	518	59	11	0	2.90	1449.00
SSE	208	763	714	99	15	0	3.00	1799.00
S	221	961	1012	188	19	0	3.31	2401.00
SSW	178	968	1079	179	21	0	3.42	2425.00
SW	175	1006	1016	162	22	0	3.37	2381.00
WSW	195	916	1067	250	52	0	3.49	2480.00
W	212	979	1112	441	81	2	3.61	2827.00
WNW	168	718	839	245	101	0	3.51	2069.00
NW	151	435	373	98	28	0	3.09	1085.00
NNW	139	375	284	55	11	0	2.88	864.00
NO DIRECT	0	0	0	0	0	0	0.00	0.00
AVG SPEED	1.33	2.98	4.81	6.64	8.89	16.77	3.26	
TOT ENTRY	3080	12838	12589	2660	451	3		31621

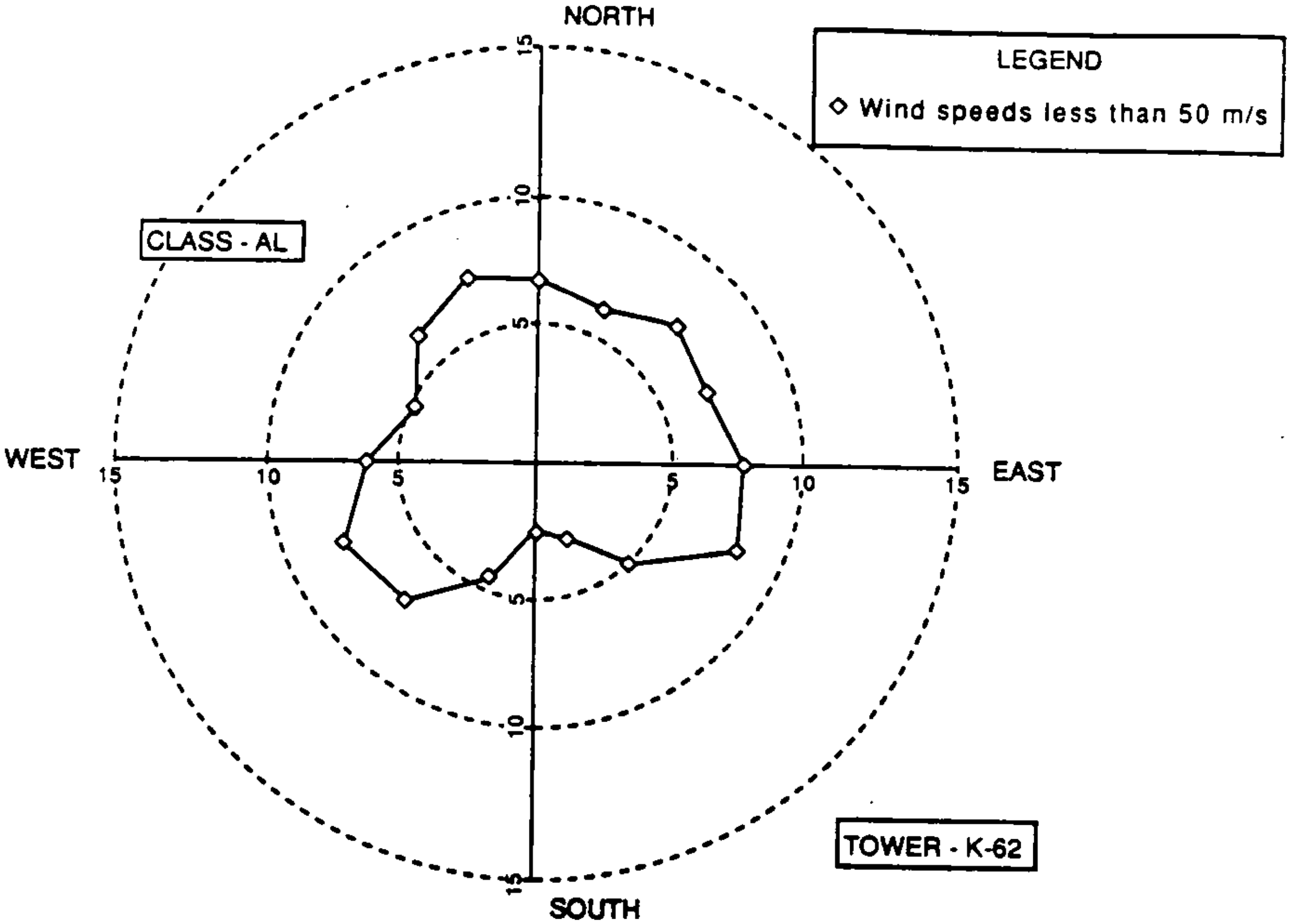
PERCENT FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
	SPEED IN METERS/SECOND						
N	0.47	1.37	1.11	0.23	0.03	0.00	3.21
NNE	0.48	1.97	2.33	0.71	0.10	0.00	5.59
NE	0.75	3.61	4.64	1.20	0.12	0.00	10.32
ENE	0.82	3.89	3.13	0.33	0.01	0.00	8.18
E	0.71	2.93	1.84	0.16	0.01	0.00	5.65
ESE	0.61	2.29	1.42	0.15	0.03	0.00	4.50
SE	0.70	2.02	1.64	0.19	0.03	0.00	4.58
SSE	0.66	2.41	2.26	0.31	0.05	0.00	5.69
S	0.70	3.04	3.20	0.59	0.06	0.00	7.59
SSW	0.56	3.06	3.41	0.57	0.07	0.00	7.67
SW	0.55	3.18	3.21	0.51	0.07	0.00	7.52
WSW	0.62	2.90	3.37	0.79	0.16	0.00	7.84
W	0.67	3.10	3.52	1.39	0.26	0.01	8.95
WNW	0.52	2.27	2.65	0.77	0.32	0.00	6.53
NW	0.48	1.38	1.18	0.31	0.09	0.00	3.44
NNW	0.44	1.19	0.90	0.17	0.03	0.00	2.73
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-3. Annual Windrose for P-Area Meteorological Tower, 1982-1986, All Stabilities, Laurinat (1987)

W8908052

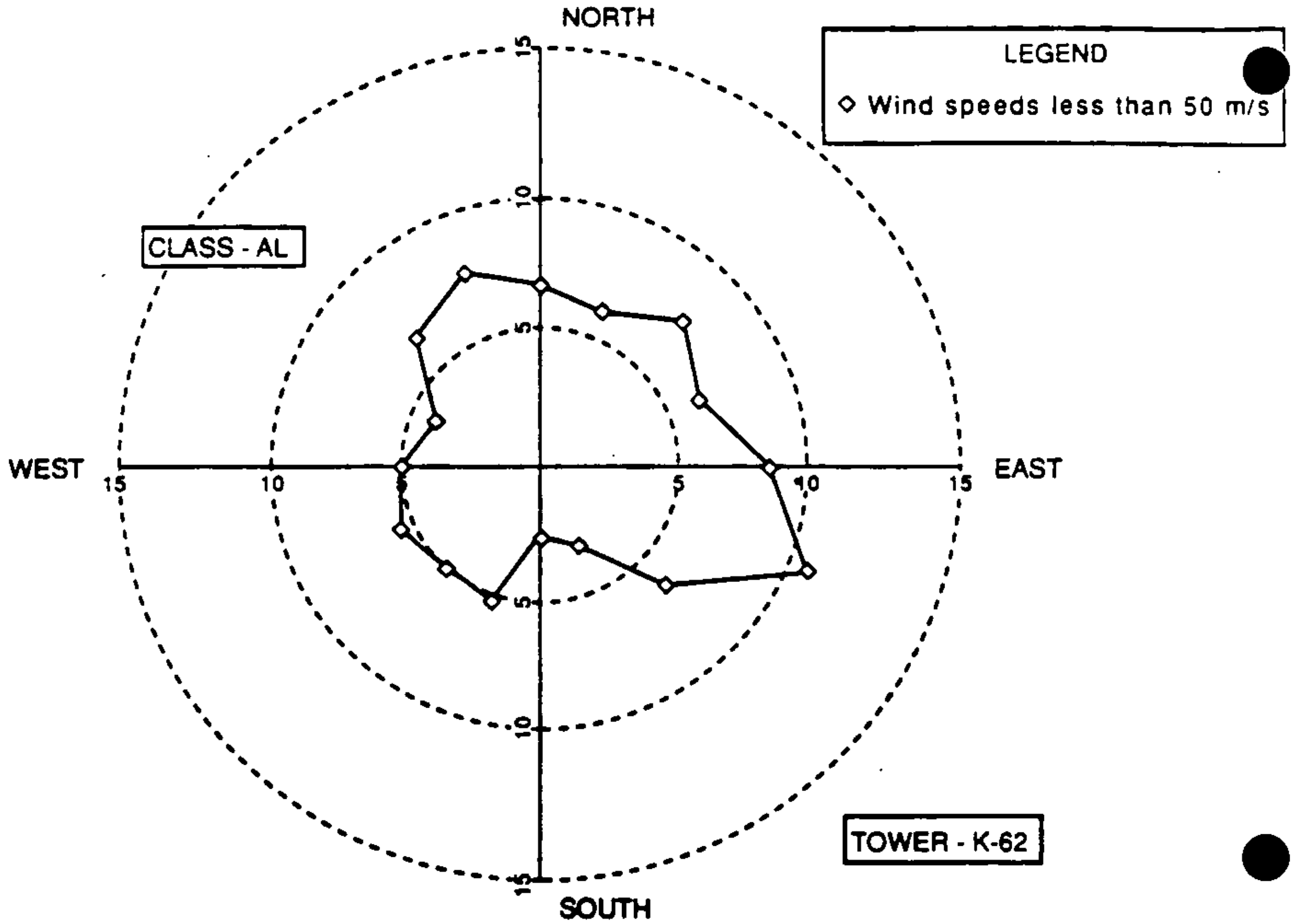


JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY — SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY — SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	468	1076	747	196	48	0	2.56	2535	0.41	0.95	0.66	0.17	0.04	0.00	2.23
NNE	634	1774	1685	691	168	12	3.11	4975	0.56	1.56	1.49	0.61	0.15	0.01	4.38
NE	563	2607	2938	1145	114	38	3.52	7589	0.50	2.47	2.57	1.01	0.10	0.03	6.69
ENE	710	3336	3446	848	107	9	3.76	8456	0.63	2.94	3.04	0.75	0.09	0.00	7.45
E	568	2744	3070	613	83	26	3.42	7104	0.50	2.42	2.70	0.54	0.07	0.02	6.26
ESE	542	2173	2212	468	48	2	3.22	5446	0.48	1.91	1.95	0.41	0.04	0.00	4.80
SE	644	2366	3013	615	97	4	3.41	6941	0.57	2.09	2.65	0.72	0.08	0.00	6.11
SSE	496	2336	3755	1043	177	16	3.73	7826	0.44	2.06	3.31	0.92	0.16	0.01	6.89
S	536	2569	3237	752	186	12	3.55	7091	0.47	2.26	2.69	0.66	0.16	0.01	6.25
SSW	559	2900	2532	700	131	13	3.35	6535	0.49	2.29	2.23	0.62	0.12	0.01	5.76
SW	689	2826	3212	1072	167	16	3.42	7791	0.61	2.49	2.56	0.94	0.15	0.01	6.86
WSW	609	2790	2606	1034	330	36	3.46	7405	0.54	2.46	2.30	0.91	0.29	0.03	6.52
W	631	2500	2982	1391	675	56	3.71	8323	0.55	2.28	2.63	1.23	0.59	0.04	7.33
WNW	614	2330	3011	1725	995	84	3.87	8766	0.54	2.06	2.85	1.52	0.89	0.07	7.72
NW	614	2090	1081	944	343	37	3.35	5909	0.54	1.84	1.66	0.83	0.30	0.03	5.21
NNW	444	1315	951	324	74	1	2.89	3109	0.39	1.16	0.84	0.29	0.06	0.00	2.74
NO DIRECT	2247	3071	1623	555	132	81	2.23	7709	1.98	2.71	1.43	0.49	0.12	0.07	2.23
AVG SPEED	1.25	2.90	4.86	6.69	9.16	14.96	3.31								
TOT ENTRY	11568	40803	42501	14316	3874	449		113511							

*DIRECTION FROM WHICH WIND BLOWS ; WIND ROSE INDICATES DIRECTION TOWARD WHICH WIND BLOWS

FIGURE 1-4. Annual Wind Rose for K-Area Meteorological Tower, 1975-1979, All Stabilities, Hoel (1983)



JOINT FREQUENCY DATA

OCCURRENCE FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
	SPEED IN METERS/SECOND							
N	79	271	197	39	7	0	3.00	593
NNE	164	478	513	182	38	1	3.12	1378
NE	91	410	575	228	14	0	3.88	1318
ENE	112	462	657	183	55	4	3.53	1473
E	133	463	560	151	23	13	3.32	1333
ESE	101	375	450	133	31	1	3.36	1091
SE	125	457	701	314	53	4	3.71	1654
SSE	90	386	941	408	123	14	4.25	1962
S	65	413	794	258	90	10	3.98	1630
SSW	94	437	709	207	48	13	3.71	1502
SW	141	500	782	356	75	18	3.72	1871
WSW	117	506	496	291	145	30	3.81	1586
W	87	457	700	442	390	45	4.95	2121
WNW	120	568	945	588	390	19	4.27	2630
NW	144	500	480	251	119	6	3.47	1500
NNW	94	356	266	63	22	0	3.04	803
NO DIRECT	390	508	552	253	75	64	2.89	1842
AVG SPEED	1.41	3.01	4.90	6.72	9.22	13.47	3.83	
TOT ENTRY	2147	7551	10301	4346	1566	242		26285

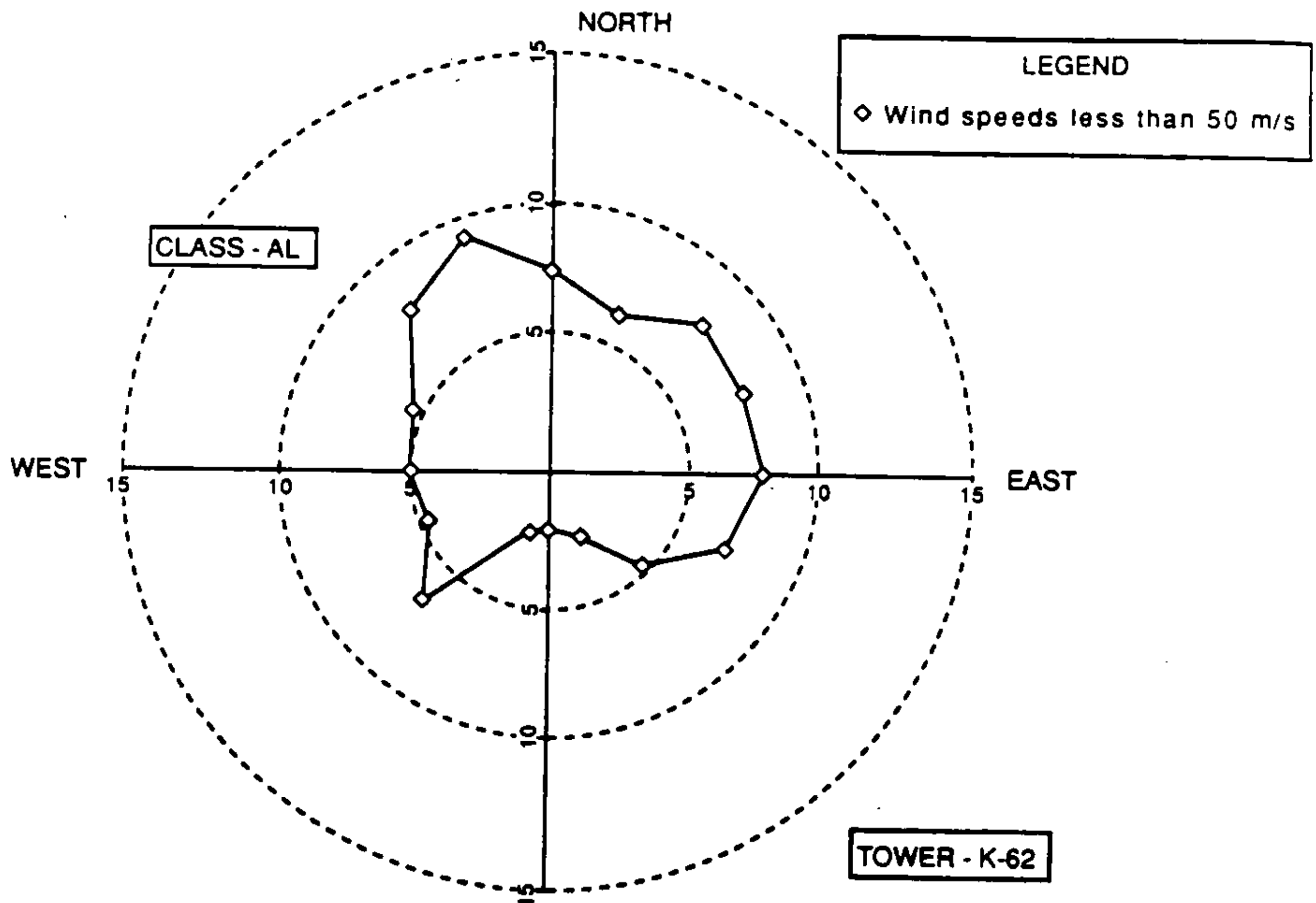
PERCENT FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
	SPEED IN METERS/SECOND						
N	0.30	1.03	0.75	0.15	0.03	0.00	2.26
NNE	0.82	1.82	1.96	0.09	0.14	0.08	5.23
NE	0.33	1.56	2.19	0.07	0.06	0.00	5.01
ENE	0.43	1.76	2.50	0.70	0.21	0.01	5.61
E	0.51	1.78	2.09	0.57	0.06	0.04	5.07
ESE	0.35	1.43	1.71	0.31	0.12	0.03	4.15
SE	0.43	1.74	2.67	1.19	0.23	0.04	6.29
SSE	0.34	1.36	3.20	1.78	0.47	0.05	7.20
S	0.33	1.39	3.02	0.97	0.26	0.23	6.20
SSW	0.38	1.65	2.67	0.79	0.18	0.04	5.71
SW	0.54	1.90	2.98	1.36	0.29	0.05	7.12
WSW	0.45	1.63	1.95	1.11	0.56	0.11	6.03
W	0.33	1.74	2.96	1.89	1.48	0.17	8.07
WNW	0.46	2.26	3.59	2.18	1.45	0.07	10.01
NW	0.55	2.13	1.83	0.59	0.45	0.02	5.57
NNW	0.38	1.35	1.02	0.24	0.08	0.00	3.05
NO DIRECT	1.40	1.53	2.10	0.55	0.29	0.24	6.12

*DIRECTION FROM WHICH WIND BLOWS; WIND ROSE INDICATES DIRECTION TOWARD WHICH WIND BLOWS

FIGURE 1-5. Winter Wind Rose for K-Area Meteorological Tower, 1975-1979, All Stabilities, Hoel (1983)

W8908052

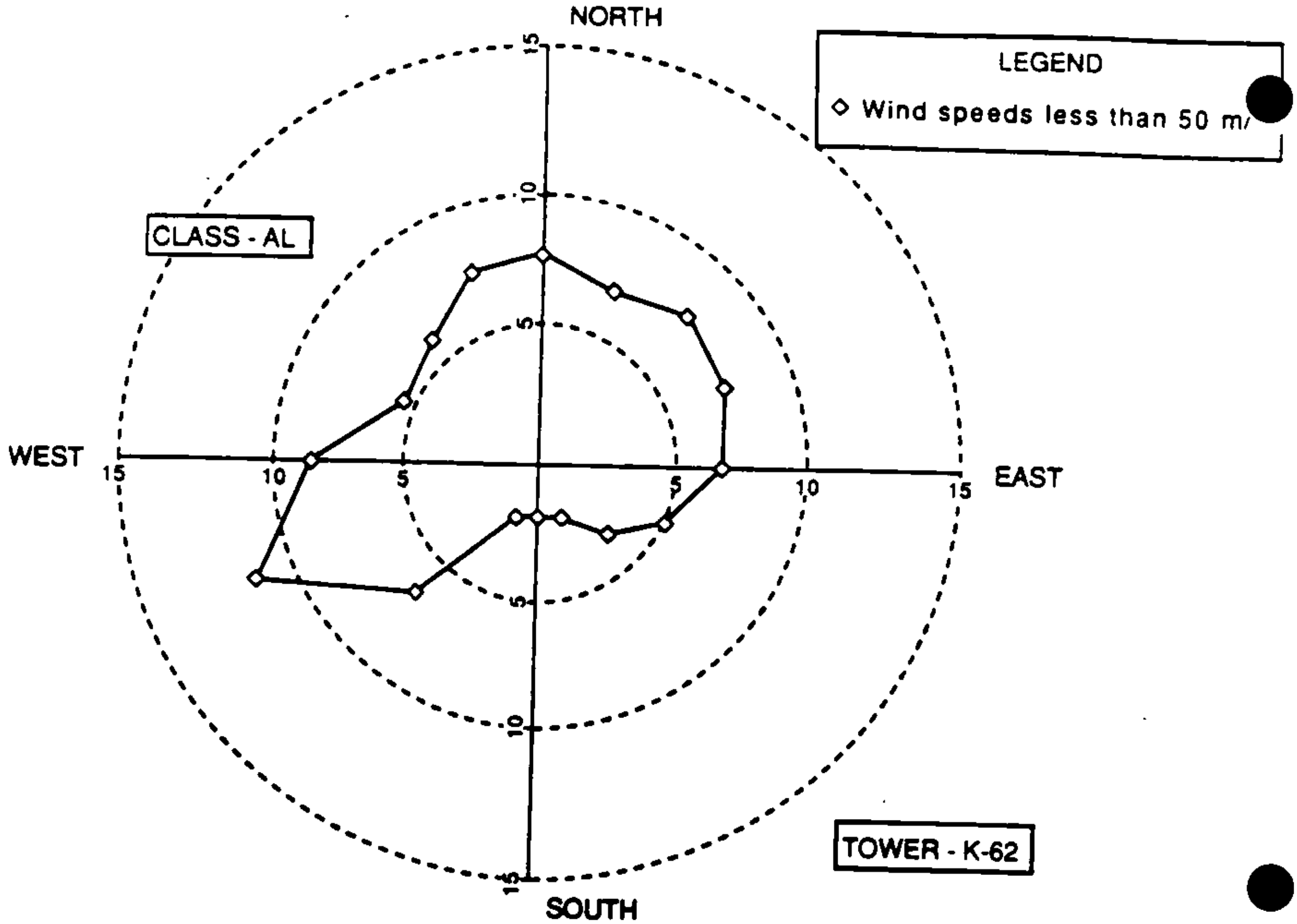


JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	120	214	154	67	31	0	2.61	588	0.37	0.65	0.50	0.21	0.09	0.00	1.83
NNE	94	232	244	154	23	0	3.21	747	0.28	0.71	0.75	0.47	0.07	0.00	2.29
NE	123	857	733	402	20	0	3.61	2135	0.38	2.03	2.25	1.23	0.06	0.00	6.53
ENE	138	632	591	192	22	0	3.37	1575	0.42	1.94	1.81	0.59	0.06	0.00	4.84
E	104	622	705	142	35	0	3.58	1608	0.32	1.91	2.16	0.44	0.11	0.00	4.53
ESE	142	661	802	158	7	0	3.37	1770	0.44	2.83	2.46	0.48	0.02	0.00	5.43
SE	196	719	1164	318	53	0	3.85	2447	0.80	2.20	3.83	0.97	0.10	0.00	7.50
SSE	117	802	1345	334	23	0	3.96	2622	0.36	2.46	4.74	1.02	0.07	0.00	8.85
S	144	863	1050	181	34	1	3.58	2273	0.44	2.86	2.22	0.58	0.10	0.00	6.97
SSW	164	809	744	169	20	0	3.34	1906	0.50	2.40	2.28	0.52	0.06	2.00	5.84
SW	197	843	997	299	60	0	3.51	2396	0.80	2.90	2.08	0.52	0.18	0.00	7.35
WSW	140	896	867	370	102	4	3.85	2399	0.46	2.86	2.75	1.13	0.31	0.01	7.32
W	162	774	894	452	155	0	3.75	2437	0.50	2.37	2.74	1.36	0.48	0.00	7 47
WNW	105	580	853	433	173	6	4.08	2152	0.32	1.70	2.62	1.33	0.53	0.00	6.83
NW	104	453	597	261	59	2	3.62	1476	0.32	1.39	1.83	0.80	0.18	0.00	4.53
NNW	104	304	230	125	27	1	3.01	791	0.32	0.53	0.71	0.38	0.06	0.00	2.43
NO DIRECT	778	1527	596	165	27	0	2.36	3095	2.39	4.06	1.83	0.51	0.09	0.00	1.83
AVG SPEED	1.30	2.57	4.86	6.68	9.11	12.64	3.41								
TOT ENTRY	3432	11988	12588	4220	871	16		32615							

*DIRECTION FROM WHICH WIND BLOWS : WIND ROSE INDICATES DIRECTION TOWARD WHICH WIND BLOWS

FIGURE 1-6. Spring Wind Rose for K-Area Meteorological Tower, 1975-1979, All Stabilities, Hoel (1983)

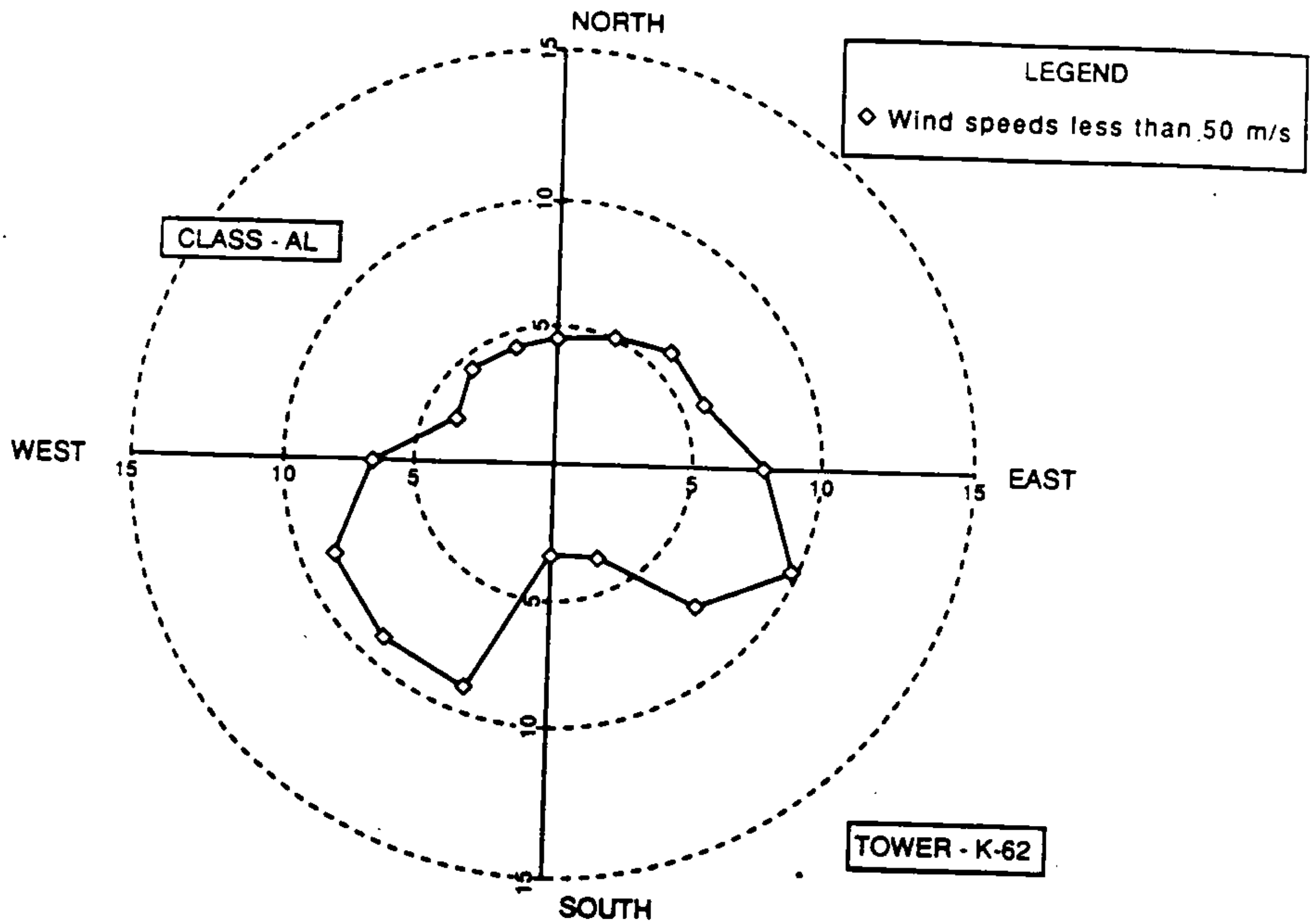


JOINT FREQUENCY DATA

	OCCURRENCE FREQUENCY								PERCENT FREQUENCY						
	SPEED IN METERS/SECOND						AVERAGE	TOTAL	SPEED IN METERS/SECOND						
DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	SPEED	TOT	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	151	233	94	27	7	0	2.18	512	0.55	0.84	0.34	0.08	0.02	0.00	1.85
NNE	140	256	92	28	27	9	2.40	554	0.51	0.93	0.33	0.10	0.09	0.03	2.00
NE	182	653	693	192	40	36	3.27	1796	0.66	2.51	2.36	0.89	0.14	0.13	6.50
ENE	266	1342	1248	214	11	0	3.28	3083	0.57	4.85	4.51	0.77	0.04	0.00	11.15
E	219	1075	928	106	2	0	3.19	2330	0.79	3.89	3.36	0.38	0.00	0.00	8.43
ESE	204	772	491	44	3	0	2.87	1514	0.74	2.79	1.78	0.16	0.01	0.00	5.48
SE	226	766	564	62	2	0	2.87	1620	0.82	2.77	2.04	0.22	0.00	0.00	5.85
SSE	188	814	810	126	7	0	3.22	1945	0.68	2.94	2.93	0.46	0.02	0.00	7.03
S	219	937	766	60	1	0	3.11	1983	0.79	3.38	2.77	0.22	0.00	0.00	7.17
SSW	206	966	598	32	6	0	2.91	1808	0.76	3.49	2.16	0.12	0.02	0.00	6.54
SW	235	1048	686	51	2	0	2.96	2021	0.85	3.79	2.48	0.16	0.00	0.00	7.31
WSW	232	986	634	78	19	1	2.37	1949	0.84	3.96	2.28	0.28	0.05	0.00	7.06
W	227	819	585	128	29	0	2.99	1788	0.82	2.96	2.12	0.46	0.10	0.00	6.47
WNW	249	686	372	77	15	0	2.81	1399	0.90	2.40	1.35	0.28	0.05	0.00	5.06
NW	225	466	251	28	6	0	2.44	976	0.81	1.60	0.81	0.09	0.02	0.00	3.53
NNW	142	272	125	17	9	0	2.29	565	0.51	0.99	0.46	0.06	0.02	0.00	2.04
NO DIRECT	734	689	308	56	16	2	1.87	1805	2.95	2.49	1.11	0.21	0.05	0.00	1.85
AVG SPEED	1.25	2.97	4.74	6.54	9.94	13.67	2.84								
TOT ENTRY	4049	12821	9202	1326	202	48		27648							

*DIRECTION FROM WHICH WIND BLOWS ; WIND ROSE INDICATES DIRECTION TOWARD WHICH WIND BLOWS

FIGURE 1-7. Summer Wind Rose for K-Area Meteorological Tower, 1975-1979, All Stabilities, Hoel (1983)



JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY, SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY, SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	119	368	292	62	3	0	2.87	834	0.44	1.33	1.09	0.23	0.01	0.00	3.10
NNE	236	806	847	327	80	2	3.29	2298	0.89	2.90	3.14	1.21	0.30	0.00	8.52
NE	167	847	961	323	40	2	3.56	2340	0.62	3.14	3.56	1.20	0.15	0.00	8.62
ENE	192	900	960	257	19	5	3.42	2323	0.71	3.34	3.52	0.95	0.07	0.01	8.63
E	113	584	884	215	23	13	3.71	1832	0.42	2.17	3.28	0.80	0.08	0.04	6.79
ESE	95	366	469	134	7	1	3.37	1071	0.35	1.35	1.74	0.30	0.02	0.00	3.97
SE	98	426	564	123	9	0	3.44	1220	0.36	1.58	2.08	0.46	0.03	0.00	4.52
SSE	101	363	559	115	24	4	3.46	1166	0.37	1.35	2.07	0.43	0.08	0.01	4.32
S	87	354	427	256	61	1	3.84	1205	0.32	1.31	1.58	0.96	0.30	0.00	4.47
SSW	92	388	490	292	57	0	3.76	1319	0.34	1.44	1.61	1.08	0.21	0.00	4.66
SW	115	437	554	367	30	0	3.85	1503	0.43	1.62	2.03	1.36	0.11	0.00	5.57
WSW	110	432	579	296	64	3	3.89	1483	0.41	1.60	2.15	1.09	0.24	0.01	5.50
W	155	538	803	369	101	11	3.73	1977	0.57	2.00	2.98	1.37	0.37	0.04	7.33
WNW	141	476	841	647	426	57	4.40	2588	0.52	1.77	3.12	2.40	1.58	0.21	9.60
NW	141	608	553	306	160	29	3.68	1887	0.52	2.26	2.05	1.47	0.58	0.11	7.00
NNW	104	383	327	119	17	0	3.16	950	0.39	1.42	1.21	0.44	0.06	0.00	3.52
NO DIRECT	345	348	167	78	14	15	1.97	967	1.28	1.29	0.62	0.29	0.06	0.05	3.08
AVG SPEED	1.22	3.00	4.50	6.72	9.13	14.51	3.49								
TOT ENTRY	2411	8614	10266	4374	1155	143		26963							

*DIRECTION FROM WHICH WIND BLOWS; WIND ROSE INDICATES DIRECTION TOWARD WHICH WIND BLOWS

FIGURE 1-8. Fall Wind Rose for K-Area Meteorological Tower, 1975-1979, All Stabilities, Hoel (1983)

TABLE 1-9

Frequency of Wind Direction Persistence at SRS, 1975-1979 Meteorological Data

Persistence (hours)	Sector Width (degrees) ±5	±15	±25	±35	±45
0	0.641	0.269	0.142	0.090	0.067
1	0.206	0.220	0.156	0.109	0.080
2	0.081	0.138	0.127	0.102	0.078
3	0.034	0.097	0.098	0.086	0.073
4	0.016	0.067	0.078	0.073	0.064
5	0.008	0.048	0.063	0.063	0.057
6	0.004	0.034	0.051	0.052	0.050
>6	0.008	0.128	0.285	0.425	0.531

Source: Hoel (1983)

location in South Carolina was estimated to be 7.11×10^{-5} per year. This results in a point-strike recurrence interval of about once every 14,000 years. Tornado statistics compiled by McDonald and reported by Hoel (1983) for a three-degree square area centered on the SRS for the period 1950-1978 resulted in occurrence frequency estimates similar to the more recent data set. These earlier data are summarized in Table 1-10, stratified by month and F-scale intensity categories. The F-scale intensity categories are defined in Table 1-11. These data indicate that about half of the total number of observed tornadoes, and most of the tornadoes resulting in severe or devastating damage, occurred during the months of March, April, and May. However, tornadoes have been observed in the SRS area every month of the year.

Since operations began at the SRS, there have been six occurrences of a confirmed tornado on or in close proximity of the site: late June 1952, May 28, 1976, July 2, 1976, April 23, 1983, August 26, 1985, and October 1, 1989. On all occasions, only light to moderate damage (F-scale class F-2 or less) was reported. None of the damage was to production facilities on the site. Investigations of tornadoes occurring near SRS in 1975 and 1976, reported by Hoel (1983), indicated that maximum wind speeds were between 100 and 175 mph.

A site specific analysis of tornado wind risk was performed by Fujita, using a methodology similar to that recommended by the NRC (McDonald, 1983). The results of the analysis are reported by Huang (1986). This analysis was based on a compilation of tornado observations within a 100-mile radius of SRS for the period 1916-1978. Estimated probabilities of a given location experiencing a tornado-produced wind in excess of various wind speeds are provided in Table 1-12 and shown graphically in Figure 1-9. The given wind speed values represent a sum of the rotational and translational wind speed components of the tornado.

The design basis tornado for SRS facilities has a wind speed of 280 mph, a 230 mph rotational component, and a 50 mph translational component (Hoel, 1983). Based on Fujita's analysis, the estimated probability of any location on the SRS experiencing wind speeds equal to or greater than the design basis tornado wind speed is 1.2×10^{-7}/yr. The resulting recurrence interval is about once every ten million years. The probability that a design basis tornado wind speed will affect a reactor building is approximately a factor of five greater than the point probability values (Huang, 1986).

1.3.2 Extreme Winds

Extreme winds in the SRS area, other than tornado-produced winds, are associated with tropical weather systems, thunderstorms, or strong winter storms. Extreme fastest one-minute wind speeds for Augusta for the period 1950-1986 are summarized in Table 1-13 (NOAA, 1987). The maximum observed value, 83 mph, was recorded in May 1950. These data are appropriate for a 10-meter anemometer height. Recurrence probabilities for extreme "straight-line" winds (nontornadic) for the SRS were analyzed by McDonald

TABLE 1-10

Number of Tornadoes Reported Between 1950 and 1978 by Month and F-Scale for a 3° Square Area Centered on SRS

Month	F-0	F-1	F-2	F-3	F-4	F-5	Total	Percent
January	1	5	6	1	0	0	13	5.2
February	3	9	3	2	0	0	17	6.9
March	6	15	8	3	1	0	33	13.3
April	16	9	12	3	1	0	41	16.5
May	5	33	10	2	1	0	51	20.6
June	6	11	3	1	0	0	21	8.5
July	8	8	2	1	0	0	19	7.7
August	6	6	3	0	0	0	15	6.1
September	3	5	5	0	0	0	13	5.2
October	0	3	3	0	0	0	6	2.4
November	3	5	3	0	0	0	11	4.4
December	1	4	1	2	3	0	8	3.2
Total	58	113	59	15	3	0	248	100.0

Source: Hoel (1983)

TABLE 1-11

Fujita Scale for Damaging Tornado Winds

Scale	Rotational Wind Speed	Expected Damage
F-0	40 - 72	Light damage
F-1	73 - 112	Moderate damage
F-2	113 - 157	Considerable damage
F-3	158 - 206	Severe damage
F-4	207 - 260	Devastating damage
F-5	261 - 318	Incredible damage

Source: Oliver (1987)

TABLE 1-12

Probabilities of Exceeding Given Tornado Windspeeds in the SRS Area

Wind Speed (mph)	Occurrence Probability (events/yr)
50	7.2×10^{-4}
60	5.2×10^{-4}
70	4.0×10^{-4}
80	3.0×10^{-4}
90	2.1×10^{-4}
100	1.5×10^{-4}
110	1.0×10^{-4}
120	6.8×10^{-5}
130	5.0×10^{-5}
140	3.8×10^{-5}
150	2.6×10^{-5}
160	1.6×10^{-5}
170	1.2×10^{-5}
180	8.0×10^{-6}
190	5.0×10^{-6}
200	4.1×10^{-6}
210	2.2×10^{-6}
220	1.5×10^{-6}
230	1.0×10^{-6}
240	7.2×10^{-7}
250	4.6×10^{-7}
260	3.0×10^{-7}
270	2.0×10^{-7}
280	1.2×10^{-7}
290	7.8×10^{-8}
300	5.6×10^{-8}

Source: Huang (1986)

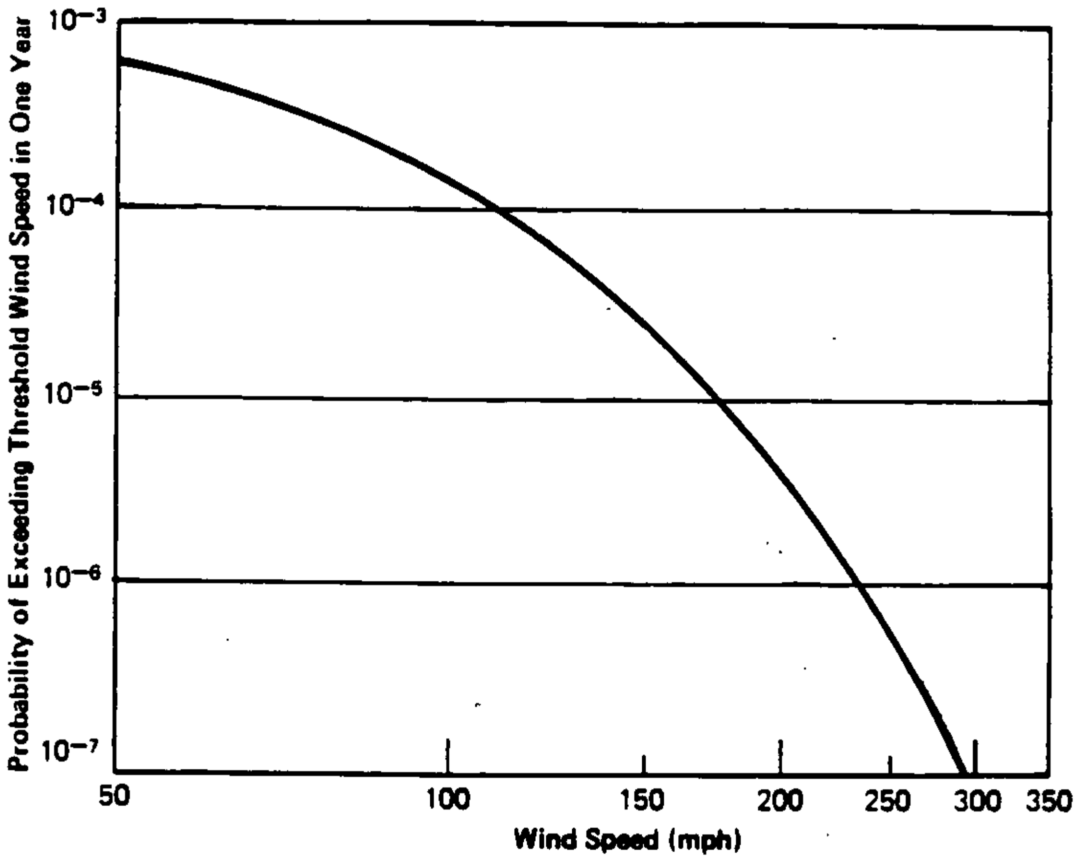


FIGURE 1-9. Annual Probability of Occurrence of Tornado-Produced Wind Speeds Within 100 Miles of SRS, Hoel (1983)

TABLE 1-13

Observed Annual Fastest One-Minute Windspeeds at Augusta, Georgia

Year	Wind Speed[a] (mph)	Direction	Date
1950	83	SW	5/28
1951	34	W	2/7
1952	42	E	7/25
1953	73	NE	6/10
1954	44	NW	8/28
1955	48	S	5/29
1956	48	W	7/15
1957	31	W	11/30[b]
1958	36	NW	11/28
1959	36	NW	9/29[b]
1960	36	W	7/22
1961	48	N	6/11
1962	41	NW	4/11
1963	40	W	11/29
1964	43	S	5/21
1965	67	E	6/10
1966	37	NW	5/27[b]
1967	52	W	5/8
1968	43	NW	7/16
1969	43	NE	7/8
1970	52	NW	7/16
1971	34	SW	7/11
1972	56	SW	3/2
1973	37	NW	11/21
1974	49	W	3/21
1975	37	W	7/6[b]
1976	32	NW	3/9
1977	43	S	10/2
1978	39	SW	1/26
1979	30	W	5/12
1980	32	W	5/12
1981	33	NW	3/16
1982	40	NW	2/16
1983	32	NW	12/31
1984	32	SW	3/28
1985	35	W	2/11
1986	32	NE	7/2

[a] Wind speeds corrected to 33 ft anemometer height.
[b] Wind speed occurred more than once during the year.

Source: NOAA (1987)

and reported by Huang (1986). The analysis was based on annual extreme wind speed data from Augusta for the period 1950-1978 and a Fischer-Tippett Type I extreme value distribution function statistical model. This analysis method is consistent with guidance given in Ramsdell (1986). Table 1-14 shows expected fastest-mile wind speeds corresponding to selected point-recurrence intervals. These data are shown graphically in Figure 1-10. The extreme fastest-mile wind speed for any location on the SRS for a 100-year recurrence interval was estimated to be 87 mph.

1.3.3 Hurricanes

A total of 36 hurricanes have caused damage in South Carolina over the 290-year period from 1700-1989. The average frequency of occurrence of a hurricane in the state is once every eight years; however, the observed interval between hurricane occurrences has ranged from two months to 27 years. The percent occurrence of hurricanes in South Carolina by month is given in Table 1-15. Eighty percent have occurred in August and September.

Because the SRS is approximately 100 miles inland, winds associated with tropical weather systems can usually be expected to have diminished below hurricane force (sustained speeds of 75 mph or greater). Winds associated with Hurricane Gracie, which passed to the north of the plant site on September 29, 1959, were measured as high as 75 mph on an anemometer located in F Area. No other hurricane force wind has been measured on the site. On September 22, 1989, the center of Hurricane Hugo passed about 100 miles northeast of the SRS. The maximum 15-minute average wind speed observed onsite during this hurricane was 38 mph. The highest observed instantaneous wind speed was 62 mph. These data were collected from the onsite tower network (measurements taken at 200 ft above ground). Extreme rainfall and tornadoes, which frequently accompany tropical weather systems, will usually have the most significant hurricane-related impact on SRS operations.

1.3.4 Thunderstorms

Monthly and annual average thunderstorm days observed at Augusta from 1951-1986 are listed in Table 1-16. Over 50% of the annual average total occurred during the months of June, July, and August. Thunderstorm occurrence was least frequent during the months of October through January, with an average of about one day per month.

The occurrence of hail with thunderstorms is infrequent. Based on observations in a one degree square of latitude and longitude that includes SRS, hail occurred once every two years on the average (Pautz, 1969).

The frequency of cloud to ground lightning strikes has been estimated using an empirical relationship described by Marshall (1973). The estimated average number of lightning strikes per square kilometer (km^2) per year is given by:

$$NE = ((0.1 + 0.35 \sin (L))A$$

TABLE 1-14

Estimated Expected "Straight-Line" Wind Speed in the SRS Area for Various Recurrence Intervals

Recurrence Interval (yr)	Occurrence Probability (events/yr)	Expected Fastest-Mile Wind Speed (mph)
10	1×10^{-1}	61
50	2×10^{-2}	79
100	1×10^{-2}	87
200	5×10^{-3}	95
500	2×10^{-3}	105
1,000	1×10^{-3}	113
10,000	1×10^{-4}	139
100,000	1×10^{-5}	163
1,000,000	1×10^{-6}	189

Source: Huang (1986)

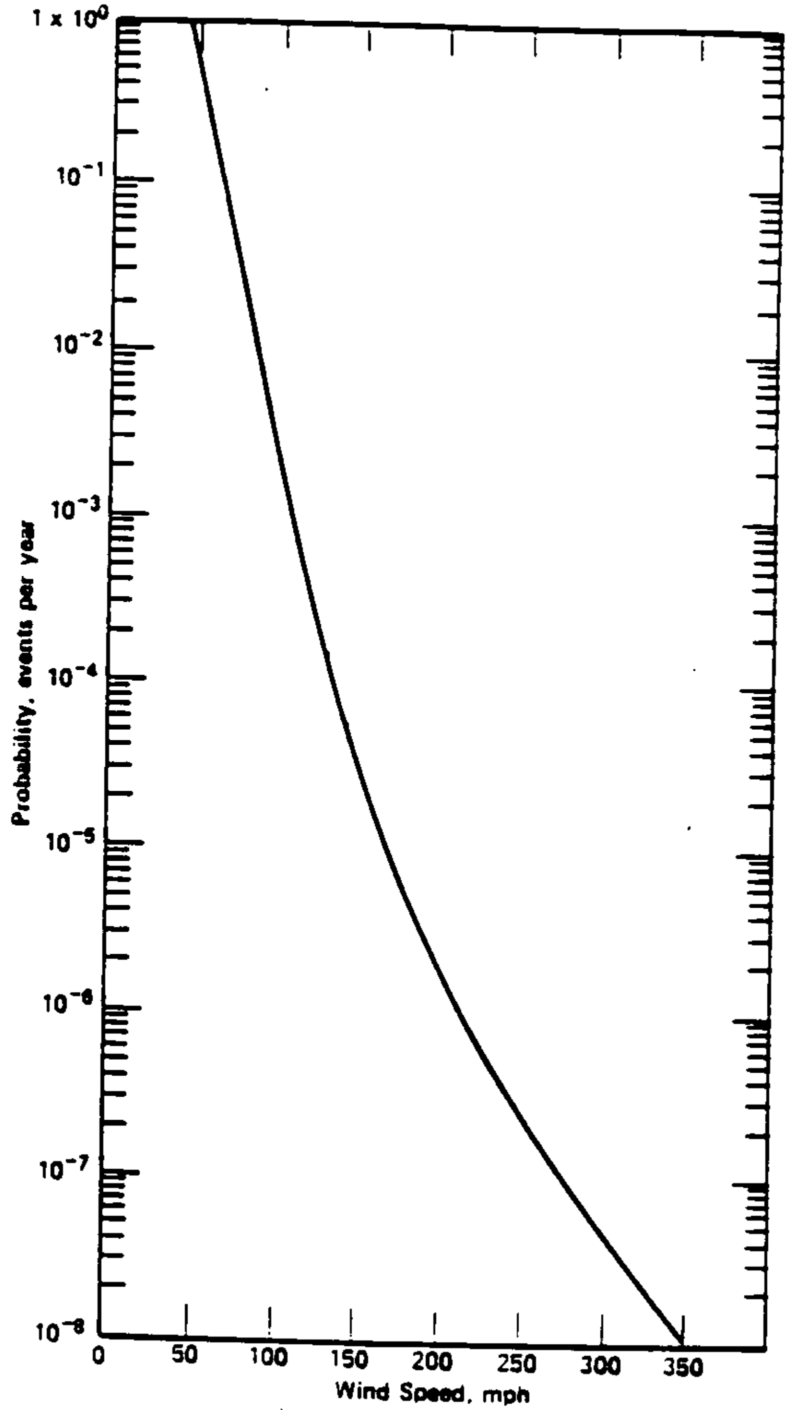


FIGURE 1-10. Expected Annual Probability of Occurrence of "Straight-Line" Fastest Mile Wind Speeds at SRS, Hoel (1983)

TABLE 1-15

Occurrence of Hurricanes in South Carolina by Month[a]

Month	Number	Percent of Total
June	1	2.8
July	2	5.6
August	11	30.6
September	18	50.0
October	4	11.1

[a] Period of record, 1700-1989

TABLE 1-16

Average Number of Thunderstorm Days at Augusta, GA[a]

Month	Thunderstorm Days
January	1
February	2
March	3
April	4
May	7
June	9
July	13
August	10
September	4
October	1
November	1
December	1
Annual	56

[a] Period of record, 1951-1986

Source: NOAA (1987)

where:

NE is the number of flashes to earth/km^2/thunderstorm day

L is the average reactor area latitude (33° 73')
and A is given by (0.4 ±0.2)

Assuming the most conservative value for A, the number of flashes per square kilometer was estimated to be six per year. Four of six strikes would be expected to occur in the summer months.

1.3.5 Extreme Precipitation

Estimated extreme rainfall totals for the SRS region over periods from 30 minutes to 48 hours for various recurrence intervals are shown in Table 1-17. These estimates, calculated using a Fisher-Tippett Type II extreme value distribution function, were taken from Hershfield (1963); Miller (1964); and Frederick (1977). The extreme rainfalls for the shorter duration events would be produced primarily by spring and summer thunderstorms. For the longer duration periods, the remnants of tropical weather systems would be expected to produce the estimated rainfall totals.

1.3.6 Ice and Snow

Winter storms that produce accumulations of ice or snow in excess of one inch are rare. Snowfalls of one inch or greater occur once every five years on the average. Furthermore, any accumulation of ice or snow would rarely last longer than three days.

A summary of maximum total snowfalls for 24-hour and monthly periods, observed at the Augusta NWS site, is given in Table 1-18. For the 36-year period 1951-1986, the greatest single snowfall occurred in February 1973. This storm produced a total accumulation of 14 inches, including 13.7 inches in a 24-hour period. Total snow accumulation for any other storm during this period of record was less than five inches. The maximum ground snow load for the SRS area for a 100-year mean recurrence interval has been estimated to be about 5 lb-force/ft^2 (ANSI, 1982).

For a nine-year period of record reported by Tattelman (1973), storms resulting in an accumulation of ice on exposed surfaces occurred in the SRS vicinity an average of about once every two years. Average ice accumulations for various recurrence intervals for a region consisting of Gulf Coast and south Atlantic states are given in Table 1-19. Based on a 50-year period of record that was analyzed (1920-1969), a one-half inch accumulation of ice would be expected to occur once every 25 years.

TABLE 1-17

Estimated Extreme Total Rainfall[a] for Various Recurrence Intervals

Recurrence Interval (yr)	Rainfall Duration							
	30 min	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr	48 hr
1	1.3	1.6	1.9	2.1	2.3	2.5	3.2	-
2	1.5	2.0	2.2	2.4	2.5	3.4	3.9	4.4
5	1.7	2.3	2.5	3.0	3.7	4.4	5.0	5.5
10	2.1	2.6	3.2	3.5	4.4	5.0	5.5	6.5
25	2.4	3.0	3.7	4.0	5.0	6.0	6.8	7.9
50	2.6	3.3	4.0	4.4	5.5	6.5	7.5	5.6
100	2.9	4.0	4.5	4.9	6.0	7.0	8.2	9.4

[a] In inches, water equivalent

TABLE 1-18

Maximum Accumulation of Snow and Ice Pellets at Augusta, GA[a]

Month	Monthly[b] (in.)	Maximum in 24 hr[b] (in.)
January	1.5 (1970)	1.5 (1970)
February	14.0 (1973)	13.7 (1973)
March	1.1 (1980)	1.1 (1980)
April	0.0	0.0
May	0.0	0.0
June	0.0	0.0
July	0.0	0.0
August	0.0	0.0
September	0.0	0.0
October	0.0	0.0
November	T (1968)	T (1968)
December	0.9 (1958)	0.9 (1958)
Record	14.0 (1973)	13.7 (1973)

[a] Period of record, 1951-1987
[b] Year of occurrence shown in parentheses

Source: NOAA (1987)

TABLE 1-19

Estimated Ice Accumulation at SRS for Various Recurrence Intervals

Recurrence Interval (yr)	Accumulation (in.)
2	0
5	0.25
10	0.40
25	0.50
50	0.60
100	0.67

Source: Tattleman et al. (1973)

1.4 LOCAL DISPERSION CLIMATOLOGY

Characterization of the local atmospheric dispersion climatology is based on wind speed, wind direction, and turbulence data collected from the K- and P-Area meteorological towers. Information on mixing height, the height of the ground-based layer of atmosphere through which relatively vigorous turbulent mixing occurs, was taken from existing summaries of NWS upper air observations.

1.4.1 Atmospheric Stability/Winds

Hourly values of the standard deviation of the horizontal wind direction fluctuations (sigma-a) were used to categorize atmospheric turbulence by the Pasquill-Gifford (P-G) stability classification method. The P-G stability classes (A through G) were assigned according to the ranges of sigma-a values given in NRC (1980).

The percent occurrence of each of the P-G classes for the K- and P-Area tower sites for the period 1982-1986 are summarized in Table 1-20. Stability Class D, indicative of relatively neutral dispersion conditions, occurred more frequently than any other class (29% of the hours). Conditions favorable for turbulent mixing, represented by the unstable P-G classes (A, B, and C), occurred more than 40% of the time. The stable P-G classes (E, F, and G), representing conditions relatively unfavorable for turbulent mixing, occurred less than one third of the time at each location.

Joint frequency distributions and wind roses of wind direction and wind speed stratified by P-G stability class are given in Figures 1-11 through 1-17 for K Area and 1-18 through 1-24 for P Area. In general, winds were more frequently from the south, south-southeast, and east-northeast sectors during stable conditions. These conditions usually occur at night and are typically associated with the presence of a high pressure area in the southeastern U.S. Winds during relatively unstable conditions were more frequently from the west through southwest sectors.

1.4.2 Mixing Height and Low-Level Inversions

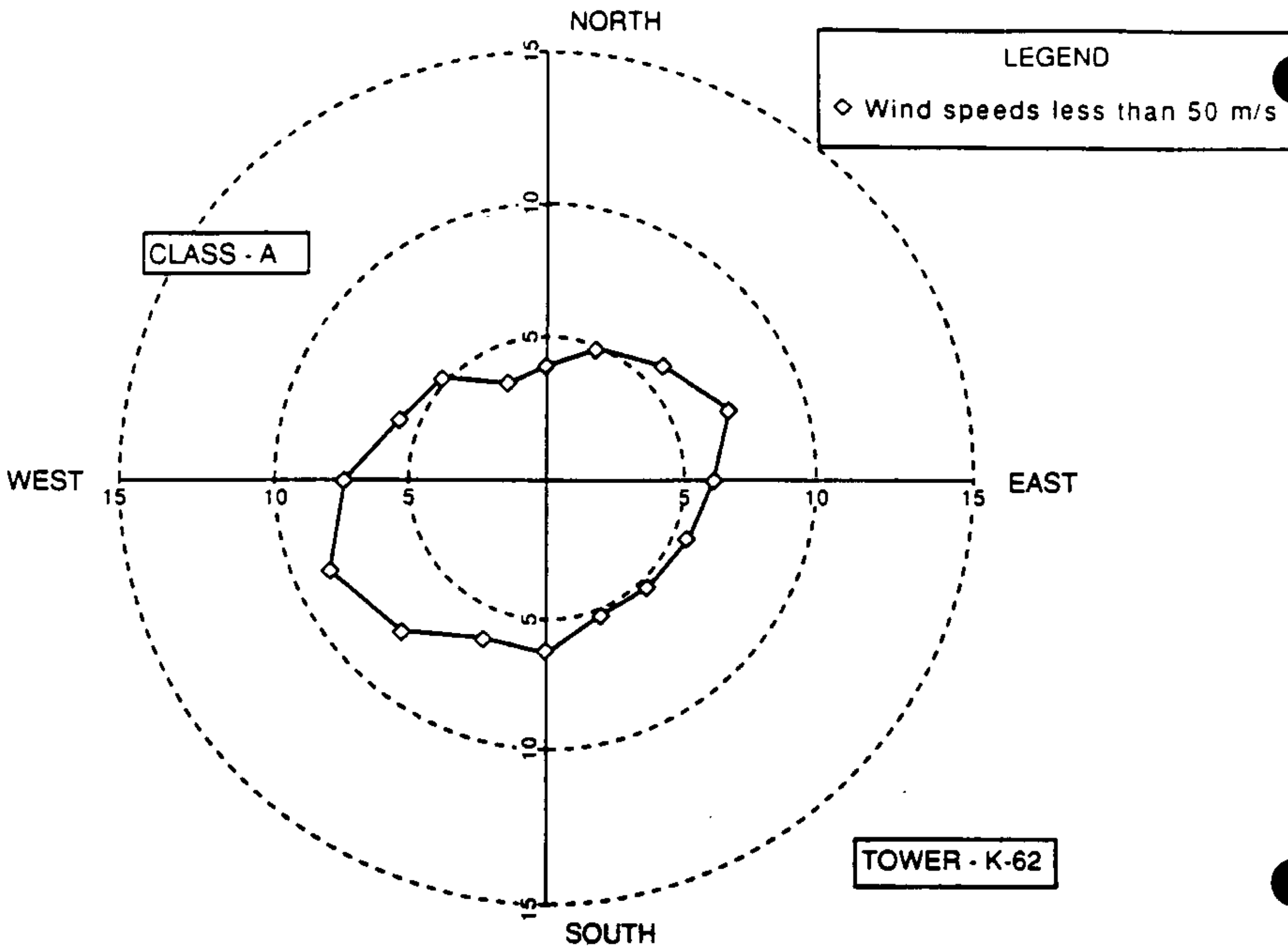
Estimates of seasonally averaged morning and afternoon mixing heights for SRS, shown in Table 1-21, were interpolated from data presented in Holzworth (1972). These data were derived from upper air data collected during the 5-year period, 1960-1964. Garrett (1981) conducted an examination of 1978 rawinsonde and surface observations for Athens, GA, Greensboro, NC, Charleston, SC, and Jacksonville, FL (Garrett, 1981). Monthly average afternoon mixing heights based on these data are shown in Figure 1-25. The afternoon mixing height values calculated by Garrett generally agree with values interpolated from Holzworth, except for summer afternoons. Garrett's estimated average summer afternoon mixing height, about 4,000 ft, is considerably less than the estimate based on Holzworth's data because convective cloud formation, prevalent in the SRS region during the summer, was considered in the methodology.

TABLE 1-20

Percent Occurrence of P-G Atmospheric Stability Classes A Through G[a]

Class	Percent Occurrence K Area	P Area
A (Extremely Unstable)	17	17
B (Moderately Unstable)	9	10
C (Slightly Unstable)	16	16
D (Neutral)	29	29
E (Slightly Stable)	23	22
F (Moderately Stable)	6	5
G (Extremely Stable)	<1	<1

[a] Based on measurements from K- and P-Area meteorological towers, 1982-1986

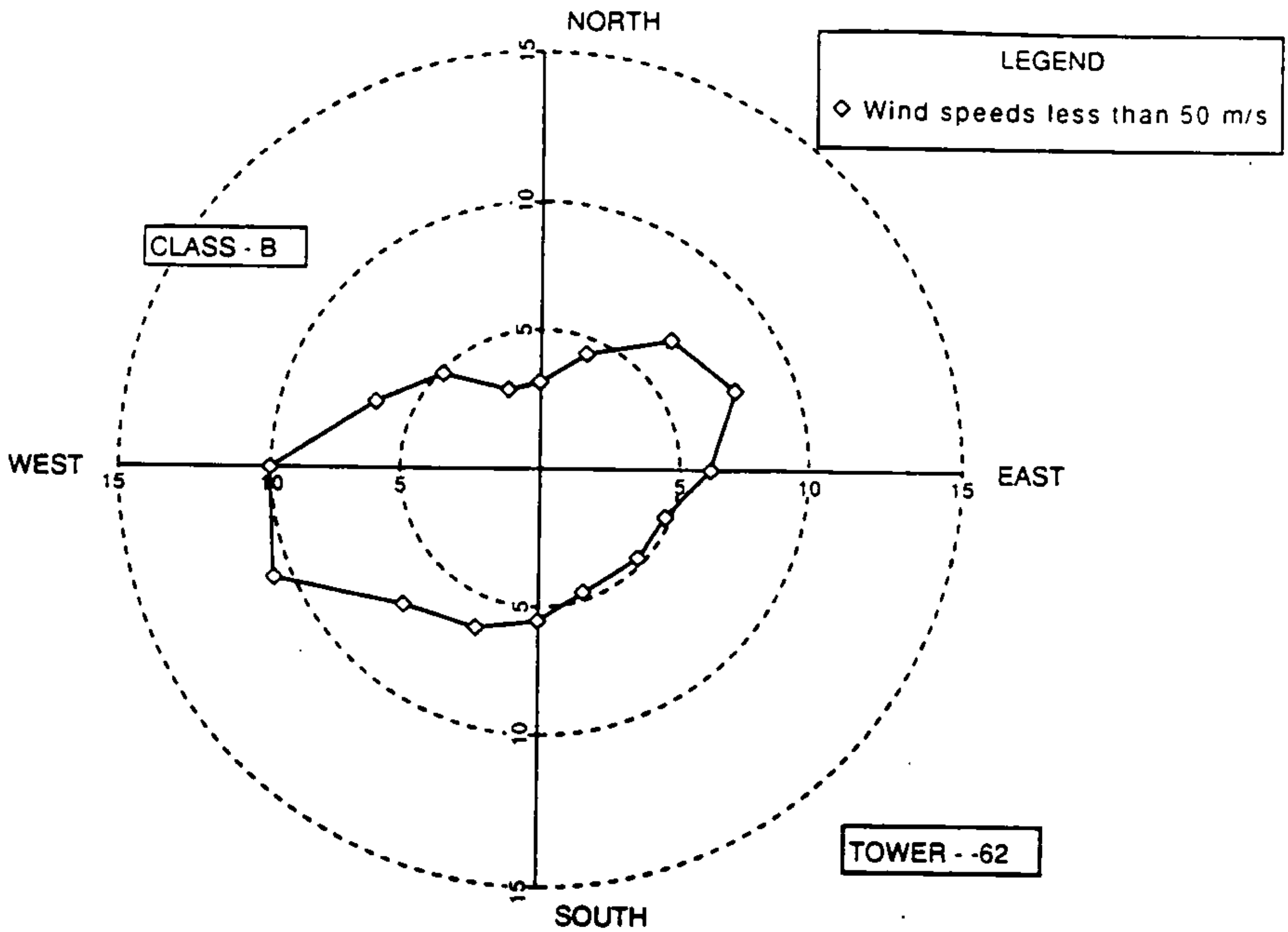


JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	113	134	25	3	3	0	1.85	278	1.82	2.16	0.40	0.05	0.05	0.00	4.48
NNE	128	156	22	2	0	0	1.74	308	2.06	2.51	0.35	0.03	0.00	0.00	4.96
NE	145	212	26	4	0	0	1.96	387	2.34	3.42	0.42	0.06	0.00	0.00	6.23
ENE	159	261	31	2	0	0	1.89	453	2.56	4.20	0.50	0.03	0.00	0.00	7.30
E	140	230	20	2	0	0	1.91	392	2.26	3.71	0.32	0.03	0.00	0.00	6.32
ESE	143	183	30	3	0	0	1.84	359	2.30	2.95	0.48	0.05	0.00	0.00	5.78
SE	152	168	20	3	0	0	1.81	343	2.45	2.71	0.32	0.05	0.00	0.00	5.53
SSE	134	169	22	6	0	0	1.74	331	2.16	2.72	0.35	0.10	0.00	0.00	5.33
S	156	220	27	4	3	0	1.87	410	2.51	3.54	0.43	0.06	0.05	0.00	6.61
SSW	155	212	35	6	1	0	1.86	409	2.50	3.42	0.56	0.10	0.02	0.00	6.59
SW	181	291	32	4	0	1	1.85	509	2.92	4.69	0.52	0.06	0.00	0.02	8.20
WSW	186	301	57	8	2	1	1.97	555	3.00	4.85	0.92	0.13	0.03	0.02	8.94
W	176	273	40	2	0	1	1.97	492	2.84	4.40	0.64	0.03	0.00	0.02	7.93
WNW	148	196	44	6	1	0	2.01	395	2.38	3.16	0.71	0.10	0.02	0.00	6.36
NW	139	150	38	7	0	0	1.82	332	2.24	2.42	0.58	0.11	0.00	0.00	5.35
NNW	119	115	13	6	1	0	1.76	254	1.92	1.85	0.21	0.10	0.02	0.00	4.09
NO DIRECT	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00		0.00
AVG SPEED	1.19	2.72	4.58	6.86	8.90	14.55	1.87								
TOT ENTRY	2374	3271	480	68	11	3		6207							

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-11. Annual Wind Rose for K-Area Meteorological Tower 1982-1986, A Stability, Laurinat (1987)



JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY, SPEED IN METERS/SECOND: 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY, SPEED IN METERS/SECOND: 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	16	61	33	3	0	0	2.40	115	0.54	1.82	0.98	0.09	0.00	0.00	3.43
NNE	24	85	46	0	0	0	2.71	155	0.72	2.53	1.37	0.00	0.00	0.00	4 62
NE	50	130	61	2	0	0	2.54	243	1.49	3.87	1.82	0.06	0.00	0.00	7 24
ENE	51	166	56	2	0	0	2.52	275	1.52	4.95	1.67	0.06	0.00	0.00	8.20
E	34	140	39	2	0	0	2.53	215	1.01	4.17	1.16	0.06	0.00	0.00	6.40
ESE	37	84	29	3	0	0	2.34	153	1.10	2.50	0.86	0.09	0.00	0.00	4.55
SE	30	104	24	2	0	0	2.57	160	0.89	3.10	0.72	0.06	0.00	0.00	4.77
SSE	30	86	35	3	0	0	2.47	154	0.89	2.56	1.04	0.09	0.00	0.00	4.58
S	29	115	41	1	0	0	2.63	186	0.86	3.43	1.22	0.03	0.00	0.00	5.54
SSW	41	119	58	5	2	0	2.43	225	1.22	3.55	1.73	0.15	0.06	0.00	6.71
SW	39	133	64	13	2	0	2.70	251	1.16	3.96	1.91	0.39	0.06	0.00	7.48
WSW	52	183	104	16	2	1	2.75	358	1.55	5.45	3.10	0.48	0.06	0.03	10.67
W	54	181	94	14	0	0	2.73	343	1.61	5.39	2.80	0.42	0.00	0.00	10.22
WNW	44	111	68	10	3	0	2.76	236	1.31	3.31	2.03	0.30	0.09	0.00	7.04
NW	35	86	45	6	0	0	2.35	172	1.04	2.56	1.34	0.18	0.00	0.00	5.12
NNW	30	53	25	6	0	0	2.21	114	0.89	1.58	0.75	0.18	0.00	0.00	3 40
NO DIRECT	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVG SPEED	1.25	2.86	4.62	6.53	8.59	18.51	2.57								
TOT ENTRY	598	1837	822	88	9	1		3355							

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-12. Annual Wind Rose for K-Area Meteorological Tower, 1982-1986, B Stability, Laurinat (1987)

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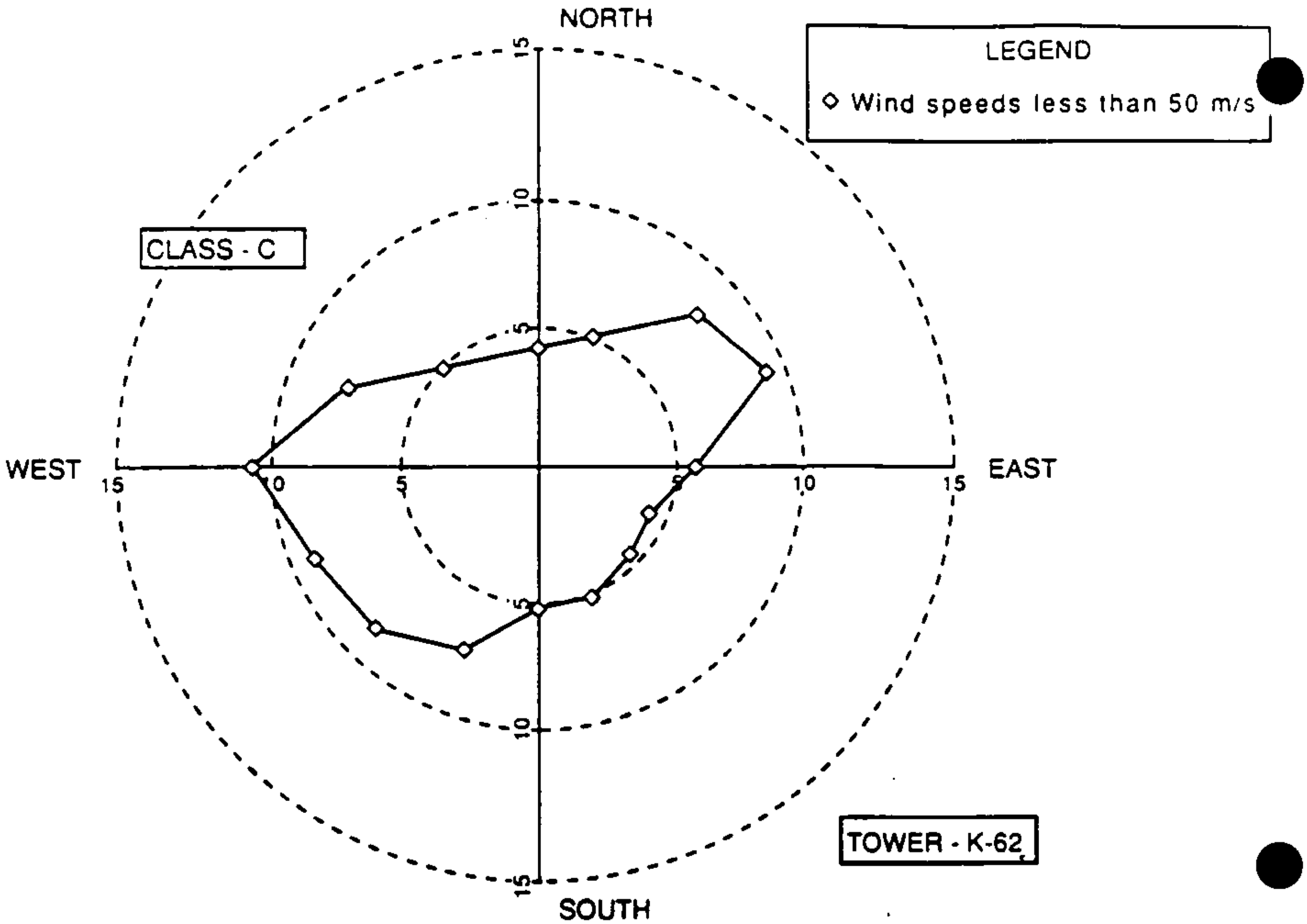

JOINT FREQUENCY DATA

OCCURRENCE FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
	SPEED IN METERS/SECOND							
N	27	73	75	15	0	0	3.08	190
NNE	34	144	98	16	0	0	2.91	292
NE	42	216	167	22	0	0	3.05	447
ENE	59	273	166	11	1	0	2.95	510
E	44	200	76	11	0	0	2.75	331
ESE	40	126	67	9	0	0	2.56	242
SE	37	125	85	8	1	0	2.84	256
SSE	37	132	101	19	2	0	2.80	291
S	44	149	96	8	0	0	2.56	297
SSW	41	178	145	38	4	0	2.96	406
SW	33	216	163	46	12	0	3.18	470
WSW	58	195	156	60	21	0	2.96	490
W	36	253	192	104	17	0	3.45	602
WNW	41	163	138	58	25	0	3.36	425
NW	27	138	85	27	7	0	3.15	284
NNW	32	74	51	17	3	0	2.70	177
NO DIRECT	0	0	0	0	0	0	0.00	0
AVG SPEED	1.18	2.52	4.79	6.71	8.83	0.00	2.98	
TOT ENTRY	632	2655	1861	469	93	0		5710

PERCENT FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
	SPEED IN METERS/SECOND						
N	0.47	1.28	1.31	0.26	0.00	0.00	3.33
NNE	0.60	2.52	1.72	0.28	0.00	0.00	5.11
NE	0.74	3.78	2.92	0.39	0.00	0.00	7.83
ENE	1.03	4.78	2.91	0.19	0.02	0.00	8.93
E	0.77	3.50	1.33	0.19	0.00	0.00	5.80
ESE	0.70	2.21	1.17	0.16	0.00	0.00	4.24
SE	0.65	2.19	1.49	0.14	0.02	0.00	4.48
SSE	0.65	2.31	1.77	0.33	0.04	0.00	5.10
S	0.77	2.61	1.68	0.14	0.00	0.00	5.20
SSW	0.72	3.12	2.54	0.67	0.07	0.00	7.11
SW	0.58	3.78	2.85	0.81	0.21	0.00	8.23
WSW	1.02	3.42	2.73	1.05	0.37	0.00	8.58
W	0.63	4.43	3.36	1.82	0.30	0.00	10.54
WNW	0.72	2.85	2.42	1.02	0.44	0.00	7 44
NW	0.47	2.42	1.49	0.47	0.12	0.00	4 97
NNW	0.56	1.30	0.89	0.30	0.05	0.00	3 :0
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0 00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-13. Annual Wind Rose for K-Area Meteorological Tower, 1982-1986, C Stability, Laurinat (1987)

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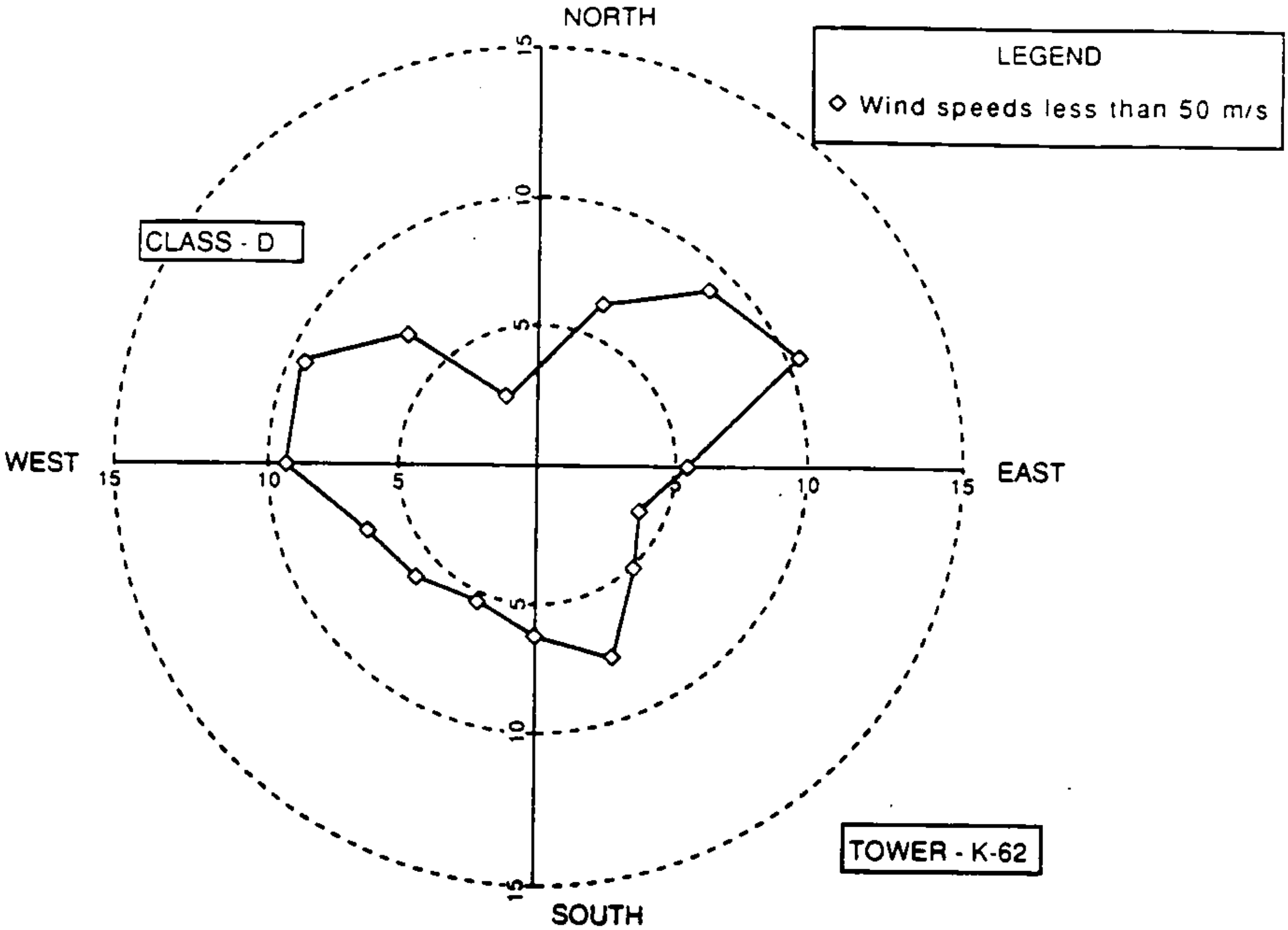


JOINT FREQUENCY DATA

OCCURRENCE FREQUENCY

DIRECTION*	SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
N	20	123	137	34	4	0	3.27	318
NNE	29	203	298	66	10	1	3.67	605
NE	45	337	406	87	11	0	3.46	886
ENE	35	461	421	98	8	0	3.70	1023
E	33	266	211	59	3	0	3.34	572
ESE	38	194	163	28	3	0	3.00	426
SE	38	214	231	50	2	0	3.38	535
SSE	43	296	340	78	10	0	3.56	767
S	33	292	237	70	7	0	3.37	639
SSW	52	257	171	49	12	0	3.02	541
SW	52	264	205	48	18	0	3.07	587
WSW	41	254	240	81	27	0	3.53	643
W	38	249	318	172	118	1	3.84	896
WNW	45	245	343	186	100	3	4.04	922
NW	40	223	247	89	37	1	3.70	637
NNW	23	118	98	12	2	0	3.10	253
NO DIRECT	0	0	0	0	0	0	0.00	0
AVG SPEED	1.06	3.06	4.82	6.71	9.10	12.23	3.49	
TOT ENTRY	605	3996	4064	1207	372	6		10250

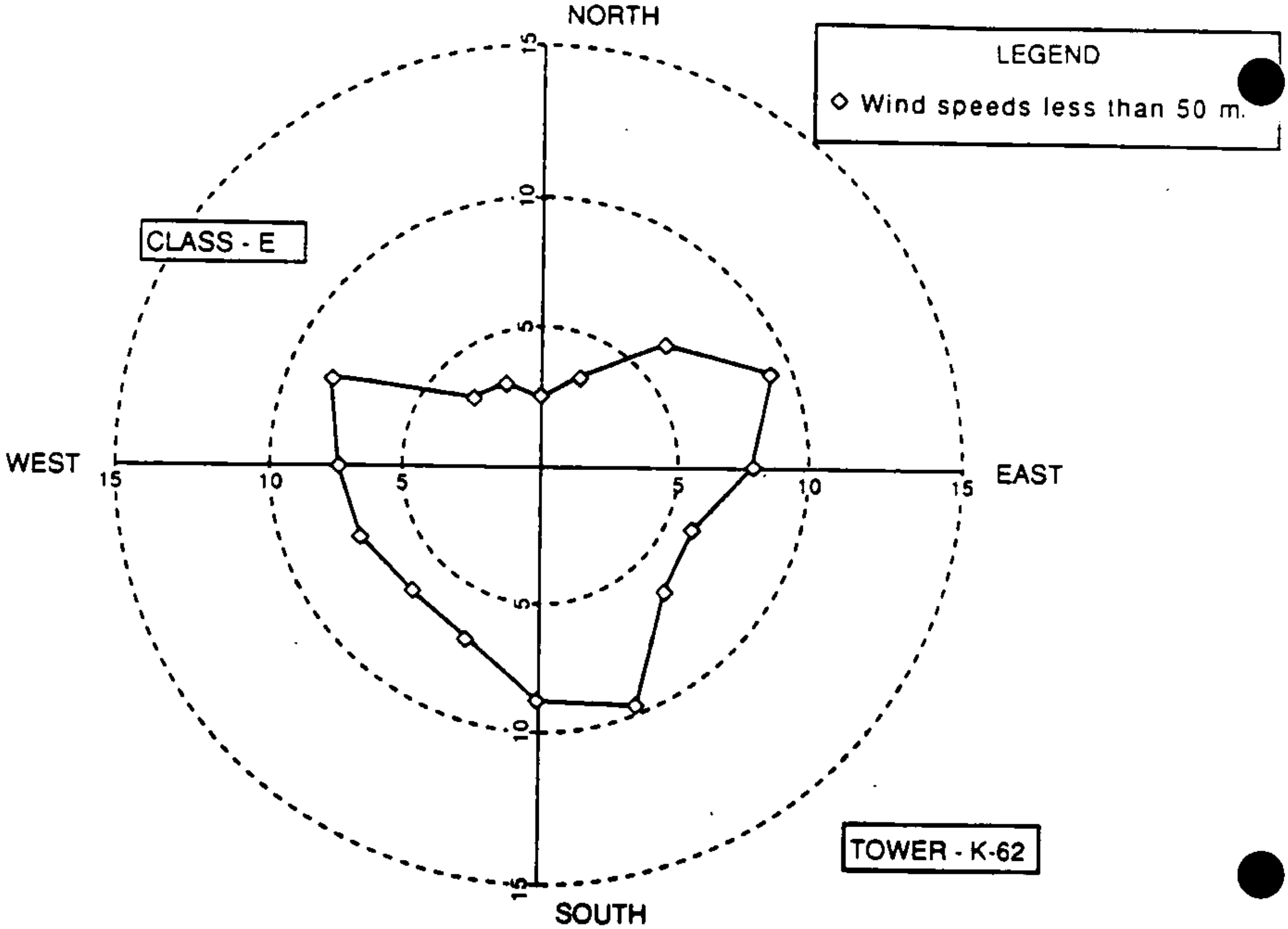
PERCENT FREQUENCY

DIRECTION*	SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	0.20	1.20	1.34	0.33	0.04	0.00	3.10
NNE	0.28	1.98	2.89	0.64	0.10	0.01	5.90
NE	0.44	3.29	3.96	0.85	0.11	0.00	8.64
ENE	0.34	4.50	4.11	0.96	0.08	0.00	9.98
E	0.32	2.60	2.06	0.58	0.03	0.00	5.58
ESE	0.37	1.89	1.59	0.27	0.03	0.00	4.16
SE	0.37	2.09	2.25	0.49	0.02	0.00	5.22
SSE	0.42	2.89	3.32	0.76	0.10	0.00	7.48
S	0.32	2.85	2.31	0.68	0.07	0.00	6.23
SSW	0.51	2.51	1.67	0.48	0.12	0.00	5.28
SW	0.51	2.58	2.00	0.47	0.18	0.00	5.73
WSW	0.40	2.48	2.34	0.79	0.26	0.00	6 27
W	0.37	2.43	3.10	1.68	1.15	0.01	8.74
WNW	0.44	2.39	3.35	1.81	0.98	0.03	9.00
NW	0.38	2.18	2.41	0.87	0.36	0.01	6.21
NNW	0.22	1.15	0.96	0.12	0.02	0.00	2 47
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0 00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-14. Annual Wind Rose for K-Area Meteorological Tower, 1982-1986, D Stability, Laurinat (1987)

W8908052

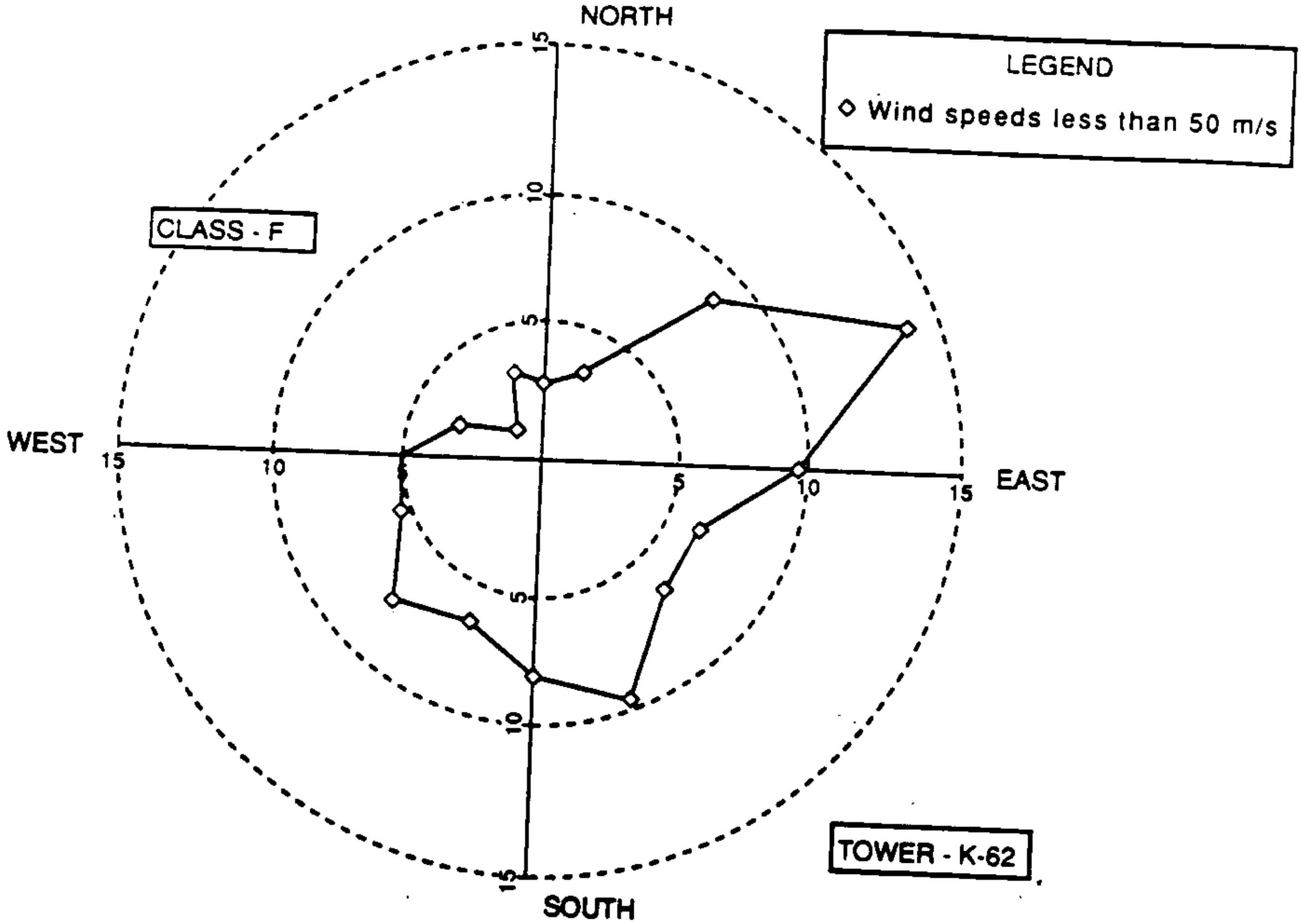


JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	19	58	111	18	0	0	3.15	206	0.23	0.71	1.35	0.22	0.00	0.00	2.50
NNE	6	81	151	43	0	0	4.22	281	0.07	0.98	1.84	0.52	0.00	0.00	3.42
NE	13	154	282	51	1	0	3.95	501	0.16	1.87	3.43	0.62	0.00	0.00	6.09
ENE	24	297	384	20	0	0	3.60	725	0.29	3.61	4.67	0.24	0.00	0.00	8.81
E	19	224	337	26	0	0	3.59	606	0.23	2.72	4.10	0.32	0.00	0.00	7.37
ESE	29	182	259	11	0	0	3.28	481	0.35	2.21	3.15	0.13	0.00	0.00	5.85
SE	18	182	301	11	0	0	3.76	512	0.22	2.21	3.66	0.13	0.00	0.00	6.22
SSE	23	289	453	13	0	0	3.72	778	0.28	3.51	5.51	0.16	0.00	0.00	9.46
S	24	319	384	9	0	0	3.44	736	0.29	3.88	4.67	0.11	0.00	0.00	8.95
SSW	26	218	275	24	0	0	3.52	543	0.32	2.65	3.34	0.29	0.00	0.00	6.60
SW	16	188	280	47	0	0	3.68	531	0.19	2.29	3.40	0.57	0.00	0.00	6.46
WSW	12	156	348	38	0	0	3.88	554	0.15	1.90	4.23	0.46	0.00	0.00	6.74
W	19	147	329	86	1	0	3.99	582	0.23	1.79	4.00	1.05	0.01	0.00	7 08
WNW	18	147	383	103	4	0	4.15	655	0.22	1.79	4.66	1.25	0.05	0.00	7 96
NW	7	77	156	35	1	0	4.23	276	0.09	0.94	1.90	0.43	0.01	0.00	3.36
NNW	13	93	138	14	0	0	3.54	258	0.16	1.13	1.68	0.17	0.00	-0.00	3 14
NO DIRECT	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0 00
AVG SPEED	1.03	3.11	4.81	6.42	8.44	0.00	3.71								
TOT ENTRY	286	2812	4571	549	7	0		8225							

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-15. Annual Wind Rose for K-Area Meteorological Tower, 1982-1986, E Stability, Laurinat (1987)



JOINT FREQUENCY DATA

OCCURRENCE FREQUENCY

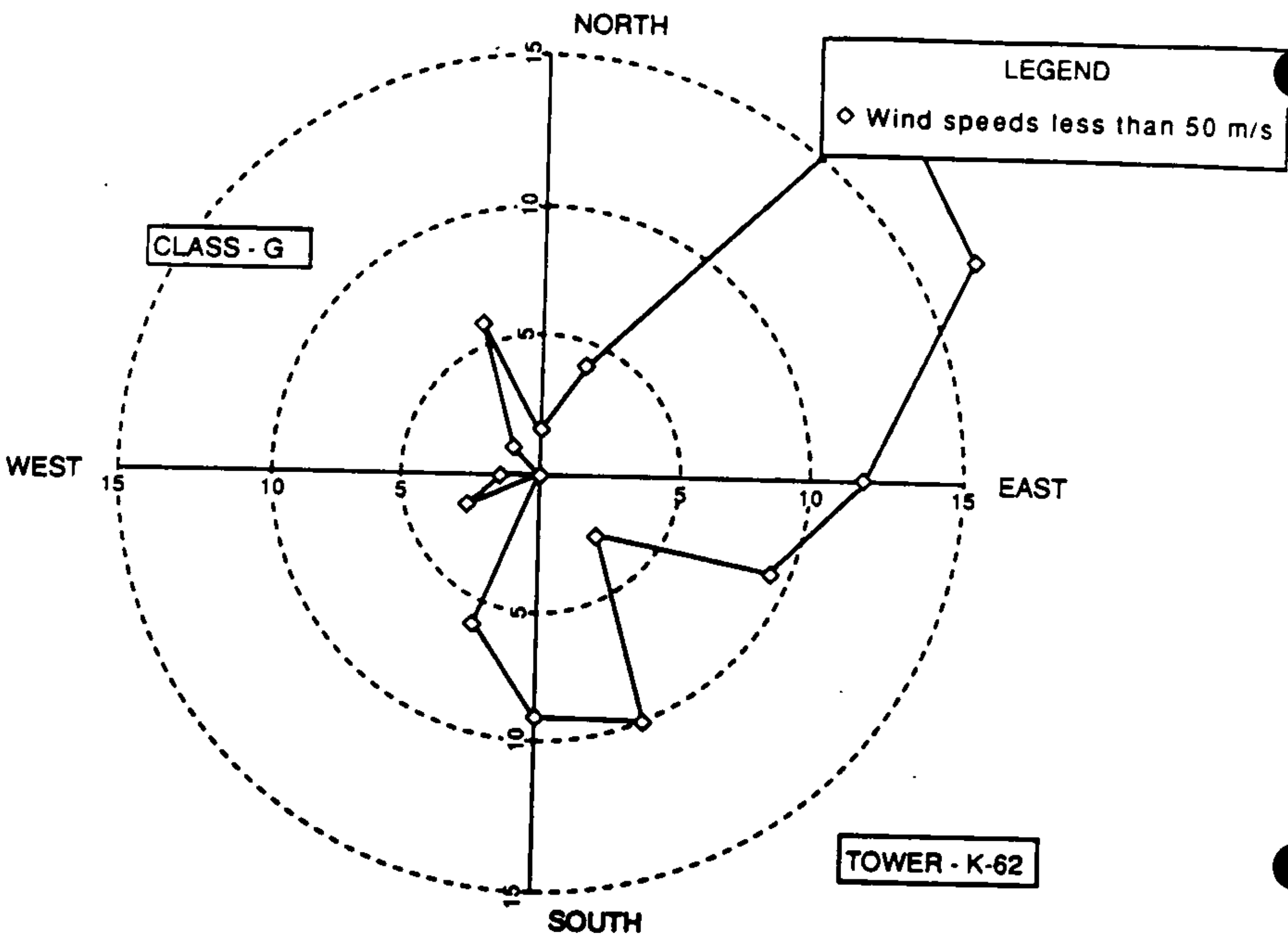
DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
	SPEED IN METERS/SECOND							
N	0	8	30	13	0	0	4.77	51
NNE	0	4	38	25	0	0	5.45	67
NE	2	24	113	32	0	0	4.36	171
ENE	1	62	201	20	0	0	4.34	284
E	2	44	123	22	0	0	4.14	191
ESE	1	31	76	18	0	0	4.45	126
SE	2	37	88	4	0	0	4.15	131
SSE	2	60	124	8	0	0	4.20	194
S	1	64	97	0	0	0	3.95	162
SSW	1	42	78	12	0	0	3.96	131
SW	3	41	90	15	0	0	4.16	149
WSW	0	22	71	17	0	0	4.67	110
W	0	26	58	15	0	0	4.46	101
WNW	0	14	45	6	0	0	4.44	65
NW	0	7	17	2	0	0	4.32	26
NNW	1	16	46	3	0	0	4.36	66
NO DIRECT	0	0	0	0	0	0	0.00	0
AVG SPEED	0.90	3.21	4.90	6.39	0.00	0.00	4.29	
TOT ENTRY	16	504	1293	212	0	0		2025

PERCENT FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
	SPEED IN METERS/SECOND						
N	0.00	0.40	1.48	0.64	0.00	0.00	2.52
NNE	0.00	0.20	1.88	1.23	0.00	0.00	3.31
NE	0.10	1.19	5.58	1.58	0.00	0.00	8.44
ENE	0.05	3.06	9.93	0.99	0.00	0.00	14.02
E	0.10	2.17	6.07	1.09	0.00	0.00	9.43
ESE	0.05	1.53	3.75	0.89	0.00	0.00	6.22
SE	0.10	1.83	4.35	0.20	0.00	0.00	6.47
SSE	0.10	2.96	6.12	0.40	0.00	0.00	9.58
S	0.05	3.16	4.79	0.00	0.00	0.00	8.00
SSW	0.05	2.07	3.75	0.59	0.00	0.00	6.47
SW	0.15	2.02	4.44	0.74	0.00	0.00	7.36
WSW	0.00	1.09	3.51	0.64	0.00	0.00	5.43
W	0.00	1.38	2.86	0.74	0.00	0.00	4.99
WNW	0.00	0.69	2.22	0.30	0.00	0.00	3.21
NW	0.00	0.35	0.84	0.10	0.00	0.00	1.28
NNW	0.05	0.79	2.27	0.15	0.00	0.00	3.26
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-16. Annual Wind Rose for K-Area Meteorological Tower, 1982-1986, F Stability, Laurinat (1987)



JOINT FREQUENCY DATA

OCCURRENCE FREQUENCY

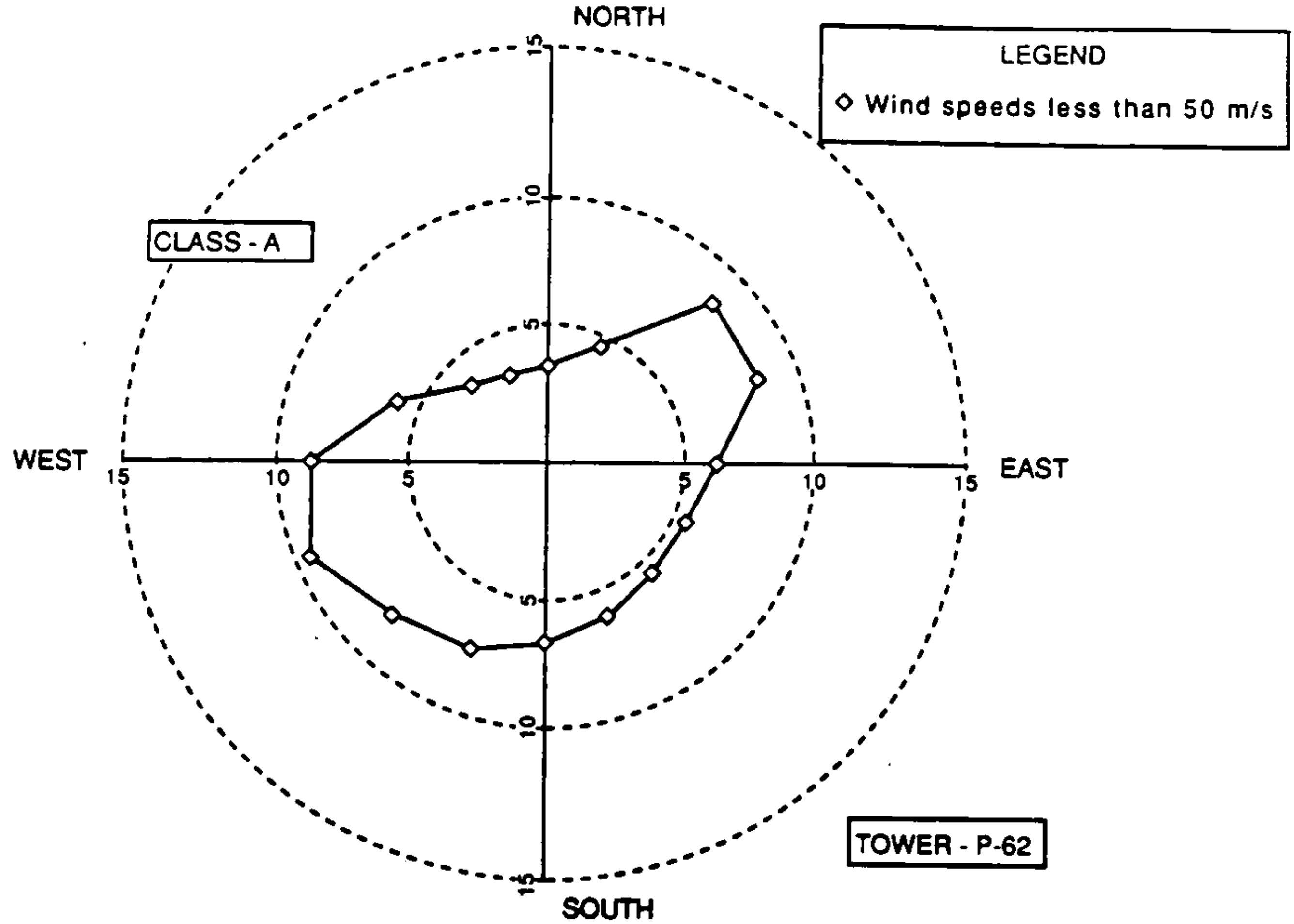
DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
	SPEED IN METERS/SECOND							
N	0	0	1	0	0	0	4.95	1
NNE	0	0	0	3	0	0	6.66	3
NE	0	0	10	3	0	0	5.14	13
ENE	0	5	6	0	0	0	3.71	11
E	0	3	5	0	0	0	4.46	8
ESE	0	2	1	3	0	0	4.44	6
SE	0	0	2	0	0	0	5.19	2
SSE	1	0	5	1	0	0	2.09	7
S	0	1	5	0	0	0	4.21	6
SSW	0	0	3	1	0	0	5.79	4
SW	0	0	0	0	0	0	0.00	0
WSW	0	0	1	1	0	0	5.89	2
W	0	0	1	0	0	0	5.17	1
WNW	0	0	0	0	0	0	0.00	0
NW	1	0	0	0	0	0	0.45	1
NNW	0	1	3	0	0	0	4.30	4
NO DIRECT	0	0	0	0	0	0	0.00	0
AVG SPEED	0.45	3.05	5.00	6.49	0.00	0.00	3.66	
TOT ENTRY	2	12	43	12	0	0		69

PERCENT FREQUENCY

DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
	SPEED IN METERS/SECOND						
N	0.00	0.00	1.45	0.00	0.00	0.00	1.45
NNE	0.00	0.00	0.00	4.35	0.00	0.00	4.35
NE	0.00	0.00	14.49	4.35	0.00	0.00	18.84
ENE	0.00	7.25	8.70	0.00	0.00	0.00	15.94
E	0.00	4.35	7.25	0.00	0.00	0.00	11.59
ESE	0.00	2.90	1.45	4.35	0.00	0.00	8.70
SE	0.00	0.00	2.90	0.00	0.00	0.00	2.90
SSE	1.45	0.00	7.25	1.45	0.00	0.00	10.14
S	0.00	1.45	7.25	0.00	0.00	0.00	8.70
SSW	0.00	0.00	4.35	1.45	0.00	0.00	5.80
SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSW	0.00	0.00	1.45	1.45	0.00	0.00	2.90
W	0.00	0.00	1.45	0.00	0.00	0.00	1.45
WNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW	1.45	0.00	0.00	0.00	0.00	0.00	1.45
NNW	0.00	1.45	4.35	0.00	0.00	0.00	5.80
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-17. Annual Wind Rose for K-Area Meteorological Tower, 1982-1986, G Stability, Laurinat (1987)

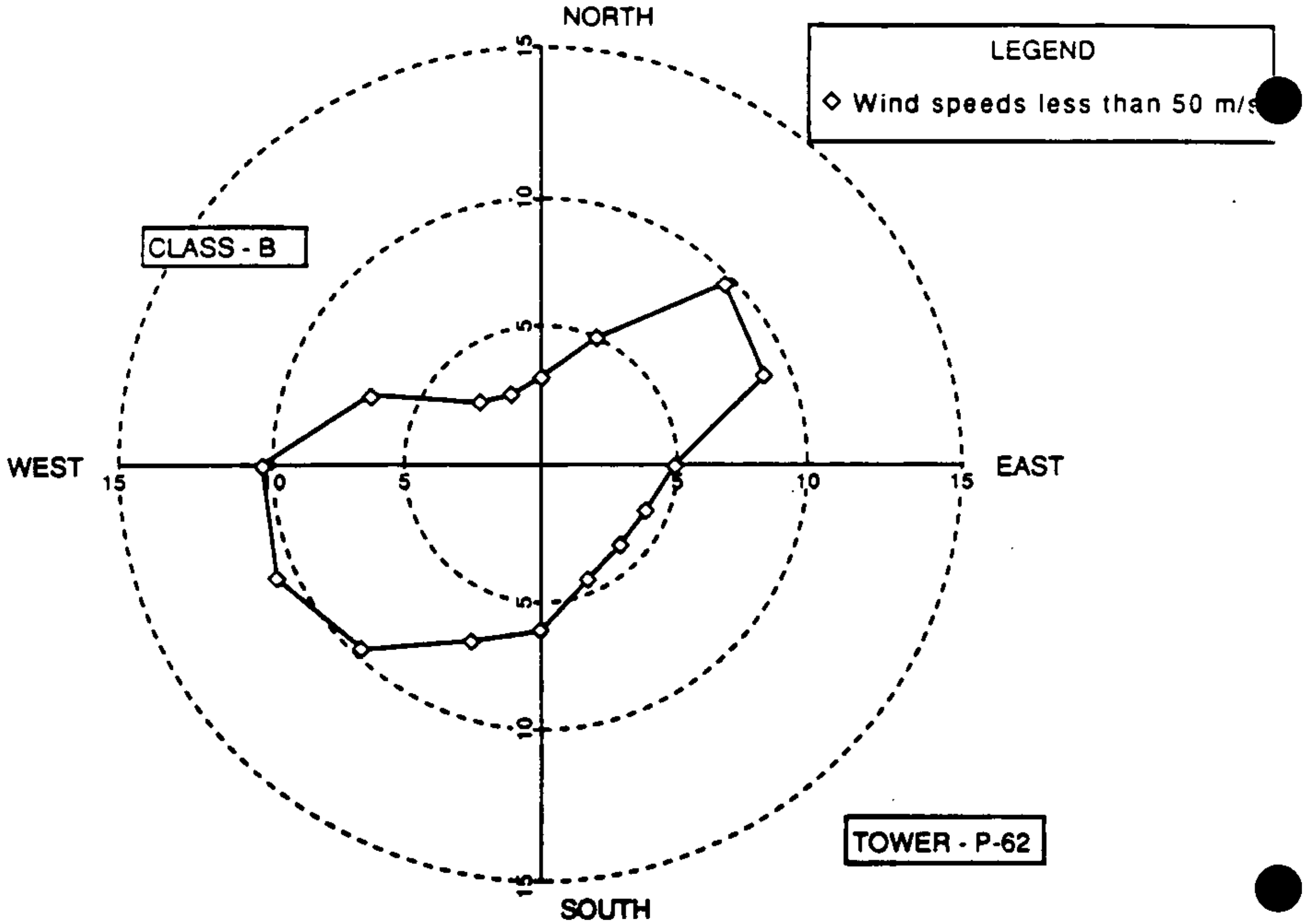


JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	83	97	14	1	0	0	1.97	195	1.55	1.81	0.26	0.02	0.00	0.00	3.64
NNE	95	135	20	1	0	0	1.96	251	1.77	2.52	0.37	0.02	0.00	0.00	4.68
NE	133	274	42	1	0	0	2.16	450	2.48	5.11	0.78	0.02	0.00	0.00	8.39
ENE	126	284	32	1	1	0	2.17	444	2.35	5.30	0.60	0.02	0.02	0.00	8.29
E	130	181	18	1	0	0	1.87	330	2.42	3.37	0.34	0.02	0.00	0.00	6.15
ESE	113	151	25	4	0	0	2.03	293	2.11	2.82	0.47	0.07	0.00	0.00	5.47
SE	136	139	18	5	0	0	1.88	298	2.54	2.59	0.34	0.09	0.00	0.00	5.56
SSE	130	150	28	3	0	0	1.88	311	2.42	2.80	0.52	0.06	0.00	0.00	5.80
S	131	171	39	6	2	0	2.06	349	2.44	3.19	0.73	0.11	0.04	0.00	6.51
SSW	115	224	40	0	2	0	2.17	381	2.14	4.18	0.75	0.00	0.04	0.00	7.11
SW	115	252	42	2	0	0	2.15	411	2.14	4.70	0.78	0.04	0.00	0.00	7.66
WSW	124	294	60	4	2	0	2.31	484	2.31	5.48	1.12	0.07	0.04	0.00	9.02
W	128	272	41	5	3	1	2.15	450	2.39	5.07	0.76	0.09	0.06	0.02	8.39
WNW	105	158	45	6	0	0	2.10	314	1.96	2.95	0.84	0.11	0.00	0.00	5.86
NW	87	109	15	6	0	0	2.01	217	1.62	2.03	0.28	0.11	0.00	0.00	4.04
NNW	68	100	16	1	0	0	1.97	185	1.27	1.66	0.30	0.02	0.00	0.00	3.45
NO DIRECT	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVG SPEED	1.32	2.72	4.59	6.71	8.58	22.41	2.07								
TOT ENTRY	1819	2991	495	47	10	1		5363							

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-18. Annual Wind Rose for P-Area Meteorological Tower, 1982-1986, A Stability, Laurinat (1987)



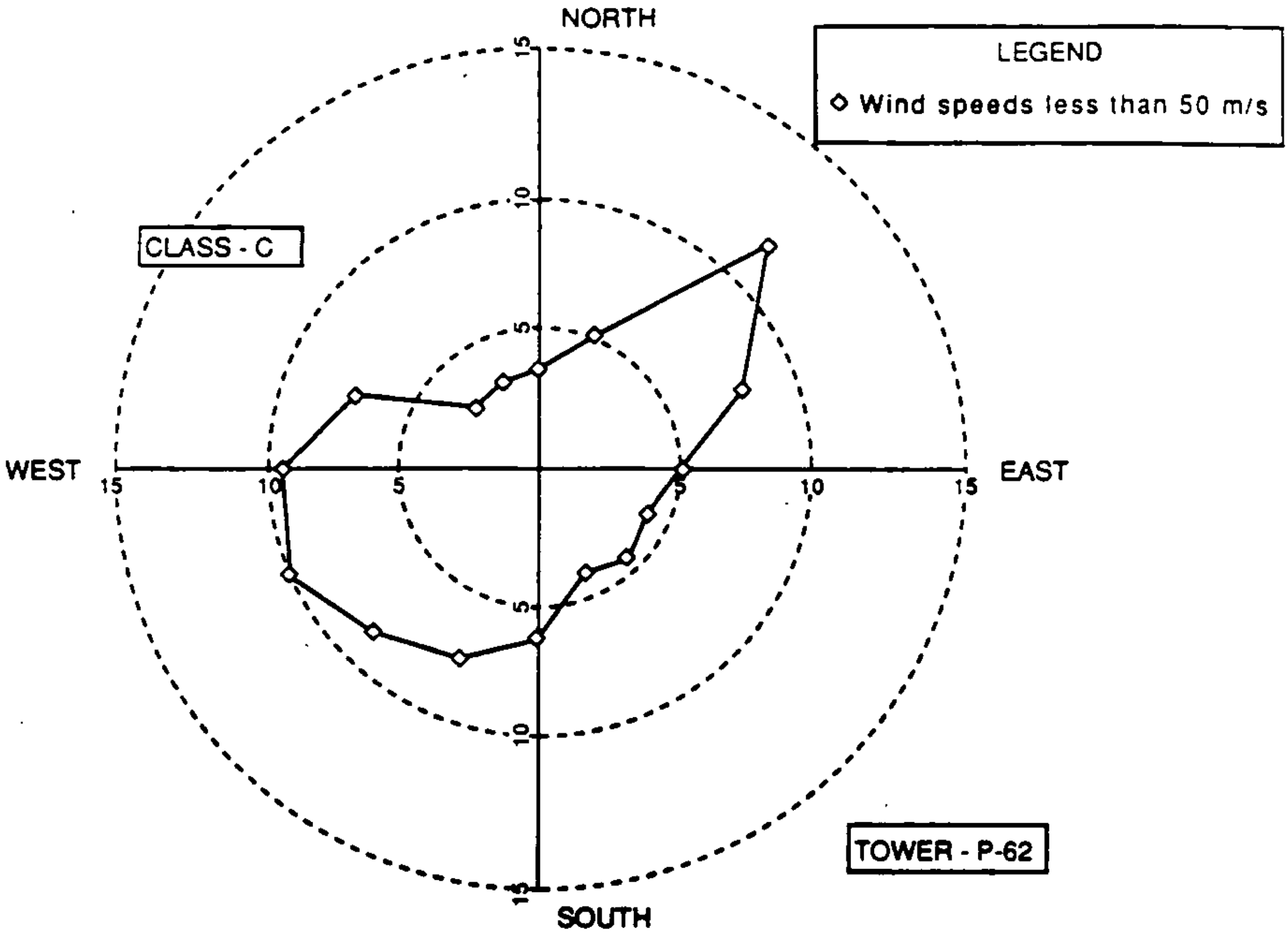
JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
N	16	51	34	2	0	0	2.82	103
NNE	20	93	39	1	0	0	2.54	153
NE	36	175	78	4	0	0	2.85	293
ENE	42	150	74	3	1	0	2.82	270
E	28	97	24	0	1	0	2.58	150
ESE	26	87	16	1	0	0	2.49	130
SE	25	64	32	2	0	0	2.62	123
SSE	20	79	31	4	0	0	2.61	134
S	33	107	38	8	0	0	2.73	186
SSW	19	121	62	5	2	0	3.09	209
SW	25	154	93	16	0	0	3.09	288
WSW	24	143	133	19	1	0	3.37	320
W	36	159	104	18	2	1	3.16	320
WNW	20	104	66	14	2	0	3.12	206
NW	13	47	39	3	0	0	3.00	102
NNW	22	37	23	4	0	0	2.47	86
NO DIRECT	0	0	0	0	0	0	0.00	0
AVG SPEED	1.40	2.94	4.67	6.80	8.94	18.65	2.89	
TOT ENTRY	405	1668	886	104	9	1		3073

DIRECTION*	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	0.52	1.66	1.11	0.07	0.00	0.00	3.36
NNE	0.65	3.03	1.27	0.03	0.00	0.00	4.98
NE	1.17	5.69	2.54	0.13	0.00	0.00	9.53
ENE	1.37	4.88	2.41	0.10	0.03	0.00	8.79
E	0.91	3.16	0.78	0.00	0.03	0.00	4.88
ESE	0.85	2.83	0.52	0.03	0.00	0.00	4.23
SE	0.81	2.08	1.04	0.07	0.00	0.00	4.00
SSE	0.65	2.57	1.01	0.13	0.00	0.00	4.36
S	1.07	3.48	1.24	0.26	0.00	0.00	6.05
SSW	0.62	3.94	2.02	0.16	0.07	0.00	6.81
SW	0.81	5.01	3.03	0.52	0.00	0.00	9.37
WSW	0.78	4.65	4.33	0.62	0.03	0.00	10.41
W	1.17	5.17	3.38	0.59	0.07	0.03	10.41
WNW	0.65	3.38	2.15	0.46	0.07	0.00	6.71
NW	0.42	1.53	1.27	0.10	0.00	0.00	3.32
NNW	0.72	1.20	0.75	0.13	0.00	0.00	2.80
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-19. Annual Wind Rose for P-Area Meteorological Tower, 1982-1986, B Stability, Laurinat (1987)



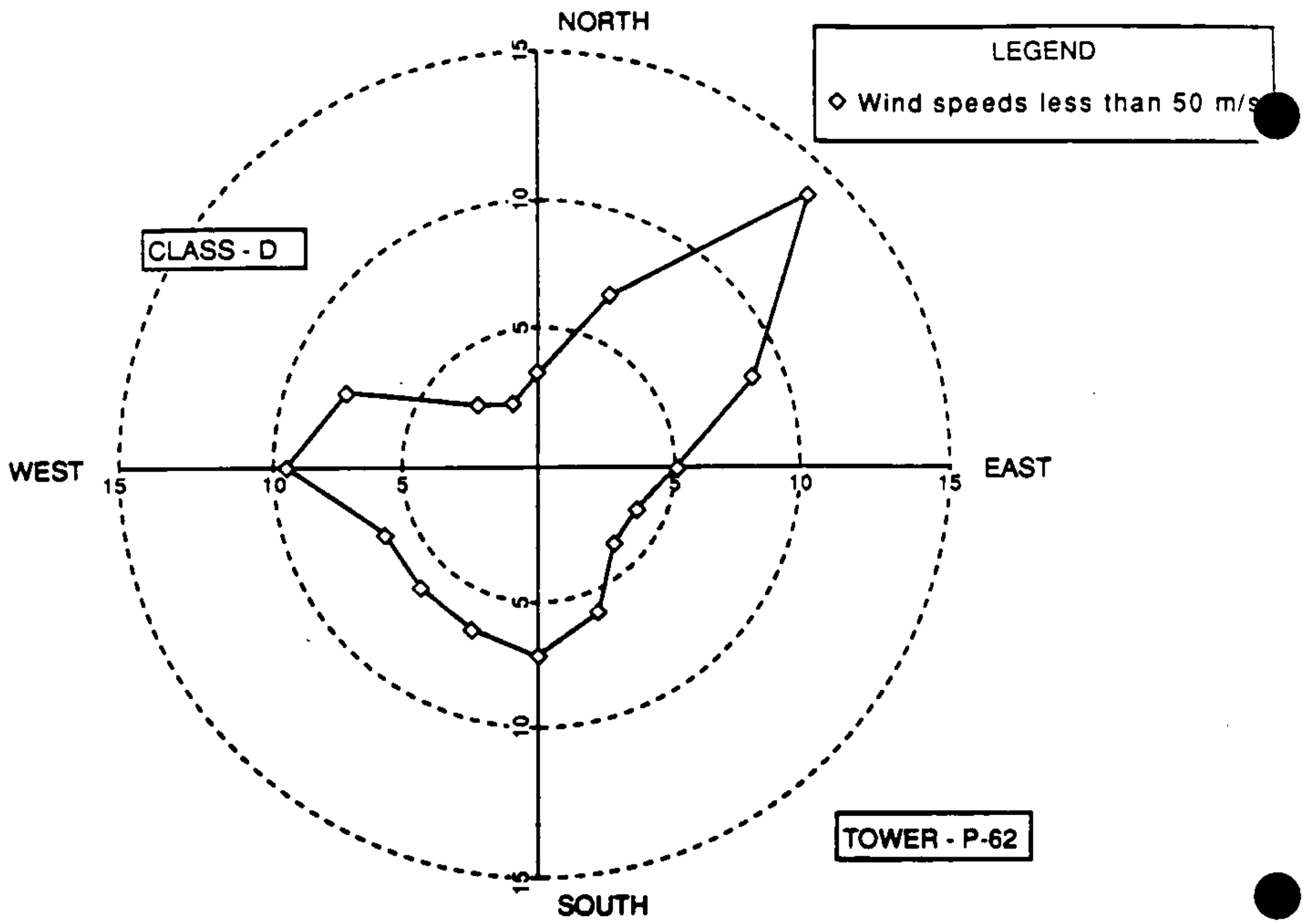
JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY — SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
N	15	89	60	8	1	0	3.15	173
NNE	14	118	105	32	2	0	3.37	271
NE	38	239	259	46	3	0	3.43	585
ENE	48	205	126	14	0	0	2.99	393
E	26	163	68	7	1	0	2.91	265
ESE	26	116	56	13	0	0	3.04	211
SE	27	98	72	30	5	0	3.32	232
SSE	22	101	70	13	3	0	2.87	209
S	29	169	103	12	1	0	3.03	314
SSW	24	160	152	37	7	0	3.36	380
SW	19	178	184	36	13	0	3.67	430
WSW	23	177	201	87	32	0	3.94	520
W	20	186	170	103	18	0	3.91	497
WNW	21	147	107	48	36	0	3.80	359
NW	21	80	46	9	9	0	3.06	165
NNW	25	71	63	13	1	0	3.08	173
NO DIRECT	0	0	0	0	0	0	0.00	0
AVG SPEED	1.35	2.97	4.80	6.70	8.76	0.00	3.35	
TOT ENTRY	398	2297	1842	508	132	0		5177

DIRECTION*	PERCENT FREQUENCY — SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	0.29	1.72	1.16	0.15	0.02	0.00	3.34
NNE	0.27	2.28	2.03	0.62	0.04	0.00	5.24
NE	0.73	4.62	5.00	0.89	0.06	0.00	11.30
ENE	0.93	3.96	2.43	0.27	0.00	0.00	7.59
E	0.50	3.15	1.31	0.14	0.02	0.00	5.12
ESE	0.50	2.24	1.08	0.25	0.00	0.00	4.07
SE	0.52	1.89	1.39	0.58	0.10	0.00	4.48
SSE	0.42	1.95	1.35	0.25	0.06	0.00	4.03
S	0.56	3.26	1.99	0.23	0.02	0.00	6.06
SSW	0.46	3.09	2.94	0.71	0.14	0.00	7.34
SW	0.37	3.44	3.55	0.70	0.25	0.00	8.31
WSW	0.44	3.42	3.88	1.68	0.62	0.00	10.04
W	0.39	3.59	3.28	1.99	0.35	0.00	9.60
WNW	0.41	2.84	2.07	0.93	0.70	0.00	6.95
NW	0.41	1.55	0.89	0.17	0.17	0.00	3.19
NNW	0.48	1.37	1.22	0.25	0.02	0.00	3.34
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-20. Annual Wind Rose for P-Area Meteorological Tower, 1982-1986, C Stability, Laurinat (1987)



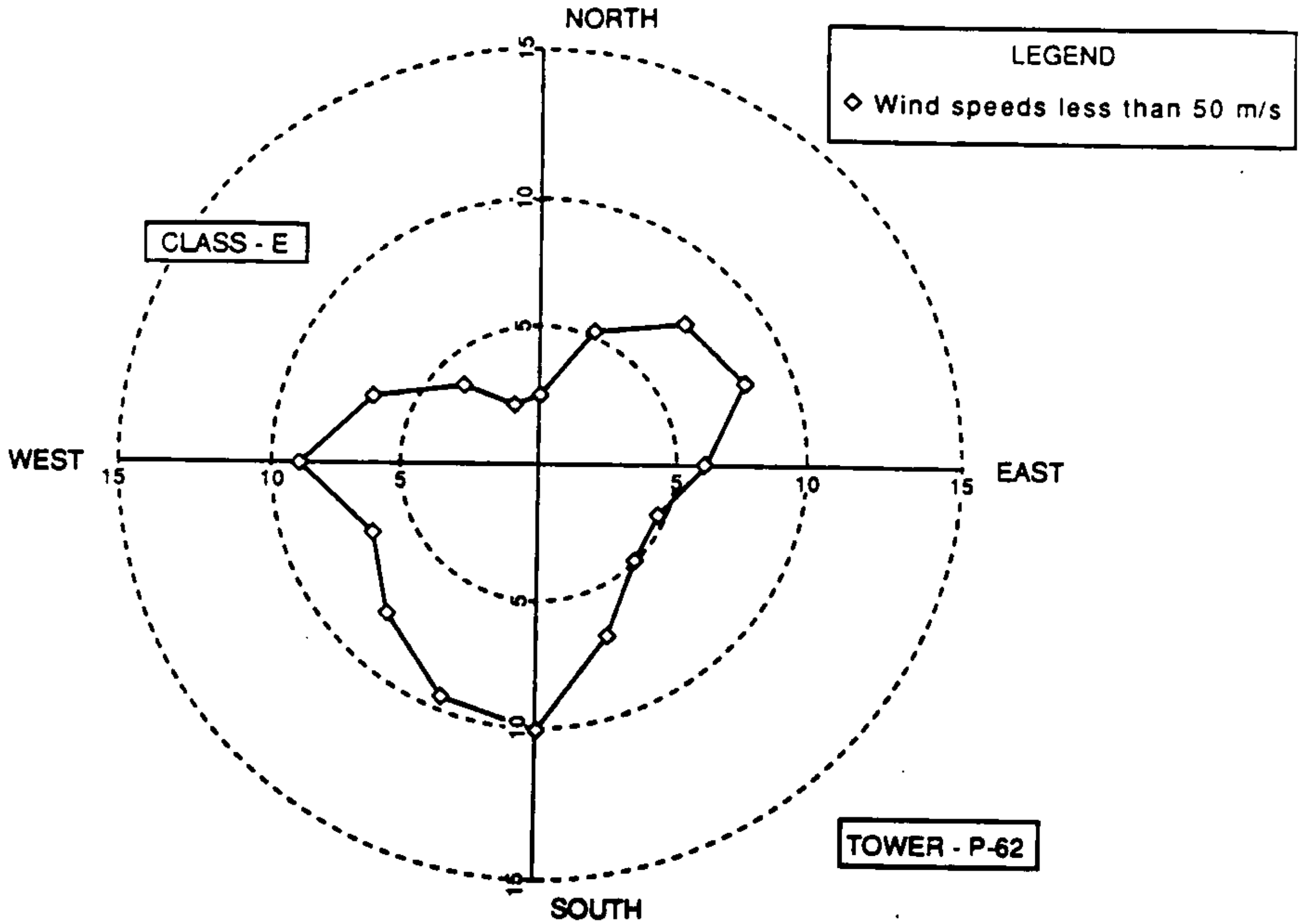
JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT
N	25	117	122	45	7	1	3.59	317
NNE	13	167	287	130	29	0	4.25	626
NE	23	315	682	253	35	0	4.41	1308
ENE	36	361	326	56	0	0	3.53	779
E	33	253	162	25	0	0	3.32	473
ESE	19	186	120.	21	8	0	3.42	354
SE	23	155	157	18	6	0	3.29	359
SSE	25	188	247	56	12	0	3.49	528
S	16	229	281	99	15	0	3.93	640
SSW	14	226	258	75	10	0	3.95	583
SW	12	233	271	40	8	0	3.87	564
WSW	14	171	287	72	17	0	4.11	561
W	22	204	375	216	58	0	4.53	875
WNW	13	200	287	122	63	0	4.33	685
NW	16	110	105	47	18	0	3.84	296
NNW	16	102	74	29	10	0	3.59	231
NO DIRECT	0	0	0	0	0	0	0.00	0
AVG SPEED	1.31	3.10	4.84	6.74	8.97	12.40	3.92	
TOT ENTRY	320	3217	4041	1304	298	1		9179

DIRECTION*	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	0.27	1.27	1.33	0.49	0.08	0.01	3.45
NNE	0.14	1.82	3.13	1.42	0.32	0.00	6.83
NE	0.25	3.43	7.43	2.76	0.38	0.00	14.25
ENE	0.39	3.93	3.55	0.61	0.00	0.00	8.48
E	0.36	2.76	1.76	0.27	0.00	0.00	5.15
ESE	0.21	2.03	1.31	0.23	0.09	0.00	3.87
SE	0.25	1.69	1.71	0.20	0.07	0.00	3.92
SSE	0.27	2.05	2.69	0.61	0.13	0.00	5.75
S	0.17	2.49	3.06	1.08	0.16	0.00	6.96
SSW	0.15	2.46	2.81	0.82	0.11	0.00	6.35
SW	0.13	2.54	2.95	0.44	0.09	0.00	6.15
WSW	0.15	1.86	3.13	0.78	0.19	0.00	6.11
W	0.24	2.22	4.09	2.35	0.63	0.00	9.53
WNW	0.14	2.18	3.13	1.33	0.69	0.00	7.47
NW	0.17	1.20	1.14	0.51	0.20	0.00	3.22
NNW	0.17	1.11	0.81	0.32	0.11	0.00	2.52
NO DIRECT	0.00	0.00	0.00	0.00	0.00	0.00	0.00

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-21. Annual Wind Rose for P-Area Meteorological Tower, 1982-1986, D Stability, Laurinat (1987)

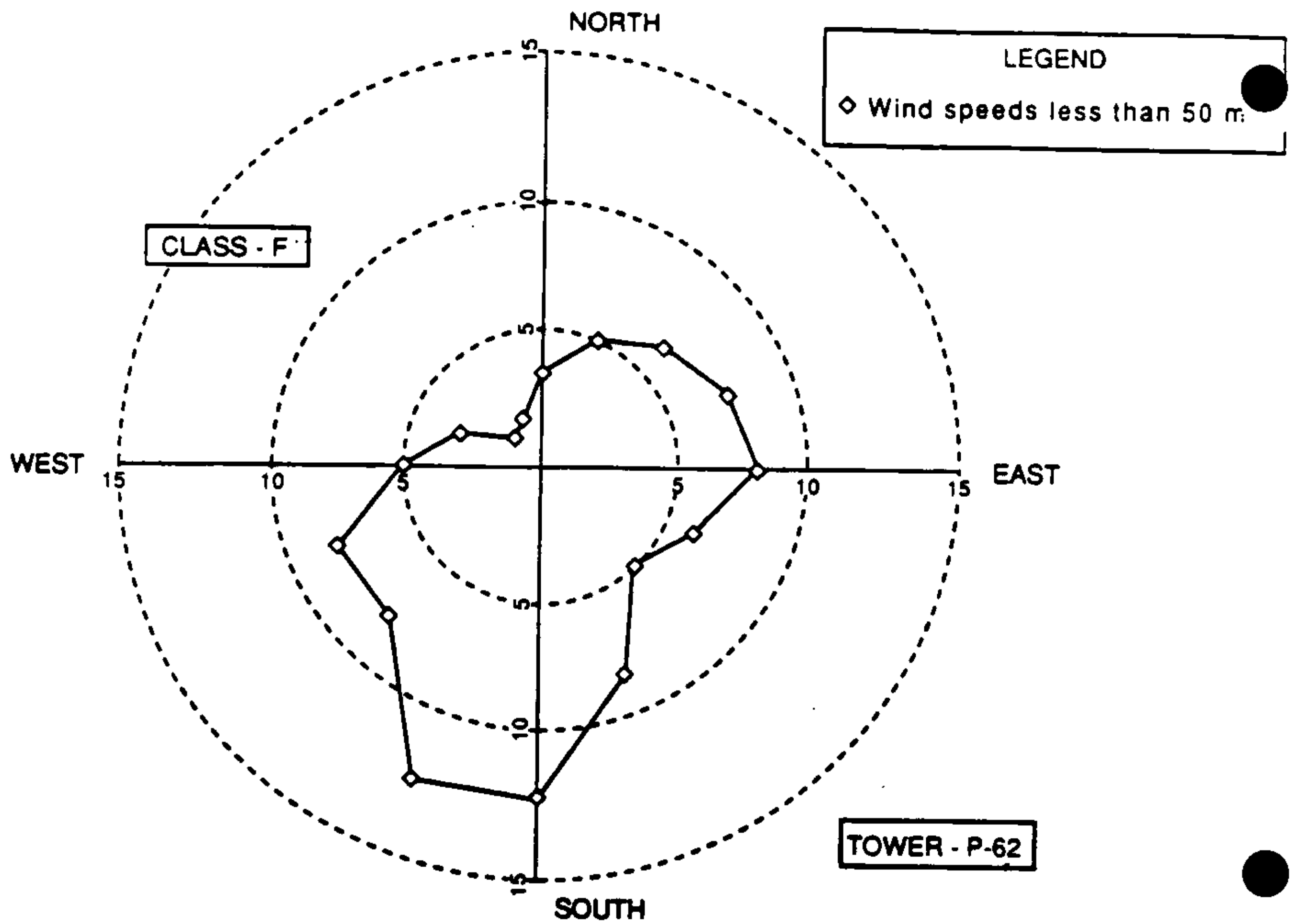


JOINT FREQUENCY DATA

	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND								PERCENT FREQUENCY SPEED IN METERS/SECOND						
DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	9	61	88	11	0	0	3.36	169	0.13	0.87	1.26	0.16	0.00	0.00	2.42
NNE	6	94	224	43	1	0	4.05	368	0.09	1.34	3.20	0.61	0.01	0.00	5.25
NE	7	113	330	65	0	0	4.41	515	0.10	1.61	4.71	0.93	0.00	0.00	7.35
ENE	6	209	330	17	0	0	3.97	562	0.09	2.99	4.71	0.24	0.00	0.00	8.03
E	9	194	213	8	0	0	3.78	424	0.13	2.77	3.04	0.11	0.00	0.00	6.05
ESE	6	145	171	3	0	0	3.69	325	0.09	2.07	2.44	0.04	0.00	0.00	4.64
SE	8	162	177	2	0	0	3.68	349	0.11	2.31	2.53	0.03	0.00	0.00	4.98
SSE	9	194	253	17	0	0	3.82	473	0.13	2.77	3.61	0.24	0.00	0.00	6.75
S	11	226	408	46	1	0	4.08	690	0.16	3.23	5.80	0.66	0.01	0.00	9.86
SSW	5	191	405	40	0	0	4.16	641	0.07	2.73	5.79	0.57	0.00	0.00	9.16
SW	4	161	335	43	0	0	4.24	543	0.06	2.30	4.79	0.61	0.00	0.00	7.76
WSW	8	111	290	45	0	0	4.26	454	0.11	1.59	4.14	0.64	0.00	0.00	6.48
W	5	140	372	84	0	0	4.50	601	0.07	2.00	5.32	1.20	0.00	0.00	8.59
WNW	6	96	299	49	0	0	4.39	450	0.09	1.37	4.27	0.70	0.00	0.00	6.43
NW	13	80	155	30	1	0	3.96	279	0.19	1.14	2.21	0.43	0.01	0.00	3.98
NNW	6	56	88	6	0	0	3.69	156	0.09	0.80	1.26	0.09	0.00	0.00	2.24
NO DIRECT	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVG SPEED	1.30	3.20	4.83	6.41	8.27	0.00	4.06								
TOT ENTRY	118	2233	4136	509	3	0		6999							

* DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-22. Annual Wind Rose for P-Area Meteorological Tower, 1982-1986, E Stability, Laurinat (1987)

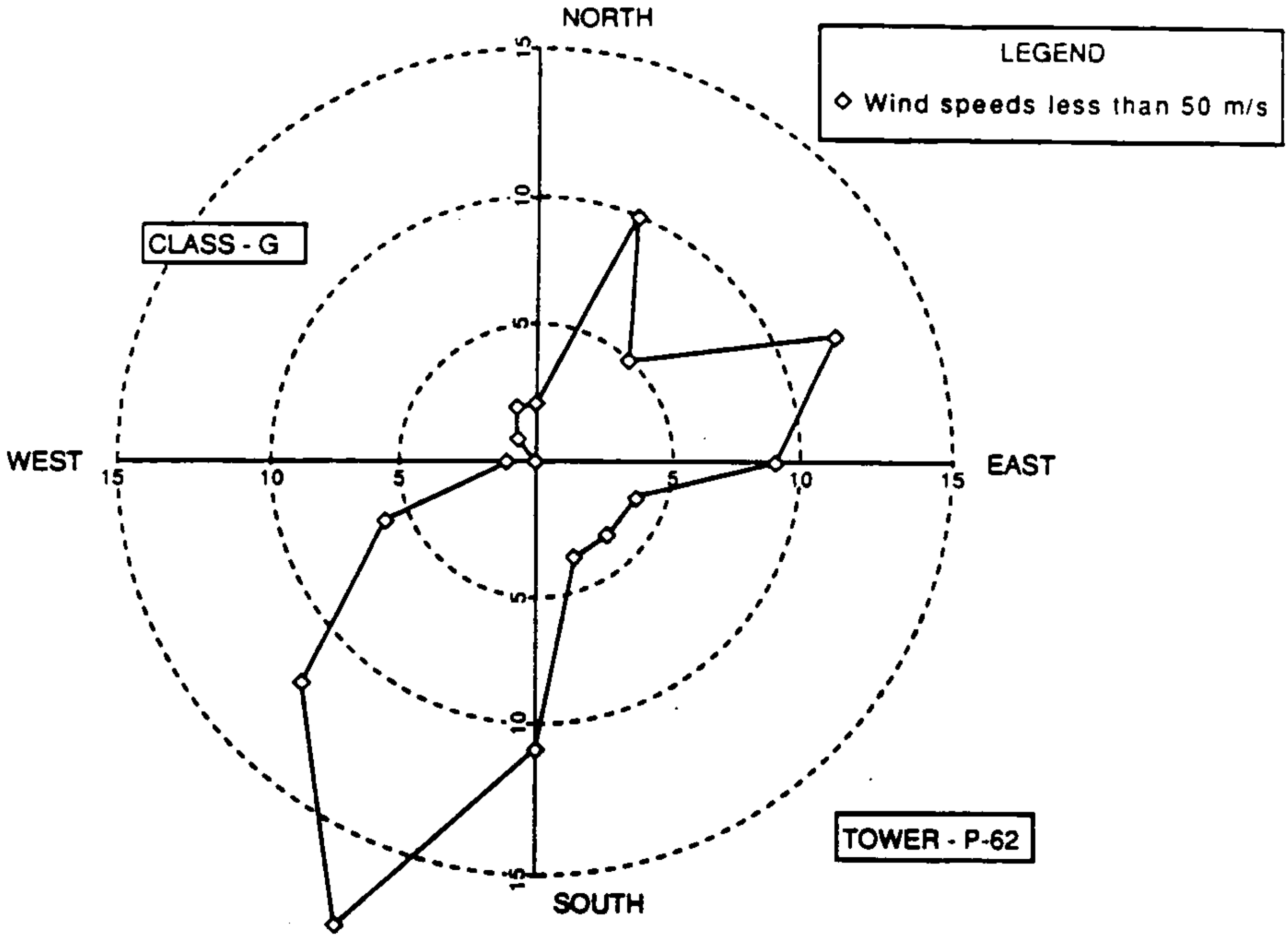


JOINT FREQUENCY DATA

DIRECTION*	OCCURRENCE FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	AVERAGE SPEED	TOTAL TOT	PERCENT FREQUENCY SPEED IN METERS/SECOND 0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	1	18	33	7	0	0	4.01	59	0.06	1.04	1.91	0.41	0.00	0.00	3.42
NNE	3	16	56	15	0	0	3.85	90	0.17	0.93	3.24	0.87	0.00	0.00	5.21
NE	1	22	74	11	0	0	4.23	108	0.06	1.27	4.28	0.64	0.00	0.00	6.25
ENE	0	20	95	9	0	0	4.63	124	0.00	1.16	5.50	0.52	0.00	0.00	7.18
E	0	36	90	8	0	0	4.32	134	0.00	2.08	5.21	0.46	0.00	0.00	7.75
ESE	2	36	60	6	0	0	3.97	104	0.12	2.08	3.47	0.35	0.00	0.00	6.02
SE	2	22	58	2	0	0	4.13	84	0.12	1.27	3.36	0.12	0.00	0.00	4.87
SSE	2	49	83	6	0	0	4.06	140	0.12	2.84	4.80	0.35	0.00	0.00	8.11
S	1	56	138	16	0	0	4.35	211	0.06	3.24	7.99	0.93	0.00	0.00	12.22
SSW	1	43	148	20	0	0	4.51	212	0.06	2.49	8.56	1.16	0.00	0.00	12.27
SW	0	28	81	23	1	0	4.73	133	0.00	1.62	4.69	1.33	0.06	0.00	7.70
WSW	2	20	91	22	0	0	4.61	135	0.12	1.16	5.27	1.27	0.00	0.00	7.82
W	1	18	49	15	0	0	4.50	83	0.06	1.04	2.84	0.87	0.00	0.00	4.81
WNW	1	13	35	6	0	0	4.37	55	0.06	0.75	2.03	0.35	0.00	0.00	3.19
NW	1	9	12	3	0	0	3.38	25	0.06	0.52	0.69	0.17	0.00	0.00	1.44
NNW	2	9	18	2	0	0	3.78	31	0.12	0.52	1.04	0.12	0.00	0.00	1.80
NO DIRECT	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVG SPEED	0.92	3.26	4.93	6.41	8.13	0.00	4.26								
TOT ENTRY	20	415	1121	171	1	0		1728							

*DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-23. Annual Wind Rose for P-Area Meteorological Tower, 1982-1987, F Stability, Laurinat (1987)



JOINT FREQUENCY DATA

	OCCURRENCE FREQUENCY								PERCENT FREQUENCY						
	SPEED IN METERS/SECOND						AVERAGE	TOTAL	SPEED IN METERS/SECOND						
DIRECTION*	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	SPEED	TOT	0 - 2	2 - 4	4 - 6	6 - 8	8 - 12	>12	TOTAL
N	0	1	1	0	0	0	4.35	2	0.00	0.98	0.98	0.00	0.00	0.00	1.96
NNE	0	1	6	3	0	0	5.21	10	0.00	0.98	5.88	2.94	0.00	0.00	9.80
NE	0	3	2	0	0	0	3.81	5	0.00	2.94	1.96	0.00	0.00	0.00	4.90
ENE	0	1	6	5	0	0	5.11	12	0.00	0.98	5.88	4.90	0.00	0.00	11.76
E	0	1	6	2	0	0	5.03	9	0.00	0.98	5.88	1.96	0.00	0.00	8.82
ESE	0	2	1	1	0	0	4.41	4	0.00	1.96	0.98	0.98	0.00	0.00	3.92
SE	0	0	4	0	0	0	5.49	4	0.00	0.00	3.92	0.00	0.00	0.00	3.92
SSE	0	2	2	0	0	0	4.12	4	0.00	1.96	1.96	0.00	0.00	0.00	3.92
S	0	3	7	1	0	0	4.54	11	0.00	2.94	6.86	0.98	0.00	0.00	10.78
SSW	0	3	14	2	0	0	4.82	19	0.00	2.94	13.73	1.96	0.00	0.00	18.63
SW	0	0	10	2	0	0	5.03	12	0.00	0.00	9.80	1.96	0.00	0.00	11.76
WSW	0	0	5	1	0	0	5.34	6	0.00	0.00	4.30	0.98	0.00	0.00	5.28
W	0	0	1	0	0	0	5.03	1	0.00	0.00	0.98	0.00	0.00	0.00	0.98
WNW	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW	0	0	1	0	0	0	4.99	1	0.00	0.00	0.98	0.00	0.00	0.00	0.98
NNW	0	0	2	0	0	0	5.32	2	0.00	0.00	1.96	0.00	0.00	0.00	1.96
NO DIRECT	0	0	0	0	0	0	0.00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AVG SPEED	0.00	3.52	5.00	6.41	0.00	0.00	4.84								
TOT ENTRY	0	17	68	17	0	0		102							

*DIRECTION FROM WHICH WIND BLOWS

FIGURE 1-24. Annual Wind Rose for P-Area Meteorological Tower, 1982-1986, G Stability, Laurinat (1987)

TABLE 1-21

Estimated Average Annual and Seasonal Mixing Heights for SRS

	Mixing Height (ft)	
	Morning	Afternoon
Winter	1150	3360
Spring	1230	5575
Summer	1310	5900
Fall	980	5000
Annual	1230	4750

Source: Holzworth (1972)

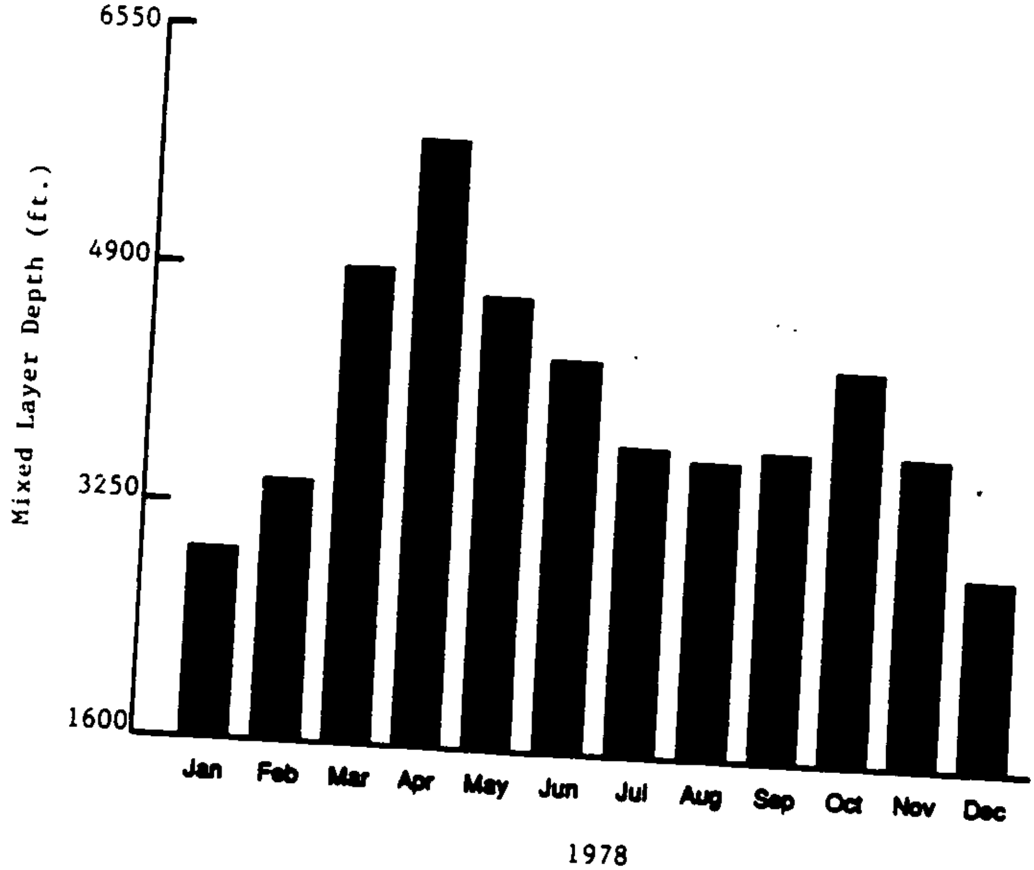


FIGURE 1-25. Estimated Monthly Average Mixing Heights at SRS, Garrett (1981)

The P-G classes are also defined by the NRC (1980) in terms of the change of temperature with height above ground. Using this classification method, the classes E, F, and G generally correspond to inversion conditions, i.e., an increase in temperature with height. Ground-based inversions generally occur on relatively cloud-free nights when the earth's surface cools more rapidly than the adjacent layer of atmosphere. Pendergast (1975) analyzed temperature data from multiple levels of the WJBF television tower for a one-year period. For approximately 30% of the time, an inversion extended through the entire 10 to 1,000-feet layer for which temperature measurements were made. For about 12% of the time, an inversion was observed through the upper portion of the 10 to 1,000-feet layer and unstable conditions were observed through the lower portion. For about 9% of the time, the ground-based inversion layer was less than the height of the tower. The latter two cases generally were found to represent the transition periods from night to day and from day to night, respectively.

Pendergast's results agree with inversion statistics given by Hosler (1961). Hosler's statistics, based on two years of NWS radiosonde and surface observations, show that ground-based inversions occurred in the SRS area approximately 40 percent of all hours and 70 percent of all nights annually.

1.4.3 Extreme Air Pollution Episodes

High air pollution potential in the southeastern U.S. is frequently associated with stagnating anticyclones (high pressure systems). According to routine rawinsonde (upper air) data summarized by Holzworth (1972), episodes of poor dispersion conditions in the SRS area lasted for two days on twelve occasions over a five-year period (1960-1964). Episodes lasting at least five days occurred on two occasions. An episode is defined by mixing heights less than 5,000 feet and average boundary layer wind speeds less than nine mph. Results of a study reported by Korshover (1975) indicate that an average of two air stagnation episodes occurred in the SRS area each year over the 40-year period from 1936-1975. The total number of stagnation days averaged about 10 per year. Korshover defined stagnation days as conditions characterized by limited dispersion lasting four days or more.

1.5 AMBIENT AIR QUALITY

Data used to characterize the ambient air quality of the SRS were collected from a network of five onsite air monitoring stations. Additional sources of air quality data in the Aiken-Augusta area include air monitoring stations operated by the States of South Carolina and Georgia.

1.5.1 Onsite Ambient Air Monitoring Program

The onsite ambient air quality monitoring program is conducted in a manner consistent with EPA guidance on air quality monitoring for Prevention of Significant Deterioration (PSD) permitting requirements (EPA, 1980) and (EPA, 1987). However, there is currently no regulatory requirement for conducting this program.

The air pollutants that are measured at each of the five stations are listed in Table 1-22. The analyzers and analysis methods used to measure ambient pollutant concentrations are identified in Table 1-23. The analyzers measuring sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3) concentrations operate continuously, using EPA designated reference or equivalent methods. Particulate measurements consist of a 24-hour continuous high volume sample taken every sixth day. Measurements of total suspended particulates (TSP) were taken through 1987; measurements for fine particulates, particulate matter less than 10 micron diameter (PM-10), began in 1988.

Locations of the monitoring sites are shown in Figure 1-26. Four of the five stations currently operating are located generally on an outer perimeter of the main area of SRS operations activity, near the four primary compass directions from the center of the site. These stations are located from 3 to 5 miles from the nearest operating facility. The fifth station, 40-G, is sited to monitor impacts specifically from the D-Area powerhouse facility. A sixth station, 37-G, was decommissioned in 1987.

The instrumentation is housed in a temperature controlled trailer. A Campbell Scientific data logger polls each continuous analyzer every five minutes and stores the data on cassette tape. Results of automatic daily zero and span checks for each analyzer are also recorded. The tapes are periodically collected, read, and the data are entered into a Digital Equipment Corporation Rainbow microcomputer for analyses and summarization. The data are also recorded on strip chart. Particulate samples, collected on tared filter paper, are taken to offsite laboratory facilities for weighing and data reduction.

A technician visits each monitoring site at least once every other work day to collect the data or samples and to perform routine maintenance activities. Full station calibrations are conducted at least monthly using National Bureau of Standards traceable calibration materials. Independent performance audits for each station are conducted quarterly. In addition, SRS participates in the EPA interlaboratory auditing program.

1.5.2 Air Quality

The SRS is located in the Augusta-Aiken Interstate Air Quality Control Region (AQCR) (EPA, 1988a). All counties within this region have been determined to be in attainment of the National Ambient Air Quality Standards (NAAQS) (EPA, 1988b). The NAAQS are listed in Table 1-24.

TABLE 1-22

Summary of Air Pollutant Measurements by Monitoring Site

Monitoring Site	Pollutants Monitored[a]
36-G[b]	SO_2, TSP, O_3, NO_2
37-G[c]	SO_2
38-G	TSP, NO_2
39-G	SO_2, TSP(2)[d], O_3, NO_2
40-G	SO_2, TSP, NO_2
41-G	TSP, NO_2

[a] PM-10 measured after 1987
[b] Monitoring discontinued in 1987, restarted in 1988
[c] Monitoring discontinued in 1987
[d] One primary, one co-located sampler

W8908052

TABLE 1-23

SRS Air Quality Monitoring Network Instrumentation

Measurement	Instrument	Sampling Method
SO_2	Monitor Labs Model 8850	Fluorescent (equivalent)
NO_2	Monitor Labs Model 8840	Chemiluminescence (reference)
O_3	Dasibi Model 1003-AH	UV Photometric (equivalent)
Particulates	General Metal Works Model 2310 (within 10 micron inlet)	High Volume (reference)
Flow control	Monitor Labs Model 8530	-

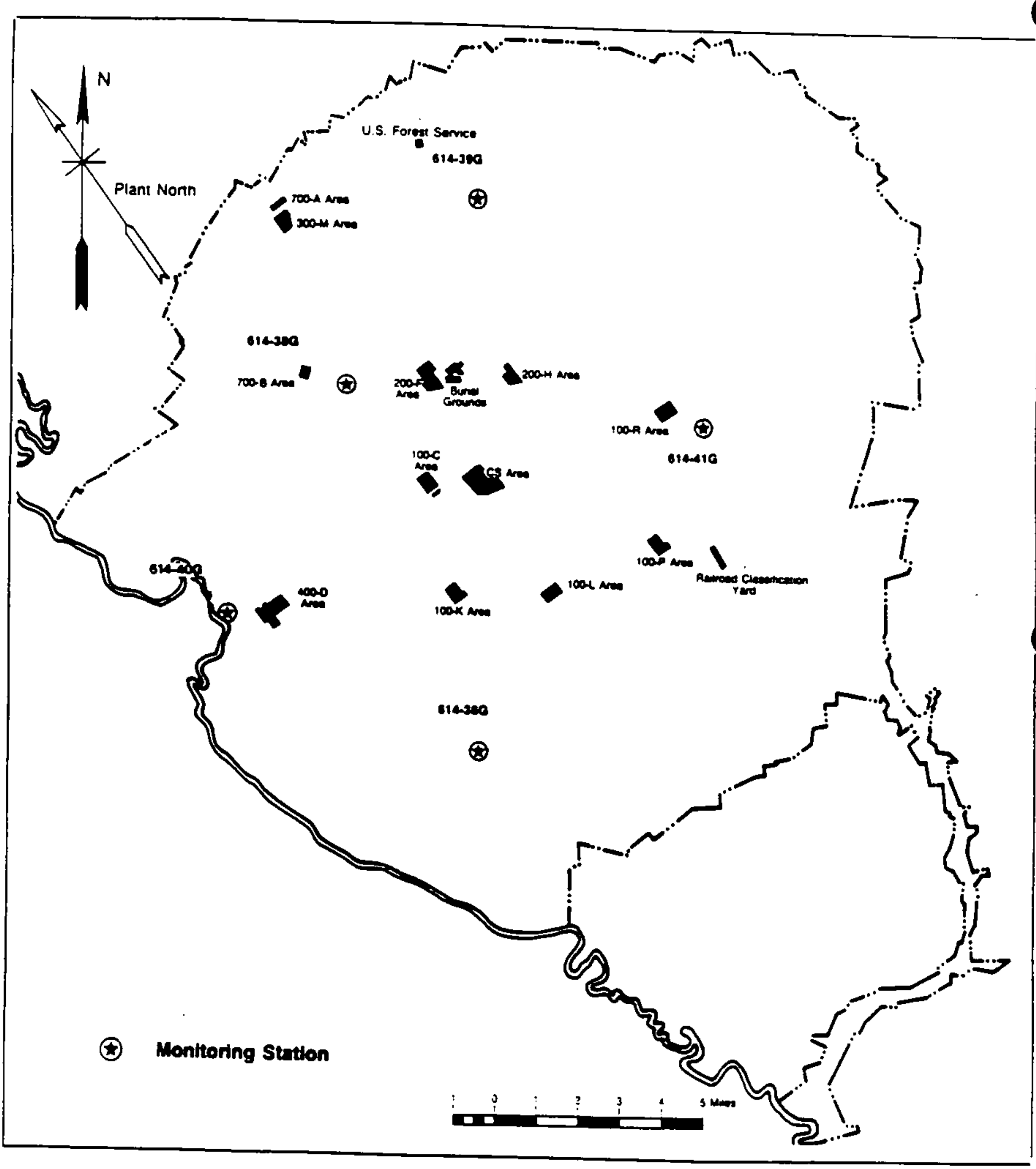


FIGURE 1-26. Ambient Air Quality Monitoring Locations on the SRS

TABLE 1-24

National Ambient Air Quality Standards

Pollutant	Primary ($\mu g/m^3$)	Secondary ($\mu g/m^3$)
Sulfur dioxide		
3 hr	-	1300[a]
24 hr	365	-
Annual	80	-
Total suspended particulates		
24 hr	260[a]	150[a]
Annual	75	60
Fine particulates[b]		
24 hr	150[a]	-
Annual	50	-
Ozone		
1 hr	235[c]	235[c]
Nitrogen dioxide		
Annual	100	100
Carbon monoxide		
1 hr	40,000[a]	-
8 hr	10,000[a]	-
Lead		
Quarterly	1.5	1.5

[a] Not to be exceeded more than once per year.
[b] Standard established in 1987.
[c] Not to be exceeded more than one day per year.

Source: 40 CFR 50, 1988

The primary standards were established to protect public health; the secondary standards were established to protect the public welfare from adverse effects. These standards have been adopted by South Carolina and Georgia.

Ambient concentration data collected from the onsite air monitoring network for each year from 1984 through 1987 are summarized in Tables 1-25 through 1-28. These are the most recent available data. No violations of the NAAQS were observed to have occurred during this four-year period. Observed ambient concentrations of SO_2, NO_2, and TSP, were generally less than 50% of either the primary or secondary ambient standard for all averaging periods.

The greatest short-term (3 and 24 hour) average concentrations of SO_2 were observed to occur at the two monitoring sites near the D-Area powerhouse. Source specific air quality impacts are not apparent for any other measured air pollutant. Although concentrations for all averaging times show some inter-annual variability, no long-term air quality trend is qualitatively apparent.

Offsite concentrations of TSP and lead, measured at monitoring stations operated by South Carolina and Georgia in the Aiken-Augusta AQCR are reported in Du Pont (1984-1987). These data show that offsite TSP concentrations are generally equal to or greater than TSP concentrations measured at SRS. Measured lead concentrations were more than 10 times less than the corresponding NAAQS.

TABLE 1-25

Summary of SRS Ambient Air Quality for 1984, Onsite Air Monitoring Network, Concentrations in $\mu g/m^3$

Pollutant	Interval	Standard	Station 36-G	37-G	38-G	39-G	40-G	41-G
SO_2	3 hr[a]	1300	79	458	-	52	193	-
	24 hr	365	26	118	-	26	29	-
	Annual[b]	80	5	16	-	5	5	-
TSP	24 hr[a]	150	104	-	65	57	63	60
	Annual[a,c]	60	33	-	30	28	32	30
O_3	1 hr	235	201	-		215	-	-
NO_2	Annual[b]	100	6	-	8	9	8	6

[a] Secondary standard
[b] Arithmetic mean
[c] Geometric mean

Source: Du Pont (1985)

TABLE 1-26

Summary of SRS Ambient Air Quality for 1985, Onsite Air Monitoring Network, Concentrations in µg/m³

Pollutant	Interval	Standard	Station 36-G	37-G	38-G	39-G	40-G	41-G
SO_2	3 hr[a]	1300	65	602	-	68	298	-
	24 hr	356	34	112	-	26	128	-
	Annual[b]	80	4	7	-	5	5	-
TSP	24 hr[a]	150	100	-	100	66	47	62
	Annual[a,c]	60	28	-	28	25	26	28
Ozone	1 hr	235	221	-	-	235	-	-
NO_2	Annual[a]	100	6	-	5	5	5	4

[a] Secondary standard
[b] Arithmetic mean
[c] Geometric mean

Source: Du Pont (1986)

TABLE 1-27

Summary of SRS Ambient Air Quality for 1986, Onsite Air Monitoring Network, Concentrations in μg/m^3

Pollutant	Interval	Standard	Station 36-G	37-G	38-G	39-G	40-G	41-G
SO_2	3 hr[a]	1300	71	138	-	99	160	-
	24 hr	365	26	42	-	34	39	-
	Annual[b]	80	4	6	-	5	7	-
TSP	24 hr[a]	150	86	-	98	148	114	89
	Annual[a,c]	60	31	-	31	30	35	30
O_3	1 hr	235	174	-	166	-	-	
NO_2	Annual[b]	100	9	-	12	8	8	5

a Secondary standard
b Arithmetic mean
c Geometric mean

Source: Du Pont (1987)

TABLE 1-28

Summary of SRS Ambient Air Quality for 1987, Onsite Air Monitoring Network, Concentrations in μg/m^3

Pollutant	Interval	Standard	Station 36-G	37-G	38-G	39-G	40-G	41-G
SO_2	3 hr[a]	1300	78	382	-	71	353	-
	24 hr	365	29	83	-	39	138	-
	Annual[b]	80	-	-	-	7	9	-
TSP	24 hr[a]	150	98	-	64	97	120	90
	Annual[a,c]	60	28	-	28	33	38	35
O_3	1 hr	235	159	-	-	196	-	-
NO_2	Annual[b]	100	-	-	8	3	8	3

[a] Secondary standard
[b] Arithmetic mean
[c] Geometric mean

Source: Du Pont (1988)

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2.0 HYDROLOGY

2.1 SURFACE WATER HYDROLOGY

2.1.1 Surface Water System

The Savannah River is the principal surface-water system near the Savannah River Site (SRS). The river adjoins the site along its southwestern boundary for a distance of about 32 km (20 miles) and is 225 river km (140 river miles) from the Atlantic Ocean (Figure 2-1).

A swamp lies in the floodplain along the Savannah River for a distance of about 26 km (16 miles) of the total distance of 32 km. The average width of the swamp is 2.4 km or about 1.5 miles. A small embankment or natural levee has built up along the north side of the river from sediments deposited during periods of flooding. The top of the natural levee is about 1 to 2 meters above the river during normal flow (river stage 26 meters or 86 feet at the SRS boat dock). In the swampy part of the floodplain, large stands of cypress-tupelo and bottomland hardwoods can be found.

Six tributaries to the Savannah River are located on the SRS: Upper Three Runs Creek, Beaver Dam Creek, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek (Figure 2-2). Each of the creeks originates on the Aiken Plateau and descends 15 to 61 m before discharging in the Savannah River.

2.1.1.1 Data Source

The flow data used for computing statistics for the Savannah River and Savannah River Site streams were obtained from U.S. Geological Survey stream measurement data. The data set consisted of daily average flows with varying periods of record (from 2 to 81 years) for SRS streams and the Savannah River.

Several flow statistics were derived from this data set over the period of record: daily minimums, maximums, and means; average flow; 7-day low flow and the 7Q10 flow. The location of the measurements is shown in Figure 2-2. Emphasis was placed on low flow statistics, because disposal of wastes and maintenance of conditions for aquatic life are usually based on some type of low flow statistic. The 7-day low flow is widely used and is less likely to be influenced by minor disturbances upstream than is the minimum daily flow (Riggs, 1985). The 7Q10 or the 7-day low flow with a 10-year recurrence interval is a measure of the dependability of flow. The 7Q10 is derived from the frequency curve of the yearly 7-day low flow statistics over the period of record at that stream/river location. The Log Pearson Type III distribution statistics are normally used for computation of low flows in natural streams. Other distributions may be more appropriate in streams that are not naturally driven (such as those where cooling water may be the dominant component of flow).

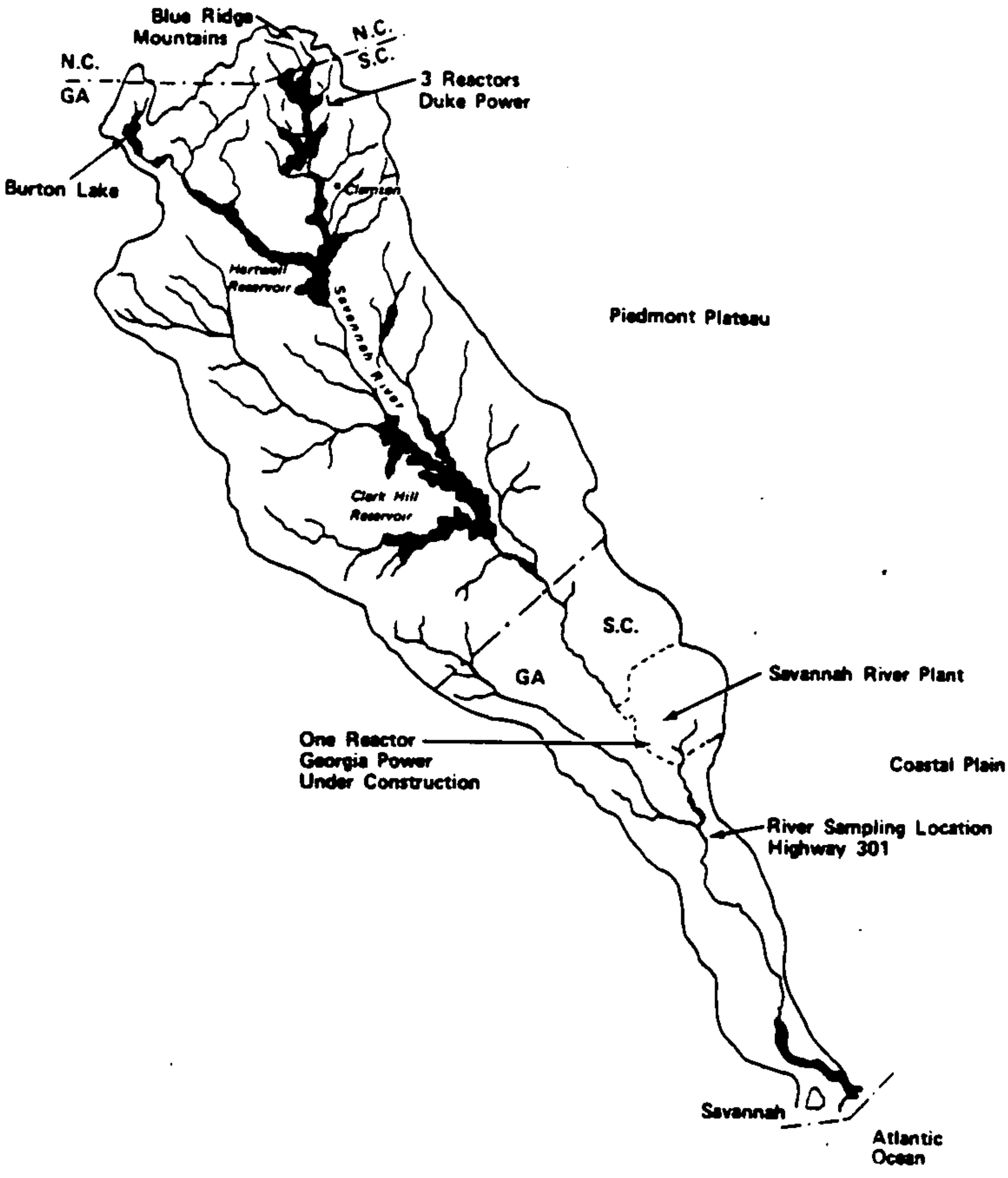

FIGURE 2-1. Savannah River System

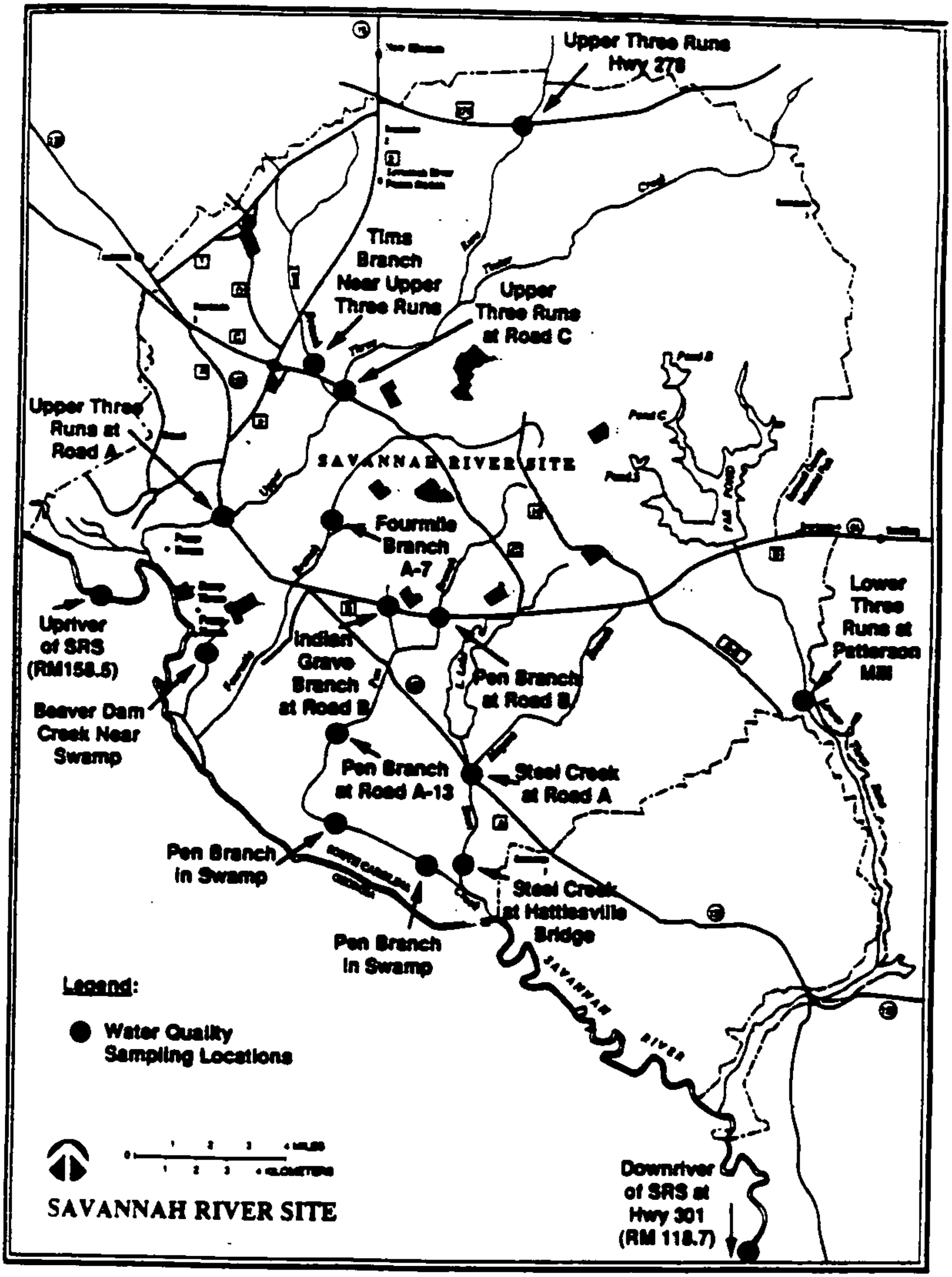

FIGURE 2-2. Surface Water Features at the Savannah River Site

The Log Pearson Type III distribution was applied to all SRS stream locations where a 7Q10 was computed (a program equivalent to the USGS A193 for computing Log Pearson Type III distributions was used). The climatic year, April 1 to March 31, is used for calculation of low flow statistics. In the U.S., this period will contain the low flow period for each year. The flow statistics are summarized in Table 2-1 (average flow, standard deviation, 7Q10, and 7-day low flow) and daily means, maximums, and minimums are shown in Figures 2-4 through 2-7 and Figures 2-9 through 2-18.

2.1.1.2 Savannah River

2.1.1.2.1 Physiography

The Savannah River drainage basin has a total area of 27,388 km^2 and forms the boundary between the States of Georgia and South Carolina. The total drainage area of the river encompasses all or part of 41 counties in Georgia, South Carolina, and North Carolina (Figure 2-1). The Savannah River Basin is located in three physiographic regions of provinces: the Mountain, the Piedmont, and the Coastal Plain (Figure 2-1).

The Mountain Province contains most of the major tributaries of the Savannah River, including the Seneca, Tugaloo, and Chattooga Rivers. The region is characterized by a relatively steep gradient, ranging in elevation from about 1676 to 305 m, and includes 5235 km^2 (19%) of the total drainage basin. The Mountain Province lies in the Blue Ridge Mountains, and has a bedrock composed of gneisses, granites, schists, and quartzites; the subsoil is composed of brown and red sandy clays. In this region the Savannah River and its tributaries have the character of mountain streams, with shallow riffles, clear creeks, and a fairly steep gradient. The streambed is mainly sand and rubble.

The Piedmont Region has an intermediate gradient, with elevations ranging from 305 to 61 m. This region includes 13,548 km^2 (50%) of the total drainage basin. Soils in the Piedmont are primarily red, sandy, or silty clays, with weathered bedrock consisting of ancient sediments containing granitic intrusions. The Piedmont is bordered by the Fall Line, an area where the sandy soils of the Coastal Plain meet the rocky terrain of the Piedmont foothills. The city of Augusta, GA, is located near this line. The Savannah River picks up the majority of its silt load in the Piedmont Region and most of this silt load is deposited in the large reservoirs located in the Piedmont Region.

The Coastal Plain has a negligible gradient ranging from an elevation of 61 m to sea level. The soils of this region are primarily stratified sand, silts, and clays. The Coastal Plain contains 8631 km^2 (31%) of the total Savannah River drainage area (27,388 km^2), and includes the city of Savannah, Georgia. In the Coastal Plain, the Savannah River is slow moving. Tidal effects may be observed up to 64 km (40 miles) upriver, and a salt front extends upstream along the bottom of the riverbed for about 32 km (20 miles).

TABLE 2-1

Flow Summary for the Savannah River and Savannah River Site Streams*

	Mean ft³/sec	Std Dev ft³/sec	7Q10 ft³/sec	7-Day Low Flow ft³/sec
Savannah River				
at Augusta, GA	9556	2611	4534	3745
SRS Boat Dock	-	-	4717	3773
Hwy 301[b]	10352	2830	5101	4808
Clyo	12008	3687	5457	4765
Upper Three Runs				
at Hwy 278	106	8	58.7	45.0
SRS Road C	203	30	116	117
SRS Road A	252	41	128	124
Beaver Dam Creek				
at 400 D	86.7	8.7	31.0	16.3
Four Mile Creek				
at SRS Site 7	17.7	5.4	5.8	5.5
Pen Branch				
at Road B	8.1	8.2	(3)	1.4
at SRS Road A-13	339	45	40.4	40.3
Steel Creek				
at Hattiesville Bridge	53.8	12.3	14.8	14.0
Lower Three Runs				
Below Par Pond	31.0	10.4	1.4	1.1
Near Snelling, SC	85.3	27.9	15.0	15.1

* Period of Record is given in Appendix A
[a] Gauge not rated for flow above 22,000 ft/sec
[b] Eleven (11) years missing between 1971 and 1982
[c] Period of Record not long enough to make calculation

Dredging operations on the Savannah River have been conducted by the U.S. Corps of Engineers between the cities of Savannah and Augusta, GA. This program, initiated in October 1958, was designed to dredge and maintain a 2.7 m nagivation channel. A total of 61 sets of pile dikes were placed to constrict the river flow, thereby increasing flow velocities, and a total of 11,477 linear meters of wood and stone revetment was laid to reduce erosion on banks opposite from the dikes. In addition, the channel was dredged, and 31 cutoffs were made, reducing the total river distance from Augusta to Savannah by about 24.1 km. The project was completed in July 1965; periodic dredging was continued to maintain the channel until 1985.

Three significant breaches in the natural river levee occur in the swampy part of the floodplain along the river boundary of SRS. The breaches are at the mouth of Beaver Dam, Four Mile, and Steel Creeks. River water overflows the levee and the creek mouths and fills the swamp at river stages greater than 27 m (91 ft). During swamp flooding, the water from the creeks flows through the swamp parallel to the main channel flow until it mixes with the main river flow at Little Hell Landing.

2.1.1.2.2 Flows

The SRS is located in the Coastal Plain Province of the Savannah River, about 32 km downstream of Augusta, Georgia (Figure 2-1). Construction of upriver reservoirs (J. Strom Thurmond (formerly Clarks Hill), Richard B. Russell, Hartwell, Keowee, and Jocassee), and the New Savannah River Bluff Lock and Dam have reduced the variability of the river flow (Figure 2-3). Low flows in the Savannah River typically occur during the autumn months while higher flows occur in late winter and early spring.

Upstream of SRS at Augusta, GA, the average flow for the 81-year period of record is 283.9 cubic meters/sec (10,025 cfs). The average flow at Augusta, GA since the filling of Thurmond Lake (Clarks Hill) has been 271 m^3/sec (9556 ft^3/sec) (Table 2-1, Figure 2-4). Flows increase below Augusta, GA to about 340 m^3/sec (12,000 ft^3/sec) near Clyo, GA, about 100 miles downriver (Table 2-1). The 7Q10 flow at Augusta, GA is 106 m^3/sec (3745 ft^3/sec). Daily minimum, mean, and maximum flows for the Savannah River are summarized in Figures 2-4, 2-5, 2-6, and 2-7, and in Appendix E.

The peak historic flood for the 81-year period of record was 9910 m^3/sec (350,000 ft^3/sec) in 1929 (Bennett et al., 1989). Since the construction of the upstream reservoirs, the maximum average monthly flow has been 1242 m^3/sec (43,800 ft^3/sec) for the month of April (1964-1981; DOE, 1984).

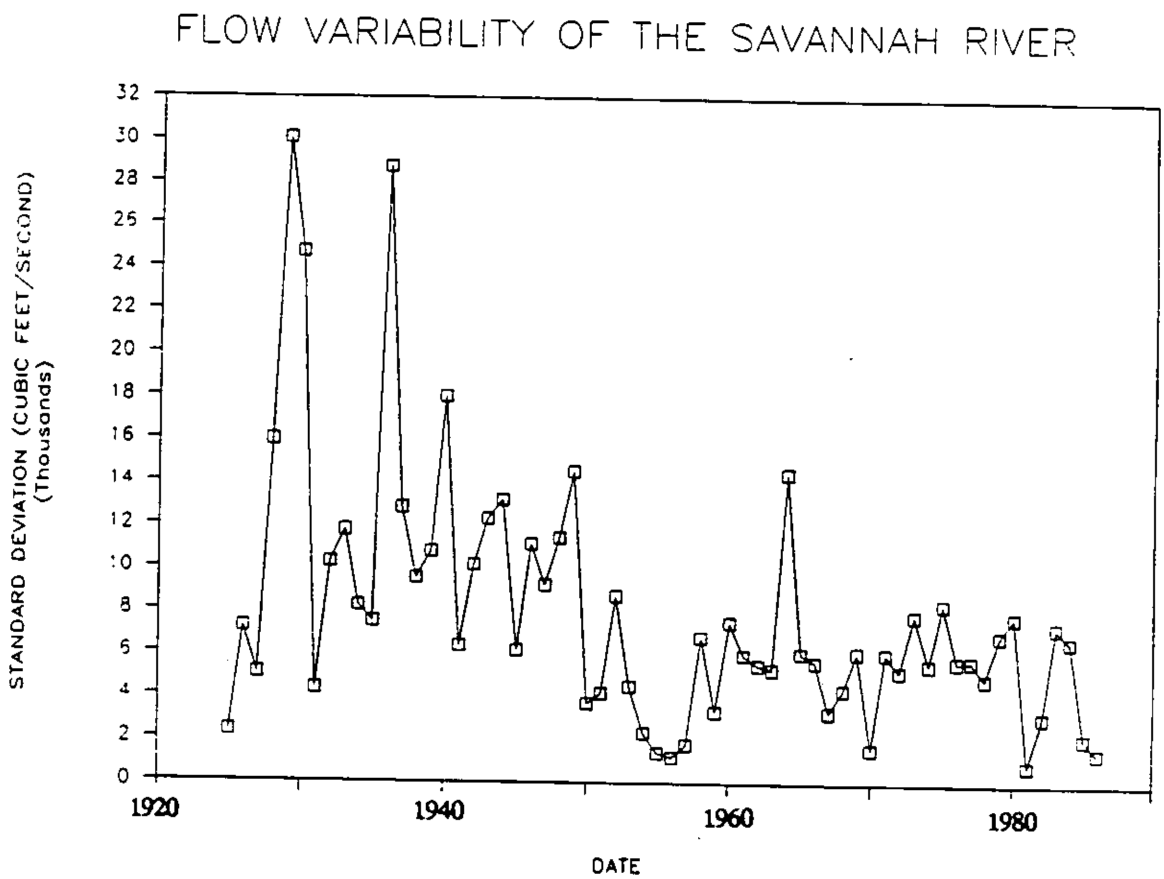

FIGURE 2-3. Flow Variability of the Savannah River

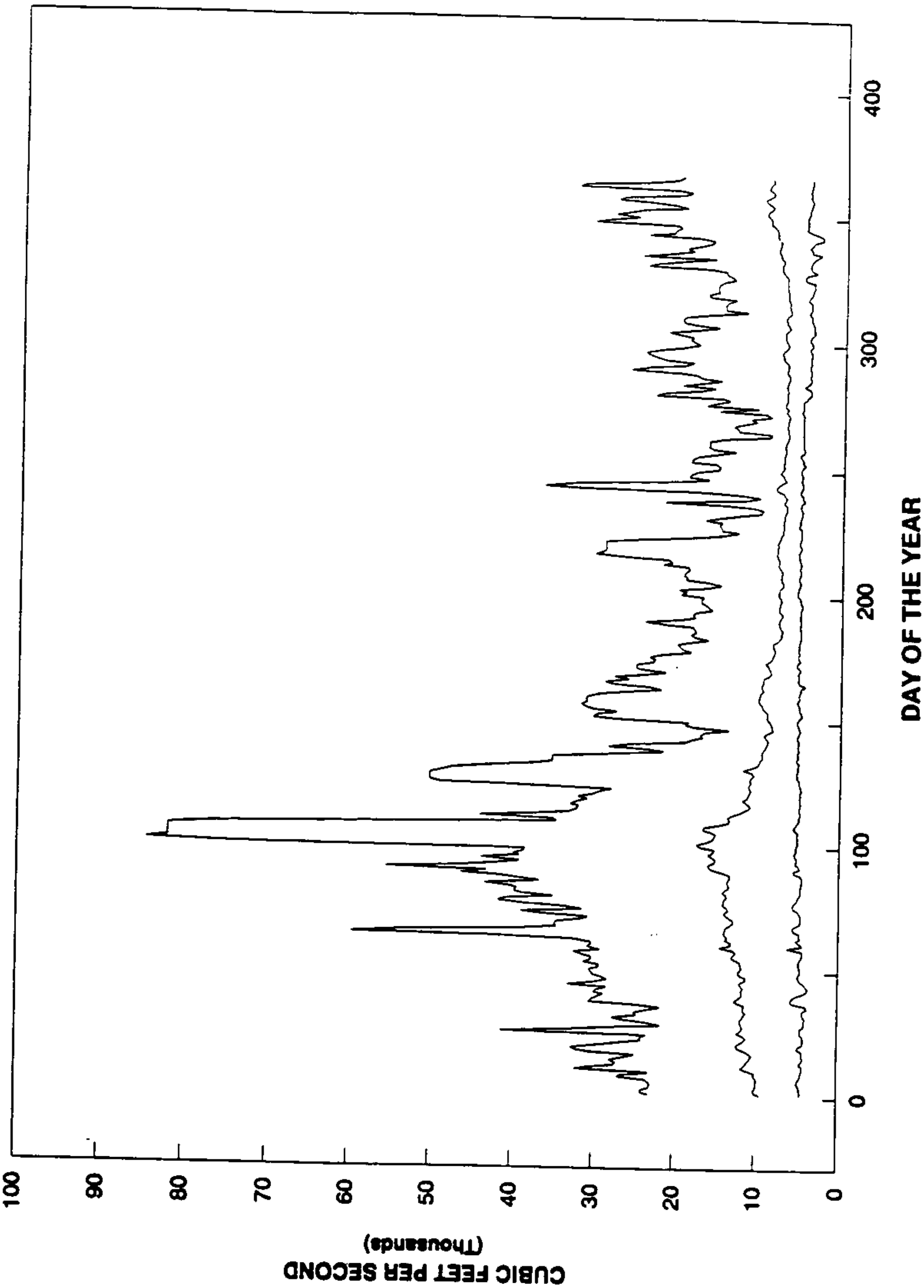

FIGURE 2-4. Maximum, Mean, and Minimum Daily Flow in Savannah River at Augusta, GA (Period of Record 1954-1987)

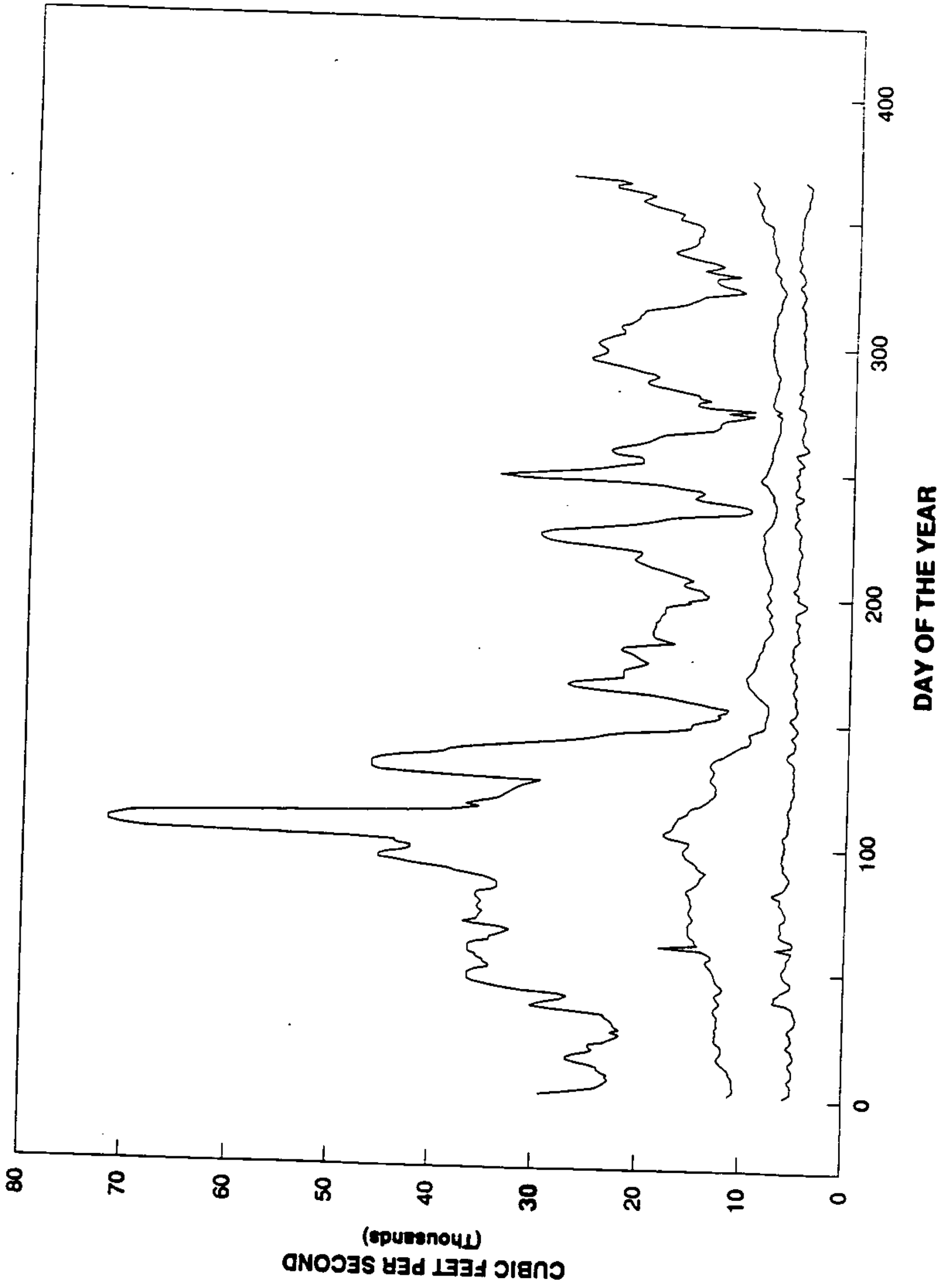

FIGURE 2-5. Maximum, Mean, and Minimum Daily Flow in the Savannah River at Highway 301 (Period of Record 1954-1970; 1982-1986)

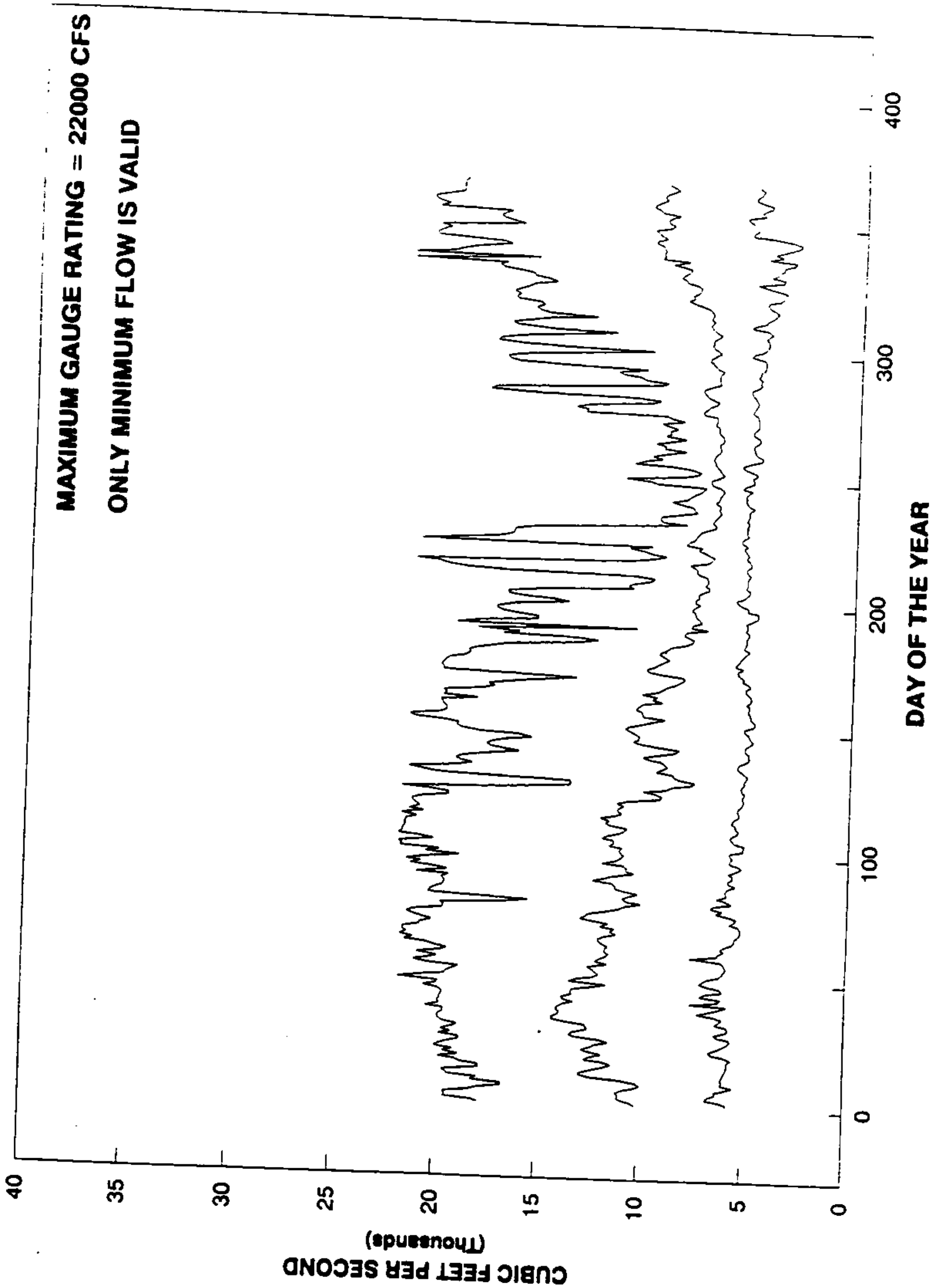

FIGURE 2-6. Maximum, Minimum, and Mean Daily Flow in the Savannah River at SRS (Period of Record 1972-1986)

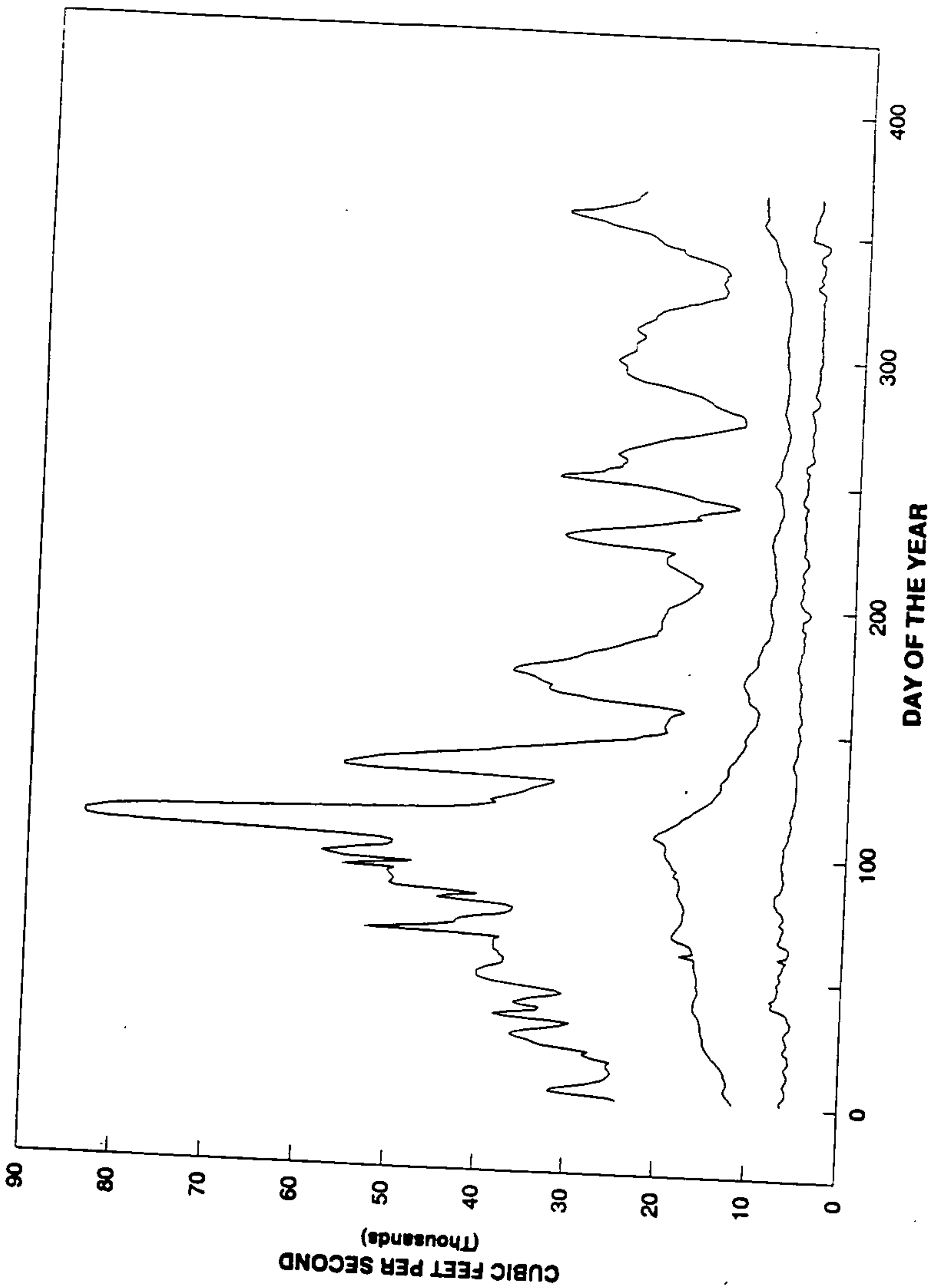

FIGURE 2-7. Maximum, Mean, and Minimum Daily Flow in the Savannah River Near Clyo, GA (Period of Record 1954-1987)

2.1.1.2.3 Droughts

Since the mid-1950's, three severe droughts (1954-1956; 1980-1981; 1985 to present) have occurred in the southeastern United States (SAIC, 1989). Before the 1980's, the record event for the Savannah River Basin occurred from 1954 to 1956. However, during this decade extremely dry conditions have prevailed. The drought period of 1980-1981 was intense but of relatively short duration. The current drought, which began in 1985, is considered the worst on record; inflows to the Savannah River during this period are the lowest recorded during this century (COE, 1988).

Average river flows recorded at Augusta during 1981 and 1982 were markedly lower than the historical mean; the mean value for 1981 (197 m^3/sec) was, at that time, the lowest since the very dry year of 1955 (193 m^3/sec; SAIC, 1989). During Water Years (October 1 through September 30) 1984 through 1988, mean annual river discharges at Augusta were 182, 176, 222, and 151 m^3/sec (range: 107-759 m^3/sec), respectively (Bennett et al., 1986, 1987, 1988; SAIC, 1989).

Since 1963, the U.S. Army Corps of Engineers has attempted to maintain a minimum of 178.4 m^3/sec (630 ft^3/sec) below the New Savannah River Bluff Lock and Dam at Butler Creek (River Mile 187.4 near Augusta, GA; COE, 1981). During the 18-year period from 1964 to 1981 (climatic years ending March 31), the average of the 7-day low flow for each year measured at the New Savannah River Bluff Lock and Dam was 181 m^3/sec (Watts, 1982), or about 2.3 m^3/sec (86 ft^3/sec) less than at the SRS (Ellenton Landing, River Mile 156.8).

During the current drought, the U.S. Army Corps of Engineers has maintained minimum water releases from the Thurmond Dam based on requirements of downstream users, primarily the Savannah River Site (SAIC, 1989). Low flow tests conducted during 1980 and 1981 established minimum flow requirements of 138 and 117 m^3/sec (4873 and 4130 ft^3/sec) at the SRS to ensure three- and two-reactor operation, respectively. Maintaining these flows requires a discharge of 102 m^3/sec (13,600 ft^3/sec). Maintaining water quality and managing fish and wildlife resources downstream required that flows at Augusta be kept close to this value during October and November 1986 and less during the spring, summer, and fall of 1988 (SAIC, 1989).

Beginning in 1986, the Corps of Engineers began developing a strategy and plans to address the worsening water shortage conditions in the Savannah River Basin; this effort has resulted in the Savannah River Basin Drought Contingency Plan (COE, 1989). One of the primary objectives of the plan is to operate Thurmond Dam at water release levels sufficient to maintain flows of no less than 102 m^3/sec (3600 ft^3/sec) to meet downstream water requirements. This plan would maintain river flows required for the maintenance of downstream water quality and for the management of fish and wildlife resources as long as possible without jeopardizing water supplies. The plan utilizes "lake level" as a water shortage indicator and a triggering mechanism to initiate reservoir management action to avert a water supply crisis. Figure 2-8 indicates the action levels (in meters above mean sea level) for Thurmond Reservoir of at least 127 m^3/sec (4485 ft^3/sec) (COE, 1988).

2.1.1.3 SRS Streams and Swamp

2.1.1.3.1 Tributaries to the Savannah River on the SRS Site

Six principal tributaries to the Savannah River are located on the SRS: Upper Three Runs Creek, Beaver Dam Creek, Four Mile Creek, Pen Branch, Steel Creek, and Lower Three Runs Creek (Figure 2-2).

Each of these onsite streams originates on the Aiken Plateau in the Coastal Plain and descend 15 to 61 m before discharging into the Savannah River. On the plateau, the streams are clear except during periods of heavy rain which cause high water. Most of the rainfall soaks into the ground, and seepage from the sandy soil furnishes the streams with a rather constant supply of water throughout the year.

Five of these onsite streams have received thermal discharges from cooling water operations. These discharges of thermal effluents, ranging from about 3 to 20 times the natural stream flows, have caused the streams to overflow their original banks. These higher flows have caused erosion of the original floodplain resulting in wider and deeper streams and a change from channel flow to braided flow in the lower stream reaches. These changes are most evident in streams that have received cooling water discharges from SRS reactors.

2.1.1.3.2 Upper Three Runs Creek

Upper Three Runs Creek, the longest of the plant streams, drains an area of over 500 square kilometers and differs from the other five onsite streams in two respects: it is the only stream, with headwaters arising outside the plant site; and it is the only stream that has never received heated discharges of cooling water from the production reactors. Its two significant tributaries are Tinker Creek, the largest, and Tims Branch. Tims Branch receives industrial wastes from the fuel fabrication facilities (M Area), the Savannah River Laboratory, and a small coal-fired plant.

Upper Three Runs Creek was designated as a National Hydrologic Benchmark Stream by the United States Geological Survey (USGS) in 1966 and a recording station was established where U.S. Route 278 crosses the stream (near the northeast corner of the SRS). In benchmark streams, the water quality, temperature, and flow are measured monthly to provide hydrologic data for a river stream basin that is likely to be governed solely by natural conditions. Extensive flow measurements continue to be made on this high quality blackwater stream. Flow rates are also measured downstream of the Route 278 site at SRS Road C, and SRS Road A. Average daily flows were calculated to be 2.89, 5.75, and 7.11 m^3/sec (102, 203, and 251 ft^3/sec), respectively. The minimum daily flow rates recorded at these sites during this period were 1.27, 3.31, and 3.51 m^3/sec (45, 117, and 124 ft^3/sec), respectively). The maximum daily flow rates, means, and mimimums are shown in Figures 2-9, 2-10, and 2-11.

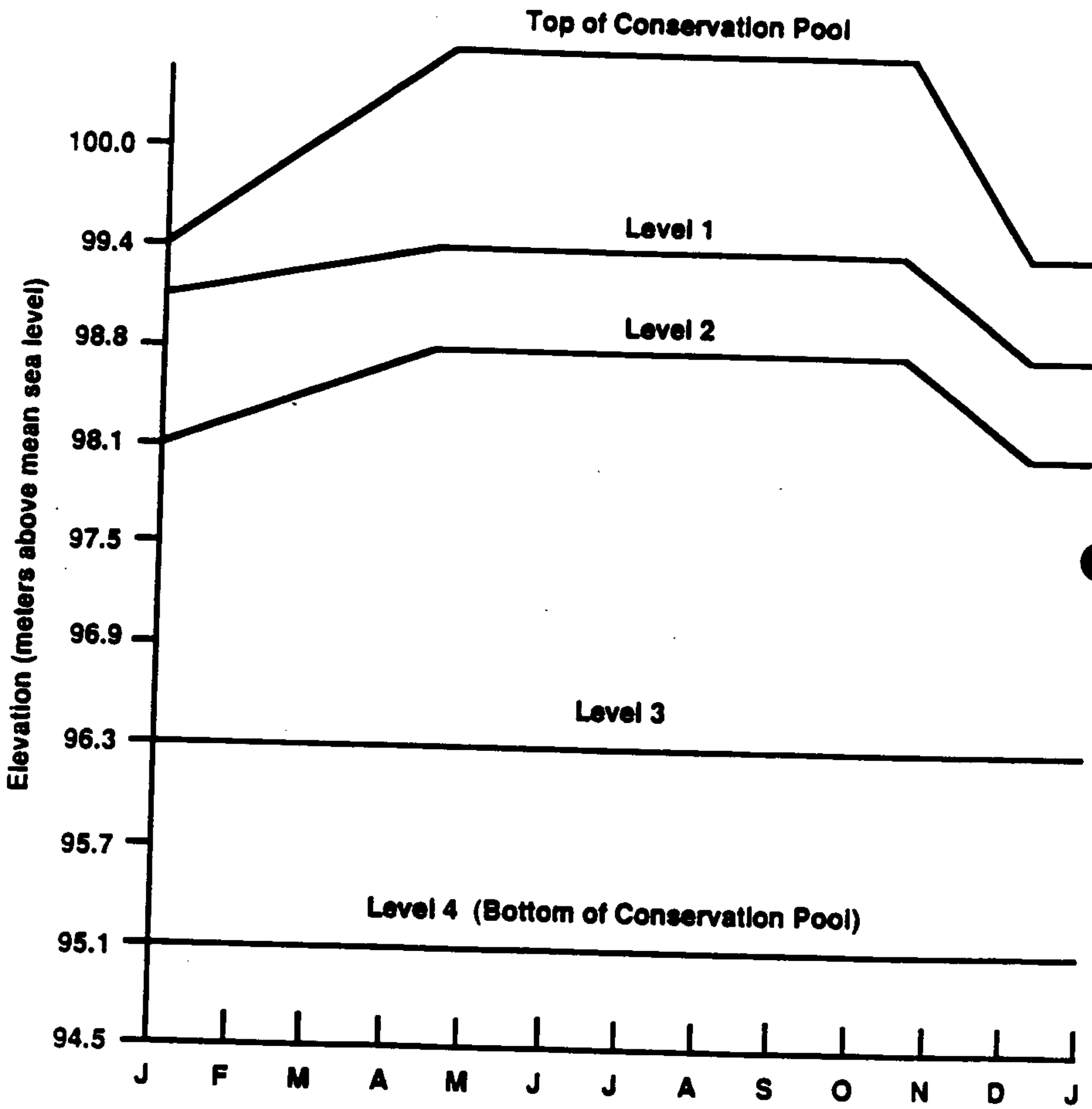

FIGURE 2-8. Thurmond Reservoir Action Levels

2.1.1.3.3 Beaver Dam Creek

Beaver Dam Creek is believed to have been an intermittent flowing stream prior to SRS operation (Jacobsen, 1972). The stream is located 1.6 to 3.2 km west of Four Mile Creek and flows in a southwestern direction from the 400-D Area through the swamp to the Savannah River. Beaver Dam Creek received effluent from both the heavy water production plant and the coal-fired generating station until 1982. The heavy water production plant, which supplies D-Area steam and a large fraction of SRS-generated electrical power, was placed on standby in 1982. Currently, Beaver Dam Creek receives condenser cooling water from the coal-fired powerhouse, neutralization wastewater, sanitary wastewater, ash basin effluent waters, and various laboratory wastewaters.

Since June 1974, a flow recorder located 1.6 km downstream from 400-D Area in Beaver Dam Creek (Figure 2-2) has recorded a mean discharge of 2.4 m^3/sec (85 ft^3/sec) and the range of daily flows are shown in Figure 2-12.

2.1.1.3.4 Four Mile Creek

Four Mile Creek follows a generally southwesterly path to the Savannah River for a distance of about 24 km. In the swamp along the river, part of Four Mile Creek flows into Beaver Dam Creek during reactor operations. Most of the Four Mile Creek flow discharges through an opening in the natural levee between the swamp and river, seeps through the levee into the river, or flows down the swamp and mixes with the flows from Steel Creek and Pen Branch (Figure 2-2). Four Mile Creek and Beaver Dam Creek together drain about 90 square kilometers and receive discharges from five plant areas. From the Separations Areas, the upper reach of Four Mile Creek receives powerhouse wastewater, cooling water, steam condensate, and sanitary treatment plant wastewater discharges. Reactor cooling water from C Area is discharged to Four Mile Creek. Small quantities of ambient-temperature cooling water and automotive shop effluents are also discharged to Four Mile Creek from the Central Shops Area.

The average flow upstream of any plant discharge is about 0.14 m^3/sec (5 ft^3/sec) and is increased by 200-F, 200-H, and Central Shops effluents and drainage to about 18 ft^3/sec just upstream from the confluence with the C-Reactor discharges (Table 2-1 and Figure 2-13). After the junction with the C-Reactor cooling water, the creek flows about 11 km before entering the river swamp. Upon reaching the river swamp, part of the Four Mile Creek flow joins effluents from the 400-D Area power operating plant and additional 400-D Area facilities in Beaver Dam Creek about 1/4 mile from the Savannah River. The 7Q10 for Four Mile Creek above the confluence with C-Reactor discharge is 0.16 m3/sec (5.8 ft3/sec)(Table 2-1).

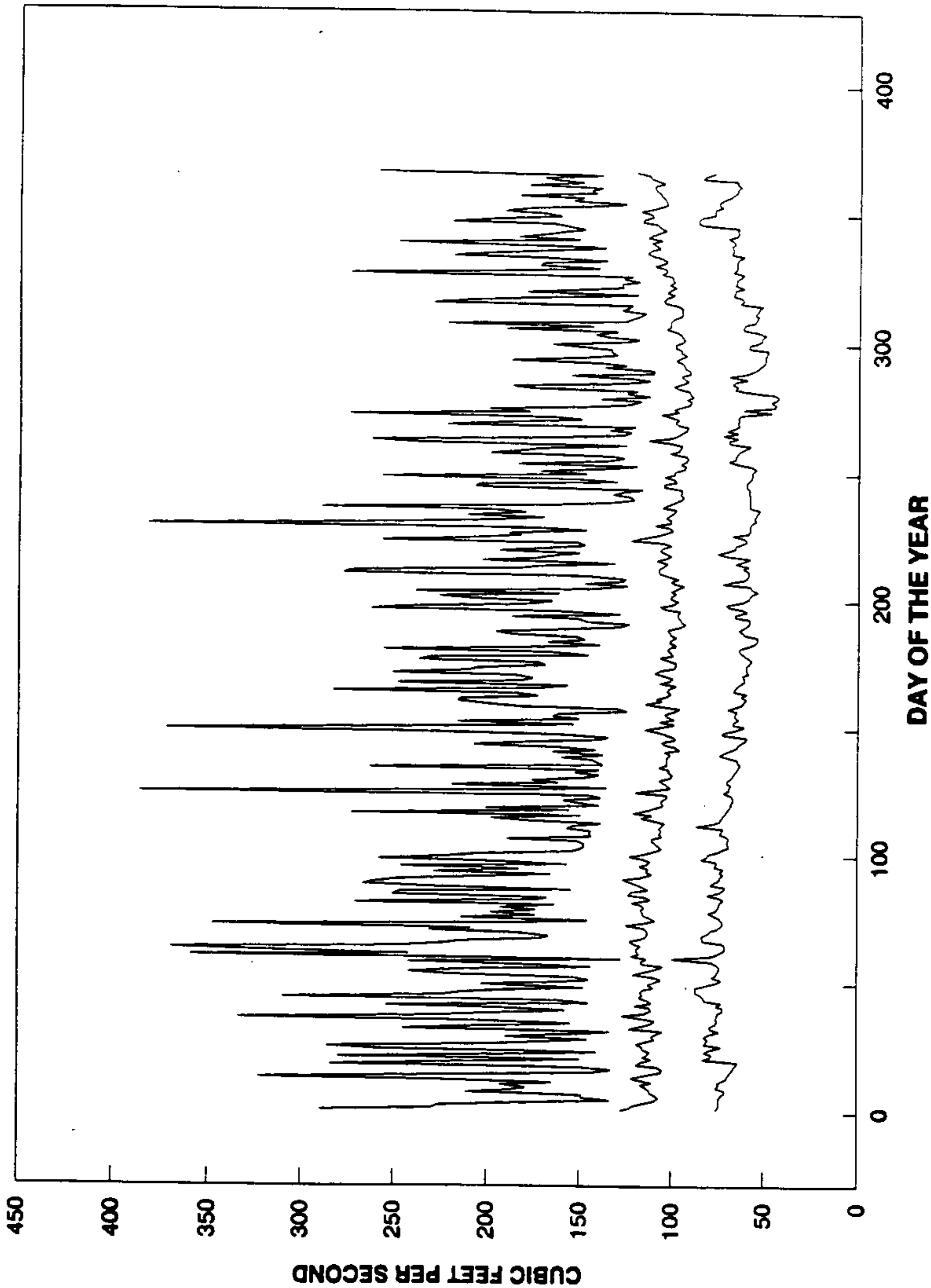

FIGURE 2-9. Maximum, Mean, and Mean Daily Flow in Upper Three Runs Creek at Highway 278 (Period of Record 1966-1987)

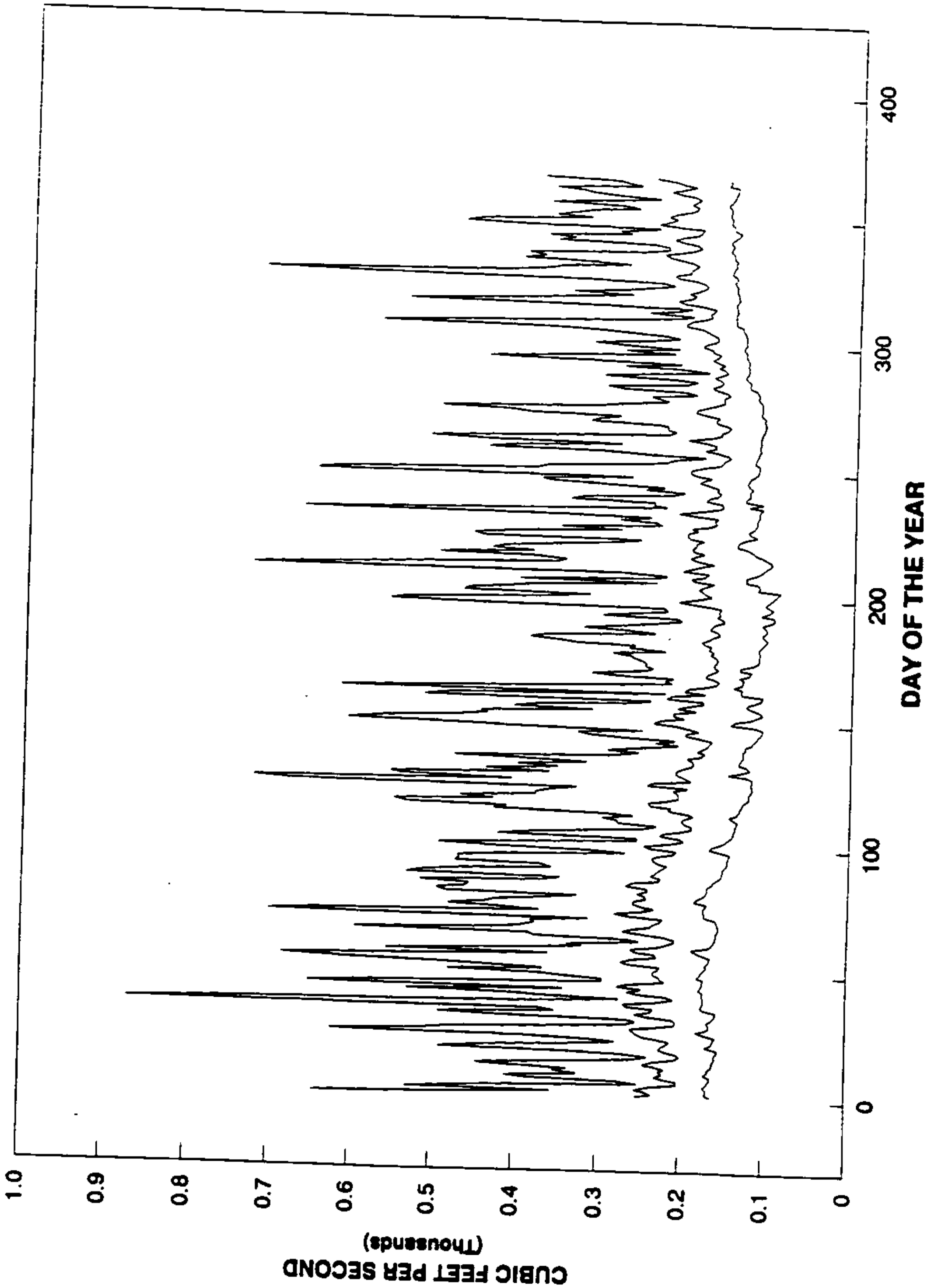

FIGURE 2-10. Maximum, Mean, and Minimum Daily Flow in Upper Three Runs Creek at SRS Road C (Period of Record 1974-1986)

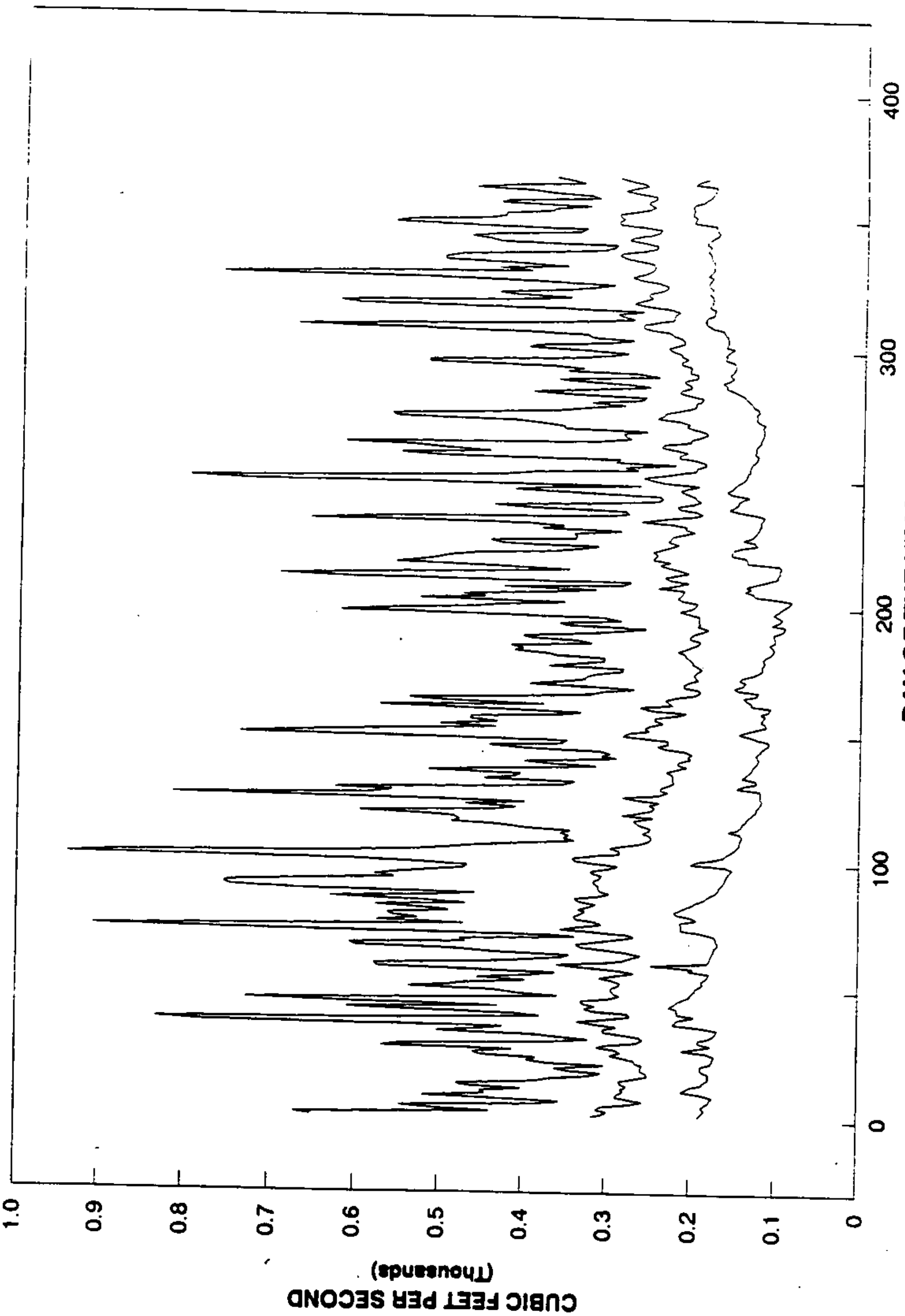

FIGURE 2-11. Maximum, Mean, and Minimum Daily Flow in Upper Three Runs Creek at SRS Road A (Period of Record 1974-1986)

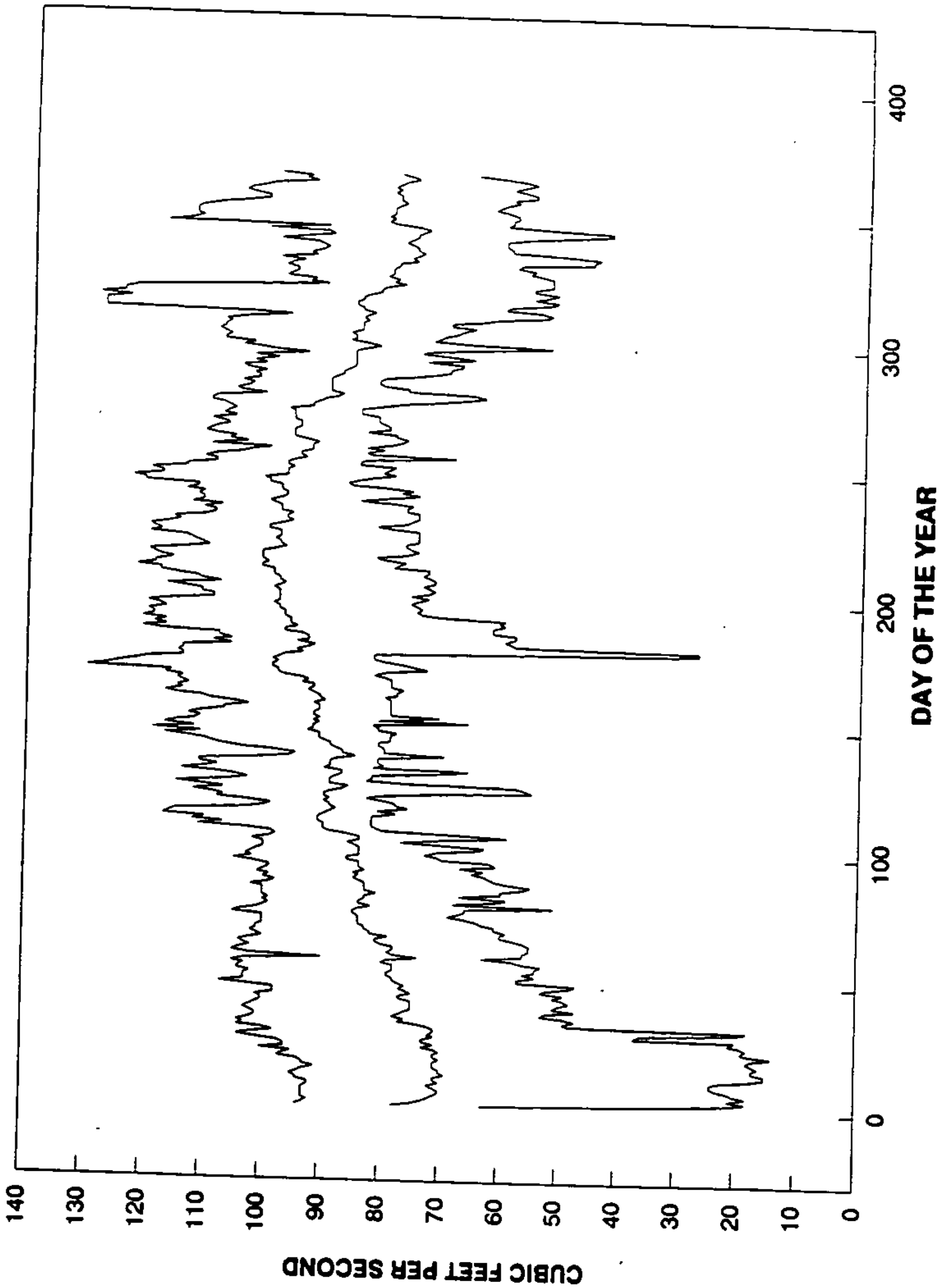

FIGURE 2-12. Maximum, Mean, and Minimum Daily Flow in Beaver Dam Creek at 400 Area (Period of Record 1974-1986)

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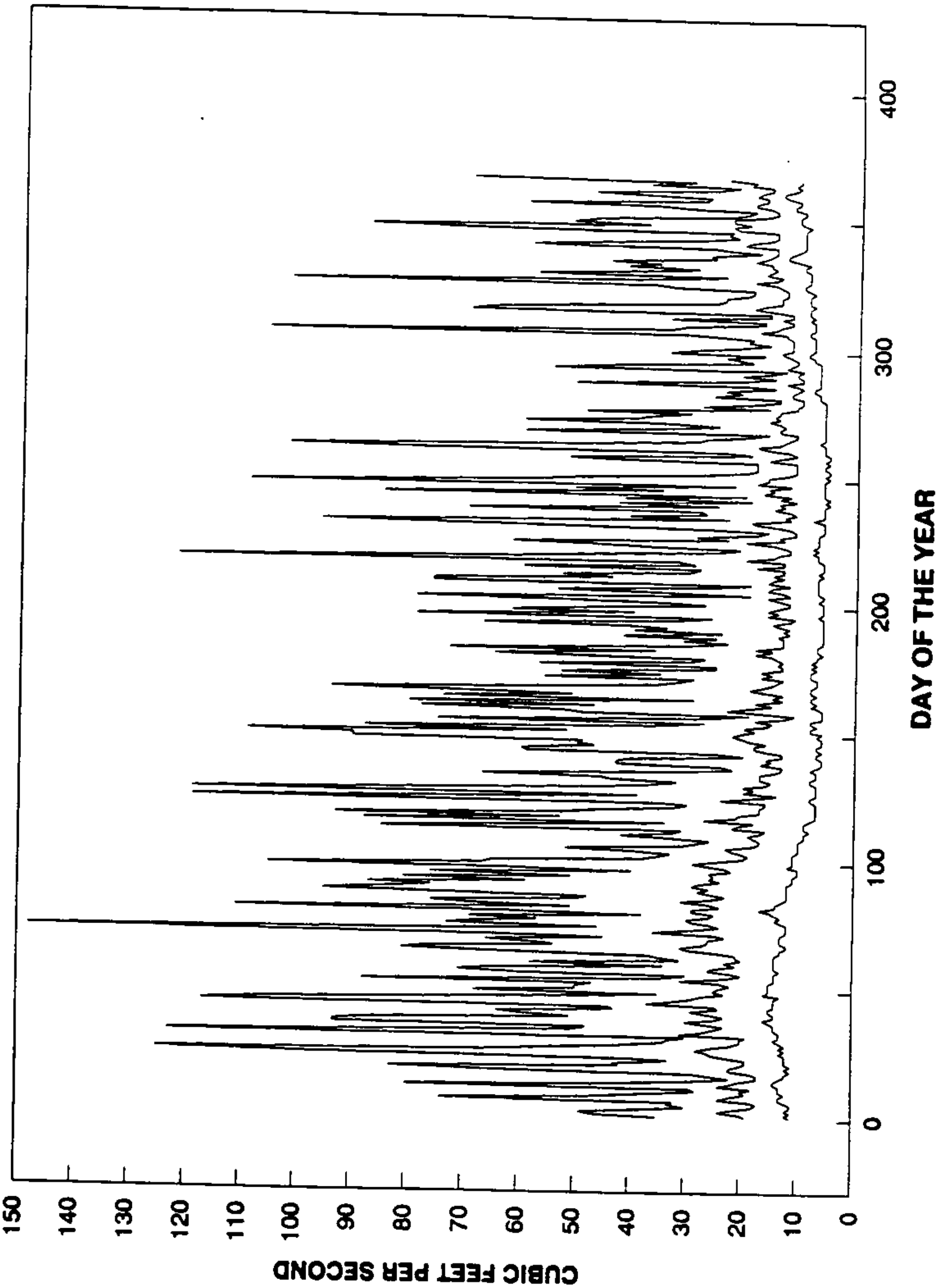

FIGURE 2-13. Maximum, Mean, and Minimum Daily Flow in Four Mile Creek at Site 7 (Period of Record 1984-1986)

W8908052

2.1.1.3.5 Pen Branch and Indian Grave Branch

Pen Branch follows a path roughly parallel to Four Mile Creek until it enters the river swamp. The only significant tributary to Pen Branch is Indian Grave Branch, which flows into Pen Branch about 8 km upstream from the swamp. Pen Branch enters the swamp about 5 km from the river, flows directly toward the river for about 2.4 km, and then turns and runs parallel to the river for about 8 km before discharging into Steel Creek about 0.8 km from its mouth. Pen Branch and Indian Grave Branch drain about 56 square kilometers of watershed upstream from the swamp. Indian Grave Branch receives the effluent cooling water from K Reactor.

Upstream of K-Area discharges, Indian Grave Branch flow averages only about 0.03 m^3/sec (1 ft^3/sec) and Pen Branch proper is also a small stream averaging 0.23 m^3/sec (8 ft^3/sec), Figure 2-14 and Table 2-1. The 7Q10 for Pen Branch above confluence with Indian Grave was not calculated (time series not long enough). Since November 1976, a USGS flow recorder has been maintained at SRS Road A-13.2 on Pen Branch. During the period 1976-1986, the flow at this station ranged from a minimum of about 0.003 m^3/sec (1 ft^3/sec) during a K-Reactor outage to a maximum of 21.2 m^3/sec (750 ft^3/sec) during simultaneous K-Reactor operation and a heavy precipitation event. During water year 1982, the mean flow rate at this station was 9.6 m^3/sec (339 ft^3/sec), which indicates the magnitude of reactor cooling water discharges on resulting Pen Branch flow rates (Figure 2-15 and Table 2-1). The 7Q10 for Pen Branch above the swamp is 39 ft^3/sec (Table 2-1).

2.1.1.3.6 Steel Creek

Steel Creek flows southwesterly for about 7.2 km, then turns to flow almost due south for about 8.8 km, and enters the river swamp about 5 km from the river. In the swamp, it is joined by the flow from Pen Branch and part of the flow from the Four Mile Creek/Beaver Dam Creek system. The drainage area of Steel Creek and its main tributary, Meyers Branch, is about 90 square kilometers. Steel Creek formerly received cooling water discharges from two reactors (L and P), but it currently receives only about 0.4 m^3/sec (14.1 ft^3/sec) of process wastewaters and sanitary treatment wastewaters at about natural temperature from P Area. The discharge of cooling water effluent from P Reactor to Steel Creek was discontinued in 1963 when this reactor was switched to cooling with recirculated water from Par Pond; thermal discharge from L Reactor ceased in 1968 when the reactor was placed in standby condition. L Reactor was restarted in 1985. At the present time, thermal effluents from L Area are discharged to L Lake, a 1000-acre cooling water reservoir. Overflow from L Lake during periods of normal reactor operation will be about 11 m^3/sec (388 ft^3/sec).

Since March 1974, the USGS has maintained a continuous flow recorder on Steel Creek at Old Hattiesville Bridge, which is located about 0.8 km upstream of the confluence with the onsite swamp. During the period

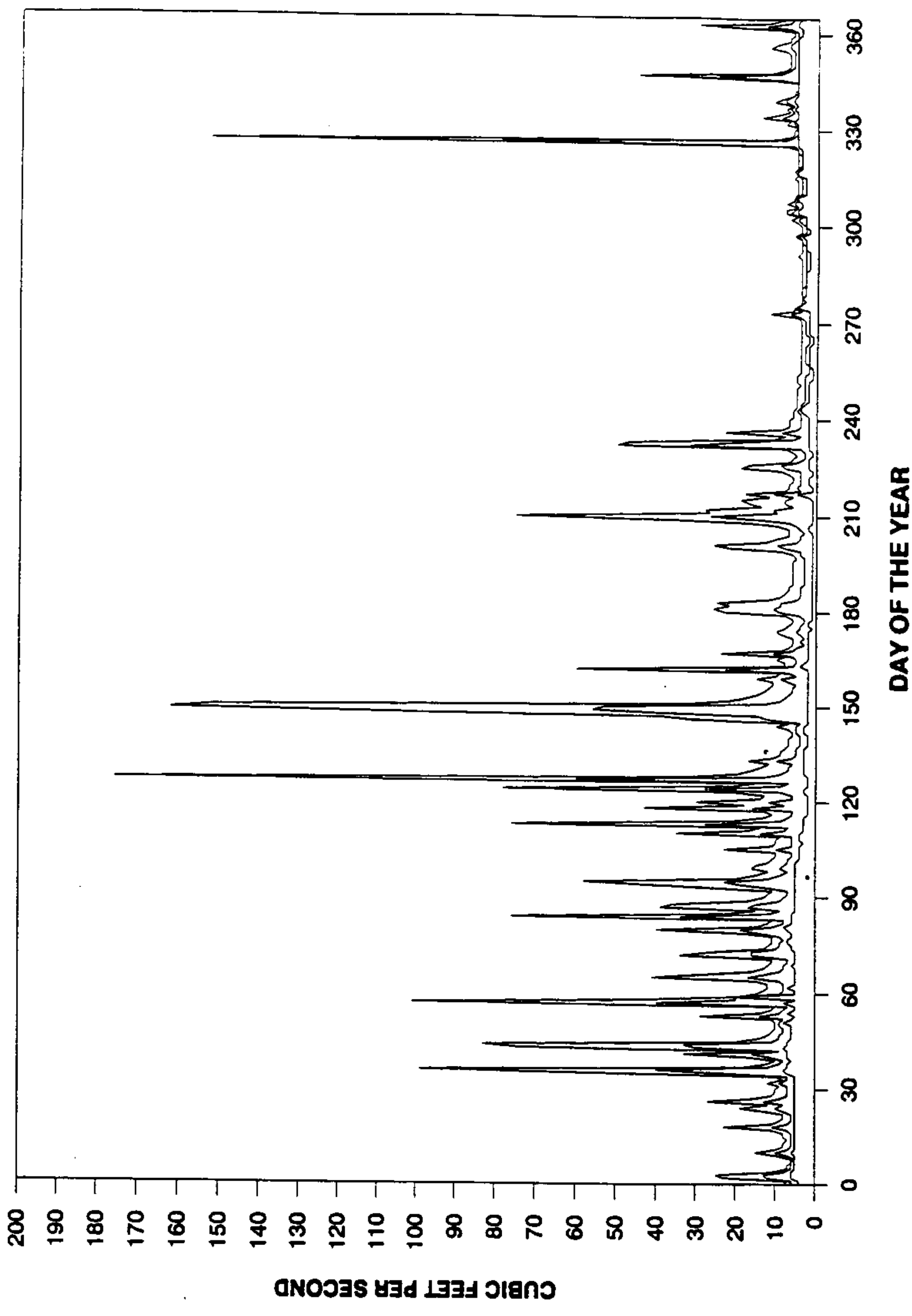

FIGURE 2-14. Maximum, Mean, and Minimum Daily Flow in Pen Branch at Road B (Period of Record 1984-1986)

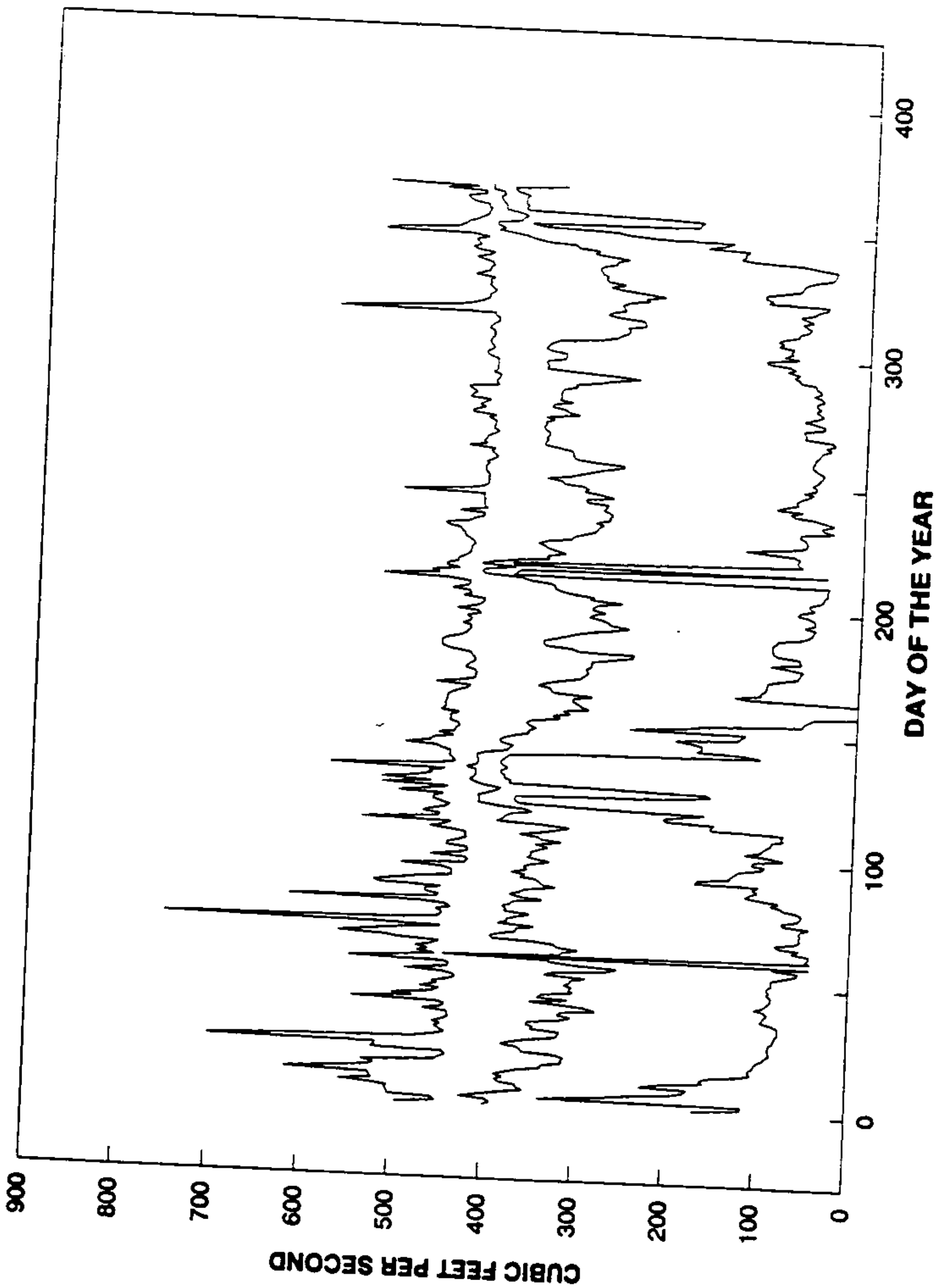

FIGURE 2-15. Maximum, Mean, and Minimum Daily Flow in Pen Branch at Road A-13 on SRS (Period of Record 1974; 1977-1986)

1974-1985 (prior to L-Reactor restart in 1985), the minimum flow was 0.4 m^3/sec (14 ft^3/sec) and the maximum flow was 8.72 m^3/sec (308 ft^3/sec). The mean discharge at this station is 1.5 m^3/sec (54 ft^3/sec) (Table 2-1, Figure 2-16).

2.1.1.3.7 Lower Three Runs Creek and Par Pond

Lower Three Runs Creek has the second largest watershed of these SRS streams (about 460 square kilometers). Near its headwaters a large impoundment, Par Pond, has been formed by the construction of an earthen dam. The three main arms of the pond follow the streambed and drainage areas of the upper reaches of the Lower Three Runs Creek and its tributaries, Poplar Branch and Joyce Branch. From the dam, Lower Three Runs Creek flows in a southerly, then southwesterly course for about 32 km to the Savannah River. Several small tributaries arising off the plant site flow into the creek in its lower reaches.

Before construction of Par Pond, effluent cooling water from R Reactor was discharged via Joyce Branch to Lower Three Runs Creek. Following the completion of Par Pond in 1958, the overflow to Lower Three Runs Creek has varied, depending on the utilization of the pond cooling water system by R and P Reactors. In 1964, R Reactor was shut down and placed in standby condition. Even when both R and P Reactors were utilizing the pond, the temperature of the pond overflow water was near ambient. During periods of no overflow, about 0.15 m^3/sec (5.3 ft^3/sec) seeps through and under the dam to enter Lower Three Runs Creek (Jacobsen et al., 1972). This seepage is usually several degrees cooler than the surface water in the pond during the summer months.

The Par Pond impoundment covers 2640 acres to an average depth of about 6 m. The maximum depth near the dam is about 17 m. Pond C, a 140-acre "precooler" body of water, is separated from Par Pond by a dam, and is part of the P-Reactor effluent canal system. There are three major arms in Par Pond (Figure 2-2): the north or upper arm; the middle arm; and the south or lower arm.

Since May 1974, a USGS flow recorder has been maintained in Lower Three Runs Creek below the Par Pond overflow at SRS Road B. During the period 1974-1982, the average flow at this station was 0.9 m^3/sec (31.8 ft^3/sec). The maximum flow and the minimum flows are shown in Figure 2-17.

A second USGS gaging station has been maintained downstream near Pattersons Mill on Lower Three Runs Creek. During the period 1974-1982, the average flow at this station was 2.4 m^3/sec (85 ft^3/sec). The maximum flows and the minimum flows are shown in Figure 2-18.

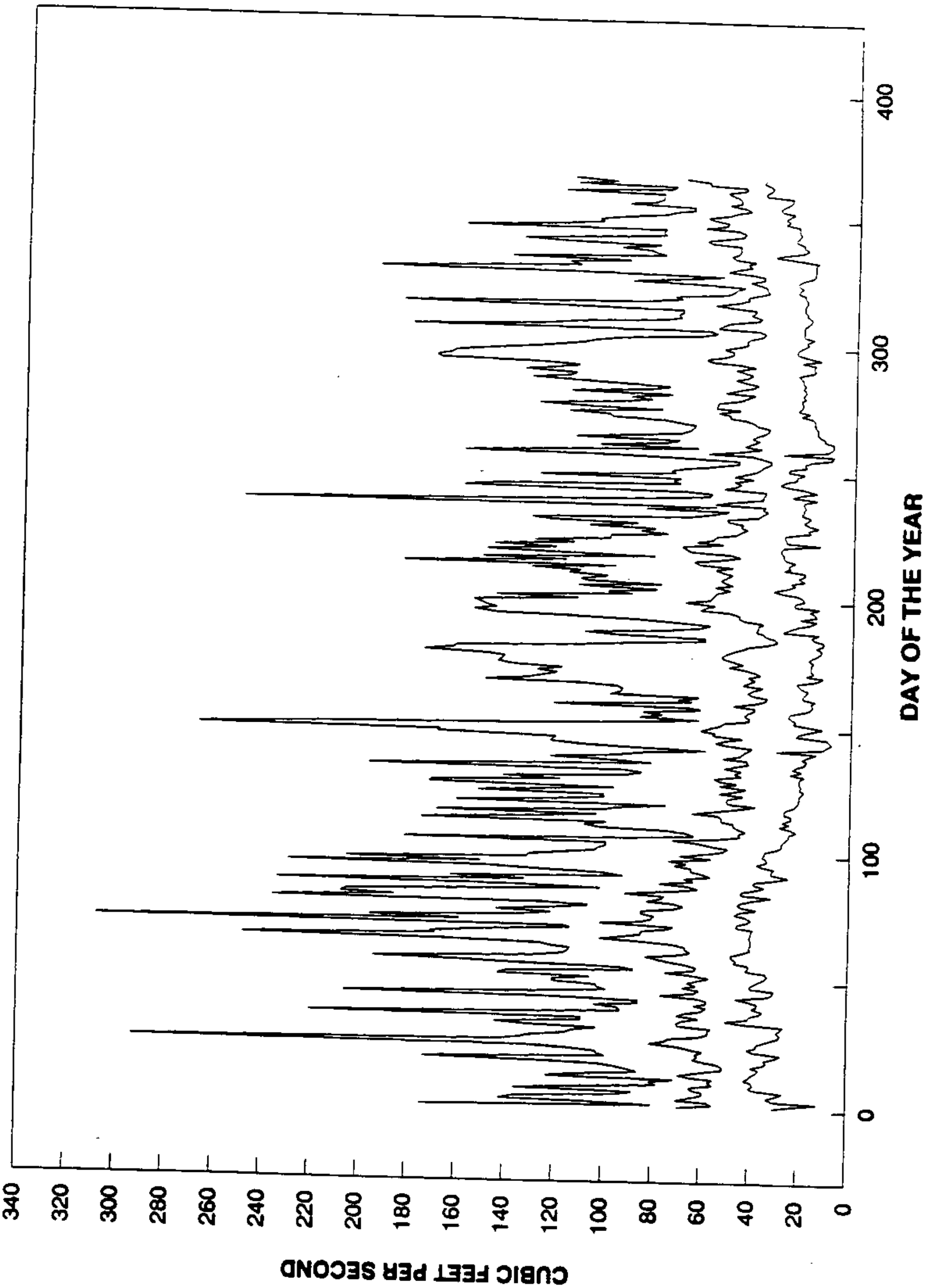

FIGURE 2-16. Maximum, Minimum, and Mean Daily Flow in Steel Creek at Hattiesville (Period of Record 1974-1985)

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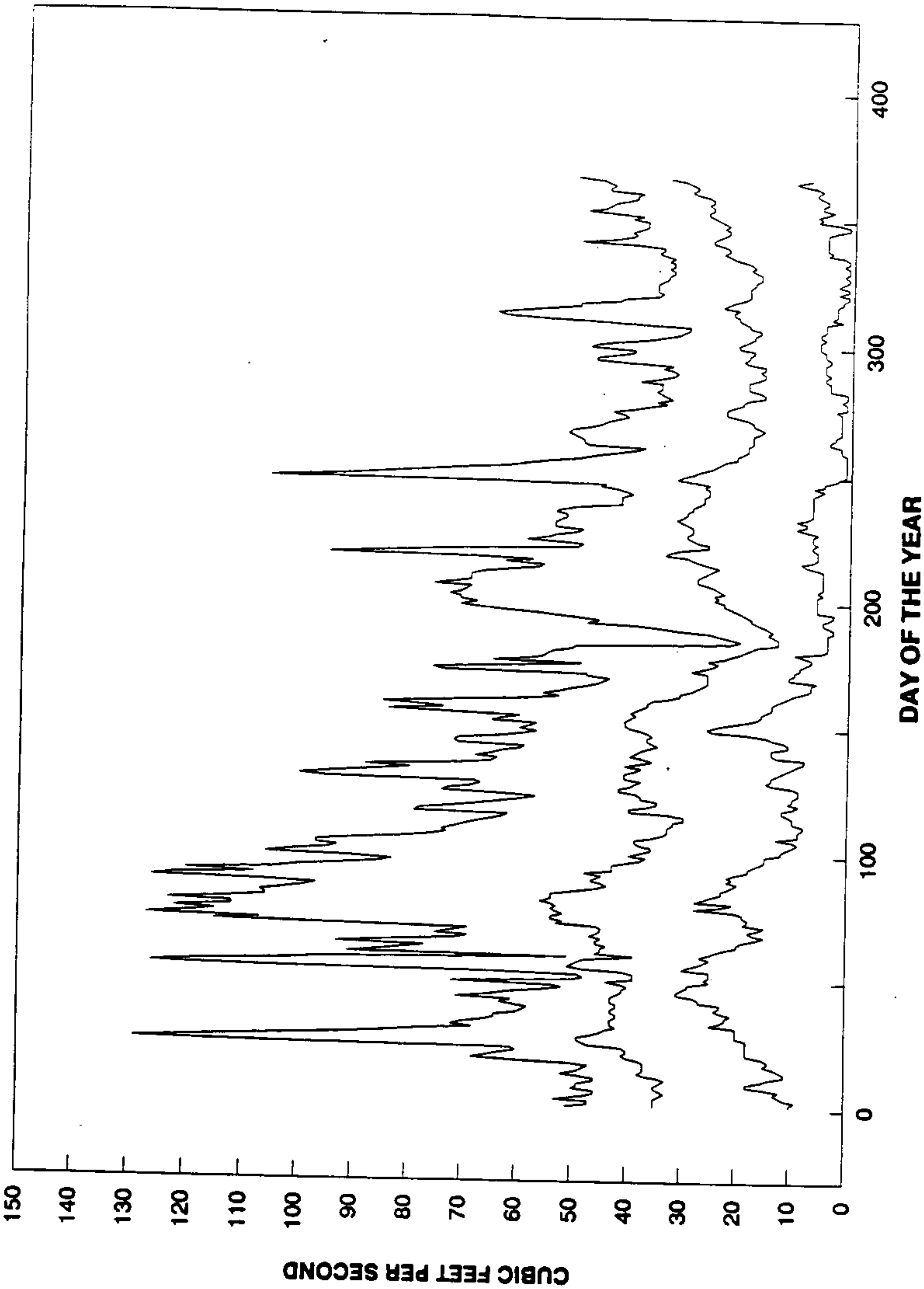

FIGURE 2-17. Maximum, Mean, and Minimum Daily Flow in Lower Three Runs Below Par Pond (Period of Record 1974-1983)

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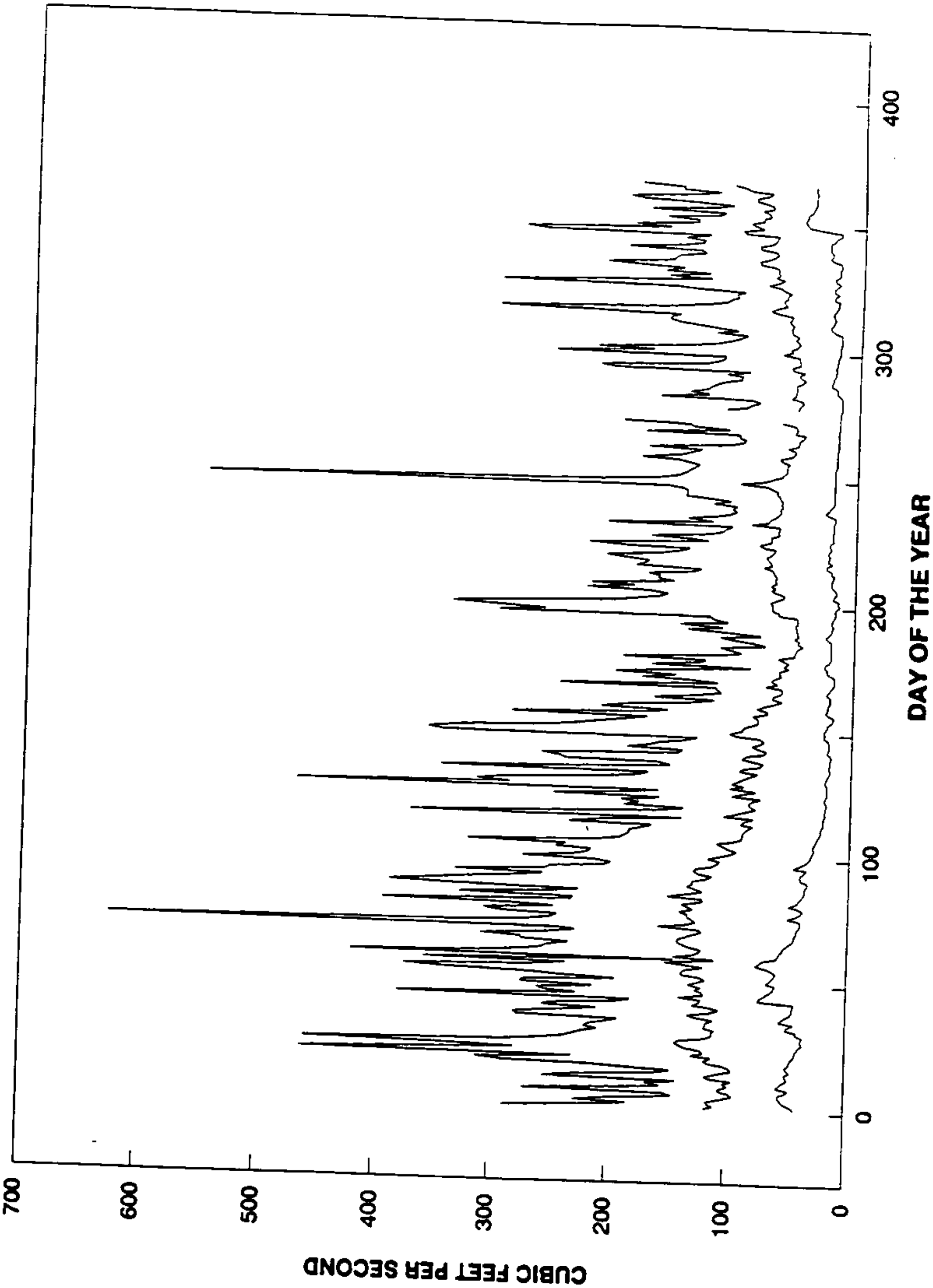

FIGURE 2-18. Maximum, Mean, and Minimum Daily Flow in Lower Three Runs Near Snelling, SC (Period of Record 1974-1987)

2.1.1.3.8 River Swamp

On the SRS, a floodplain swamp parallels the Savannah River for a distance of about 15 km and averages about 2.8 km in width (Figure 2-2). A small embankment or natural levee has built up along the north side of the river from sediments deposited during periods of flooding. On the SRS side of the levee, the ground slopes downward, is marshy, and contains large stands of cypress tupelo forest and bottomland hardwoods. During periods of high river level (about 27 m), river water overflows the levee and stream mouths and floods the entire swamp area, leaving only isolated islands that are also inundated during extremely high water levels. When flow subsides, stagnant pools of water remain, but even with the pools and meandering channels, much of the substrate in the swamp is inundated to shallow depths.

Three significant breaches in the natural levee allow discharge of creek water to the river - the mouths of Beaver Dam Creek, Four Mile Creek, and Steel Creek. Pen Branch does not discharge directly to the river, but flows through the swamp and joins Steel Creek about 0.8 km above the Steel Creek mouth. During swamp flooding, water from Beaver Dam Creek, Four Mile Creek, Pen Branch, and Steel Creek flows through the swamp parallel to the river and across the offsite Creek Plantation swamp. The flow recombines with the main flow of the Savannah River flow near Little Hell Landing.

2.1.1.4 Additional Surface Water Bodies

In addition to the streams, swamp, and Par Pond, surface water is held in more than 50 artificial impoundments totaling about 300 acres. Water is retained intermittently in wetlands and in more than 200 natural basins, including some Carolina Bays.

2.2 SURFACE WATER USE

2.2.1 Water Use History

The Savannah River forms the boundary between the States of Georgia and South Carolina. Upstream of the Savannah River Site, the river supplies domestic and industrial water needs for Augusta, GA and North Augusta, SC. The river receives treated wastewater from these municipalities and from Horse Creek Valley (Aiken, South Carolina). The Savannah River Class B waterway is used for fishing, both commercial and sport, and pleasure boating downstream from the Savannah River Site.

Water withdrawn from the river is used for various SRS activities, but is used primarily to cool the production reactors. It is also used as a drinking water supply, after treatment, at Port Wentworth, GA (Cherokee Hill Water Treatment Plant) for an effective consumer population of about 20,000, and at Hardeeville, SC (Beaufort-Jasper Water Treatment Plant), for a consumer population of approximately 51,000. It is estimated that each individual served by the two water treatment plants consumes an average of 1.3 liters of water per day.

2.2.2 Surface Water Usage by the Savannah River Site

The Savannah River Site is a major user of water from the Savannah River; it could remove 41 m^3/sec (1450 ft^3/sec) if all 26 pumps are in simultaneous use at three river pump stations (DOE, 1984). Currently, the Savannah River Site withdraws a maximum of 26 m^3/sec (920 ft^3/sec) from the river (DOE, 1984). K and L Reactors each receive about 11 m^3/sec (388 ft^3/sec) of cooling water, Par Pond receives about 0.6 m^3/sec (21 ft^3/sec) to compensate for seepage and evaporation, and the coal-fired power plant receives about 2.8 m^3/sec (100 ft^3/sec). After the river water is used as secondary coolant in L and K Reactors, it is discharged to Steel Creek and Pen Branch, respectively, which flow through an onsite swamp system to the Savannah River.

Under adverse river flow conditions, the removal of the full 41 m^3/sec (1450 ft^3/sec) would consume about 30% of the usual river minimum flow of about 13.4 m^3/sec (4720 ft^3/sec) at SRS (DOE, 1984). Present operations typically remove about 9% of the average annual Savannah River flow (Du Pont, 1981). The total withdrawal rate for the Savannah River Site will be about 26 m^3/sec (920 ft^3/sec). Under seven-day, ten-year low flow conditions of 13.4 m^3/sec (4720 ft^3/sec; DOE, 1984), the SRS will withdraw about 24% of the river flow; under average river flow 270 m^3/sec (9556 ft^3/sec at Augusta) conditions, the plant would withdraw about 13% for all operations.

2.2.3 Surface Water Usage by Nearby Industrial Facilities

Two neighboring facilities use or plan to use Savannah River water for industrial cooling purposes. The South Carolina Electric and Gas Company's Urquhart Steam Station, located upstream of the SRS, uses about 7.4 m^3/sec (260 ft^3/sec) as once-through cooling water (DOE, 1984). The Alvin W. Vogtle Nuclear Power Plant, near Hancock Landing, uses up to 2.8 m^3/sec (100 ft^3/sec) of river water as makeup water for its recirculating cooling towers.

2.2.4 Surface Water Usage by Down River Consumers

The Beaufort-Jasper Water Authority in South Carolina (River Mile 39.2) withdraws about 0.23 m^3/sec (8 ft^3/sec) to supply domestic water for a population of about 51,000 (Figure 2-19). The Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia (River Mile 29.0), withdraws about 1.4 m^3/sec (50 ft^3/sec) from the river to supply a business-industrial complex near Savannah which has an estimated consumer population of about 20,000 (Figure 2-20).

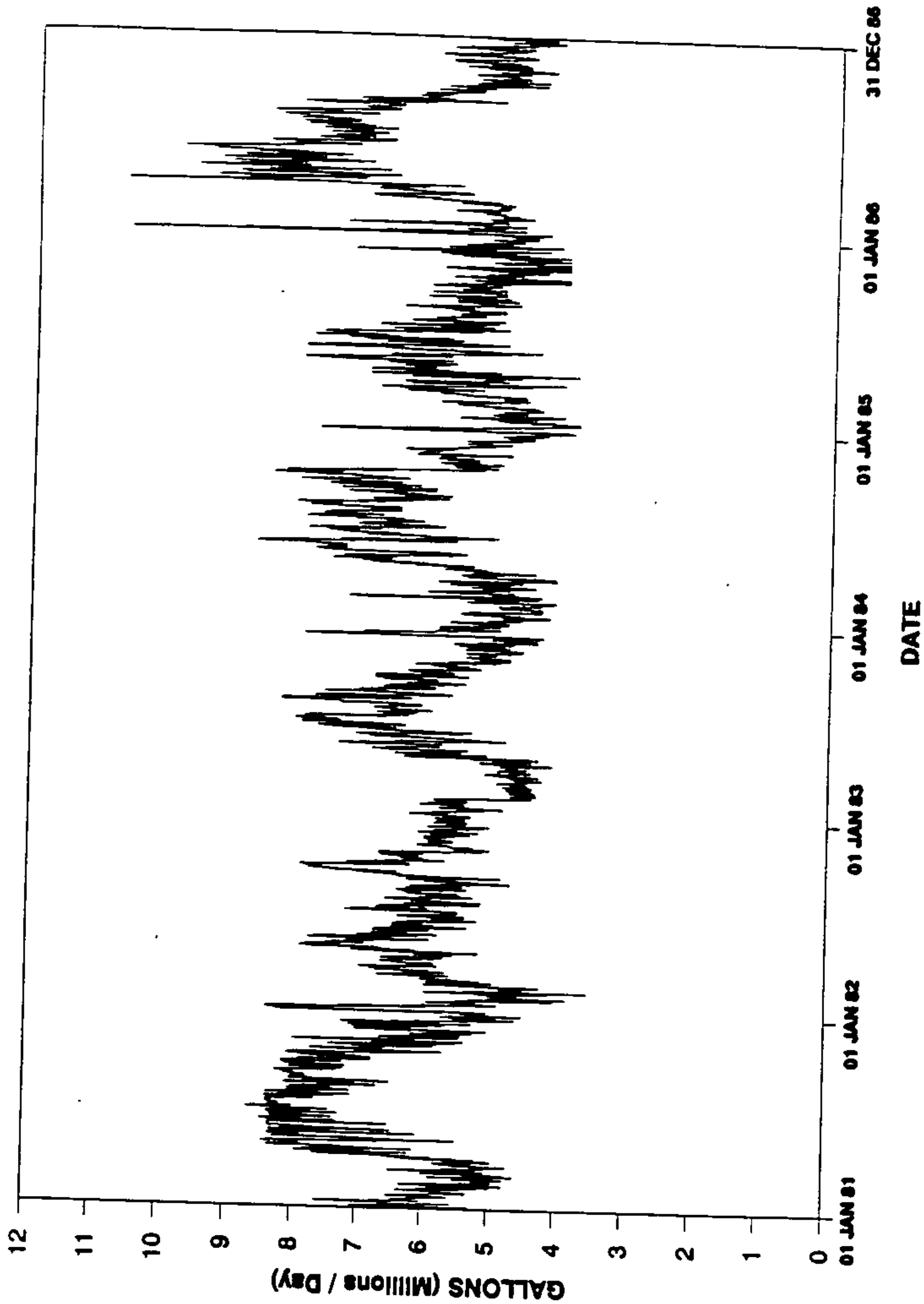

FIGURE 2-19. Beaufort-Jasper Finished Water Production

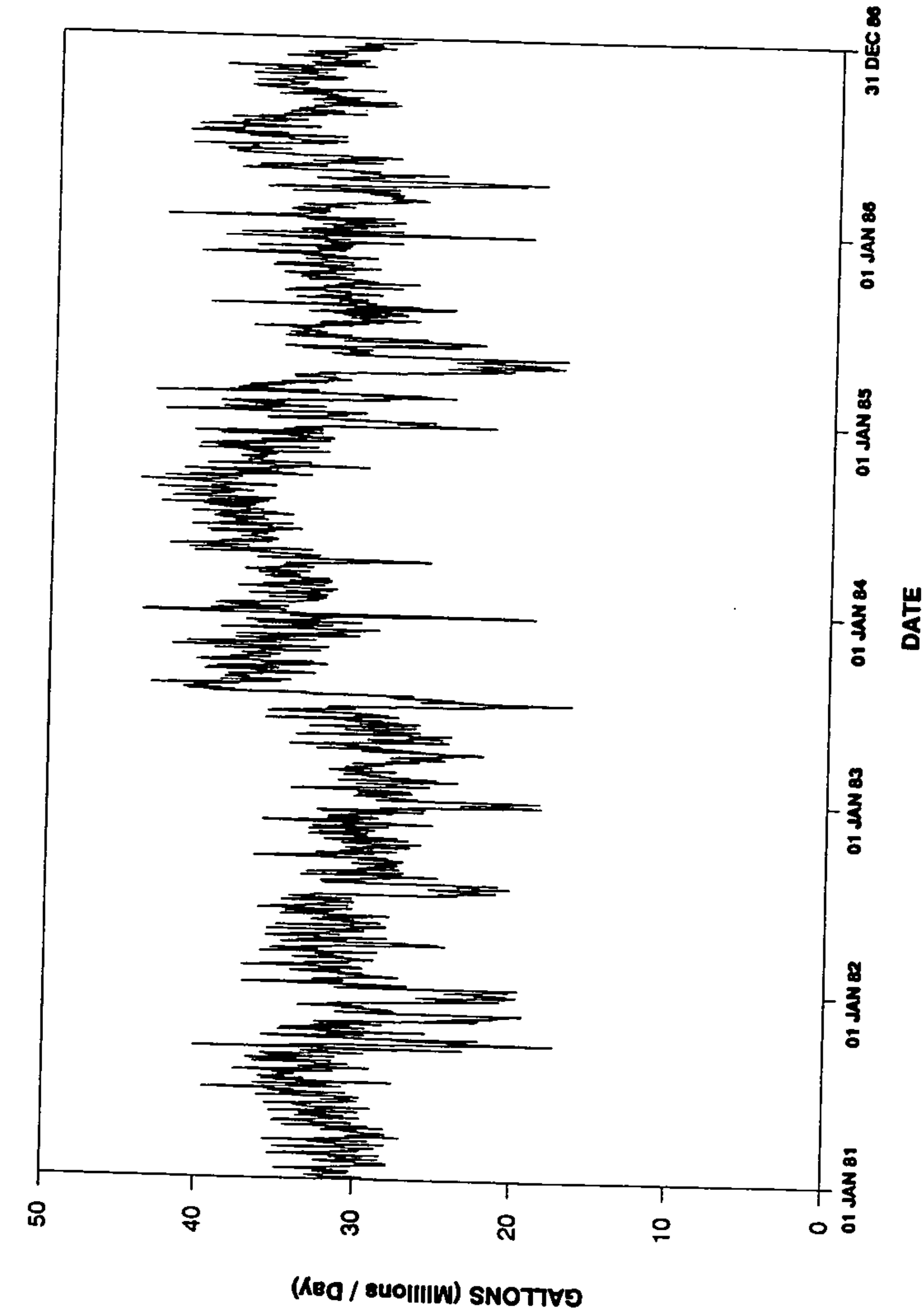

FIGURE 2-20. City of Savannah Finished Water Production

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3.0 RADIATION AND HAZARDOUS CHEMICAL ENVIRONMENT

3.1 RADIATION ENVIRONMENT

3.1.1 Sources of Environmental Radiation

There are three general sources of radiation exposure for persons in the United States. These are (1) radiation of natural origin, unperturbed by human activities, (2) radiation of natural origin perturbed by human activities, and (3) man-made sources.

Natural sources include cosmic radiation from outer space, cosmogenic radionuclides formed by interaction of cosmic radiation with elements in the earth's atmosphere, terrestrial radiation from natural radioactive materials in the ground, radiation from radionuclides naturally in the body, and inhaled and ingested radionuclides of natural origin.

Enhanced natural sources of radiation are those of natural origin, but enhanced by man's activities. These include air travel at high altitudes with its attendant increase in cosmic radiation, movement of radionuclides in the ground as in phosphate mining, and removal of radioactive materials from the ground such as uranium mining and disposal of mill tailings (exposure to radon and its daughter products).

Manmade sources result from exposures to radiopharmoceuticals and x-rays in medicine, consumer products such as smoke detectors and static eliminators, and x-rays from television receivers.

An average member of the public receives an annual dose of about 295 millirem from natural sources of radiation in the vicinity of the Savannah River Site. Based on national averages, this is about 81% of the total radiation dose received annually by members of the public from all sources. Medical exposures account for about 15% of the annual dose, and the combined doses from nuclear facilities (other than SRS), consumer products, weapons test fallout, and miscellaneous other sources account for about 4% of the dose. Releases of radioactivity to the environment from the Savannah River Site accounts for about 0.01% of the total environmental radiation dose.

Cosmic radiation consists of energetic particles of galactic and solar origin. The radiation of solar origin is associated with solar flares, which vary in intensity on a 11-year cycle. Cosmic dose varies with latitude and altitude above the earth's surface. Sea-level dose rates range from 30 millirem per year in Florida to 45 millirem per year in Alaska; the exposure rate increases to 200 millirem per year at an altitude of about 2400 meters (Dukes, 1984). An average dose in the U.S. is about 26 millirem per year. An average member of the public also receives an annual dose of about 1 millirem from cosmic radiation exposure received in high-altitude aircraft, making a total dose of 27 millirem per year from cosmic radiation.

Cosmic radiation also interacts with materials in the atmosphere and on the surface of the earth to create radioactive nuclides. This source of radiation is called cosmogenic radiation. Many radionuclides are formed by cosmic generation, e.g., Be-7, Na-22, H-3 (tritium), C-14, and many others. Of these, C-14 accounts for most of the dose to man, about 1 millirem per year.

Natural radioactive materials that have been present since the earth was formed are called primordial radionuclides. These materials have very long radioactive half-lives, ranging from hundreds of million years to billions of years. Some of the natural radionuclides which are primordial are U-234, U-235, U-238, Th-232, Rb-87, and K-40. Variations in distribution of these naturally occurring radioactive materials with geologic formations lead to a wide variation with location. The average unshielded external dose rates from this source of exposure are approximately 60 millirem per year in Georgia and 70 millirem per year in South Carolina. However, the variation in these states (including the SRS area) ranges from 6 to more than 350 millirem per year. An average dose in the U.S. is 28 millirem per year (corrected for shielding effects).

Radioactive decay products of primordial radionuclides can enter the atmosphere through resuspension of particles or as gases. These can lead to radiation exposure by inhalation by man. Radon-222, a decay product of natural uranium-238, has been found to be the largest contributor of dose from inhalation. Radon-222 emanating from the earth and a long string of decay products, is present in the atmosphere we breathe, and can be enhanced by being trapped in building structures. It has been determined that an average individual in the U.S. receives a dose of 200 millirem per year from radon and its daughter products, the largest single source of radiation exposure to man. This inhalation dose, accounts for about 55% of the average annual radiation dose in the U.S.

Primordial radionuclides and their radioactive daughter products enter the human body in food, air, and water. An average person receives a radiation dose of about 39 millirem per year from these natural radioactive materials in the body. Potassium-40, because of the large amount of natural potassium in the body (about 140 grams) accounts for about 50% of this internal dose.

Medical radiation is the largest source of radiation exposure to manmade radiation in the U.S. The average dose to an individual from medical and dental x-rays, prorated over the total population, was 39 millirem per year (NCRP93, 1987). In addition, radiopharmaceuticals administered for diagnostic purposes account for an annual average dose of 14 millirem when prorated over the population. Thus, the average medical radiation dose in the U.S. is about 53 millirem per year.

Occupational exposures to the population occur from such occupations as medicine, industry, nuclear fuel, government, etc. The annual average dose when prorated over the population is about 0.9 millirem.

Nuclear facilities release small amounts of radioactive materials to the environment, resulting in small radiation exposures to the public. When averaged over the U.S. population, this dose amounts to about 0.05 millirem per year.

An airborne radiological survey of the Savannah River marine region was performed in 1975 to establish terrestrial dose equivalent rates (Hayes, 1977). These rates varied from 0.001 millirem per hour over water to 0.009 millirem per hour at one location on Wassaw Island. In general, the higher rates occurred over beaches, where heavy minerals containing natural uranium and thorium occur. Excluding the water areas, the terrestrial rate averages about 0.003 millirem per hour in this area, which is comparable with other Coastal Plain rates of 0.002 to 0.003 millirem per hour and which is about one-half that measured for the Savannah River Site. The average dose rate for the Savannah River marine area is about the same as those measured in Galveston, Texas, and Cape Canaveral, Florida, and somewhat less than that in the Los Angeles, California, area. One radiation anomaly defined in this survey was noted on Hutchinson Island, where dredge soils have been deposited. The cesium-137 concentration in post-1957 dredge sediment ranges from about 0.3 to 2.7 picocuries per gram. About half the cesium-137 in the post-1957 sediment can be attributed to fallout from weapons testing (Marter, 1974).

A variety of consumer and industrial products yield ionizing radiation or radioactive materials and therefore result in radiation exposure to the general population. Some of these sources are television sets, luminous-dial watches, airport x-ray inspection systems, smoke detectors, tobacco products, fossil fuels, and building materials. The estimated dose for the U.S. population from these sources is 13 millirem per year.

There have been no atmospheric nuclear weapons tests since 1980. However, some radioactive materials from weapons tests prior to 1980 still remain in the environment. The average annual dose to a member of the U.S. population from this source is currently about 1 millirem.

Small doses result from miscellaneous radiation sources not previously described. Among these sources are transportation of radioactive materials, mineral extraction industry, etc. The average annual dose from these sources in the U.S. is about 0.06 millirem.

3.1.2 Radiation Levels in the Vicinity of the Savannah River Site

A summary of the major sources of exposure for the population within 80 kilometers of the Savannah River Site and for the river-water consuming population in Beaufort and Jasper Counties, South Carolina, and in Port Wentworth, Georgia, is presented in Table 3-1 based on the year 2000 population distribution. Table 3-2 shows potential health effects from a lifetime of exposure to this environmental radiation on the population groups described above. These health effects were calculated with risk

TABLE 3-1

Major Sources of Radiation Exposure in the Vicinity of the Savannah River Site - Based on Year 2000 Population[d]

Source of Exposure	Dose to Avg. Individual, mrem/year	Percent of Exposure	Population Dose, per-rem/yr
Natural background radiation			
Cosmic	27	7.44	
Cosmogenic	1	0.28	
Terrestrial	28	7.71	
Inhaled	200	55.09	
In the body	39	10.74	
Total	295 (a)	81.26	344,855
Medical radiation			
Diagnostic X-rays	39	10.74	
Nuclear medicine	14	3.86	
Total	53 (a)	14.60	61,957
Occupational	0.9 (b)	0.25	1,052
Nuclear facilities	0.05 (c)	0.01	58
Consumer products	13 (a)	3.58	15,197
Weapons test fallout	1 (a)	0.28	1,169
Miscellaneous	0.06 (a)	0.02	70
SRS 1988 releases atmospheric and liquid	0.04 (c)	0.01	52
Grand total	363	100.00039	424,411

a. Average for United States population.

b. Average for U.S. Population - Avg for SRS exposed employees in 1988 was 111 mrem.

c. Average for 80 km-radius population and downstream water consumers.

d. Estimated populations in year 2000 are: 80-km-radius = 852,000, downstream water consumers = 317,000.

TABLE 3-2

Potential Health Effects from the Radiation Environment Based on Year 2000 Population

Source of Radiation Exposure	Population Dose, per-rem/yr	Fatal Cancers Per Year of Exposure
Natural background radiation	344,855	137.942
Medical radiation	61,957	24.783
Occupational	1,052	0.421
Nuclear facilities	58	0.023
Consumer products	15,197	6.079
Weapons test fallout	1,169	0.468
Miscellaneous	70	0.028
SRS 1988 releases atmospheric and liquid	52	0.021
Total - all sources of exposure	424,410	169.764

Summary of Health Effects in Year 2000 Population (1,169,000 people)	
All Causes fatal cancers in lifetime (16% of pop.)	191360
All radiation fatal cancers in lifetime of exposure	11883
All Radiation cancers as percentage of all cause cancers	6.21%
Potential SRS Radiation cancers as percent of all cause cancers if exposed a lifetime at 1988 doses	0.00001%

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estimators proposed by the Environmental Protection Agency (EPA, 1989). Table 3-2 shows that approximately 190,000 members of the year 2000 population (approximately 16% of the population) will die at some time in their lifetime from all causes of cancer. The radiation environment will account for about 6% of these cancer deaths, with natural sources of radiation, the largest source of environmental radiation, accounting for about 81% of the cancer deaths from environmental radiation.

Many of the factors such as the natural background dose and medical dose are independent of the site. The factors that are site-dependent are discussed below.

The Savannah River Site and surrounding area lie between latitudes 33°N and 34°N, with an altitude variation between sea level and 300 meters above sea level. It has been estimated that the total unshielded dose equivalent from cosmic radiation in the vicinity of the Savannah River Site (80-kilometer-radius) is 35 millirem per year, of which 29 millirem per year is from the ionizing component and 6 millirem per year is from neutrons (Dukes, 1984). Shielding by buildings and body reduces the cosmic dose to about 27 millirem per year (NCRP93, 1987), a 23% reduction.

Atmospheric testing of nuclear weapons caused 25,600,000 curies of cesium-137 to be deposited on the earth's surface (United Nations, 1977 and United Nations, 1982). About 104 millicuries of cesium-137 per square kilometer were deposited in the latitude band (30°N to 40°N) where South Carolina is located. The resultant deposition of cesium-137 was 2,850 curies in the 27,400 square kilometer Savannah River watershed and 80 curies in the 780 square kilometer SRS site. The deposited cesium-137 became attached to soil particles and has undergone only slow transport from the watershed. Onsite monitoring conducted by the SRS Health Protection Department shows an average of 48 millicuries per square kilometer at the site perimeter (1980-1988 average) in the upper 8 centimeters of the soil column. This amount is slightly less than half of the amount originally deposited. The difference demonstrates that some of the cesium has moved down the soil column, some has decayed, and some has undergone hydrologic transport to the Savannah River.

Gamma radiation measurements are measured annually in and around the SRS site with thermoluminescent dosimeters. Radiation levels measured in 1988 at reactor area fences were 99, 80, and 99 milliroentgens per year at K, L, and P Reactors, respectively. This can be compared with natural background levels of 62, 77, and 99 milliroentgens per year at the site perimeter, at a 25-mile radius, and at 100 miles, respectively. Additionally, a radiation survey is made annually along major SRS roads. The most recent survey in 1989 indicated no significant contamination along any major road.

Since 1954, approximately 600 curies of cesium-137, 70 curies of cobalt-60, and 100 curies of strontium-90 have been released to surface streams on the SRS. Most of these materials were released in the 1950's and 1960's, and have been discussed in detail (DOE, 1984). Some of these materials were absorbed in sediments in streambeds, in the onsite Savannah River Swamp, and in the offsite Creek Plantation Swamp. Only cesium-137 is still transported to the Savannah River in measurable but small quantities. The impact of this transport is described in Section 4 of this EID. A more detailed discussion is included in Appendix B.

3.2 HAZARDOUS CHEMICAL ENVIRONMENT

3.2.1 Atmospheric

Essential and bulk materials shipped from offsite vendors to onsite facilities are normally consumed during processing, laboratory operations, and maintenance/construction activities. Nonradioactive hazardous materials and other bulk chemicals received at SRS facilities are listed in Table B-2 in Reference WSRC, 1989. This listing represents a time frame when three reactors were operating at full power to produce plutonium and tritium with all support facilities operating.

The nonradioactive materials presenting the greatest risks to the public and worker health and safety during transportation and loading/unloading operations were identified in Reference WSRC, 1989. These chemicals and their annual receipt rates are shown in Table 3-3.

Estimated ambient impacts of airborne emissions from these chemicals and other chemicals regulated by SCDHEC are discussed in Section 4.1.1.

TABLE 3-3

Large Volume Chemicals Received at SRS[a]

Chemical	Annual Receipts
Chlorine[b]	700,000, lb
Sodium hypochlorite	54,000 gal
Gasoline and light petroleum distillates	4,700,000 gal
Nitric acid	
51%	8,700,000 lb
64%	5,700,000 lb
Phosphoric acid	98,000 lb
Sodium hydroxide	15,000,000 lb
Sulfuric acid	1,500,000 lb
Trichloroethane	50,000 gal
Hydrogen fluoride	20,000 lb

[a] From Table 3-1 in WSRC, 1989.
[b] Represents a maximum value because sodium hypochlorite was substituted for chlorine gas in some facilities after this listing.

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4.0 ENVIRONMENTAL CONSEQUENCES OF K-, L-, AND P-REACTOR OPERATIONS

4.1 NONRADIOLOGICAL AIR POLLUTION IMPACTS OF REACTOR OPERATIONS

The primary sources of nonradiological air pollutants in the reactor areas are the K- and P-Area powerhouses, which supply steam and electric power to the K, L, and P Areas, and six continuously operating diesel generators in the 108 building of each reactor area. The 108 building diesels power DC motors that maintain process cooling water to the reactors in the event of a primary power outage. Emissions from these sources consist primarily of criteria air pollutants. The criteria air pollutants are those substances which have national ambient standards established under Section 109 of the Clean Air Act.

Other sources of nonradiological air pollutants include six to eight emergency diesel generators in each area, coal storage pile and transfer operations associated with the boilers, and vehicular traffic. The impact of these pollution sources are not quantitatively evaluated, since emissions from each are relatively small.

4.1.1 Atmospheric Emissions

Reactor area facility operations and emissions information were taken from South Carolina Department of Health and Environmental Control (SCDHEC) air permits, routine SRS emissions inventory reports, and Livengood (1989). Specific air emissions estimates were based on data from these sources and appropriate Environmental Protection Agency (EPA) emission factors (EPA, 1986; EPA, 1988).

The powerhouses in the K- and P-Areas each consist of two stoker-grate coal-fired boilers. Each boiler has a rated capacity of 194.5 million BTU per hour input and can generate up to 140,000 pounds of steam per hour for space heating. In addition, turbogenerators in the K- and P-Area powerhouses have electric power ratings of 12,500 kw and 11,500 kw, respectively. Maximum steam demand for each operational reactor area has been estimated to range from 25,000 pounds per hour during the winter to 15,000 pounds per hour in the summer. The K- and P-Area powerhouses supply nearly all of these steam requirements. The K-Area powerhouse supplies steam to L Area. Estimated average operational electric power demand for each area is approximately 30 Mw. The K- and P-Area powerhouses each supply up to 5 Mw of electric power. The remaining power is supplied by the D-Area powerhouse or purchased from the local utility.

Atmospheric emissions from the K- and P-Area powerhouses have been permitted by SCDHEC. Permit conditions limit emissions of total suspended particulates (TSP) and sulfur dioxide (SO_2) to 0.6 and 3.5 pounds per million BTU, respectively. Actual emissions for 1987 were about 0.4 and 1.4 pounds per million BTU for TSP and SO_2, respectively

(Du Pont, 1988). The air permit also requires that the stack effluent not exceed 40% opacity. No violations of permit conditions have occurred over the last four years (Du Pont, 1984-1988).

Estimated annual criteria pollutant emissions from the powerhouses are summarized in Table 4-1. Emissions of total oxides of sulfur (SO_x) and nitrogen (NO_x) are provided as conservative estimates for SO_2 and nitrogen dioxide (NO_2), respectively. The estimates listed in Table 4-1 are based on coal consumption for a two-year period, 1987-1988. Emissions for TSP include operation of two single-stage mechanical cyclone precipitators. These control devices were estimated to remove about 93% of the particulate matter from the effluent (Livengood, 1989). Emissions of SO_x, NO_x, and carbon monoxide (CO) are uncontrolled.

Fugitive emissions of particulates can be expected from coal handling activities associated with each powerhouse. These emissions result from wind induced erosion from adjacent storage piles, transfer operations from incoming rail car shipments, and storage pile maintenance. Emissions from these sources were estimated to be less than one ton per year (EPA, 1988).

The diesel generators in the 108 buildings are rated at 103 kw. Consequently, SCDHEC air permits are not required for operation. Estimated annual air emissions from these generators are summarized in Table 4-1.

4.1.2 Ambient Impacts

The cumulative ambient impact of nonradiological air emissions from reactor facility operations was estimated with the Industrial Source Complex (ISC) air dispersion model (EPA, 1987). Ambient pollutant concentrations were calculated using the emissions estimates listed in Table 4-1, and annual meteorological data sets for each of the five years from 1982-1986. The ISC model and development of appropriate meteorological data sets are described in more detail in Appendix D.

Estimated ambient ground-level concentrations for each primary criteria air pollutant are summarized in Table 4-2. For each averaging period, the listed value is the highest estimated concentration on or beyond the SRS boundary for any of the five annual calculations. The National Ambient Air Quality Standards (NAAQS) are also listed in Table 4-2. For all averaging times, model estimated concentrations are more than a factor of ten less than the corresponding standard. Offsite receptors having the highest estimated concentrations were generally located near the SRS boundary, southwest of the reactor areas. This pattern is consistent with wind summaries discussed in Chapter 1, which show a relatively high frequency of northeasterly winds during stable atmospheric conditions.

TABLE 4-1

Estimated Annual Atmospheric Emissions of Criteria Pollutants from Reactor Area Facilities

Source	Estimated Emissions (tons)			
	SO_x	TSP	NO_x	CO
K Powerhouse[a]	1070	216	380	135
P Powerhouse[b]	830	160	300	110
108-K diesels[c]	4	4	59	13
108-L diesels[c]	4	4	59	13
108-P diesels[c]	4	4	59	13

a SOx, NOx, and CO emissions based on consumption of 54,700 tons of lump bituminous coal averaging 1% sulfur and 8% ash content (Livengood, 1989) and EPA emission factors (EPA, 1988). TSP emissions from Livengood (1989).

b SO_x, NO_x, and CO emissions based on consumption of 42,700 tons of lump bituminous coal averaging 1% sulfur and 8% ash content (Livengood, 1989) and EPA emission factors (EPA, 1988). TSP emissions from Livengood (1989).

c Emissions based on annual consumption of 250,000 gal of number 2 diesel fuel (Du Pont, 1981) and EPA emission factors (EPA, 1986).

TABLE 4-2

Estimated Air Quality Impacts for Criteria Pollutant Emissions from Reactor Operations

Pollutant	Averaging Period	Estimated Concentration (μg/m³)	NAAQS[a] (μg/m³)
SO_x	3-hour	92	1300[b]
	24-hour	21	365
	Annual	1	80
TSP	24-hour	4	150
	Annual	<1	50
NO_x	Annual	<1	100
CO	1-hour	20	40000
	8-hour	5	10000

a Listed standards are for SO_2, PM-10 (particulates less than 10 micron diameter), NO_2, and CO

b Secondary standard

4.2 RADIOLOGICAL IMPACTS OF REACTOR OPERATIONS

The operation of the K, L, and P Reactors would have radiological impacts similar to the operating history of each reactor. The net effects would be consistent with previous releases of radioactive materials to the environment, total occupational dose to SRS workers, and the amount of radioactive waste (high and low level) to be disposed. This section characterizes the radiological impacts due to the normal operation of K, L, and P Reactors. Appendix A describes dose calculation models and basic assumptions.

Figure 4-1 shows potential pathways for radiation exposure to man from radionuclides released from a nuclear facility. External doses result from exposure to airborne effluents, from swimming and other recreational activities, and from exposure to ground deposition of radionuclides. There are no known users of Savannah River water for irrigation downstream from SRS; contaminants that might reach groundwater beneath SRS will not reach offsite sources that are used for irrigation. Internal doses result from the inhalation of airborne effluents and ingestion of food and water that contain radionuclides.

4.2.1 Atmospheric Releases of Radioactivity

Radioactive materials would be released to the atmosphere during K-, L-, and P-Reactor operations from three release points: (1) from reactor stacks, which would discharge most of the gaseous effluents generated in reactor building operations; (2) at ground level from evaporation of water from fuel and target disassembly basins; and (3) at ground level from evaporation of water from seepage basins. The releases from the stacks would consist of radioactive gases that enter the reactor ventilation system from the evaporation of process water, from the pressurized blanket gas system, and from the air space between the reactor and the thermal shield. Table 4-3 lists the combined atmospheric releases from normal K-, L-, and P-Reactor operations from the above listed sources. The values are based on annual releases from reactor operations during the period 1984 to 1986. Estimated annual releases to the atmosphere from full power operation of a single reactor are shown in Table A-10 of Appendix A.

4.2.2 Wastewater Discharges of Radioactivity

The K, L, and P Reactors are similar in design and, therefore, have similar liquid effluent pathways to the environment. During normal operations, radioactive materials would be discharged in liquid effluents as a result of small process water leaks into the cooling water in the reactor heat exchangers, and by release to the process sewer. Deionized liquids would also be discharged about twice a year from the disassembly basins to the seepage basins. This purge of water would be necessary to keep the tritium

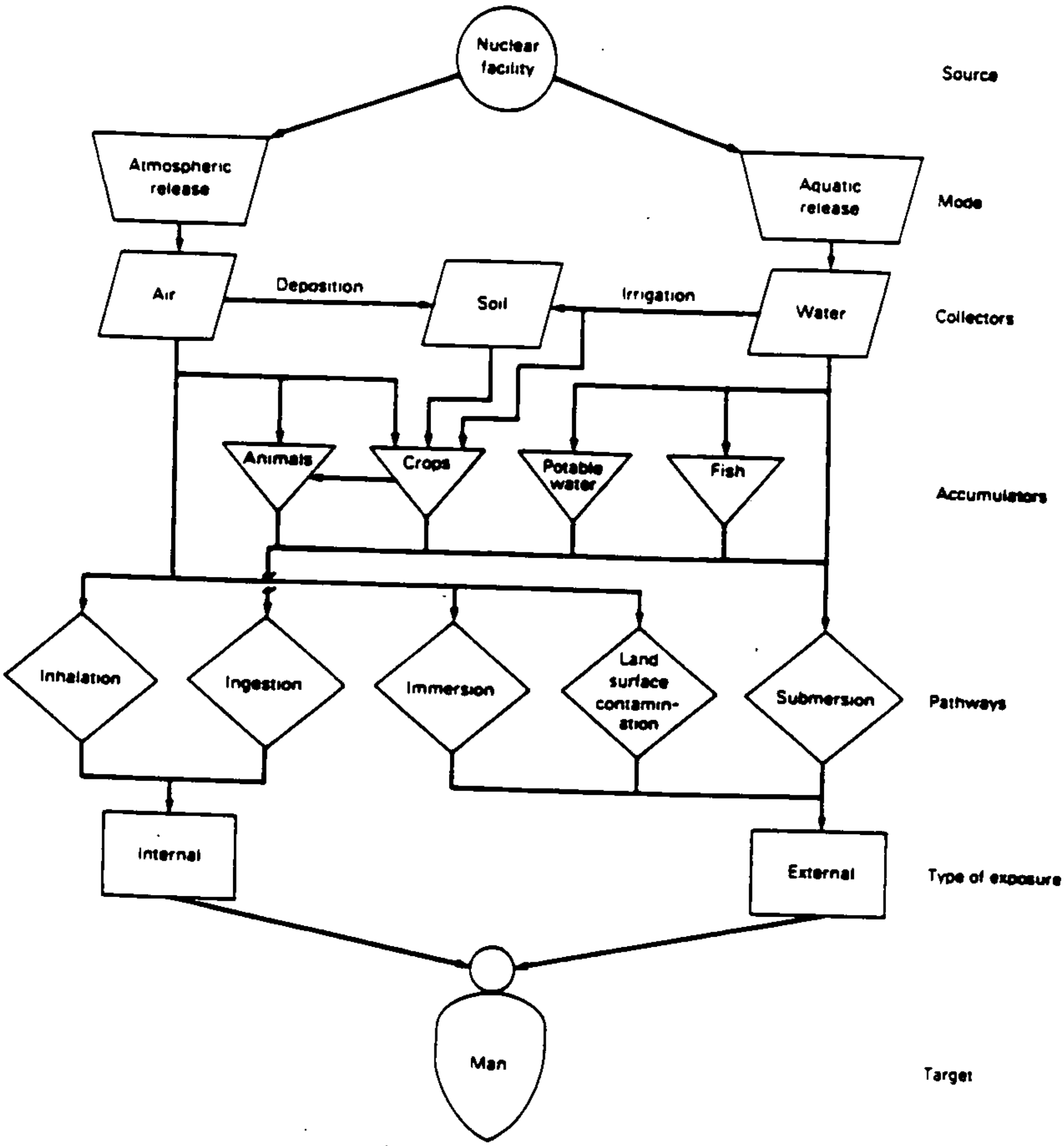

FIGURE 4-1. Exposure Pathways Considered in Radiological Impact Assessments

TABLE 4-3

Expected Annual Atmospheric Releases from K-, L-, and P-Reactor Operations (curies per year)[a]

Radionuclide	Totals for 3 Reactors
H-3[b]	1.97E+05
C-14	4.17E+01
Ar-41	5.70E+04
Kr-85m	1.49E+03
Kr-87	1.03E+03
Kr-88	1.55E+03
I-131	8.60E-03
Xe-133	6.30E+03
Xe-135	2.29E+03
Unidentified beta-gamma[c]	3.13E-04
Unidentified alpha[d]	6.61E-06

[a] The expected annual average concentrations at the SRS site boundary would be well within the DOE derived concentration guides for uncontrolled areas (DOE Draft Order 5400.XX, Rev 10/10/88).

[b] Includes evaporative losses at ground level from the disassembly basins and the seepage basins.

[c] Assumed to be strontium-90.

[d] Assumed to be plutonium-239.

concentration in the disassembly basin water below the level that ensures safe working conditions. The water in the disassembly basins becomes contaminated when fuel and target assemblies are discharged from the reactors. Some tritium and other radionuclides would be carried over in the process water adhering to the assemblies, and some as tritiated heavy water (DTO) contained as water of hydration in aluminum oxide on the assemblies. The disassembly basin water would be filtered, deionized, and monitored before it is discharged.

The migration of the water discharged in a shallow aquifer from the seepage basins would allow tritium to partially decay before entering surface waters.

Water in the water table at the K Reactor flows to the east and discharges at Pen Branch, and to the west and discharges at Indian Grave Branch. Indian Grave Branch merges with Pen Branch and flows toward the mouth of Steel Creek which discharges at the Savannah River.

Water in the water table at the L Reactor flows to the southeast toward L Lake and to the west toward Pen Branch. L Lake is a man-made impoundment produced by damming Steel Creek.

P Reactor lies on top of a water table "mound". Therefore, groundwater moves in all directions from the P Reactor. Likely discharge points are Steel Creek, Par Pond, and Meyers Branch.

A more detailed description of the subsurface hydrology is included in Volume 1 of the Reactor Operation EID.

Table 4-4 lists the combined expected annual liquid radioactive releases from K, L, and P Reactors to seepage basins. Table 4-5 lists the combined expected annual liquid radioactive releases from K, L, and P Reactors to surface streams. Measured migration of tritium from seepage basins is included in these values. The values are based on annual average releases during the period 1984 to 1986. Estimates of annual liquid releases from individual reactor areas are shown in Table A-11 of Appendix A.

4.2.3 Dose Commitments from Reactor Operations

4.2.3.1 Maximum Individual Dose from Atmospheric Releases

The individual who would receive the highest dose from atmospheric releases from the K, L, and P Reactors was assumed to reside continuously at the SRS boundary. The selection of the location of maximum potential dose in the southwest sector was based on considerations of distance to the site boundary, releases to the atmosphere, and meteorological dispersion characteristics.

TABLE 4-4

Expected Annual Liquid Releases to Seepage Basins from K-, L-, and P-Reactor Operations (curies per year)

Radionuclide	Totals for 3 Reactors
H-3	1.21E+04
P-32	1.24E-03
S-35	2.83E-02
Cr-51	2.19E-01
Co-58,60	5.12E-03
Sr-89	1.63E-03
Sr-90	1.02E-03
Zr,Nb-95	5.38E-02
Ru-103,106	2.89E-03
Sb-124,125	6.81E-03
I-131	2.64E-02
Cs-134	9.36E-03
Cs-137	9.55E-02
Ce-141,144	4.12E-02
Pm-147	8.79E-03
Beta	3.99E-01
Alpha	4.58E-03

TABLE 4-5

Expected Annual Liquid Releases to Surface Streams from K-, L-, and P-Reactor Operations (curies per year)

Totals for Radionuclide	3 Reactors
H-3	1.16E+04
Co-58,60	1.00E-03
Cs-137	3.33E-07
Unidentified beta-gamma[a]	1.30E-02
Unidentified alpha[b]	3.19E-04

[a] Assumed to be strontium-90.
[b] Assumed to be plutonium-239.

The maximum committed effective dose equivalent to an individual was calculated as 0.34 mrem as the result of combined annual K-, L-, and P-Reactor atmospheric releases. This dose is only 0.12 percent of the average dose of 295 mrem received by an individual living near the SRS from annual exposure to natural radiation. More detailed dose data are given in Appendix A.

4.2.3.2 Population Dose from Atmospheric Releases

The collective committed effective dose equivalent to the population of 852,000 (projected for the year 2000) who would be living within 80 kilometers from the SRS was calculated to be 21.4 person-rem from a combined annual average release from K, L, and P Reactors. These doses are only 0.01 percent of the average dose of 251,000 person-rem received by this same population from annual exposure to natural radiation. More detailed dose data are given in Appendix A.

4.2.3.3 Maximum Individual Dose from Liquid Releases

The individual who would receive the highest dose from liquid effluents from K-, L-, and P-Reactor operation was assumed to live near the Savannah River downstream from the SRS. This individual was assumed to use river water regularly for drinking, to consume fish from the river, and to receive external exposures from shoreline activities, swimming, and boating. This individual was also assumed to eat more fish than an average person.

The maximum committed effective dose equivalent to an individual was calculated to be 0.032 mrem as a result of combined annual K-, L-, and P-Reactor liquid releases. This dose is only 0.01 percent of the average dose of 295 mrem received by the same individual from annual exposure to natural radiation. More detailed dose data are given in Appendix A.

4.2.3.4 Population Dose from Liquid Release

Savannah River water is not used for drinking within 80 kilometers of the SRS; therefore, the dose to the population in this area would come from eating fish and shellfish, from shoreline activities, and from swimming and boating.

The collective committed effective dose equivalent to the population of 852,000 (projected for the year 2000) who would be living within 80 kilometers of the SRS was calculated to be 0.01 person-rem from a combined annual average release from K, L, and P Reactors. This dose is only 0.000004 percent of the average dose of 251,000 person-rem received by this same population from annual exposure to natural radiation. More detailed dose data are given in Appendix A.

The Beaufort-Jasper and Port Wentworth population groups use the Savannah River as a source of potable water. Though these groups are beyond the 80-kilometer-radius of the SRS (about 160 kilometers downstream), the drinking water doses have been calculated. The collective committed effective dose equivalent delivered to these populations (about 317,000 people are expected to consume water from the Beaufort-Jasper and Port Wentworth water treatment plants by the year 2000) from drinking water was calculated as 9.3 person-rem from combined annual K-, L-, and P-Reactor operations. This dose would be about 0.01 percent of the exposure of about 94,000 person-rem to these populations from annual exposure to natural radiation. More detailed dose data are given in Appendix A.

4.2.4 Cesium-137 and Cobalt-60 Redistribution Dose Commitment

Radiocesium has been released to onsite streams and bottomlands at the Savannah River Site, including Four Mile Creek, Pen Branch/Steel Creek, and Lower Three Runs Creek (Figure 4-2). Most of this radiocesium [about 460 Ci (Du Pont, 1981)] originated from releases in the 1960s from fuel storage facilities at the 5 production reactors operating at the time. Additional releases between 1955 and 1980, totaling as much as 100 Ci, included discharges to Four Mile Creek from the 200-F and -H Separations areas, weapons test fallout, and other sources (Du Pont, 1981 and DOE, 1984). Of the 560 Ci released to onsite streams, appoximately 290 Ci (Du Pont, 1981) have been measured in transport at stream monitoring stations at Road A (SC Hwy 125). In 1981, approximately 67 Ci of cesium-137 remained in Steel Creek with another 30 Ci in the area between the Steel Creek Delta and the lower end of the Creek Plantation Swamp (DOE, 1984). The location of Creek Plantation Swamp is shown in Figure 4-2.

A total of approximately 66 curies of Co-60, formed by neutron activation of stainless steel in the reactors, has been discharged to SRS streams in the years following startup of the first reactor in December 1953 (DOE, 1984). An estimated 27 Ci (15 from L Reactor and 12 from P Reactor) of this total were discharged to Steel Creek. Because Co-60 has a half-life of 5.26 years, most of this radiocobalt has been eliminated through radioactive decay. For example, only about 2.1 curies of Co-60 were estimated to remain in the Steel Creek-Savannah River system in 1984 (DOE, 1984).

Environmental concerns for the remobilization of this radiocesium and radiocobalt in Steel Creek associated with the restart of L-Reactor operations prompted special measurement of Cs-137 and Co-60 in the Savannah River starting in 1983 (DOE, 1984 and DOE, 1987). Sampling stations for these measurements are located at Shell Bluff (upriver) and Hwy 301 Bridge (downriver). Savannah River flow is also measured upriver and downriver of the SRS (Du Pont, 1984; Du Pont, 1985; Du Pont,

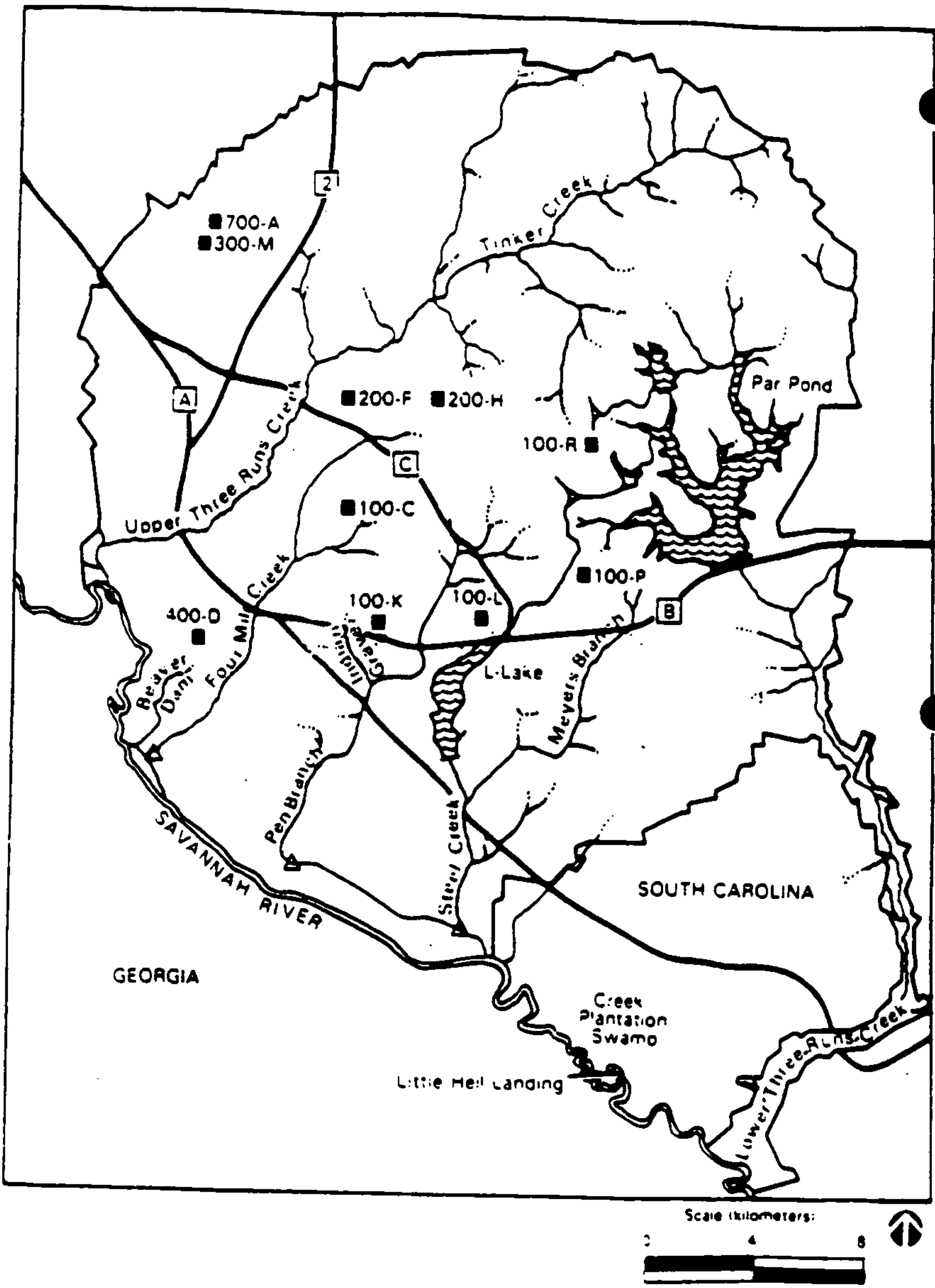

FIGURE 4-2. Savannah River Site Map

1986; Du Pont, 1987; Du Pont, 1988; and Westinghouse, 1989). Although Cs-137 has been detected in these special studies of Savannah River water, Co-60 has not been detected (Du Pont, 1984).

The SRS contribution of Cs-137 to the Savannah River can be estimated by multiplying total annual flow times the mean annual concentration of Cs-137 and subtracting the upriver from the downriver value. This is illustrated below for 1983.

Downriver

(1.189E + 13 L)(0.067 pCi/L)(1.0E-12 Ci/pCi) = 0.797 Ci

Upriver

(9.911E + 12 L)(0.016 pCi/L)(1.0E-12 Ci/pCi) = 0.159 Ci

Difference 0.638 Ci SRS contribution in 1983

Similar calculations are shown for 1983 through 1988 in Table 4-6. Over this six-year period, the average annual release of Cs-137 from SRS streams to the Savannah River is estimated to be approximately 0.51 Ci. Based on Table 4-6, it does not appear that the restart of L Reactor in October 1985 had a significant impact on radiocesium transport in the Savannah River resulting from SRS operations. By analogy, the restart of K, L, and P Reactors, scheduled for 1990, should not significantly increase radiocesium transport in the Savannah River. It is anticipated that the SRS contribution of Cs-137 transport will remain in the range of 0.25-0.77 curie per year (mean ±2 standard deviations, Table 4-6).

The Cs-137 contributions of individual SRS streams to the Savannah River have been estimated (Hayes, 1990). Based on that study, the primary source of cesium in the river from SRS operations is Cs-137 remobilized from sediments in the SRS stream system. Analyses of the Cs-137 transport data indicate that the CS-137 contributions to the Savannah River by area are as follows: L-40.3%, P-28.7%, K-3.5%, and Four Mile Creek (Separations) -27.5%.

4.2.5 Summary of Offsite Dose Commitment from K-, L-, and P-Reactor Operations

Table 4-7 summarizes the maximum individual committed effective dose equivalents and population collective committed effective dose equivalents for combined K-, L-, and P-Reactor operations. The numbers listed as totals for individual doses are conservative maximums; to receive these doses, the "composite" individual would have to occupy several locations simultaneously. Also, these doses are bounding cases in that they are based on full-power operations of all three reactors.

TABLE 4-6

Cesium-137 Transport in the Savannah River Resulting from SRS Operations

Above the Savannah River Site

Year	River Flow (L/yr)	Mean Cs-137 (pCi/L)	Mean Transport (Ci/yr)
1983	9.91E+12	0.0160	0.159
1984	8.94E+12	0.0120	0.107
1985	6.69E+12	0.0150	0.100
1986	5.33E+12	0.0210	0.112
1987	5.70E+12	0.0100	0.057
1988	4.68E+12	0.0140	0.065

Below the Savannah River Site

Year	River Flow (L/yr)	Mean Cs-137 (pCi/L)	Mean Transport (Ci/yr)	Contribution from SRS (Ci/yr)
1983	1.19E+13	0.067	0.797	0.638
1984	1.07E+13	0.064	0.685	0.578
1985	8.02E+12	0.077	0.618	0.518
1986	6.06E+12	0.114	0.691	0.579
1987	7.22E+12	0.074	0.534	0.477
1988	5.15E+12[a]	0.065	0.335	0.270
			6 yr avg	0.510
			Std Dev	0.130

[a] Measured below the Vogtle Electric Generating Plant

TABLE 4-7

Summary of Committed Effective Dose Equivalents from K-, L-, and P-Reactor Operations

Maximum Individual Adult Dose (millirem)

Source	SRS Reactors
Atmospheric releases	3.42E-01
Liquid releases	3.18E-02
Cs-137 and Co-60 transport	2.81E-01
Total	6.55E-01

Regional Population Dose (person-rem)

Source	Within 80 km	Beaufort-Jasper & Port Wentworth
Atmospheric releases	2.14E+01	-
Liquid releases	7.41E-03	9.26E+00
Cs-137 and Co-60 transport	7.93E-01	3.22E-01
Total	2.22E+01	9.58E+00

The composite maximum individual dose of 0.66 millirem is 0.22 percent of the average dose of 295 millirem received by an individual living near the SRS from natural radiation. The population dose of 31.8 person-rem to the 80-km-radius population (852,000 people) and downriver water consuming population groups (317,000 people) is 0.01 percent of the exposure of 345,000 person-rem received by these population groups from natural radiation.

4.2.6 Health Effects from K-, L-, and P-Reactor Operations

Radiation-induced health effects that could occur as a result of K-, L-, and P-Reactor operations (including atmospheric and liquid radioactive releases) were calculated using health risk estimators proposed by the Environmental Protection Agency (EPA, 1989). The risk estimator used was 400 cancer deaths per 1,000,000 person-rem exposure. Multiplying the regional population doses (from Table 4-7) by this risk estimator projects a maximum of 0.01 excess cancer fatalities in the population within 80 kilometers of the SRS and 0.004 excess cancer fatalities in the downriver water-consuming populations of Port Wentworth and Beaufort-Jasper. These risk estimates may be considered conservative values as they are based on full power operation of all three reactors.

4.2.7 Occupational Dose

At the K, L, and P Reactors, occupational dose would be maintained as low as reasonably achievable. All personnel who work in or enter areas that have radiation exposure potential receive personal monitoring devices. In addition, a comprehensive bioassay program is maintained for all employees who work in areas where there is a potential for biological uptake of radioactivity. Table 4-8 lists the total dose commitments to workers in the reactor areas during operations at full power and moderator containing normal amounts of tritium. When L Reactor was operated at full power part of the time in 1986, the heavy water moderator contained little tritium. During 1987, all reactors were operated at partial power, and in 1988 were shut down for about nine months after operating at 50 percent of full power.

Table 4-8 lists 11 reactor-years of operation with tritium in equilibrium in the moderator. The annual average occupational dose commitment per reactor-year was 55.6 rem. The work force for a reactor area varies with the amount of construction work and work crew assignments consistent with program schedules. The average work force in each reactor is about 400 people; thus, the average annual individual dose to workers in the K-, L-, and P-Reactor areas would be about 140 millirem.

TABLE 4-8

Occupational Dose in Reactor Areas at Full Power with Moderator Tritium in Equilibrium[a]

Year	Reactor (person-rem cumulative) C	K	P
1983	59.4	60.6	54.5
1984	58.8	61.3	48.5
1985	59.9	50.7	42.5
1986	Shutdown	58.6	57.0
Average	59.4	57.8	50.6

Overall average per reactor-year -- 55.6 person-rem

[a] L-Reactor operated at full power in Nov-Dec 1986 but moderator contained little tritium.

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4.2.8 Solid Radioactive Waste

About 640, 675, and 690 cubic meters of solid radioactive waste would be generated annually at the K, L, and P Reactors, respectively. This waste would be packaged and transported to the SRS low-level waste burial ground. The burial ground is divided into sections to accommodate different levels of radioactivity. The waste is buried in trenches that are about 6 meters deep and 6 meters wide. The exact location of the burial trenches is defined, and accurate records are kept of the contents of each trench.

Currently, radioactive waste from the reactor areas is separated into two types, trash that is contained in metal burial boxes and metal scrap from fuel and target disassembly operations. Existing burial space for trash will be filled by the 1st quarter of Calendar Year (CY) 1992 and metal scrap in the 4th quarter of CY 1991. When existing burial space is used, a new burial ground will be put in operation just north of the existing burial ground. The new burial ground will have a capacity for waste from 20 years of operation of the SRS facilities.

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5.0 TRANSPORTATION

Radioactive materials transported on the Savannah River Site include radioactive materials in the forms of powders, bulk liquids, samples, solid billets, fabricated components, gases, solid wastes, and contaminated equipment. Nonradioactive hazardous material forms that are transported at the SRS include bulk liquids, granular solids, liquid gases, laboratory reagents, and janitorial supplies. A comprehensive listing of the radioactive and nonradioactive hazardous materials transported on the SRS is provided in Appendix B of the Safety Analysis report for onsite transportation of hazardous materials (WSRC, 1989).

Packaging for hazardous materials transported at the site incorporates U.S. Department of Transportation (DOT) specification packaging, including cargo vehicles that meet DOT specifications; DOE and NRC certified Type B packaging for radioactive materials; and SRS-designed packaging for specialized applications.

Transportation operations are controlled by established procedures and other administrative controls. Vehicles move between facilities, carrying out specified hazardous material activities, with only infrequent flow modifications to accommodate special cargoes. These transportation operations are normally conducted between shift changes when the traffic density is lower. Except for rail operations, vehicles move over the roads independently of other vehicle movements. With the exception of the relatively low traffic density, onsite transportation has the appearance of general commerce transportation off the site.

5.1 ONSITE AND OFFSITE SHIPMENTS

The flow of hazardous materials to and from each onsite facility can be grouped into three categories: essential materials, products, and wastes. Essential materials are the raw materials, process chemicals, and other supplies that are the feed stocks used in SRS facilities to produce products. Products of a facility may be feed stocks for one or more other facilities. Hazardous radioactive and nonradioactive wastes are generated at various stages of these processes. Some wastes are treated and disposed of at the SRS while others are packaged and shipped offsite.

Uranium fuel and target assemblies are produced in the 3/700 Area from raw materials received from offsite sources. The assemblies/targets are transported to the 100 Areas where they are charged into the reactor core. The irradiated fuels and targets that are subsequently discharged from the reactors are then transported to the 200 Areas (the separations areas) for chemical processing. Chemical processing operations may generate products that are subsequently reworked into targets or assemblies. For previous Pu-238 campaigns, for example, the use of neptunium-aluminum billets was required. These billets were produced from the processing of uranium fuels in the 200 Area. The billets were then transported to the 3/700 Area where they were used to fabricate targets. The targets in turn were transported to the reactor areas where they were irradiated to produce Pu-238. The irradiated targets were transported to the 200 Areas where the Pu-238 was recovered and incorporated into product capsules. These radioactive heat source capsules were subsequently shipped to offsite users.

Truck Shipments

In support of interrelated processing and reactor support activities, essential materials other than the radioactive materials are transported at the SRS. Nitric acid, sodium hydroxide, liquid chlorine, petroleum distillates, and more than 100 other hazardous materials are transported to and from onsite facilities (WSRC, 1989). Gasoline and other light petroleum distillates are the most frequently moved nonradioactive hazardous materials shipped by truck. These shipments account for 78% of nonradioactive hazardous materials shipments by truck. Nitric acid is next representing 11% of the shipments. The flow of nonradioactive hazardous materials is shown in Reference WSRC, 1989.

Each facility also generates wastes as inevitable by-products of its function. Although some wastes are chemical hazards only, some are mixed radioactive-chemical wastes, and others are radioactive only. Waste that are low-level radioactive wastes or mixed waste are transported to the SRS Burial Ground in the 200 Area for evaporation before transfer into waste tanks. Nonradioactive hazardous wastes are transported on trucks to onsite storage areas.

Rail Shipments

Coal and cask car movements comprise the bulk of the rail traffic on the SRS. Coal is moved from the CSX interchanges at Dunbarton and Ellenton to area powerhouses for use in steam-generating boilers. Cask cars are moved between the reactors and the 200-F and 200-H separations buildings. Other cargo, such as tank cars, steel, utility poles, bulk chemicals, helium, and a variety of other goods are moved from the CSX Railroad to the SRS Railroad and then to areas within the site. The various categories of radioactive materials received and shipped to and from the reactor areas are described in Section 5.1.1 below.

5.1.1 Onsite shipments to and from Reactor Areas

Shipments on the SRS rail system to or from reactor areas would include the following:

1. Empty reactor fuel element casks.

2. Intact irradiated fuel in 70-ton casks (CD casks) on flatbed rail cars to 200-F or 200-H Areas.

3. Any irradiated fuel with cladding defects in a special containment device ("harp") within a 55-ton failed fuel element cask to a 200 Area.

4. Occasional containers of helium or Polybor or other nonradioactive materials.

Onsite truck shipments for reactor areas would include the following:

1. Unirradiated fuel in steel shipping boxes and other reactor lattice components from the 300-M Area.

2. Irradiated lithium-aluminum control rods and blanket assemblies in a 45-ton cask on a flatbed trailer from the reactor disassembly basins to 200-H Area.

3. Irradiated scrap metal in a 15-ton cask or replacement cask from the reactor area disassembly basins to the SRS burial ground.

4. Moderator (D_2O) in stainless steel 55-gallon drums between reactor areas and the 400-D Area (the contaminant removal and purification facilities).

5. D_2O purification deionizers from reactor areas. After the resin is depleted, the deionizer would be shipped to 100-K Area in a cask on a special flatbed trailer for dedeuterization before being shipped to the burial ground. A replacement D_2O equilibrated purification deionizer would be shipped concurrently from 100-K.

6. Basin water deionizers mounted in casks on a special trailer to Building 245-H for regeneration and return to reactor area service.

7. Liquid and gas samples in a DOT package on a pickup truck to laboratories on each shift.

8. Dry wastes intermittently generated during jobs such as replacing containment filters to the SRS burial ground.

9. Liquid light-water wastes to the underground storage tank in the 100-C Area (infrequently) or, when volumes are large, to F-Area waste management tanks in an unshielded tank trailer.

10. Nonradioactive materials to reactor areas. Bulk shipments include:

    - One ton chlorine cylinders,
    - 15 gallon drums or tank car, sodium hypochlorite
    - Caustic soda, tank truck,
    - Sulfuric acid, tank truck,
    - Diesel fuel oil, tank truck, and
    - Diesel fuel for emergency generators, tank truck.

5.1.2 Offsite Shipments

Shipments of materials from off the site to support the operation of K, L, and P Reactors include petroleum distillate products from major distribution terminals in Richmond County, Georgia, and Aiken County, South Carolina; chemicals from various commercial distribution points; and nuclear materials from other DOE facilities. These offsite shipments of nuclear and other hazardous materials are subject to the same Department of Transportation (DOT) regulations (49 CFR 170-179) as other similar cargo in commerce.

Primary reliance for safety in the commercial transport of hazardous materials, including nuclear material, is placed on the containment afforded by the packaging. The hazardous materials packaging standards applicable to the SRS are those established by DOT regulations and DOE Orders. For nonradioactive hazardous materials, DOT regulations specify the use of containers that are compatible with the chemicals and will confine the material during normal handling and transportation. For radioactive materials, these standards are based on material-specific requirements for containment, shielding, nuclear criticality safety, and heat dissipation.

The standards for nuclear materials provide that the packaging shall prevent the loss or dispersal of the radioactive contents, retain shielding efficiency, assure nuclear criticality safety, and provide adequate heat dissipation under normal conditions of transport and under specified accident damage test conditions. The quantity of material contained in packages not designed to withstand accidents (i.e., Type B or other non-Type A containers) is limited as specified in international and DOT regulations. If all the radioactive contents of a Type B container were released during/after an accident on the SRS, the consequences would therefore be within the limits deemed acceptable by the international and U.S. expert agencies responsible for setting radiation and environmental protection standards. Additionally, the quantities of material contained in Type B shipping packages is limited so that standards for external radiation levels, temperature, pressure, and containment are not exceeded based on criteria established in NRC regulations addressing the packaging and transportation of radioactive materials (10 CFR Part 71).

Protection of transportation workers and of the public from external radiation is provided by DOE limitations on the radiation levels at the surface of, and at specified distances from, the outside of nuclear materials packages, and by storage and segregation provisions for such packages when in transit. The number of packages in a single vehicle or area is limited to control the aggregate radiation level and to ensure nuclear criticality safety. In addition, shipments of special nuclear materials such as plutonium and enriched uranium are escorted by specially equipped DOE couriers to safeguard against theft or sabotage.

5.2 EMISSIONS FROM OPERATIONS OF VEHICLES

DOE owned and privately owned vehicles are operated on over 150 miles of paved roads on the plant to permit ready access between production and support facilities throughout SRS. Unpaved roads serve environmental monitoring stations, timber management needs, and security checkpoints. Transportation of the plant population to their work place is served by four-lane highways from Augusta, Georgia, and Aiken, South Carolina. Adequate roads serve Barnwell and Allendale, South Carolina. South Carolina Highway 125 is open to the public for through traffic and is controlled with passes.

Vehicles operated on these highways result in the release of typical combustion products dependent upon vehicle class and type of fuel consumed. See Section 5.4.1 for the discussion on air quality influences of operating vehicles on SRS.

In general, transportation requirements on the Savannah River Site fall into one of four categories: personnel, construction, stores, and operations. Personnel transportation is primarily by car and light trucks, except for shuttle busses (vans) that serve the plant areas during the day shift. Subcontractors operate commercially owned vehicles to transport personnel and materials. Construction transportation, other than of construction personnel, includes equipment and materials. Construction traffic is routed either to a construction site directly or through the Central Shops Area and then to the construction site. Summary information from reference SAIC, 1987 follows.

Stores and operations traffic use road systems between all areas on the site. About 30 trucks per day deliver store materials to Central Stores in the 700-A Area. Central Stores off-loads, stores, and redistributes the material at a rate of about 9 truck loads per day. In addition, about 40 truck loads per day of stores material are delivered to specific production areas without passing through Central Stores. This material is primarily bulk chemical purchases and other goods used only in specific areas of the plant.

Operations traffic includes the transfer by truck of intermediate products in the Savannah River Site production cycle from one processing area to another, the transfer of materials within a production area, and specific transfers of other items between production areas, generally shipments to the Burial Grounds. The CSWE Department is responsible for the majority of the operations traffic including the maintenance of all DOE owned vehicles. CSWE has several types of activities requiring road usage, including Central Trucking, grounds maintenance, and heavy equipment. Requests from other site organizations for transport service by Central Trucking are routed through the dispatcher. For the nine-month period from March to November 1985, total moves recorded by the dispatcher averaged 426 per month, and ranged from 358 to 490.

At the end of FY 88, the DOE owned fleet consisted of:

- 330 sedans and stations wagons
- 1108 trucks of less than 8600 lb
- 74 trucks of 8600 to 12,499 lb
- 87 trucks of 12,500 to 23,999 lb
- 94 trucks of 24,000 lb or more, and
- 106 special purchase vehicles including ambulances and buses

Operation of these DOE owned vehicles on the SRS roads resulted in consumption of 1,321,365 gallons of gasoline and diesel fuels in FY 88.

Private vehicle traffic on SRS peaks at the normal commuter rush hours. During the day, most private vehicles remain parked, with government-owned and other official vehicles comprising the major portion of the traffic.

In October 1985, traffic counts were made by Wackenhut Services, Inc., at some of the site gates (barricades) and on the roads leading into the 700-A Administration Area. The 700-A Area traffic count was made on Wednesday, October 9, 1985, from 7-8 a.m. The count of inbound traffic (into the 700-A Area) was as follows:

Point X:	Road 1, northeast bound from SC Hwy 125	866 vehicles
Point Y:	Green Pond Church Road, southeast bound	515 vehicles
Point Z:	Road 1, southwest bound from Road 2	722 vehicles

Barricades 1 through 5 are generally considered outer gates, with 6 through 10 typically serving intrasite traffic. In addition, Barricades 9 and 10 provide access between the 3/700 Area and the other site areas. Gate traffic was counted in hourly increments at Gates 1 through 5, 9, and 10. Peak inbound morning traffic at Barricade 1 on Road C was 2,570 vehicles. Peak outbound traffic was 2,730.

It is likely that most commuters use the same barricade to leave work that they used to get to work. Estimates in October 1985 for peak period traffic at barricade entry points to the SRS facilities other than those facilities in 3/700 Area were:

Gate	Number of Vehicles
1	2,570
2	1,680
3	265
4	510
5	275
1 to 5	5,300

Traffic counts were repeated in late 1988 and the peak traffic in the 3/700 Area was estimated to have increased about 30% compared to values in SAIC, 1987. In March 1986, private vehicles counted in parking lots were 7,420 in 3/700 Area and a total of 5,150 in all other site parking lots (SAIC, 1987).

The 1988 counts indicated a large increase in private vehicles parked in expanded 3/700 Area parking lots. Consumption of fuels by private vehicles operated by employees traveling to their work site was not estimated.

5.3 RADIOLOGICAL IMPACTS

5.3.1 Routine Radiation Exposures

5.3.1.1 Onsite Transportation

Nuclear materials moved onsite are packaged to contain the material during transit and shielded to minimize radiation exposures to drivers, riggers, and other personnel near the material during transportation activities. The DOE contract specifies that the operating contractor is to use procedural controls, escorts, and traffic controls when transporting materials onsite. Personnel involved in these shipments were TLD radiation detection devices; but with few exceptions, radiation exposures received during transportation are small components of the radiation dose equivalents accumulated by these individuals. Radiation exposure records show that the cumulative exposures to employees assigned to transportation and rigging activities average about 2 to 3 person-rem per year per reactor area when three reactors are operated at full power and with D_2O at tritium equilibrium levels.

For railcar shipments, the 70-ton casks used to ship irradiated reactor fuel are separated from the locomotive by one or two spacer cars. The incremental exposure to the rail crew is estimated to be less than 10 mrem per year. The casks used to ship irradiated materials from reactor areas by truck are mounted on assigned trailers and do not require rigging. The annual radiation exposure for a driver operating a cask truck on a full-time basis is typically about 300 mrem per year or less.

5.3.1.2 Offsite Transportation

The radiation levels from offsite shipments to or from the SRS are well below DOT radiation limits for transportation of nuclear materials. Most of these shipments are made on exclusive use vehicles and have measured radiation levels representing small percentages of the applicable DOT radiation standards: (1) depleted uranium forms - less than 1%, (2) uranyl nitrate solutions in MC 312 cargo tankers - less than 2%, and (3) safe secure transporter (SST) - about 10%.

5.3.2 Safeguards

Special Nuclear materials (SNM) products and enriched uranium resulting from the operation of the reactors and their support facilities are shipped to and from the Savannah River Site in packages that meet DOT Type A or Type B requirements. These shipments are safeguarded by the use of DOE's SST system with a courier escort. The SST-type transporter is essentially a mobile vault with built-in deterrent and disabling devices; it is operated by carefully selected, specially trained personnel. SST tractors and DOE escorts are also used to move the MC 312 cargo tankers containing enriched uranyl nitrate hexahydrate solution.

5.3.3 Accident Release Risks

5.3.3.1 Onsite Shipments

The cumulative risks for release of radionuclides during onsite transportation to and from 100 Areas are estimated to be about 5.2×10^{-3} Ci beta-gamma per year, 5.1×10^{-5} Ci alpha per year, and 6.8×10^{-2} Ci tritium per year, as shown in Table 5-1 (WSRC, 1989). The cumulative risks for release of radioactivity for all SRS facilities are estimated to be 7.5×10^{-3} Ci beta-gamma per year, 8.1×10^{-8} Ci alpha per year, and 7.0×10^{-2} Ci tritium per year (WSRC, 1989).

A more detailed discussion of the potential impact to human health from onsite transportation accidents involving radioactive materials is presented below. A number of postulated accidents and their consequences are reviewed. For atmospheric releases, accident analyses have been performed for both reactor facility and support facility operations. Based on those analyses, the bounding case atmospheric release scenario for the site is a uranyl nitrate hexahydrate (UNH) trailer accident at the intersection of SRS Roads 1A and D. In terms of liquid releases, the bounding transportation accident for the site is a high-level waste (HLW) trailer accident resulting in a unmitigated discharge to the Savannah River. These atmospheric and liquid release scenarios are summarized in Table 5-2.

The release conditions detailed in Table 5-2 were established on the basis of largest relative contributions to risk as determined by a comprehensive study of hypothetical and historical rail and truck transportation accidents at the SRS (WSRC, 1989). The study generated the source terms, accident probabilities, and accident frequencies used in this assessment.

The effective dose equivalents and the potential health impacts associated with each accident scenario are shown in Table 5-3. The overall risks presented by the accidents are detailed in Table 5-4 in terms of the probability of receiving a given dose in a given year. Though a bounding transportation accident involving a reactor-related operation has been examined (the D_2O drum rupture), the greatest impacts to individuals and populations at risk are associated with support facility operations. Therefore, the discussion below is limited to an analysis of the support facility accident scenarios.

5.3.3.1.1 Atmospheric Releases

The risks to individuals from atmospheric releases of radioactivity are associated with (1) inhalation of radioactive material and (2) direct radiation from exposure to the plume. The magnitude of the impact to

TABLE 5-1

Risk of Release of Radionuclides from Shipments to/from Reactor Areas

Truck	Alpha	Beta & Gamma	Tritium
		(Ci/yr)	
Irradiated targets cask	-	-	2×10^{-7}
100-Area scrap metal casks	ES[a]	ES	ES
Analytical samples/every shift	-	-	6.8×10^{-3}
Unshielded tank trailers	5.1×10^{-5}	5.0×10^{-3}	-
Deionizer casks	-	2×10^{-4}	-
D_2O drums	-	-	6×10^{-2}
Unirradiated fuel/target assemblies	ES	ES	-
Rail			
Irradiated fuel element casks	5×10^{-9}	2×10^{-6}	8×10^{-4}
Totals	5.1×10^{-5}	5.2×10^{-3}	6.8×10^{-2}

[a] Extremely small.

Source: WSRC (1989)

TABLE 5-2

Projected Releases from Transportation Accidents

Radionuclide(s) Released[a]	Atmospheric Releases: UNH Trailer Accident[b]	HLW Trailer Accident	TRU Drum Failure and Fire	Rupture of D_2O Drum	Liquid Releases: HLW Trailer Accident
	Curies				
H-3				1.00E+03	
Sr-90		2.00E-04			2.00E+00
Zr-95		1.05E-03			1.05E+01
Nb-95		2.10E-04			2.10E+00
Ru-103		2.29E-03			2.29E+01
Ru-106	10 Ci	1.44E-02			1.44E+02
Cs-134	B-G	3.00E-05			3.00E-01
Cs-137		2.66E-04			2.66E+00
Ce-141		2.20E-04			2.20E+00
Ce-144		1.46E-03			1.46E+01
U-235	100E-01				
Pu-238			8.40E-03		
Pu-239		1.00E-02			1.00E+02
Postulated location	A Area Roads 1A&D	F Area (Road C)	Burial ground entrance	Road 3 & SC 125	Upper Three Runs

[a] Source terms based on values reported in WSRC, 1989.
[b] Uranyl nitrate hexahydrate composition is sensitive information. The source term used for the dose estimates was based on 10 Ci of mixed beta-gamma fission products.

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TABLE 5-3

Dose and Health Effects Estimates for Transportation Accidents

Event Description	Dose Equivalent/Event Max Ind 200 ft (mrem)	Max Ind Perimeter (mrem)	Onsite Popula (per-rem)	Offsite Popula (per-rem)	Health Effects Per Event[a] Onsite Popula	Offsite Popula
Atmospheric Releases						
UNH trailer accident	1.81E+05	1.12E+03	2.31E+02	5.61E+02	9.24E-02	2.24E-01
HLW trailer accident	5.67E+04	2.51E+01	1.11E+02	1.01E+02	4.44E-02	4.04E-02
TRU drum failure and fire	4.29E+04	1.53E+01	7.73E+01	8.80E+01	3.09E-02	3.52E-02
Rupture of D_2O drum	5.96E+02	7.94E-01	1.81E-01	1.89E+00	7.24E-05	7.56E-04
Liquid Releases						
HLW trailer accident	N/A	2.51E+01	N/A	5.47E+03	N/A	2.19E+00

[a] Health effects estimates are based on 400 fatal cancers/1,000,000 person-rem as proposed for use in EPA, 1989.

TABLE 5-4

Annual Transportation Accident Risks

Event Description	Probability of Event (yr^{-1})	Risk Estimates (yr^{-1}) Max Ind 200 ft (mrem)	Max Ind Perimeter (mrem)	Onsite Popula (per-rem)	Offsite Popula (per-rem)
Atmospheric Releases					
UNH trailer accident	1.30E-04	2.35E+01	1.46E-01	3.00E-02	7.29E-02
HLW trailer accident	1.50E-09	8.51E-05	3.77E-08	1.67E-07	1.52E-07
TRU drum failure and fire	1.50E-05	6.44E-01	2.30E-04	1.16E-03	1.32E-03
Rupture of D_2O drum	3.10E-05	1.85E-02	2.46E-05	5.61E-06	5.86E-05
Liquid Releases					
HLW trailer accident	1.50E-11	N/A	3.77E-10	N/A	8.21E-08

[a] A risk estimate is the product of the dose/event and the probability of the event.

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human health is dictated by the behavior and the fate of the plume following a release. At SRS, the movements of accidental releases of airborne radioactivity are modeled using the computer code AXAIR. AXAIR (Huang and Pillinger, 1985) is an SRS version of an NRC computer code (NRC, 1979) specifically designed for use in performing accident consequence analyses. AXAIR was used in this study to estimate doses via the inhalation and direct radiation pathways to the onsite maximum individual, the offsite maximum individual, and the onsite and offsite populations based on demographic projections for the year 2000. The dose commitments calculated by AXAIR are those that would be exceeded only 0.5% of the time under worst-case meteorological conditions.

5.3.3.1.1.1 Maximum Onsite Individual

For the maximum onsite individual, the largest doses are associated with a uranyl nitrate hexahydrate trailer accident in A Area. Such an accident would potentially liberate 0.1 Ci of alpha and 10 Ci of beta/gamma activity, and would have significant health consequences for an individual located directly downwind at the minimum evacuation distance of 200 feet. Additionally, as indicated by Table 5-5, the UNH trailer accident has the greatest probability of occurrence relative to the other postulated accidents.

5.3.3.1.1.2 Maximum Offsite Individual

For the atmospheric release scenarios examined, there were no cases of site boundary doses that would present a significant threat to human health or suggest a need for offsite emergency response. The criteria requiring an offsite emergency planning zone are perimeter doses exceeding a 5 rem effective dose equivalent, a 25 rem thyroid dose, or a 25 rem dose to a critical organ (Du Pont, 1983). As shown in Table 5-4, the largest effective dose equivalent projected for a hypothetical individual at the site boundary was 1.12 rem - 22.4% of the criterion.

5.3.3.1.1.3 Onsite and Offsite Populations

The impact to the onsite and offsite populations from postulated atmospheric releases can only be described in a statistical fashion because the doses involved would be very minor contributions to the overall doses received by these persons. The figure-of-merit used in this study to assess health effects is the number of fatal cancers potentially associated with the theoretical dose contributions of the SRS. The health effects estimates shown in Table 5-4 are based on the central risk estimate recommended for use in 40 CFR Part 61 (EPA, 1989). Use of the EPA value suggests that 0.092 and 0.224 excess fatal cancers, respectively, would ultimately appear in the onsite and offsite populations if the worst-case doses were received. In those same populations, however, approximately 2420 and 133,700 fatal cancers, respectively, will result from other sources (EPA, 1989). Therefore, no observable impacts to the onsite and offsite populations surrounding the SRS are expected from the atmospheric release of materials liberated by transportation accidents.

5.3.3.1.2 Liquid Releases

If a transportation accident were to occur near an onsite stream or marsh, the potential offsite transport of radioactivity via the Savannah River would be of concern. In this section, the impact of a bounding case liquid release to SRS surface waters is evaluated for a maximum individual and for the downstream consumers of treated Savannah River water. Since onsite streams are not used as drinking water sources, onsite population doses are not applicable. Additionally, transportation accidents are not expected to impact groundwater (WSRC, 1989). Therefore, this discussion focuses exclusively on onsite maximum individual and population doses.

The method used in this assessment to calculate dose-to-man from liquid releases is that recommended in the U.S. NRC Regulatory Guide 1.109 (NRC, 1977a). The computer code LADTAP II, developed by the NRC and the Oak Ridge National Laboratory (Simpson and McGill, 1980), determines downstream concentrations and doses to individuals and populations resulting from ingestion of and contact with radionuclides in fresh or salt water systems. LADTAP II, as modified by SRS, produces downstream concentrations of radionuclides in the Savannah River using a conservative estimate, 6000 cfs, of the river flow rate at the time of the accidental release. Other site-specific factors and human water usage parameters are also included in the SRS version of the code.

5.3.3.1.2.1 Maximum Individual

The doses reported in Table 5-4 for a maximum individual are based on a hypothetical person living just downstream of the SRS and subsisting principally on a diet of untreated Savannah River water and Savannah River fish. Additionally, this individual is assumed to spend many hours fishing, swimming, and boating at that location. No such person is known to exist.

For the postulated worst-case accident, an HLW trailer overturning into Upper Three Runs, the effective dose equivalent to the maximum individual is approximately 25 mrem. Given that the average individual living in the CSRS receives a dose of approximately 295 mrem/yr, the additional 8% contribution from the HLW trailer accident would not represent a significant health threat to the very conservatively defined maximum individual. Further, the probability of the HLW trailer accident is so small that the overall risk to an individual is essentially negligible.

5.3.3.1.2.2 Offsite Population

The offsite populations at risk from a liquid release of radioactivity are the downstream consumers of drinking water distributed by the Beaufort-Jasper and Port Wentworth water treatment plants. Both plants utilize Savannah River water at locations approximately 100 miles below the SRS. The collective dose to both populations from the bounding accident would be 5470 person-rem which could potentially produce two fatal cancers within the combined populations. However, the probability of the accident occurring is approximately one chance in 10^{11}/yr. Consequently, the risk to the offsite populations from this source of radioactivity is an insignificant component of the overall risks to which they are exposed.

5.3.3.2 Offsite Shipments

Nuclear materials shipped offsite are normally in solid form and packaged to meet accident resistance criteria specified in DOT regulations. An NRC analysis (NRC, 1977b) of radiological risks nationwide included an examination of these shipments and may be referred to for additional information.

Uranyl nitrate hexahydrate solution is shipped in DOT MC-312 cargo tanks that might, after an accident, release UNH solution on or near a bridge and could contaminate a stream supplying a public water supply. In an extreme accident scenario involving a major fire, some respirable particulates might be generated. The integrated radiological risk to the population along the route from these scenarios is estimated to be about 2×10^{-6} person-rem per shipment (Du Pont, 1982).

5.4 NONRADIOLOGICAL IMPACTS

Routine transportation activities involving nonradioactive hazardous materials onsite may influence air quality because of emissions by vehicles. Release of hazardous materials resulting from leaking containers or dispersal following an accident may expose persons near or downwind of the accident.

5.4.1 Emissions from Vehicles

Air pollutants emitted from routine operation of vehicles supporting SRS activities have been estimated. SRS vehicle fleets that were included in the analysis are operated by the primary operating contractor, the security contractor, DOE, the Savannah River Ecology Laboratory, and the U.S. Forestry Service. Emissions from vendor-operated vehicles transporting materials and supplies on and offsite were also estimated. Several small vehicle fleets are operated onsite by support services and subcontractors. These fleets were not included in this analysis.

Emissions were estimated for the primary fuel combustion products, carbon monoxide (CO), nitrogen oxides (NO_x), and hydrocarbons (HC), and for particulate matter resulting from the vehicle exhaust, tire abrasion, and roadway dust.

Mileage and fuel consumption data for the onsite fleets were summarized from motor vehicle operations information reported annually by DOE and fuel supplies reported in WSRC (1989). Accrued mileage and fuel consumption for the offsite transportation sources were based on information given in SAIC (1987) and WSRC (1989). The emission estimates were calculated using these mileage and fuel use data and appropriate emission factors from Environmental Protection Agency (EPA) publications. Emission factors (amount per vehicle mile) for CO, NO_x, and HC were based on EPA (1984), assuming a 1988 vehicle fleet, and the emission factors for particulates were taken from EPA (1985). Vehicles were classified as either light duty (gasoline fueled) or heavy duty (diesel fueled). Offsite transportation was assumed to consist of heavy duty vehicles.

Estimated annual emissions for all SRS activities is summarized in Table 5-5. Annual vehicle emissions directly related to operation of light duty vehicles assigned to the K, L, and P Reactors is estimated to be approximately one-tenth of the listed totals, based on vehicle utilization information reported during 1989.

Operational transportation related air pollution is not expected to result in a significant ambient air quality impact at SRS since the emissions listed in Table 5-5 are distributed over a network of more than 150 miles of road throughout the entire SRS. Furthermore, most of the emissions occur during daylight hours when atmospheric conditions are generally favorable for dispersion of air pollutants.

Relatively large annual emissions of air pollutants can be expected from operation of private vehicles used for commuting. However, these emissions would occur over several hundred square miles on and surrounding the SRS. Relatively high air pollutant concentrations could occur along the principal routes leading into the SRS during the morning and evening rush periods. However, any impact would be extremely localized and short lived.

5.4.2 Risk from Nonradiological Materials

For nonradioactive hazardous materials moved onsite, liquid chlorine transported in one-ton cylinders and bulk acids transported as concentrated liquids pose the greatest risks to onsite and offsite personnel. Risk values are 5.9×10^{-1} person/yr onsite and 8.8×10^{-3} person/yr offsite for individuals exposed above the toxic health effects thresholds for these materials. The expected frequency of accidents involving releases of liquid chlorine is 1.1×10^{-3}/yr (WSRC, 1989).

The release of acids from tank trucks or chlorine from damaged drums of sodium hypochlorite pose much smaller risks. See WSRC, 1989 for assessments of risks from onsite transportation activities of nonradioactive hazardous materials.

TABLE 5-5

Estimated Annual SRS Emissions of Air Pollutants from Routine Transportation Sources

	Cars and Light Trucks	Heavy Duty Trucks[a]
Fuel	Gasoline	Diesel
Gallons consumed	866,000	550,000
Miles incurred	12,500,000	3,000,000
Emissions (tons)		
Carbon monoxide	326	20
Nitrogen oxides	42	35
Hydrocarbons	36	8
Particulates	330	79

[a] Includes emissions from offsite vehicles.

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6.0 IMPACTS FROM REACTOR SUPPORT FACILITIES

6.1 RADIOLOGICAL IMPACTS OF SUPPORT FACILITIES

Associated with reactor operations are support facilities that manufacture fuel and target elements (300-M Raw Materials Area), purify heavy water moderator (400-D Heavy Water Area), process reactor fuel and target elements (200-F and -H Separations Areas), and provide technical support (Savannah River Laboratory). (Appendix C provides a brief description of these existing support facilities and new support facilities that are in the planning or construction stage.) All of these operations release small amounts of radioactive materials to the environment. This section characterizes the release of radioactive materials and presents the radiological impact of the releases on the maximally exposed individuals and on population groups.

6.1.1 Atmospheric Releases of Radioactivity from Existing Support Facilities

The operation of K, L, and P Reactors will result in releases of radioactive materials to the atmosphere from support facilities comparable to the releases from these facilities in recent years. Table 6-1 lists the annual average releases from support facilities based on averages for the years 1985 and 1986.

6.1.2 Atmospheric Releases of Radioactivity from New Support Facilities

Currently, a number of new support facilities are in the planning or construction stage and do not currently release radioactive materials to the atmosphere. These new facilities, which will be in operation by the year 2000, are the Defense Waste Processing Facility (DWPF), the Consolidated Incineration Facility (CIF), and the Replacement Tritium Facility (RTF). In addition, the F and H Effluent Treatment Facility (ETF) was placed in operation in late 1988 and releases of radioactive materials from this facility are not included in Table 6-1. Estimated annual average releases of radioactivity to the atmosphere from these new support facilities are listed in Table 6-2.

6.1.3 Wastewater Discharges of Radioactivity from Existing Support Facilities

Liquid releases of radioactivity to surface streams from the fuel and target production area, heavy water rework area, chemical separations areas, and the Savannah River Laboratory consist of direct releases and migration of groundwater from beneath seepage basins. In 1988, an Effluent Treatment Facility (ETF) was placed in operation for the Separations Areas. Following startup, discharges of process wastewater to seepage basins were discontinued. Seepage basins in these areas are no longer used for the discharge of radioactivity but the inventory of

TABLE 6-1

Expected Annual Atmospheric Releases from Reactor Support Facilities (curies per year)

Nuclide	Support Facilities				
	Sepns	Raw Mat.	H.Water	SRL	Total
H-3 (oxide)	1.88E+05	0.00E+00	1.55E+03	1.65E+01	1.89E+05
H-3 (elem.)	1.60E+05	0.00E+00	0.00E+00	0.00E+00	1.60E+05
H-3 Total	3.48E+05	0.00E+00	1.55E+03	1.65E+01	3.49E+05
C-14	2.80E+01	0.00E+00	0.00E+00	0.00E+00	2.80E+01
Ar-41	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85	6.80E+05	0.00E+00	0.00E+00	0.00E+00	6.80E+05
Kr-87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-131m	2.65E+00	0.00E+00	0.00E+00	0.00E+00	2.65E+00
Xe-133	3.20E-03	0.00E+00	0.00E+00	0.00E+00	3.20E-03
Xe-135	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-129	7.60E-02	0.00E+00	0.00E+00	0.00E+00	7.60E-02
I-131	3.14E-02	0.00E+00	0.00E+00	1.80E-03	3.32E-02
Co-60	4.00E-06	0.00E+00	0.00E+00	0.00E+00	4.00E-06
Se-75	1.52E-05	0.00E+00	0.00E+00	0.00E+00	1.52E-05
Sr-89,90	1.39E-03	0.00E+00	0.00E+00	1.30E-05	1.40E-03
Zr-95	1.68E-02	0.00E+00	0.00E+00	0.00E+00	1.68E-02
Nb-95	2.89E-02	0.00E+00	0.00E+00	0.00E+00	2.89E-02
Ru-103	7.25E-03	0.00E+00	0.00E+00	0.00E+00	7.25E-03
Ru-106	5.12E-02	0.00E+00	0.00E+00	0.00E+00	5.12E-02
Cs-134	3.62E-04	0.00E+00	0.00E+00	0.00E+00	3.62E-04
Cs-137	4.07E-03	0.00E+00	0.00E+00	0.00E+00	4.07E-03
Ce-141	1.83E-03	0.00E+00	0.00E+00	0.00E+00	1.83E-03
Ce-144	3.11E-02	0.00E+00	0.00E+00	0.00E+00	3.11E-02
Os-185	3.60E-04	0.00E+00	0.00E+00	0.00E+00	3.60E-04
U-235,238	2.00E-03	1.04E-04	0.00E+00	0.00E+00	2.10E-03
Pu-238	1.28E-03	0.00E+00	0.00E+00	0.00E+00	1.28E-03
Pu-239	4.01E-04	1.41E-05	0.00E+00	1.50E-06	4.17E-04
Am-241,243	2.90E-04	0.00E+00	0.00E+00	0.00E+00	2.90E-04
Cm-242,244	1.37E-04	0.00E+00	0.00E+00	0.00E+00	1.37E-04

TABLE 6-2

Expected Annual Atmospheric Releases from New Reactor Support Facilities (curies per year)

Nuclide	NEW SRS FACILITIES NOT IN OPERATION 1984 - 1986				
	DWPF	F & H ETF	CIF	RTF	TOTAL SRS
H-3	1.99E+01	5.99E+02	8.08E+01	5.00E+03	5.70E+03
C-14	2.12E-02	0.00E+00	0.00E+00	0.00E+00	2.12E-02
CR-51	0.00E+00	2.35E-07	6.48E-05	0.00E+00	6.50E-05
CO-58	0.00E+00	4.69E-08	0.00E+00	0.00E+00	4.69E-08
CO-60	6.12E-08	4.69E-08	1.76E-05	0.00E+00	1.77E-05
ZN-65	0.00E+00	3.76E-08	0.00E+00	0.00E+00	3.76E-08
SE-79	8.84E-09	0.00E+00	0.00E+00	0.00E+00	8.84E-09
SR-89	0.00E+00	1.89E-06	5.02E-05	0.00E+00	5.21E-05
SR-90	2.29E-05	3.24E-06	4.23E-05	0.00E+00	6.84E-05
Y-90	2.36E-05	7.95E-07	9.05E-07	0.00E+00	2.53E-05
Y-91	0.00E+00	3.49E-06	3.00E-05	0.00E+00	3.35E-05
ZR-95	0.00E+00	8.07E-06	2.02E-05	0.00E+00	2.83E-05
NB-95	0.00E+00	1.13E-05	4.86E-05	0.00E+00	5.99E-05
TC-99	3.79E-07	0.00E+00	0.00E+00	0.00E+00	3.79E-07
RU-103	0.00E+00	1.40E-05	0.00E+00	0.00E+00	1.40E-05
RU-106	3.18E-05	8.44E-05	3.52E-05	0.00E+00	1.51E-04
SN-126	6.89E-09	0.00E+00	0.00E+00	0.00E+00	6.89E-09
SB-125	6.67E-07	9.38E-09	0.00E+00	0.00E+00	6.76E-07
I-129	8.19E-05	5.41E-08	0.00E+00	0.00E+00	8.20E-05
I-131	0.00E+00	5.41E-08	0.00E+00	0.00E+00	5.41E-08
TE-125M	1.00E-05	7.52E-10	0.00E+00	0.00E+00	1.00E-05
TE-127M	4.46E-09	0.00E+00	0.00E+00	0.00E+00	4.46E-09
TE-127	4.37E-09	0.00E+00	0.00E+00	0.00E+00	4.37E-09
CS-134	2.92E-05	1.97E-06	0.00E+00	0.00E+00	3.12E-05
CS-135	9.37E-09	0.00E+00	0.00E+00	0.00E+00	9.37E-09
CS-137	4.07E-03	5.71E-06	1.70E-04	0.00E+00	4.25E-03
CE-141	0.00E+00	9.81E-07	0.00E+00	0.00E+00	9.81E-07
CE-144	3.04E-06	3.94E-05	1.32E-04	0.00E+00	1.74E-04
PR-144	3.05E-06	3.87E-05	1.32E-04	0.00E+00	1.74E-04
PM-147	7.62E-06	1.37E-06	6.16E-05	0.00E+00	7.06E-05
SM-151	1.59E-07	0.00E+00	0.00E+00	0.00E+00	1.59E-07
EU-152	1.39E-09	0.00E+00	0.00E+00	0.00E+00	1.39E-09
EU-154	2.30E-07	0.00E+00	0.00E+00	0.00E+00	2.30E-07
EU-155	1.61E-07	0.00E+00	0.00E+00	0.00E+00	1.61E-07
TH-234	0.00E+00	3.22E-10	0.00E+00	0.00E+00	3.22E-10
U-235	0.00E+00	4.07E-08	0.00E+00	0.00E+00	4.07E-08
U-238	0.00E+00	1.82E-09	0.00E+00	0.00E+00	1.82E-09
PU-238	7.89E-07	1.46E-07	0.00E+00	0.00E+00	9.35E-07
PU-239	7.10E-09	8.84E-08	0.00E+00	0.00E+00	9.55E-08
PU-240	4.82E-09	0.00E+00	0.00E+00	0.00E+00	4.82E-09
PU-241	7.71E-07	0.00E+00	0.00E+00	0.00E+00	7.71E-07
AM-241	8.62E-09	0.00E+00	0.00E+00	0.00E+00	8.62E-09
CM-244	2.66E-08	0.00E+00	0.00E+00	0.00E+00	2.66E-08

radioactivity in groundwater will continue to outcrop to surface streams in decreasing amounts until depleted by radioactive decay and migration. Table 6-3 lists the expected annual average releases of radioactivity to surface streams, including measured migration of tritium (10,500 Ci/yr) and strontium-90 (0.242 Ci/yr) from the seepage basins. As mentioned above, the migration component is expected to decrease with time through radioactive decay and depletion of tritium and strontium-90 in the groundwater. Thus, the use of current migration of tritium and strontium-90 in dose calculations is conservative in that doses will be overestimated for the year 2000. The releases in Table 6-3 are based on average release values for the years 1984 through 1986.

6.1.4 Wastewater Discharges of Radioactivity from New Support Facilities

The only new support facilities that will discharge radioactivity to a surface stream in wastewater is the F and H Effluent Treatment Facility (ETF). The F and H Effluent Treatment Facility (ETF), which was placed in operation in late 1988, decontaminates wastewater that was previously discharged to seepage basins in the Separations Areas. With the startup of this facility, discharge of wastewater to seepage basins was discontinued. Essentially all radioactivity except tritiated water is removed in the treatment process. The decontaminated wastewater, containing tritiated water, is discharged to a surface stream. When in full-scale operation, the ETF is expected to discharge about 30,000 Ci/yr of tritiated water to a surface stream. The estimated annual average releases of radioactivity to a surface stream from the F and H ETF are listed in Table 6-4.

6.1.5 Dose Commitments from Existing Support Facilities Operations

6.1.5.1 Maximum Individual Dose from Atmospheric Releases

The individual who would receive the highest dose from atmospheric releases from existing support facilities was assumed to reside continuously at the SRS perimeter. The location on the site perimeter where this individual resides was selected as the one where the total maximum offsite doses are predicted to occur. The effective dose equivalent commitment to the maximally exposed individual from atmospheric releases from existing support facilities was calculated to be 0.31 millirem. The maximum organ dose was 2.81 millirem to the thyroid.

6.1.5.2 Population Dose from Atmospheric Releases

The effective dose equivalent commitment to the 80-kilometer-radius population of 852,000 people (year 2000) from atmospheric releases from existing support facilities was calculated to be 21.1 person-rem. The maximum organ dose was 127 person-rem to the thyroid.

TABLE 6-3

Expected Annual Liquid Releases to Surface Streams from Existing Support Facilities (curies per year)

Nuclide	Existing Support Facilities				
	Sepns	Raw Mat.	H.Water	SRL	Total
H-3	1.38E+04	0.00E+00	3.12E+03	0.00E+00	1.70E+04
Sr-90	2.73E-01	0.00E+00	6.73E-03	1.39E-04	2.80E-01
I-129	2.20E-02	0.00E+00	0.00E+00	0.00E+00	2.20E-02
Cs-137	1.49E-01	0.00E+00	4.83E-04	0.00E+00	1.49E-01
U-235,238	0.00E+00	1.83E-02	0.00E+00	0.00E+00	1.83E-02
Pu-239	1.47E-02	0.00E+00	1.26E-02	2.22E-04	2.75E-02

TABLE 6-4

Expected Annual Liquid Releases to Surface Streams from New Support Facilities (curies per year)

	NEW SRS FACILITIES NOT IN OPERATION 1984 - 1986	
Nuclide	F & H ETF	Total
H-3	3.25E+04	3.25E+04
SR-90	5.00E-02	5.00E-02
BETA(a)	1.20E-01	1.20E-01
ZR-95	2.00E-02	2.00E-02
NB-95	1.50E-02	1.50E-02
RU-106	6.00E-01	6.00E-01
CS-137	2.50E-02	2.50E-02
PM-147	5.00E-02	5.00E-02
U-235	0.00E+00	0.00E+00
ALPHA(b)	5.00E-03	5.00E-03

a. Assumed to be SR-90.

b. Assumed to be PU-239.

6.1.5.3 Maximum Individual Doses from Liquid Releases

The individual who would receive the highest dose from liquid releases from existing support facilities was assumed to reside continuously on or near the Savannah River just downstream of SRS. This individual is assumed to spend much time in recreational activities on the river, drinks river water, and consumes a large amount of fish from the river. The effective dose equivalent commitment to the maximally exposed individual from liquid effluent releases from existing support facilities operations was calculated to 0.14 millirem. The highest organ dose was 0.31 millirem to bone surfaces. This includes dose from current contribution of migration of radioactivity from seepage basins to surface streams and is expected to decrease in future years.

6.1.5.4 Population Dose from Liquid Releases

One of the population groups exposed to effects from SRS releases are parts of the 80-km-radius population who use the river for recreational activities and consume sport and commercial fish catches from the river. Other exposed population groups are 317,000 domestic water customers (Year 2000) from two water treatment plants located about 160 kilometers (100 miles) downstream of SRS, i.e., the plant at Port Wentworth, GA, and the Beaufort-Jasper Water Authority in South Carolina. The effective dose equivalent commitment to the 80-kilometer-radius population was calculated to be 0.26 person-rem; the population dose to Port Wentworth and Beaufort-Jasper customers was calculated to be 15.7 person-rem. The maximum organ dose to water treatment plant customers was calculated to be 47.2 person-rem to bone surfaces.

6.1.6 Dose Commitments from New Support Facilities Operations

6.1.6.1 Maximum Individual Doses from Atmospheric Releases

The individual who would receive the highest dose from atmospheric releases from new support facilities was assumed to reside continuously at the SRS perimeter. The location on the site perimeter where this individual resides was selected as the one where the total maximum offsite doses are predicted to occur. The effective dose equivalent commitment to the maximally exposed individual from atmospheric releases from new support facilities was calculated to be 0.0064 millirem. The maximum organ dose was 0.0091 millirem to the thyroid.

6.1.6.2 Population Dose from Atmospheric Releases

The effective dose equivalent commitment to the 80-kilometer-radius population of 852,000 people (year 2000) from atmospheric releases from new support facilities was calculated to be 0.5 person-rem. The maximum organ dose was 0.62 person-rem to the thyroid.

6.1.6.3 Maximum Individual Dose from Liquid Releases

The individual who would receive the highest dose from liquid releases from new support facilities was assumed to reside continuously on or near the Savannah River just downstream of SRS. This individual is assumed to spend much time in recreational activities on the river, drinks river water, and consumes a large amount of fish from the river. The effective dose equivalent commitment to the maximally exposed individual from liquid effluent releases from new support facilities operations was calculated to be 0.11 millirem. The highest organ dose was 0.16 millirem to bone surfaces.

6.1.6.4 Population Dose from Liquid Releases

One of the population groups exposed to effects from SRS releases are parts of the 80-kilometer-radius population who use the river for recreational activities and consume sport and commercial fish catches from the river. Other exposed population groups are 317,000 domestic water customers (year 2000) from two water treatment plants located about 160 kilometers (100 miles) downstream of SRS, i.e., the plant at Port Wentworth, GA, and the Beaufort-Jasper Water Authority in South Carolina. The effective dose equivalent commitment to the 80-kilometer-radius population was calculated to be 0.076 person-rem; the population dose to Port Wentworth and Beaufort-Jasper customers was calculated to be 26.6 person-rem. The maximum organ dose to water treatment plant customers was calculated to be 34.2 person-rem to bone surfaces.

6.1.7 Summary of Offsite Doses from Support Facilities Operations

Table 6-5 summarizes the dose to the maximally exposed individuals and population dose from operation of existing and new support facilities. The numbers listed as totals for individual doses are conservative maximums; to receive these doses, the "composite" individual would have to occupy several locations simultaneously.

The composite individual dose of 0.57 millirem is only about 0.2 percent of the average individual dose of 295 millirem received by an individual near the SRS from natural sources. The doses this individual receives are well below the DOE protection guides of 100 millirem per year from all pathways (not to exceed 25 millirem from atmospheric pathways) (DOE, 1985). The population dose of 64.2 person-rem is only 0.02 percent of the dose of about 345,000 person-rem to the population within 80 kilometers of SRS and the Beaufort-Jasper and Port Wentworth drinking water population from natural radiation sources.

6.1.8 Health Effects from Support Facilities Operations

Radiation-induced health effects that could occur as a result of support facilities operations (including atmospheric and liquid releases) were calculated using risk estimators proposed by the Environmental Protection

TABLE 6-5

Summary of Committed Effective Dose Equivalents from Support Facilities Operations

Maximum Individual Adult Dose (millirem)

Source	millirem
Atmospheric Releases	
Existing Facilities	3.12E-01
New Facilities	6.42E-03
Liquid Releases	
Existing Facilities	1.41E-01
New Facilities	1.11E-01
Total	5.70E-01

Regional Population Dose (person-rem)

Source	Within 80 km	Beaufort-Jasp & Port Wentw.
Atmospheric Releases		
Existing Facilities	2.11E+01	-
New Facilities	5.04E-01	-
Liquid Releases		
Existing Facilities	2.59E-01	1.57E+01
New Facilities	7.57E-02	2.66E+01
Total	2.19E+01	4.23E+01

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Agency (EPA, 1989). The risk estimator used was 400 cancer deaths per 1,000,000 person-rem exposure. Multiplying the regional population doses (from Table 6-5) by this risk estimator projects a maximum of 0.01 excess cancer fatalities in the population within 80 kilometers of SRS and 0.02 excess cancer fatalities in the Beaufort-Jasper and Port Wentworth drinking water population.

6.1.9 Occupational Dose

The annual occupational radiation doses in support facilities are shown in Table 6-6 for the period 1983 through 1986. Three reactors were operated at full power in that time interval except in December 1986. The annual average occupational doses were 695 person-rem in Separations Areas (200 F and H), 76 person-rem in the Fuel and Target Fabrication Area (300 M), and 77 person-rem in other support facilities, a total of 849 person-rem in all support facilities. Brief descriptions of support facilities are given in Appendix C.

TABLE 6-6

Occupational Dose in Support Facilities (person-rem)[a]

Year	200 F&H	300 M	Other	Total
1983	651.8	87.8	55.8	795.4
1984	664.5	78.3	69.7	812.5
1985	760.9	68.2	83.2	912.3
1986	704.0	71.2	99.2	874.4
Average	695.3	76.4	77.0	848.65

[a] In 1983 through 1986 three reactors were operated at full power.

References: DPSPU-85-11-1 Radiation Exposure Report
DPSPU-87-11-1 Radiation Exposure Report

6.2 NONRADIOLOGICAL ATMOSPHERIC IMPACTS OF SUPPORT FACILITIES OPERATIONS

Nonradiological air pollutants emitted from support facility operations include criteria and hazardous air pollutants. The criteria air pollutants are those substances which have national ambient standards established under Section 109 of the Clean Air Act. Hazardous air pollutants are considered to be those substances that are listed under the Superfund Amendments and Reauthorization Act (SARA), have national emission standards established under Section 112 of the Clean Air Act, or have ambient standards established under draft South Carolina air toxics regulations.

6.2.1 Criteria Air Pollutants

The primary continuous sources of criteria air pollutants in the reactor support areas are the coal-fired powerhouses in A, D, and H Areas, the fuel and target assembly fabrication facilities in M Area, and the chemical separations facilities in the F and H Areas. In addition, two diesel generators operate continuously in each of the F and H Areas. Other sources of criteria air pollutants from support facility areas include about 50 emergency diesel generators, coal storage piles and transfer operations, vehicular traffic, chemical storage tanks, and activities associated with ongoing construction projects.

6.2.1.1 Atmospheric Emissions

Support facility operations and emissions information were taken from South Carolina Department of Health and Environmental Control (SCDHEC) air permits, routine SRS emissions inventory reports, and Livengood (1989). Specific air emissions estimates were based on data from these sources and appropriate Environmental Protection Agency (EPA) emission factors.

6.2.1.1.1 Powerhouses

The powerhouses in A and H Areas produce steam for space heating and operational processes in their respective areas. The H-Area powerhouse also provides steam to C Area. The A-Area powerhouse consists of two coal-fired stoker-grate boilers each with a rated capacity of 71.7 million BTU per hour input. Each boiler can produce up to 60,000 pounds of steam per hour. The powerhouse facility at H Area consists of three boilers with identical capacity and design.

The D-Area powerhouse consists of four coal-fired, wet-bottom boilers each having a rated capacity of 396 million BTU per hour input. These boilers produce steam for space heating requirements in D, C, F, and H Area. The powerhouse is also equipped with seven turbogenerators to supply electric power to the onsite electrical grid. Peak SRS electric power demand at full operation is estimated to be about 180 Mw. The

D-Area powerhouse supplies about 60 Mw of electric power. The remaining power is supplied by the K- and P-Area powerhouses (approximately 10 Mw) or purchased from the local utility (approximately 110 Mw).

Atmospheric emissions from the powerhouse facilities have been permitted by SCDHEC. Permitted emissions limits are identical to those described for the K- and P-Area powerhouses in Chapter 4 (0.6 and 3.5 pounds per million BTU input for total suspended particulates (TSP) and sulfur dioxide (SO_2), respectively, and 40 percent effluent opacity). No violations of the permit conditions have been reported over the last several years (Du Pont, 1984-87).

Estimated annual criteria air pollutant emissions from the powerhouses are summarized in Table 6-7. Emissions of total oxides of sulfur (SO_x) and nitrogen (NO_x) are provided as conservative estimates of SO_2 and nitrogen dioxide (NO_2), respectively. These estimates were based on coal consumption for a two-year period, 1987-1988. Data for this period is considered reasonably representative of present site-wide powerhouse utilization.

The TSP emissions estimates listed in Table 6-7 include operation of effluent control devices. Control devices for the A- and H-Area powerhouses consist of two single stage mechanical cyclone precipitators which have been estimated to remove about 93 percent of the particulate matter from the effluent on the average. Each of the four stacks adjacent to the D-Area powerhouse is equipped with a dry cyclonic dust collector and an electrostatic precipitator in series. These control devices have been estimated to remove about 99 percent of the particulate matter on the average (Livengood, 1989). Emissions of SO_x, NO_x, and carbon monoxide (CO) are uncontrolled.

Fugitive emissions of particulates can be expected from coal handling activities associated with each powerhouse. These emissions are due to wind induced erosion from adjacent storage piles, transfer operations for incoming rail car shipments, and storage pile maintenance. Emissions from these sources were estimated to be less than a ton per year (EPA, 1988). In addition, a 300-ton coal crusher at the D-Area powerhouse, permitted by SCDHEC, emits relatively small amounts of particulates.

6.2.1.1.2 F-, H-, and M-Area Processes

Chemical processes associated with fabrication of reactor fuel and target assemblies, and radionuclide separations following irradiation of the assemblies in the reactors, require nitric acid (HNO_3). These processes result in atmospheric emissions of NO_x from the 313-M and 321-M building stacks, the 221-F stack (F-canyon exhaust), and the 221-H stack (H-canyon exhaust).

The NO_x emissions from each of these facilities have been permitted by the SCDHEC. Permit conditions limit effluent opacity to 40 percent. In addition, the H-Area effluent is limited to annual average NO_x emissions

TABLE 6-7

Estimated Annual Emissions of Criteria Pollutants from Support Area Facilities

Area	Source	Emissions (tons)			
		SO_x	TSP	NO_x	CO
A	Powerhouse[a]	390	65	140	50
D	Powerhouse[b]	6930	210	4650	82
H	Powerhouse[c]	370	70	135	50
	Canyon (221-H)	-	-	60	-
	Diesels[d]	3	3	42	9
F	Canyon (221-F)	-	-	600	-
	Diesels[e]	4	4	54	12
M	Process stacks	-	-	10	-

[a] SO_x, NO_x, and CO emissions based on consumption of 20,000 tons of lump bituminous coal averaging 1% sulfur and 8% ash content (Livengood, 1989), and EPA emission factors (EPA, 1988).

[b] SO_x, NO_x, and CO emissions based on consumption of 273,400 tons of pulverized bituminous coal averaging 1.3% sulfur and 10% ash content (Livengood, 1989), and EPA emission factors (EPA, 1988).

[c] SO_x, NO_x, and CO emissions based on consumption of 19,150 tons of lump bituminous coal average 1% sulfur and 8% ash content (Livengood, 1989), and EPA emission factors (EPA, 1988).

[d] Emissions based on consumption of 180,000 gallons of number 2 diesel fuel (Livengood, 1989), and EPA emission factors (EPA, 1986).

[e] Emissions based on consumption of 230,000 gallons of number 2 diesel fuel (Livengood, 1989), and EPA emission factors (EPA, 1986).

Additional sources: Livengood (1989) (Powerhouse TSP emissions) and Du Pont (1982) (F and H-canyon emissions, and M-Area emissions) of 25 pounds per hour. Permit compliance information reported in Du Pont (1984-87) indicate that emissions form the H- and M-Area stacks have not violated permit conditions over the last four years. Periodic opacity exceedances have been reported for the F-canyon stack effluent.

Estimated process-related NO_x emission for each area are given in Table 6-7. The emissions from the F-canyon stack are controlled by a nitric acid absorption column which recovers HNO_3 by scrubbing the NO_x in the process offgas. This process has been estimated to remove about 70 percent of the NO_x entering the column. A project is currently underway to automate control and improve efficiency of the absorption column process, reducing the quantities of NO_x released to the atmosphere (WSRC, 1989). Emissions from the H-Area stack are controlled by a glass fiber filter which removes more than 95 percent of the NO_x in the process offgas. Emissions from the 313-M stack are controlled by a nitric acid scrubber system which removes approximately 30 percent of the NO_x from the process offgas. The NO_x emissions from the 320-M stack are uncontrolled.

Diesel generators operating in the support facility areas are primarily used for emergency power. The emergency generators are permitted to operate up to 83 hours per month; however, actual operating time is typically a few hours per month for testing. In addition, two generators in H Area and two generators in F Area are permitted to operate continuously. Estimated annual emissions from operation of these generators are also listed in Table 6-7.

6.2.1.3 Cumulative SRS Air Quality Impacts

The cumulative impact of criteria air pollutant emissions from reactor and support facility operations were estimated using the Industrial Source Complex (ISC) air dispersion model (EPA, 1987). Ambient pollutant concentrations were calculated using emissions estimates given in Chapter 4, Section 4.2.1, and in Table 6-7, and meteorological data sets for each of the five years from 1982-1986. The ISC model and preparation of the meteorological data sets are described in more detail in Appendix D.

Model estimated ambient ground-level concentrations for each primary criteria pollutant are summarized in Table 6-8. For each averaging period, the listed value is the highest estimated concentration for receptor locations on or beyond the SRS boundary for any of the five annual calculations. The National Ambient Air Quality Standards (NAAQS) are also listed in Table 6-8. For all averaging times, the model estimated concentrations are generally much less than the corresponding ambient standard. Maximum offsite concentrations occurred southwest of the SRS. This pattern is due to the proximity of the D-Area powerhouse and the relatively high frequency of northeasterly winds during stable atmospheric conditions.

TABLE 6-8

Estimated Air Quality Impacts for Criteria Pollutant Emissions - Reactor and Support Facility Operations

Pollutant	Averaging Period	Estimated Concentration ($\mu g/m^3$)	NAAQS[a] ($\mu g/m^3$)
SO_x	3-hour	950	1300[b]
	24-hour	240	365
	Annual	12	80
TSP	24-hour	8	150
	Annual	<1	50
NO_x	Annual	9	100
CO	1-hour	26	40000
	8-hour	10	10000

a Listed standards are for SO_2, PM-10 (particulates less than 10 micron diameter), NO_2, and CO.

b Secondary standard

The model estimated concentrations were also compared to available air monitoring data to qualitatively assess the contribution of SRS emissions to observed ambient concentrations. Air monitoring data from the three-year period 1984-1986 were used for this examination. These data are discussed in Chapter 1.

Ambient SO_x concentrations estimated by the model agree reasonably well with onsite SO_2 measurements, indicating that SRS emissions contribute substantially to actual ambient SO_2 concentrations on and near the SRS. Model estimated maximum 3- and 24-hour average SO_x concentrations at receptors representing the onsite air monitoring locations were two to five times greater than observed maxima. Estimated annual SO_x concentrations were within a factor of two of observed onsite SO_2 concentrations.

Available TSP data from onsite samplers and from nearby samplers operated by the states of Georgia and South Carolina show that observed TSP concentrations throughout the Aiken-Augusta area are frequently greater than 50 percent of the secondary 24-hour and annual standard. These data, and the model estimated TSP concentrations, suggest that the impact of particulate emissions from all SRS facility operations on observed concentrations is small relative to the impact of total regional particulate emissions.

Model estimated annual average NO_x concentrations agree reasonably well with measured concentrations of NO_2. The onsite NO_x emissions likely contribute substantially to observed concentrations, although the impact of these emissions are small relative to the ambient standards.

6.2.2 Hazardous Air Pollutants

Routine atmospheric emissions of hazardous chemicals from all SRS operations are reported annually to SCDHEC as required by Title III of SARA. Atmospheric emissions reported for calendar year 1988 are summarized in Table 6-9. These data are considered reasonably representative of current operational practices at SRS. All of these chemicals except aluminum oxide, chlorofluorocarbon (CFC) 113, lead, and manganese compounds are regulated under South Carolina's draft air toxics regulations.

The hazardous chemicals released to the atmosphere in the greatest amounts (CFC 113, nitric acid, sodium hydroxide, and trichloroethane) are from support facility operations. CFC 113 is used primarily for metal component degreasing operations in M Area. Studies are currently underway to develop and implement a detergent degreasing agent that is much less volatile than CFC 113. Consequently, these emissions will likely be eliminated within the next few years (WSRC, 1989). Most of the nitric acid and sodium hydroxide emissions result from the chemical separations processes in the F and H Areas. Nitric acid is also emitted from fuel and target fabrication operations in M Area. Trichloroethane (TCE) emissions occur in relatively small quantities from many areas at SRS.

TABLE 6-9

Atmospheric Emissions of Hazardous Chemicals at SRS

Chemical	Annual Emission (pounds)
Aluminum Oxide	<1
Chlorine	<1
Chlorofluorocarbon 113	326,000
Lead	<1
Manganese Compounds	<1
Methyl Isobutyl Ketone	<1
Nitric Acid	54,100
Phosphoric Acid	<1
Sodium Hydroxide	10,270
Sulfuric Acid	<1
Trichloroethane	10,400
Xylene (Mixed Isomers)	1,230

The draft South Carolina air toxics regulations require a demonstration that emissions of designated hazardous air pollutants from proposed new or modified sources will not result in ambient 24-hour average concentrations at the site boundary in excess of threshold values. These values are generally a factor of 200 less than the American Council of Governmental and Industrial Hygienists threshold limit value, or other appropriate limiting value for the substance.

The ISC air dispersion model was used to estimate maximum offsite 24-hour average concentrations of nitric acid and sodium hydroxide. Concentrations were calculated using the emissions data given in Table 6-9 and hourly average meteorological data for 1985. (Previous analyses for the criteria pollutants indicated that the 1985 meteorological data provided reasonably conservative 24-hour ambient pollutant concentrations.)

The estimated maximum 24-hour ground-level concentrations are summarized in Table 6-10. The proposed South Carolina ambient standard is also shown. Estimated concentrations for each pollutant are much less the proposed standard.

6.2.3 Impacts from New Facilities

New support facilities at SRS that are expected to be operational by the year 2000 are described in Appendix C. Construction activities associated with these facilities may temporarily increase criteria pollutant concentrations near the construction site. However, the offsite impact of these activities are expected to be negligible. Operations of the Defense Waste Processing Facility (DWPF) and the Consolidated Incineration Facility (CIF) will result in emissions of up to 37 tons per year of NO_x from each facility (DOE, 1988; DOE, 1989). The impact of these emissions on ambient NO_2 concentrations is expected to be small. Emissions of the other criteria air pollutants from these facilities are estimated to be generally less than one ton per year. Since steam and electricity for these facilities will be provided from existing supplies, no significant increase in powerhouse emissions are anticipated.

Operational processes associated with the DWPF will result in annual atmospheric emissions of up to 87 tons of benzene and 150 pounds of mercury from the H, S, and Z Areas. Estimated site boundary concentrations of these substances have been estimated to be less than the ambient standards established under the South Carolina draft air toxics regulations (DOE, 1988). Emissions of hazardous air pollutants from the CIF include hydrochloric acid, mercury, lead, fluorides, and organic compounds. Periodic monitoring programs and trial burn tests will be utilized to ensure that emissions are below applicable standards (DOE, 1989).

TABLE 6-10

Estimated Ambient Concentrations of Selected Hazardous Air Pollutants

Pollutant	Estimated Concentration[a] ($\mu g/m^3$)	Proposed SCDHEC Standard[a] ($\mu g/m^3$)
Nitric Acid	2	25
Sodium Hydroxide	<1	10

[a] Maximum 24-hour average concentration at the SRS boundary

REFERENCES FOR CHAPTER 6

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7.0 CUMULATIVE IMPACTS

7.1 RADIOLOGICAL IMPACTS

The cumulative radiological impacts are the sum of the impacts from cesium-137 transport in the Savannah River, from reactor operation, from existing support facilities, from new support facilities in the planning, construction, or early startup stage, and from other nearby nuclear facilities within an 80-km-radius. Nuclear facilities within 80 km include the Alvin W. Vogtle Nuclear Power Plant, the Barnwell Nuclear Fuel Plant (not expected to operate), and Chemical Nuclear Services, Inc., a commercial low-level radioactive waste disposal site. Operations of these facilities were reviewed to determine the potential cumulative radiological impact of all the facilities operating together.

Facilities currently operating at SRS are three operating reactors and support facilities. New support facilities are in the planning, construction, or early startup stage. New and existing support facilities are listed in the sections describing the radiological effect of these facilities; in addition, most of the support facilities are briefly described in Appendix C.

The Alvin W. Vogtle Nuclear Power Plant is about 7 km SSW of the SRS 400-D Heavy Water Rework Area. It is a two-unit pressurized water reactor (PWR) nuclear plant. Both units are currently in operation.

The Barnwell Nuclear Fuel Plant is about 14 km east of the center of SRS. This plant has never operated nor is it ever expected to operate. The normal operations of the Chem-Nuclear Services, Inc. low-level radioactive waste disposal site does not entail discharges of low-level radioactive materials to surface streams or the atmosphere.

The cumulative effective dose equivalent commitment to the maximally exposed offsite individuals and to the population are summarized in Table 7-1. The maximum individual dose is conservative because the "composite" individual would have to reside continuously at several different locations to receive the dose. The doses shown are for the year 2000 and are based on full-scale operation of all reactors and new and existing support facilities. Population doses reflect the expected population growth by the year 2000.

The composite maximally exposed individual dose of 1.25 millirem (0.67 millirem from atmospheric releases and 0.58 millirem from liquid releases) is only 0.4 percent of the 295 millirem dose received by this individual in a year from natural sources. The 97 person-rem population dose (43 person-rem from atmospheric releases and 54 person-rem from liquid releases) is only 0.03 percent of the 345,000 person-rem to the population living within 80 km of SRS and the Beaufort-Jasper and Port Wentworth drinking-water populations from natural sources.

Table 7-1
Cumulative Effective Dose Equivalent From SRS
Reactor Operation And Other Nearby Nuclear Facilities

Source of Exposure	Atmospheric Releases	Liquid Releases	Total
Maximum Individual Dose (millirem per year)			
Transport of Cs-137 in Savannah River	—	2.81E-01	2.81E-01
K-,L-,& P-Reactor operation	3.42E-01	3.18E-02	3.74E-01
Existing support facilities	3.12E-01	1.41E-01	4.53E-01
New support facilities	6.42E-03	1.11E-01	1.28E-01
Vogtle Nuclear Power Plant	5.85E-03	1.57E-02	2.16E-02
Total	6.66E-01	5.81E-01	1.25E+00
Regional Population Dose (person-rem per year) (a)			
Transport of Cs-137 in Savannah River	—	1.11E+00	1.11E+00
K-,L-,& P-Reactor operation	2.14E+01	9.27E+00	3.07E+01
Existing support facilities	2.11E+01	1.59E+01	3.70E+01
New support facilities	5.04E-01	2.67E+01	2.87E+01
Vogtle Nuclear Power Plant	1.92E-02	8.42E-01	8.61E-01
Total	4.30E+01	5.38E+01	9.68E+01

a. Includes doses from water consumed at Beaufort-Jasper and Port Wentworth.

7.2 HEALTH EFFECTS

The cumulative potential radiation-induced health effects from the operation of SRS reactors and support facilities and other nuclear facilities with 80 km (from atmospheric and liquid releases and transportation of cesium-137 in the Savannah River) were calculated by multiplying the population dose by the risk estimator of 400 cancer fatalities per 1,000,000 person-rem exposure. The projected cumulative health effect that might occur is 0.04 excess cancer fatalities from full-scale operation of all three reactors and support facilities in the year 2000.

APPENDIX A

RADIATION DOSE CALCULATIONS AND ASSUMPTIONS FOR NORMAL OPERATIONS

The normal operation of K, L, and P Reactors and associated support facilities will result in releases of radioactive materials. This appendix describes the methods and assumptions used to determine the radiological impacts associated with these normal releases.

Most of the radioactive materials released from SRS, with the exception of tritium oxide, generally result in such low concentrations in the environment that they may not be detectable by conventional monitoring procedures. Therefore, radiation doses to offsite individuals and population groups are calculated with mathematical models. These models use known transport mechanisms for atmospheric and liquid releases and known major pathways to man. Environmental measurements of tritium oxide are used to verify atmospheric dispersion in the transport models. Results of these comparisons are published annually in environmental reports for SRS. A comparison for several recent years is shown in Table A-1.

The models used for calculating the annual doses from SRS releases are radiation transport and dose models developed for the nuclear industry (NRC, 1977) to assess the effects of the operations of licensed commercial nuclear facilities. The models are implemented for dose calculations in this document in the following computer codes.

MAXIGASP: calculates maximum and average doses to offsite individuals from atmospheric releases.

POPGASP: calculates population doses from atmospheric releases.

LADTAP: calculates both maximum and average doses to offsite individuals and the population from atmospheric releases.

MAXIGASP and POPGASP are SRS-modified versions of the Nuclear Regulatory Commission (NRC) programs called XOQDOQ and GASPAR. The modifications were made to meet the requirements for input of physical and biological data which are specific to SRS. The basic calculations in the XOQDOQ and GASPAR programs were not modified. LADTAP is an unmodified version of the NRC program of the same name. The exposure pathways considered in these computer programs are illustrated in Figure A-1 and are briefly described below. Details on these computer models are available in (Eckerman, 1980 and Simpson, 1980).

Plume: external dose from radioactive materials transported by the atmosphere.

Ground: external dose from radioactive materials deposited on the ground.

Inhalation: Internal dose from inhalation of radioactive materials transported by the atmosphere.

Vegetation: Internal dose from consumption of vegetable food crops that are contaminated by radioactive materials deposited from the atmosphere.

Milk: Internal dose from consumption of milk that is contaminated by radioactive materials deposited from the atmosphere on vegetation.

Meat: Internal dose from consumption of meat products that are contaminated by radioactive material deposited from the atmosphere on vegetation.

Radiation doses are calculated for the maximally exposed individual, for the regional population within 80 kilometers of SRS, and to the population being served by the Beaufort-Jasper County, SC and Port Wentworth, GA water treatment plants.

A.1 ATMOSPHERIC TRANSPORT AND DOSE

The transport of radioactive materials from SRS by the atmosphere is calculated on the basis of meteorological conditions. Meteorological conditions are continuously measured at eight onsite meteorological towers and at a 1,200-ft television transmitting tower which is 30 km (18.8 mi) northwest of the geometric center of the SRS.

Calculations of atmospheric transport and deposition given in this document are based on meteorological dispersion and deposition which were calculated from meteorological measurements made over a five-year period (1982-1986). These measurements were collected from a meteorological tower located near the center of the SRS at the 200-H Separations Area. These data, in the form of frequency of wind speed, wind direction, and atmospheric stability category, are presented in Table A-2. H-Area meteorological data were used in all dose calculations to facilitate direct comparisons of reactor impacts. Composite doses were calculated using the site center as the release point. Reactor specific doses were calculated using the reactor building's coordinates as the release point.

The meteorological frequency tables shown in Table A-2 were used as input to the XOQDOQ atmospheric dispersion/deposition computer model. XOQDOQ accounts for the motion of the wind and the vertical and horizontal dispersion of the released radionuclides within the moving air mass, and for their removal from the air by deposition and radioactive decay. The model estimates the radioactive concentration in air per unit release rate (sometimes called "chi over Q") at prescribed ground-level positions in the vicinity of the point of release. Deposition of the radionuclides on the ground at these locations is also estimated (Tables A-3 and A-4).

These atmospheric transport models are based on methods that are used widely in the nuclear industry (NRC, 1973). At SRS, this model is implemented in the computer program XOQDOQ (Sagendorf, 1977). Environmental measurements of tritium oxide are used to verify atmospheric dispersion in the transport models. Results of these comparisons are published annually in environmental reports for SRS. A comparison for several recent years is shown in Table A-1.

A.1.2 Dose Calculations for Atmospheric Releases

Calculation of offsite individual and population dose commitments due to atmospheric releases of radioactivity are provided by MAXIGASP and POPGASP computer programs. Measured annual radioactive releases, annual average concentration and deposition factors (Tables A-3 and A-4), population distribution (Table A-5), and production data for vegetables, crops, meat, and milk (Table A-5) are all used in these programs. Individual and population radioactive intakes are based on inhalation and consumption rates for food and water as shown in Table A-6.

Radioactive intakes by offsite populations are converted to dose commitments by use of the DOE internal dose factors (DOE, 1988). These dose factors are based on methodology recommended by the International Commission on Radiological Protection (ICRP, 1978; ICRP, 1979). The dose factors provide estimates of 50-year dose equivalent commitments to a reference man for a unit intake of radioactivity.

The maximally exposed individual was assumed to be a "reference man" who resides at the point of highest exposure along the SRS buffer zone boundary. This maximum individual is also assumed to have living and consumption habits that would tend to maximize his dose.

For calculation of population dose from atmospheric releases, the estimated Year 2000 population of about 852,000 people living within 80 km of the center of SRS was used. Average living and consumption habits were used for these population dose calculations.

A.1.3 Environmental Dose Commitment Concept

Man can receive dose externally from radioactive materials outside the body or internally from the intake of radioactive material by inhalation, skin absorption, or ingestion. Radionuclides that enter the body are distributed to various body organs and are removed by normal biological processes and radioactive decay. The rate at which each radionuclide is removed from the body depends on its chemical, physical, and radiological properties. Historically, dose calculations have included an accounting of doses resulting from the fraction of radionuclides retained in the body for up to 50 years following the year of intake. This 50-year "integrating period" is included in the DOE internal dose factors used in dose calculations for this document.

Similarly, radioactive material released in any year, remains in the environment for varying lengths of time, depending on many environmental factors and the decay rate of each radionuclide. The environmental dose commitment (EDC) concept is employed to account for this residual radioactivity.

The EDC concept was developed by the Environmental Protection Agency (EPA, 1974). EPA has defined the environmental dose commitment as "... the sum of all doses to individuals over the entire time period the material persists in the environment in a state available for interaction with humans." The EPA report describes how this concept is implemented and presents some sample calculations. These calculations integrate doses for 100 years following radionuclide release rather than "the entire time period." This 100-year integrating period is distinct from the 50-year period described above because it deals with the accumulation of doses from residual radioactivity in the environment rather than in the body.

The 100-year integrating period was used in this analysis; in other words, all population dose calculations will include an accounting of population doses caused by environmental radioactivity levels for 100 years following each year's release. The 100-year period provides results that are meaningful by accounting for impacts over a period of time equal to the maximum lifetime of an individual; thus, it provides a measure of risk to an individual. Longer integrating periods or an infinite time integral would require extremely speculative predictions about man's environment for thousands of years into the future.

For all EDC calculations, no attempt was made to predict changes in environmental characteristics. Population size and distribution were based on latest estimates for the Year 2000. Historic meteorology was assumed to continue into the future. Food production and consumption patterns were assumed to be static.

A.2 LIQUID TRANSPORT AND DOSE

Radioactive materials released to SRS streams flow to the Savannah River. Although many of the radionuclides are measurable at the point of release, they fall below the minimum detectable concentration after dilution with river water. Only tritium oxide and trace amounts of strontium-90 and cesium-137 are routinely detected in the river. To account for the off-site doses from all releases to streams, it is necessary to employ an analytical model.

The radioactive materials released into streams, like those released to the atmosphere, become involved in complex physical, chemical, and biological processes. Some of these process involve dilution, while others involve physical and biological reconcentration. Transport of the radioactive materials released in liquid effluents then follow various pathways to man (Figure A-1). These pathways are briefly described as follows:

Drinking Water: internal dose from consumption of drinking water from the Savannah River and containing radioactive materials transported by the river.

Sport and Commercial Fish: internal dose from consumption of fish of Savannah River origin.

Salt Water Invertebrates: internal dose from consumption of shellfish from estuaries of the Savannah River.

Recreation: external dose from recreational activities on and along the Savannah River, i.e., shoreline activities, boating, and swimming.

The irrigation pathway shown in Figure A-1 is not included because no use of river water downstream from SRS for irrigation was known.

A.2.1 Flow Rate Data

Dilution of radioactive materials in the river is based on averages of continuous flow measurements made at the SRS by the U.S. Geological Survey (USGS). The average flow rate in the river used in calculations for this document was 10,000 cubic feet per second. A dilution factor of three was used for shellfish dose calculations because of dilution of estuarine waters with sea water.

A.2.2 Dose Calculations for Liquid Releases

Calculation of offsite individual and population dose commitment due to liquid releases of radioactivity from SRS are provided by the LADTAP computer program. Annual releases of radioactivity to the river, average river flow rates, population data, data for sports and commercial fish harvests, community water consumption, and recreational use of the river are all used in the LADTAP program. The data used in these calculations, as well as human consumption rates for water and fish, are shown in Tables A-7 and A-8.

The individual who would receive the maximum potential dose from liquid releases was assumed to live near the Savannah River, downstream from SRS. This individual was assumed to use river water regularly for drinking, to consume a large amount of river fish, and to receive external exposure from shoreline activities, swimming, and boating.

There is no known use of Savannah River water for human consumption to a distance of about 160 km downstream of SRS. At this distance, Beaufort and Jasper Counties, SC, will pump river water for treatment and service to a year 2000 population of about 117,000. Several kilometers farther downstream, the Cherokee Hill Water Treatment Plant draws water from the Savannah River to supply a business-industrial complex near Savannah, GA.

This water is not used at present for normal domestic service. However, it is assumed that about 200,000 people will use this water by the year 2000. Although these population groups are beyond the 80-km radius, drinking water doses for these groups have been included in this document. All population doses are 100-year environmental dose commitments.

A.3 RADIATION-INDUCED HEALTH EFFECTS

The projections of risk from exposure to ionizing radiation described in this section are an adaptation of a recent Environmental Protection Agency (EPA) report (EPA, 1989a) on this subject. The EPA report is an update of information previously published in the National Academy of Sciences (NAS) BEIR III Report (NAS, 1980). The reader is referred to these reports for more details.

A.3.1 Relationship of Dose to Risk and Health Effect

Ionizing radiation is radiation that strips electrons from matter through which it passes. The highly reactive electrons and ions created by this process in a living cell can produce, through a series of chemical reactions, permanent changes (mutations) in the cell's genetic material, the DNA. These may result in a cell death or an abnormally functioning cell. A mutation in a germ cell (sperm or ovum) may be transmitted to an offspring and be expressed as a genetic effect in that individual or to an individual of a subsequent generation; such a defect is commonly referred to as a genetic effect. There is also strong evidence that the induction of a mutation in a non-germ (somatic) cell can serve as a step in the development of a cancer. Finally, mutational or other events, including possible cell killing, produced in rapidly growing and differentiating tissues of an embryo or a fetus can give rise to birth defects; these are referred to as teratological effects. At acute doses above about 25 rads, radiation induces other deleterious effects in man; however, for low doses and dose rates encountered in the environment from SRS releases, only the three kinds of effects referred to above are thought to be significant.

Most important from the standpoint of total societal risk from exposures to low-level ionizing radiation are the risks of cancer and genetic mutations. These are believed to be stochastic effects; i.e., the probability of these effects increases with the absorbed dose of radiation, but the severity of the effects is independent of dose. There is no convincing evidence for a "threshold", i.e., some dose level below which the risk is zero. Any dose of radiation, no matter how small, might give rise to a cancer or a genetic effect. Conversely, there is no way to be certain that a given dose of radiation, no matter how large, has caused an observed cancer in an individual or will cause one in the future.

A.3.2 Cancer Risk Estimates for Low-LET Radiation

Low-LET (low-linear energy transfer) radiation is sparsely ionizing radiation like the energetic electrons produced by x-rays, gamma rays, and beta particles. Most of the radioactive materials released from SRS to the environment, including tritium, emit low-LET radiation during the process of radioactive decay. It is for this type of radiation that most of the observations of radiation-induced cancers in humans have been made. Observed groups include Japanese A-Bomb survivors and medical patients treated with diagnostic or therapeutic radiation.

The EPA has primarily used the BEIR III linear dose response model for estimating the response of radiogenic cancer due to low-LET radiation. To project the number of fatalities resulting from leukemia and bone cancer, EPA uses an absolute risk model, a minimum induction period of two years, and a 25-year expression period. To estimate the number of fatalities resulting from other cancers, EPA uses a relative risk projection model, a 10-year minimum induction period, and the remaining balance of an exposed person's lifetime as the expression period. These response and projection models were used with adjustments for age sensitivity and age distribution in the general population in arriving at a central estimate for lifetime risk of fatal cancers from ionizing radiation.

The EPA central estimate of lifetime risk, approximately 400 fatal cancers per 10^6 person-rad, is taken from the NAS BEIR III Committee report (NAS, 1980), incorporating the most conservative model assumptions utilized by the committee, i.e., a linear dose response and age-specific relative risks projected over a lifetime for solid tumors (L-RR, linear-relative risk). The EPA believes that 1200 fatal cancers per 10^6 person-rad reflects more recent information discussed in the EPA report (DOE, 1988), but because of conservatisms in the model, is considered an upper bound limit, pending a current review being made by the National Academy of Sciences. Because of uncertainties, the lower bound may be as much as a factor of 10 lower, or 120 fatal cancers per 10^6 person-rad. EPA decided to employ the central estimate of 400 fatal cancers per 10^6 person-rad and a range of 120-1,200 fatal cancers per 10^6 person-rad in its risk assessment methodology for proposed rule making for National Emission Standards for Radioactive Materials to the Atmosphere (EPA, 1989b).

A.3.3 Genetic Effect Estimates for Low-LET Radiation

Genetic harm (or genetic effects) of radiation exposure is defined as heritable changes induced in the germ cells (eggs or sperm) of exposed individuals, which are transmitted to and expressed only in their progeny and in future generations. Genetic effects do not affect the persons exposed, but relates only to subsequent progeny. About 30 generations (nearly 1000 years) are needed for complete expression of genetic effects.

The damage, in the form of a mutation or a chromosomal aberration, is transmitted to, and may be expressed in, a child conceived after the radiation exposure. However, the damage may also be expressed in subsequent generations or only after many generations. Alternatively, it may never be expressed because of failure to reproduce or failure of the chance to reproduce.

Although genetic effects may vary greatly in severity, the genetic effects considered by the EPA include only those disorders and traits that cause a serious handicap at some time during a lifetime.

Estimates of the genetic risk per generation are conventionally based on a 30-year reproductive generation. That is, the median parental age for reproduction of children is defined as age 30 (one-half the children are produced by persons less than age 30 and one-half by persons over 30). Thus, the radiation dose up to age 30 is used to estimate the genetic risks. The EPA estimation of genetic effects includes both first generation estimates and total genetic burden estimates over all generations. The estimates are based on extrapolation of animal data to man. While there are no comparable human data at present, information on hereditary defects among the children of A-Bomb survivors provides a degree of confidence that the animal data do not lead to underestimates of the genetic risks to humans.

The EPA estimates a nominal risk of genetic effects over all generations of 260 genetic effects per million person-rad over a 30-year reproductive generation with a range of 50 to 1,000 genetic effects per million person-rad.

A.3.4 Teratologic Effects Estimate for Low-LET Radiation

Teratologic effects are developmental effects caused by radiation exposure to fetuses. The most important of these defects, mental retardation, has been seen in humans only in offspring of A-Bomb survivors. Other effects observed include growth retardation, increased microcephaly (small head size), increased mortality (especially infant mortality), temporary suppression of antibody protection against influenza, and increased frequency of chromosomal aberrations in peripheral lymphocytes. For the two effects that have received the most study, mental retardation and microcephaly, there is a limited time period that the fetus is sensitive to radiation effects. This time period is estimated to be at eight to 15 weeks of gestation. The EPA estimates a nominal risk factor for mental retardation at 4,000 effects per million person-rad received at eight to 15 weeks of gestation with a range of 2,500 to 5,500 effects per million person-rad.

A.3.5 Summary of Health Effects Estimates for Low-LET Radiation

Table A-9 summarizes radiation health effect risk estimators developed by the EPA (EPA, 1989a) for low-LET radiation. Also shown are EPA radiation risk estimators for high-LET radiation, not previously discussed in this section.

A.4 OFFSITE ATMOSPHERIC AND LIQUID DOSES AND POTENTIAL HEALTH EFFECTS

This section presents tabular summaries of offsite doses calculated with atmospheric and liquid transport and dose models described in this appendix. These tables also include potential health effects (fatal cancers) calculated with radiation risk estimators described in this appendix.

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TABLE A-1

Comparison of Measured and Calculated Atmospheric Tritium Oxide at the SRS Boundary

Year	Tritium Oxide Concentration, pCi/Cubic Meter		
	Calculated	Measured	Ratio: Calc/Meas.
1985	190	120	1.6
1986	88	79	1.1
1987	81	81	1.0
1988	87	54	1.6

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Table A-2

Meteorological Joint-Frequency Distribution: H-Area Tower 1982-1986

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION — ATMOSPHERIC STABILITY CLASS A

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.366	0.312	0.357	0.360	0.363	0.233	0.267	0.264	0.275	0.298	0.340	0.380	0.386	0.374	0.340	0.284	5.200
4.00	0.462	0.610	0.766	0.806	0.752	0.587	0.474	0.496	0.533	0.678	0.794	1.033	0.857	0.704	0.477	0.391	10.419
6.00	0.105	0.099	0.122	0.159	0.128	0.142	0.077	0.108	0.099	0.159	0.216	0.241	0.247	0.150	0.136	0.096	2.284
8.00	0.006	0.009	0.003	0.009	0.009	0.003	0.009	0.014	0.014	0.009	0.026	0.009	0.026	0.014	0.011	0.017	0.184
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.003	0.011	0.003	0.000	0.006	0.006	0.000	0.003	0.037
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.003	0.003	0.000	0.000	0.009
TOTAL	0.94	1.03	1.25	1.33	1.25	0.96	0.83	0.89	0.92	1.15	1.38	1.67	1.52	1.25	0.96	0.79	18.13

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION — ATMOSPHERIC STABILITY CLASS B

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.051	0.074	0.068	0.085	0.057	0.057	0.062	0.043	0.048	0.096	0.077	0.082	0.085	0.077	0.082	0.071	1.115
4.00	0.187	0.309	0.394	0.477	0.321	0.278	0.247	0.201	0.332	0.278	0.440	0.618	0.417	0.335	0.179	0.153	5.166
6.00	0.119	0.159	0.340	0.281	0.148	0.136	0.105	0.074	0.170	0.218	0.281	0.423	0.360	0.218	0.111	0.079	3.223
8.00	0.017	0.000	0.020	0.011	0.003	0.011	0.011	0.009	0.020	0.026	0.045	0.031	0.088	0.079	0.074	0.017	0.462
12.00	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009	0.000	0.003	0.014	0.014	0.009	0.011	0.062
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.38	0.54	0.82	0.85	0.53	0.48	0.43	0.33	0.57	0.63	0.84	1.16	0.96	0.72	0.45	0.33	10.03

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION — ATMOSPHERIC STABILITY CLASS C

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.065	0.068	0.088	0.136	0.062	0.045	0.040	0.051	0.051	0.091	0.119	0.091	0.088	0.113	0.062	0.060	1.231
4.00	0.287	0.567	0.854	0.794	0.479	0.380	0.326	0.346	0.434	0.460	0.610	0.658	0.567	0.451	0.306	0.204	7.724
6.00	0.184	0.460	0.987	0.567	0.309	0.241	0.218	0.224	0.386	0.522	0.494	0.635	0.539	0.400	0.238	0.153	6.558
8.00	0.054	0.079	0.221	0.057	0.040	0.031	0.040	0.034	0.071	0.145	0.165	0.184	0.312	0.269	0.088	0.096	1.886
12.00	0.000	0.003	0.006	0.003	0.000	0.000	0.009	0.011	0.017	0.017	0.014	0.085	0.116	0.128	0.026	0.023	0.457
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.003
TOTAL	0.59	1.18	2.16	1.56	0.89	0.70	0.63	0.67	0.96	1.23	1.40	1.66	1.62	1.36	0.72	0.54	17.86

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION — ATMOSPHERIC STABILITY CLASS D

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.068	0.065	0.088	0.043	0.043	0.034	0.031	0.045	0.068	0.077	0.071	0.077	0.071	0.074	0.040	0.048	0.942
4.00	0.383	0.655	1.186	0.973	0.723	0.613	0.508	0.641	0.701	0.689	0.726	0.684	0.732	0.644	0.374	0.326	10.558
6.00	0.321	0.777	1.401	0.808	0.550	0.522	0.652	0.885	0.953	0.860	0.766	0.865	0.970	1.092	0.451	0.230	12.104
8.00	0.116	0.190	0.301	0.130	0.051	0.148	0.196	0.252	0.332	0.287	0.216	0.267	0.448	0.374	0.162	0.065	3.535
12.00	0.034	0.034	0.045	0.000	0.006	0.014	0.062	0.054	0.031	0.054	0.071	0.113	0.216	0.173	0.034	0.011	0.953
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.003	0.003	0.000	0.000	0.009
TOTAL	0.92	1.72	3.02	1.95	1.37	1.33	1.45	1.88	2.08	1.97	1.85	2.01	2.44	2.36	1.06	0.68	28.10

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION — ATMOSPHERIC STABILITY CLASS E

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.026	0.017	0.045	0.026	0.014	0.023	0.031	0.043	0.037	0.037	0.034	0.017	0.031	0.043	0.034	0.031	0.488
4.00	0.255	0.340	0.525	0.488	0.454	0.423	0.482	0.627	0.525	0.431	0.411	0.352	0.457	0.323	0.304	0.193	6.590
6.00	0.380	0.675	1.152	0.896	0.743	0.567	0.843	1.030	1.089	0.950	1.072	0.843	0.786	0.692	0.369	0.218	12.306
8.00	0.028	0.051	0.060	0.065	0.074	0.057	0.028	0.057	0.148	0.122	0.130	0.153	0.074	0.040	0.020	0.014	1.121

Table A-2

Meteorological Joint-Frequency Distribution: H-Area Tower 1982-1986 (continued)

12.00	0.000	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.009
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.69	1.08	1.78	1.48	1.29	1.08	1.38	1.76	1.80	1.54	1.65	1.36	1.35	1.10	0.73	0.46	20.51

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS F

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.003	0.003	0.009	0.000	0.003	0.000	0.003	0.040	0.003	0.009	0.000	0.000	0.003	0.003	0.000	0.003	0.079
4.00	0.043	0.060	0.077	0.054	0.048	0.077	0.068	0.130	0.088	0.096	0.068	0.051	0.037	0.048	0.017	0.043	1.004
6.00	0.196	0.377	0.394	0.338	0.204	0.176	0.145	0.295	0.278	0.264	0.301	0.278	0.139	0.062	0.065	0.071	3.583
8.00	0.006	0.040	0.043	0.068	0.062	0.037	0.017	0.028	0.057	0.031	0.037	0.043	0.023	0.009	0.000	0.003	0.502
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.25	0.48	0.52	0.46	0.32	0.29	0.23	0.49	0.43	0.40	0.41	0.37	0.20	0.12	0.08	0.12	5.17

JOINT FREQUENCY DISTRIBUTION OF WIND SPEED AND DIRECTION ATMOSPHERIC STABILITY CLASS G

UMAX (M/S)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
2.00	0.000	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.009
4.00	0.003	0.000	0.003	0.000	0.003	0.003	0.003	0.000	0.006	0.000	0.000	0.000	0.003	0.000	0.000	0.003	0.026
6.00	0.000	0.037	0.026	0.009	0.009	0.006	0.009	0.014	0.003	0.009	0.006	0.006	0.006	0.000	0.000	0.000	0.136
8.00	0.000	0.003	0.003	0.006	0.003	0.003	0.000	0.003	0.000	0.000	0.006	0.003	0.000	0.000	0.000	0.000	0.028
12.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14.10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL	0.00	0.04	0.04	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.20

WIND MEASURED AT 62.0 METERS.

OVERALL WIND DIRECTION FREQUENCY

WIND DIRECTION:	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
FREQUENCY:	3.8	6.1	9.6	7.6	5.7	4.9	5.0	6.0	6.8	6.9	7.5	8.2	8.1	6.9	4.0	2.9	100.0

OVERALL WIND SPEED FREQUENCY

MAX WIND SPEED (M/S):	2.000	4.000	6.000	8.000	12.000	14.100
AVE WIND SPEED (M/S):	1.000	3.000	5.000	7.000	10.000	13.050
WIND SPEED FREQUENCY:	9.06	41.49	40.19	7.72	1.52	0.02

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Table A-3

Annual Average Dispersion/Deposition Factors Within 50 Miles of SRS for Elevated Releases (62 m)

NO DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	9.595E-08	5.346E-08	3.207E-08	2.172E-08	1.599E-08	8.528E-09	3.546E-09	1.851E-09	1.213E-09	8.863E-10
SSW	1.488E-07	8.452E-08	5.013E-08	3.375E-08	2.475E-08	1.313E-08	5.419E-09	2.840E-09	1.896E-09	1.381E-09
SW	2.350E-07	1.382E-07	8.183E-08	5.472E-08	3.988E-08	2.089E-08	8.457E-09	4.436E-09	2.966E-09	2.165E-09
WSW	1.988E-07	1.093E-07	6.365E-08	4.243E-08	3.090E-08	1.624E-08	6.631E-09	3.498E-09	2.356E-09	1.735E-09
W	1.340E-07	7.777E-08	4.724E-08	3.208E-08	2.362E-08	1.257E-08	5.195E-09	2.830E-09	1.915E-09	1.381E-09
WNW	1.125E-07	6.714E-08	4.114E-08	2.802E-08	2.066E-08	1.148E-08	4.774E-09	2.509E-09	1.671E-09	1.205E-09
NW	1.093E-07	6.938E-08	4.380E-08	3.014E-08	2.233E-08	1.290E-08	5.549E-09	2.826E-09	1.805E-09	1.291E-09
NNW	1.220E-07	8.495E-08	5.592E-08	3.929E-08	2.951E-08	1.803E-08	8.109E-09	4.045E-09	2.562E-09	1.829E-09
N	1.468E-07	9.466E-08	5.948E-08	4.083E-08	3.021E-08	1.651E-08	7.396E-09	3.825E-09	2.421E-09	1.728E-09
NNE	1.634E-07	9.671E-08	5.857E-08	3.968E-08	2.916E-08	1.574E-08	6.944E-09	3.634E-09	2.334E-09	1.673E-09
NE	1.816E-07	1.024E-07	6.077E-08	4.086E-08	2.991E-08	1.593E-08	6.919E-09	3.607E-09	2.358E-09	1.712E-09
ENE	1.992E-07	1.113E-07	6.608E-08	4.287E-08	3.074E-08	1.587E-08	6.398E-09	3.298E-09	2.146E-09	1.566E-09
E	1.926E-07	1.136E-07	6.817E-08	4.415E-08	3.157E-08	1.617E-08	6.395E-09	3.242E-09	2.094E-09	1.516E-09
ESE	1.722E-07	1.019E-07	6.067E-08	3.929E-08	2.806E-08	1.431E-08	5.618E-09	2.832E-09	1.823E-09	1.316E-09
SE	1.038E-07	5.640E-08	3.336E-08	2.239E-08	1.623E-08	8.500E-09	3.462E-09	1.775E-09	1.154E-09	8.392E-10
SSE	8.039E-08	4.262E-08	2.486E-08	1.661E-08	1.220E-08	6.474E-09	2.662E-09	1.385E-09	9.074E-10	6.632E-10

2.260 DAY DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	9.574E-08	5.325E-08	3.186E-08	2.153E-08	1.581E-08	8.371E-09	3.417E-09	1.738E-09	1.110E-09	7.908E-10
SSW	1.485E-07	8.423E-08	4.986E-08	3.350E-08	2.452E-08	1.293E-08	5.257E-09	2.698E-09	1.765E-09	1.260E-09
SW	2.346E-07	1.378E-07	8.140E-08	5.433E-08	3.952E-08	2.057E-08	8.206E-09	4.212E-09	2.757E-09	1.971E-09
WSW	1.984E-07	1.089E-07	6.331E-08	4.212E-08	3.062E-08	1.600E-08	6.435E-09	3.325E-09	2.195E-09	1.584E-09
W	1.337E-07	7.750E-08	4.699E-08	3.184E-08	2.339E-08	1.238E-08	5.039E-09	2.687E-09	1.782E-09	1.258E-09
WNW	1.122E-07	6.692E-08	4.092E-08	2.781E-08	2.046E-08	1.131E-08	4.634E-09	2.385E-09	1.556E-09	1.099E-09
NW	1.091E-07	6.915E-08	4.358E-08	2.993E-08	2.213E-08	1.270E-08	5.387E-09	2.686E-09	1.680E-09	1.177E-09
NNW	1.218E-07	8.467E-08	5.562E-08	3.901E-08	2.923E-08	1.775E-08	7.855E-09	3.831E-09	2.373E-09	1.657E-09
N	1.466E-07	9.436E-08	5.918E-08	4.054E-08	2.993E-08	1.627E-08	7.185E-09	3.644E-09	2.261E-09	1.582E-09
NNE	1.630E-07	9.638E-08	5.825E-08	3.938E-08	2.888E-08	1.550E-08	6.732E-09	3.449E-09	2.168E-09	1.521E-09
NE	1.813E-07	1.020E-07	6.044E-08	4.055E-08	2.962E-08	1.569E-08	6.714E-09	3.429E-09	2.195E-09	1.562E-09
ENE	1.989E-07	1.109E-07	6.574E-08	4.256E-08	3.046E-08	1.564E-08	6.211E-09	3.135E-09	1.998E-09	1.428E-09
E	1.923E-07	1.132E-07	6.781E-08	4.383E-08	3.128E-08	1.592E-08	6.200E-09	3.075E-09	1.943E-09	1.376E-09
ESE	1.718E-07	1.015E-07	6.033E-08	3.898E-08	2.779E-08	1.408E-08	5.436E-09	2.675E-09	1.682E-09	1.185E-09
SE	1.036E-07	5.618E-08	3.315E-08	2.220E-08	1.605E-08	8.349E-09	3.338E-09	1.668E-09	1.056E-09	7.483E-10
SSE	8.020E-08	4.244E-08	2.468E-08	1.645E-08	1.205E-08	6.345E-09	2.556E-09	1.293E-09	8.233E-10	5.850E-10

Table A-3

Annual Average Dispersion/Deposition Factors Within 50 Miles of SRS for Elevated Releases (62 m) (continued

8.000 DAY DECAY, DEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
	SEGMENT BOUNDARIES IN MILES FROM THE SITE									
S	9.352E-08	5.140E-08	3.041E-08	2.037E-08	1.486E-08	7.771E-09	3.098E-09	1.546E-09	9.716E-10	6.779E-10
SSW	1.451E-07	8.126E-08	4.752E-08	3.166E-08	2.302E-08	1.198E-08	4.766E-09	2.404E-09	1.555E-09	1.089E-09
SW	2.293E-07	1.330E-07	7.759E-08	5.131E-08	3.706E-08	1.904E-08	7.424E-09	3.754E-09	2.422E-09	1.659E-09
WSW	1.937E-07	1.050E-07	6.031E-08	3.979E-08	2.874E-08	1.482E-08	5.822E-09	2.954E-09	1.895E-09	1.297E-09
W	1.307E-07	7.493E-08	4.495E-08	3.022E-08	2.207E-08	1.154E-08	4.593E-09	2.379E-09	1.504E-09	1.023E-09
WNW	1.098E-07	6.476E-08	3.919E-08	2.643E-08	1.934E-08	1.059E-08	4.259E-09	2.110E-09	1.303E-09	8.862E-10
NW	1.068E-07	6.711E-08	4.192E-08	2.861E-08	2.105E-08	1.193E-08	4.707E-09	2.101E-09	1.233E-09	8.275E-10
NNW	1.194E-07	8.238E-08	5.369E-08	3.745E-08	2.795E-08	1.677E-08	6.978E-09	3.159E-09	1.862E-09	1.252E-09
N	1.435E-07	9.153E-08	5.685E-08	3.867E-08	2.841E-08	1.530E-08	6.428E-09	3.004E-09	1.770E-09	1.190E-09
NNE	1.594E-07	9.320E-08	5.573E-08	3.739E-08	2.726E-08	1.448E-08	5.979E-09	2.774E-09	1.637E-09	1.101E-09
NE	1.770E-07	9.849E-08	5.774E-08	3.845E-08	2.793E-08	1.462E-08	5.965E-09	2.755E-09	1.618E-09	1.084E-09
ENE	1.940E-07	1.069E-07	6.266E-08	4.019E-08	2.855E-08	1.444E-08	5.574E-09	2.743E-09	1.708E-09	1.189E-09
E	1.878E-07	1.092E-07	6.468E-08	4.139E-08	2.931E-08	1.468E-08	5.548E-09	2.680E-09	1.656E-09	1.142E-09
ESE	1.679E-07	9.798E-08	5.746E-08	3.673E-08	2.595E-08	1.292E-08	4.833E-09	2.313E-09	1.421E-09	9.759E-10
SE	1.011E-07	5.420E-08	3.161E-08	2.098E-08	1.507E-08	7.722E-09	3.003E-09	1.463E-09	9.071E-10	6.264E-10
SSE	7.828E-08	4.091E-08	2.350E-08	1.552E-08	1.130E-08	5.866E-09	2.301E-09	1.138E-09	7.110E-10	4.936E-10

RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
	SEGMENT BOUNDARIES IN MILES									
S	1.733E-09	6.238E-10	2.750E-10	1.584E-10	1.045E-10	4.661E-11	1.556E-11	7.261E-12	4.584E-12	3.268E-12
SSW	2.640E-09	9.792E-10	4.357E-10	2.512E-10	1.658E-10	7.370E-11	2.431E-11	1.122E-11	7.052E-12	5.025E-12
SW	4.194E-09	1.581E-09	7.072E-10	4.080E-10	2.692E-10	1.195E-10	3.917E-11	1.795E-11	1.334E-11	1.217E-11
WSW	3.455E-09	1.254E-09	5.545E-10	3.195E-10	2.108E-10	9.394E-11	3.124E-11	1.454E-11	1.292E-11	9.872E-12
W	2.456E-09	8.902E-10	3.933E-10	2.266E-10	1.495E-10	6.663E-11	2.218E-11	1.611E-11	1.027E-11	6.089E-12
WNW	2.055E-09	7.613E-10	3.386E-10	1.952E-10	1.288E-10	5.729E-11	1.891E-11	1.351E-11	8.675E-12	5.179E-12
NW	1.906E-09	7.257E-10	3.255E-10	1.878E-10	1.239E-10	7.567E-11	3.442E-11	1.547E-11	8.067E-12	4.993E-12
NNW	2.058E-09	8.120E-10	3.679E-10	2.126E-10	1.403E-10	9.068E-11	4.303E-11	1.859E-11	9.926E-12	6.144E-12
N	2.554E-09	9.853E-10	4.436E-10	2.561E-10	1.690E-10	7.485E-11	3.945E-11	2.094E-11	1.118E-11	6.923E-12
NNE	2.925E-09	1.090E-09	4.859E-10	2.802E-10	1.849E-10	8.217E-11	4.051E-11	2.144E-11	1.128E-11	6.983E-12
NE	3.328E-09	1.205E-09	5.324E-10	3.066E-10	2.024E-10	9.020E-11	4.442E-11	2.404E-11	1.361E-11	7.871E-12
ENE	4.013E-09	1.433E-09	6.302E-10	3.628E-10	2.395E-10	1.069E-10	3.578E-11	1.673E-11	1.054E-11	8.511E-12
E	3.899E-09	1.437E-09	6.381E-10	3.678E-10	2.427E-10	1.080E-10	3.570E-11	1.647E-11	1.028E-11	7.249E-12
ESE	3.301E-09	1.243E-09	5.558E-10	3.206E-10	2.116E-10	9.392E-11	3.079E-11	1.408E-11	8.732E-12	6.127E-12
SE	1.954E-09	7.053E-10	3.112E-10	1.792E-10	1.183E-10	5.274E-11	1.758E-11	8.181E-12	5.134E-12	3.633E-12
SSE	1.465E-09	5.183E-10	2.273E-10	1.308E-10	8.633E-11	3.857E-11	1.296E-11	6.078E-12	3.829E-12	2.714E-12

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Table A-4

Annual Average Dispersion/Deposition Factors Within 50 Miles of SRS for Ground Level Releases

NO DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES FROM THE SITE .5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.906E-07	1.252E-07	5.488E-08	3.270E-08	2.241E-08	1.095E-08	4.140E-09	2.059E-09	1.321E-09	9.533E-10
SSW	6.281E-07	2.025E-07	8.838E-08	5.247E-08	3.585E-08	1.741E-08	6.523E-09	3.224E-09	2.064E-09	1.484E-09
SW	1.000E-06	3.218E-07	1.398E-07	8.265E-08	5.630E-08	2.715E-08	1.005E-08	4.930E-09	3.135E-09	2.244E-09
WSW	7.754E-07	2.467E-07	1.066E-07	6.296E-08	4.286E-08	2.071E-08	7.722E-09	3.818E-09	2.442E-09	1.756E-09
W	5.779E-07	1.858E-07	8.133E-08	4.840E-08	3.313E-08	1.613E-08	6.068E-09	3.005E-09	1.921E-09	1.381E-09
WNW	5.095E-07	1.645E-07	7.199E-08	4.282E-08	2.930E-08	1.432E-08	5.373E-09	2.640E-09	1.680E-09	1.205E-09
NW	5.446E-07	1.768E-07	7.762E-08	4.626E-08	3.169E-08	1.550E-08	5.811E-09	2.845E-09	1.805E-09	1.291E-09
NNW	7.408E-07	2.450E-07	1.087E-07	6.518E-08	4.482E-08	2.201E-08	8.274E-09	4.045E-09	2.562E-09	1.829E-09
N	7.440E-07	2.419E-07	1.061E-07	6.313E-08	4.319E-08	2.102E-08	7.849E-09	3.826E-09	2.421E-09	1.728E-09
NNE	7.250E-07	2.334E-07	1.018E-07	6.037E-08	4.123E-08	2.002E-08	7.491E-09	3.672E-09	2.335E-09	1.673E-09
NE	7.450E-07	2.380E-07	1.033E-07	6.116E-08	4.171E-08	2.024E-08	7.587E-09	3.740E-09	2.387E-09	1.715E-09
ENE	7.177E-07	2.287E-07	9.911E-08	5.819E-08	3.951E-08	1.909E-08	7.136E-09	3.535E-09	2.266E-09	1.635E-09
E	7.208E-07	2.297E-07	9.946E-08	5.836E-08	3.958E-08	1.904E-08	7.050E-09	3.460E-09	2.205E-09	1.583E-09
ESE	6.397E-07	2.031E-07	8.768E-08	5.139E-08	3.481E-08	1.668E-08	6.140E-09	2.999E-09	1.906E-09	1.366E-09
SE	3.806E-07	1.198E-07	5.194E-08	3.076E-08	2.095E-08	1.016E-08	3.813E-09	1.889E-09	1.211E-09	8.730E-10
SSE	2.947E-07	9.331E-08	4.057E-08	2.407E-08	1.647E-08	8.036E-09	3.038E-09	1.515E-09	9.745E-10	7.047E-10

2.260 DAY DECAY, UNDEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES FROM THE SITE .5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.899E-07	1.248E-07	5.456E-08	3.243E-08	2.218E-08	1.076E-08	3.996E-09	1.937E-09	1.212E-09	8.527E-10
SSW	6.272E-07	2.020E-07	8.795E-08	5.211E-08	3.554E-08	1.716E-08	6.338E-09	3.068E-09	1.925E-09	1.356E-09
SW	9.991E-07	3.209E-07	1.391E-07	8.207E-08	5.579E-08	2.675E-08	9.754E-09	4.681E-09	2.914E-09	2.042E-09
WSW	7.743E-07	2.460E-07	1.061E-07	6.254E-08	4.249E-08	2.042E-08	7.505E-09	3.634E-09	2.277E-09	1.604E-09
W	5.771E-07	1.853E-07	8.094E-08	4.807E-08	3.284E-08	1.590E-08	5.892E-09	2.856E-09	1.788E-09	1.258E-09
WNW	5.088E-07	1.640E-07	7.164E-08	4.253E-08	2.904E-08	1.411E-08	5.219E-09	2.511E-09	1.565E-09	1.099E-09
NW	5.438E-07	1.763E-07	7.725E-08	4.595E-08	3.142E-08	1.528E-08	5.643E-09	2.704E-09	1.680E-09	1.177E-09
NNW	7.397E-07	2.443E-07	1.082E-07	6.470E-08	4.440E-08	2.167E-08	8.016E-09	3.831E-09	2.373E-09	1.657E-09
N	7.429E-07	2.413E-07	1.056E-07	6.271E-08	4.282E-08	2.073E-08	7.631E-09	3.645E-09	2.261E-09	1.582E-09
NNE	7.239E-07	2.327E-07	1.012E-07	5.994E-08	4.085E-08	1.973E-08	7.268E-09	3.486E-09	2.169E-09	1.521E-09
NE	7.439E-07	2.373E-07	1.028E-07	6.073E-08	4.134E-08	1.995E-08	7.369E-09	3.557E-09	2.223E-09	1.565E-09
ENE	7.167E-07	2.281E-07	9.864E-08	5.780E-08	3.917E-08	1.882E-08	6.933E-09	3.364E-09	2.112E-09	1.492E-09
E	7.198E-07	2.291E-07	9.897E-08	5.795E-08	3.922E-08	1.876E-08	6.840E-09	3.284E-09	2.047E-09	1.438E-09
ESE	6.387E-07	2.024E-07	8.721E-08	5.100E-08	3.447E-08	1.642E-08	5.944E-09	2.835E-09	1.759E-09	1.231E-09
SE	3.799E-07	1.194E-07	5.164E-08	3.051E-08	2.073E-08	9.988E-09	3.680E-09	1.776E-09	1.109E-09	7.793E-10
SSE	2.942E-07	9.296E-08	4.031E-08	2.385E-08	1.628E-08	7.883E-09	2.921E-09	1.416E-09	8.857E-10	6.228E-10

Table A-4

Annual Average Dispersion/Deposition Factors Within 50 Miles of SRS for Ground Level Releases (continued)

8.000 DAY DECAY, DEPLETED

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

SEGMENT BOUNDARIES IN MILES FROM THE SITE

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.499E-07	1.069E-07	4.449E-08	2.549E-08	1.691E-08	7.746E-09	2.581E-09	1.125E-09	6.526E-10	4.320E-10
SSW	5.626E-07	1.729E-07	7.167E-08	4.092E-08	2.707E-08	1.233E-08	4.075E-09	1.768E-09	1.025E-09	6.765E-10
SW	8.962E-07	2.747E-07	1.133E-07	6.446E-08	4.250E-08	1.923E-08	6.280E-09	2.702E-09	1.555E-09	1.022E-09
WSW	6.947E-07	2.105E-07	8.647E-08	4.911E-08	3.236E-08	1.468E-08	4.825E-09	2.094E-09	1.212E-09	8.007E-10
W	5.177E-07	1.586E-07	6.595E-08	3.775E-08	2.501E-08	1.143E-08	3.790E-09	1.647E-09	9.532E-10	6.293E-10
WNW	4.564E-07	1.404E-07	5.838E-08	3.340E-08	2.212E-08	1.014E-08	3.357E-09	1.448E-09	8.338E-10	5.491E-10
NW	4.879E-07	1.509E-07	6.294E-08	3.608E-08	2.393E-08	1.098E-08	3.630E-09	1.560E-09	8.957E-10	5.884E-10
NNW	6.635E-07	2.091E-07	8.817E-08	5.082E-08	3.383E-08	1.558E-08	5.166E-09	2.216E-09	1.269E-09	8.321E-10
N	6.664E-07	2.065E-07	8.603E-08	4.924E-08	3.261E-08	1.489E-08	4.906E-09	2.099E-09	1.202E-09	7.884E-10
NNE	6.495E-07	1.992E-07	8.252E-08	4.708E-08	3.112E-08	1.418E-08	4.679E-09	2.013E-09	1.158E-09	7.617E-10
NE	6.674E-07	2.031E-07	8.377E-08	4.770E-08	3.149E-08	1.434E-08	4.740E-09	2.051E-09	1.184E-09	7.818E-10
ENE	6.431E-07	1.952E-07	8.038E-08	4.539E-08	2.983E-08	1.352E-08	4.458E-09	1.939E-09	1.125E-09	7.451E-10
E	6.458E-07	1.961E-07	8.066E-08	4.552E-08	2.988E-08	1.349E-08	4.404E-09	1.896E-09	1.093E-09	7.207E-10
ESE	5.732E-07	1.733E-07	7.110E-08	4.007E-08	2.627E-08	1.182E-08	3.834E-09	1.642E-09	9.433E-10	6.202E-10
SE	3.410E-07	1.023E-07	4.211E-08	2.398E-08	1.581E-08	7.192E-09	2.378E-09	1.032E-09	5.978E-10	3.953E-10
SSE	2.640E-07	7.963E-08	3.289E-08	1.876E-08	1.242E-08	5.685E-09	1.892E-09	8.264E-10	4.801E-10	3.182E-10

RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS

SEGMENT BOUNDARIES IN MILES

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.935E-09	1.216E-09	4.838E-10	2.644E-10	1.680E-10	7.217E-11	2.238E-11	8.870E-12	4.737E-12	2.932E-12
SSW	6.344E-09	1.960E-09	7.799E-10	4.262E-10	2.709E-10	1.164E-10	3.608E-11	1.430E-11	7.637E-12	4.727E-12
SW	1.002E-08	3.095E-09	1.232E-09	6.730E-10	4.278E-10	1.837E-10	5.698E-11	2.258E-11	1.206E-11	7.464E-12
WSW	7.989E-09	2.468E-09	9.821E-10	5.367E-10	3.411E-10	1.465E-10	4.543E-11	1.801E-11	9.616E-12	5.952E-12
W	5.911E-09	1.826E-09	7.267E-10	3.971E-10	2.524E-10	1.084E-10	3.362E-11	1.333E-11	7.116E-12	4.404E-12
WNW	5.067E-09	1.565E-09	6.229E-10	3.404E-10	2.164E-10	9.293E-11	2.882E-11	1.142E-11	6.099E-12	3.775E-12
NW	5.182E-09	1.601E-09	6.371E-10	3.482E-10	2.213E-10	9.505E-11	2.947E-11	1.168E-11	6.238E-12	3.861E-12
NNW	6.294E-09	1.944E-09	7.737E-10	4.228E-10	2.687E-10	1.154E-10	3.579E-11	1.419E-11	7.576E-12	4.689E-12
N	7.073E-09	2.185E-09	8.695E-10	4.752E-10	3.020E-10	1.297E-10	4.023E-11	1.594E-11	8.514E-12	5.270E-12
NNE	7.245E-09	2.238E-09	8.907E-10	4.867E-10	3.093E-10	1.329E-10	4.120E-11	1.633E-11	8.721E-12	5.398E-12
NE	7.873E-09	2.432E-09	9.679E-10	5.289E-10	3.362E-10	1.444E-10	4.478E-11	1.775E-11	9.477E-12	5.866E-12
ENE	8.596E-09	2.656E-09	1.057E-09	5.775E-10	3.670E-10	1.577E-10	4.889E-11	1.938E-11	1.035E-11	6.405E-12
E	8.469E-09	2.616E-09	1.041E-09	5.689E-10	3.616E-10	1.553E-10	4.816E-11	1.909E-11	1.019E-11	6.310E-12
ESE	7.224E-09	2.232E-09	8.881E-10	4.853E-10	3.085E-10	1.325E-10	4.109E-11	1.628E-11	8.696E-12	5.382E-12
SE	4.187E-09	1.294E-09	5.147E-10	2.813E-10	1.788E-10	7.679E-11	2.381E-11	9.438E-12	5.040E-12	3.119E-12
SSE	3.049E-09	9.420E-10	3.748E-10	2.048E-10	1.302E-10	5.592E-11	1.734E-11	6.873E-12	3.670E-12	2.272E-12

W8908052

Table A-5
Population and Food Production Within 50 Miles of SRS

SITE POPULATION DATA — 2000 POPULATION-PLT CENTER (FROM1980 CENSUS ABOUT N 62000., E 5 8000.)

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.000E+00	5.693E+03	1.269E+04	7.441E+03	1.937E+04	4.520E+04
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E+00	1.058E+03	2.326E+03	5.848E+03	1.394E+04	2.317E+04
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.709E+03	4.284E+03	7.358E+03	1.428E+04	3.263E+04
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.000E+00	1.741E+03	8.869E+03	7.839E+03	6.153E+04	7.998E+04
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.000E+00	1.158E+04	9.739E+03	1.202E+04	7.369E+03	4.071E+04
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.200E+01	2.556E+03	2.986E+03	3.634E+03	3.767E+03	1.300E+04
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.500E+01	9.960E+02	8.755E+03	8.804E+03	1.159E+04	3.021E+04
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.400E+01	6.330E+02	1.640E+03	1.640E+03	5.055E+03	9.032E+03
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.000E+00	7.580E+02	2.058E+03	1.027E+04	5.182E+03	1.828E+04
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.632E+03	3.291E+03	9.421E+03	4.476E+03	1.882E+04
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.424E+03	2.940E+03	3.126E+03	4.195E+03	1.169E+04
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.332E+03	1.118E+04	2.271E+03	1.193E+04	2.671E+04
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.200E+01	9.860E+02	1.184E+04	3.896E+03	1.092E+04	2.774E+04
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.290E+02	3.377E+03	1.588E+05	5.290E+04	1.399E+04	2.295E+05
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.610E+02	8.588E+03	1.352E+05	2.266E+04	2.421E+03	1.691E+05
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.610E+02	1.471E+04	4.129E+04	9.705E+03	1.020E+04	7.636E+04
TOTAL	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.341E+03	6.377E+04	4.179E+05	1.688E+05	2.002E+05	8.521E+05

DENSITY(/M**2) = 4.26E-05

SITE MILK PRODUCTION, LITERS — MAN"S MILK PRODUCTION ABOUT SRP SITE (L/Y)

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.639E+04	1.032E+05	1.720E+05	1.410E+06	5.574E+06	7.276E+06
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.306E+04	1.032E+05	1.720E+05	3.676E+05	6.061E+05	1.262E+06
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.732E+03	1.217E+05	1.325E+06	2.147E+06	1.388E+06	4.987E+06
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.577E+03	1.802E+05	1.918E+06	4.823E+06	5.458E+06	1.238E+07
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.848E+03	1.802E+05	1.739E+06	4.145E+06	5.755E+06	1.182E+07
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.507E+01	1.802E+05	9.313E+05	2.839E+06	1.459E+06	5.410E+06
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.212E+05	4.516E+04	1.803E+05	3.996E+05	7.463E+05
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.384E+04	2.406E+05	3.521E+05	5.643E+05	1.251E+06
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.305E+05	5.740E+05	7.696E+05	9.972E+05	2.671E+06
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.582E+05	1.890E+06	6.404E+06	7.609E+06	1.626E+07
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.653E+03	3.871E+05	6.711E+05	3.070E+06	2.835E+06	6.971E+06
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.467E+03	3.528E+05	6.678E+05	1.050E+06	2.398E+06	4.471E+06
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.161E+04	1.813E+05	3.788E+05	1.009E+06	1.774E+06	3.355E+06
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.381E+04	1.793E+05	3.456E+05	6.128E+05	8.552E+05	2.007E+06
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.745E+04	1.032E+05	4.236E+05	1.160E+06	7.811E+05	2.485E+06
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.794E+04	1.032E+05	2.949E+05	1.481E+06	3.140E+06	5.037E+06
TOTAL	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.096E+05	3.079E+06	1.179E+07	3.182E+07	4.159E+07	8.839E+07

DENSITY(/M**2) = 4.42E-03

Table A-5

Population and Food Production Within 50 Miles of SRS (continued)

MAN"S MEAT PRODUCTION ABOUT SRP SITE (KG/Y)

SITE ANNUAL MEAT PRODUCTION, KGR

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.321E+04	5.240E+05	8.733E+05	1.414E+06	3.154E+06	6.049E+06
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.630E+04	5.240E+05	8.733E+05	2.286E+06	4.059E+06	7.809E+06
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.374E+04	4.707E+05	7.797E+05	1.707E+06	3.013E+06	5.994E+06
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.645E+03	3.022E+05	5.502E+05	8.868E+05	1.058E+06	2.800E+06
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.099E+03	3.022E+05	4.743E+05	6.889E+05	1.034E+06	2.502E+06
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.558E+01	3.022E+05	4.657E+05	6.140E+05	7.099E+05	2.092E+06
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.740E+05	3.819E+05	6.559E+05	1.002E+06	2.314E+06
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.349E+05	4.352E+05	6.192E+05	9.877E+05	2.277E+06
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.753E+05	4.583E+05	7.318E+05	1.020E+06	2.385E+06
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.568E+05	3.930E+05	1.131E+06	1.581E+06	3.262E+06
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.289E+03	1.332E+05	2.007E+05	5.756E+05	7.566E+05	1.668E+06
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.060E+04	1.747E+05	1.998E+05	3.093E+05	6.652E+05	1.360E+06
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.897E+04	1.657E+05	1.189E+05	2.907E+05	5.110E+05	1.145E+06
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.010E+04	1.749E+05	1.089E+05	1.763E+05	2.448E+05	7.750E+05
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.858E+04	5.240E+05	6.984E+05	5.833E+05	7.014E+05	2.596E+06
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	9.107E+04	5.240E+05	8.197E+05	7.138E+05	1.450E+06	3.599E+06
TOTAL	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.007E+05	4.963E+06	7.831E+06	1.338E+07	2.195E+07	4.863E+07

DENSITY(/M**2) = 2.43E-03

MAN"S VEGETATION PRODUCTION ABOUT SRP SITE (KG/Y)

SITE VEGETATION PRODUCTION, KGR

DIR	0.0-1.	1.-2.	2.-3.	3.-4.	4.-5.	5.-10.	10.-20.	20.-30.	30.-40.	40.-50.	TOTAL
N	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.385E+04	4.650E+05	7.751E+05	2.158E+06	3.106E+06	6.578E+06
NNE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.885E+04	4.650E+05	7.751E+05	1.177E+06	1.609E+06	4.085E+06
NE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.126E+04	9.712E+05	1.082E+06	1.586E+06	1.931E+06	5.611E+06
ENE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.253E+04	2.574E+06	2.885E+06	2.205E+06	2.783E+06	1.047E+07
E	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.639E+04	2.574E+06	3.010E+06	2.718E+06	3.030E+06	1.136E+07
ESE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.438E+02	2.574E+06	3.818E+06	3.443E+06	9.655E+05	1.080E+07
SE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.731E+06	4.967E+06	4.699E+06	2.893E+06	1.529E+07
SSE	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	2.653E+06	3.712E+06	5.011E+06	3.160E+06	1.454E+07
S	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.355E+06	1.694E+06	2.501E+06	3.266E+06	8.816E+06
SSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.151E+06	1.330E+06	1.861E+06	2.551E+06	6.893E+06
SW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.511E+04	9.195E+05	1.325E+06	1.807E+06	1.970E+06	6.037E+06
WSW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.010E+04	7.213E+05	1.314E+06	1.857E+06	2.406E+06	6.308E+06
W	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.234E+04	1.863E+05	3.170E+05	1.184E+06	2.768E+06	4.508E+06
WNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.222E+04	1.935E+05	1.698E+05	4.890E+04	1.355E+06	1.829E+06
NW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.862E+04	4.650E+05	1.585E+06	4.197E+06	2.265E+06	8.591E+06
NNW	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	8.083E+04	4.650E+05	1.249E+06	5.695E+06	6.379E+06	1.387E+07
TOTAL	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.227E+05	2.046E+07	3.001E+07	4.215E+07	4.244E+07	1.356E+08

DENSITY(/M**2) = 6.78E-03

TABLE A-6

Human and Demographic Parameters 80-km Radius

Parameter	Maximum Individual	Average Individual[a]
Inhalation (cu m/yr)	8,000	8,000
Ingestion[b]		
Cow's milk (L/yr)	310	110
Meat (kg/yr)	110	95
Leafy vegetables (kg/yr)	64[c]	30[d]
Fruits, vegetables, and grains (kg/yr)[e]	520	190
External exposure		
Transmission factor for shielding by residential structures	0.7	0.5
Demographic data, CY 2000		
80-km residential population	-	852,000

[a] Data are recommended values from Regulatory Guide 1.109 (USNRC, 1977).
[b] For maximum individual, foodstuff produced at reference family location, except as noted, where exposure to air releases radionuclides is at a maximum. For average individual, foodstuff obtained at large from the 80-km agricultural production of man's foods; any insufficiency is assumed to be imported (uncontaminated).
[c] Seventy-five percent taken from reference family's garden (March - November growing season); remainder imported.
[d] Data from (Eckerman, 1980).

TABLE A-7

Human Parameters Used in Liquid Dose Calculations

Parameter	Maximum Individual	Average Individual
Water consumption (L/yr)	370	370
Fish consumption (kg/yr)	34	11.3
Other seafood consumption (kg/yr)	5	1
Shoreline recreation (hr/yr)	20	8.3
Shoreline recreation (person-hr)[a]	-	166,400
Boating (hr/yr)	60	-
Boating (person-hr)[a]	-	356,100
Swimming (hr/yr)	10	-
Swimming (person-hr)[a]	-	13,000

[a] For population dose calculations.

TABLE A-8

Site Parameters Used in Liquid Dose Calculations

Parameter	Value
Average river flow rate (cu ft/sec)	10,400
River dilution in estuary	3
Transit time in creeks (hr)	24
Transit time to water treatment plants (hr)	72
Water treatment time (hr)	24
Aquatic food harvest (kg/yr)	
Fish - sport	90,700
Fish - commercial	31,800
Salt water invertebrates	299,000
Irrigation	None
Shore width factor	0.2
Population in year 2000	
Beaufort-Jasper water consumers	117,000
Port Wentworth water consumers	200,000
80-km radius population	852,000

TABLE A-9

Radiation-Induced Health Effect Risk Estimators

Risk	Significant Exposure Period	Risk Factor Nominal	Risk Factor Range
Low-LET (per million person-rad)			
Teratological			
Severe mental retardation	Weeks 8 to 15 of gestation	4,000	2,500 - 5,000
Genetic			
Severe hereditary defects, all generations	30 year reproductive generation	260	60 - 1,000
Somatic			
Fatal cancers	Lifetime	390	120 - 1,200
All cancers	Lifetime	620	190 - 1,900
High-LET (per million person-rad)			
Genetic			
Severe hereditary defects, all generations	30 year reproductive generation	690	160 - 2,900
Somatic			
Fatal cancers	Lifetime	3,100	960 - 9,600
All cancers	Lifetime	5,000	1,500 - 15,000
Radon decay products (per million working level months)			
Fatal lung cancer	Lifetime	360	160 - 720

Table A-10
Annual Atmospheric Releases, per Reactor

Radionuclide	Ci/year
H-3 (oxide)	6.57E+04
C-14	1.39E+01
Ar-41	1.90E+04
Kr-85m	4.97E+02
Kr-87	3.43E+02
Kr-88	5.17E+02
Xe-133	2.10E+03
Xe-135	7.63E+02
I-131	2.87E-03
Sr-89,90 (a)	1.04E-04
Pu-239 (b)	2.20E-06

(a) Includes unidentified beta-gamma.
(b) Includes unidentified alpha.

Table A-11
Annual Liquid Releases, per Reactor

Radionuclide	K Reactor Ci/year	L Reactor Ci/year	P Reactor Ci/year	Total Ci/year
H-3	8.25E+03	1.55E+03	1.80E+03	1.16E+04
Co-58,60	3.33E-04	3.33E-04	3.33E-04	1.00E-03
Sr-90 (a)	4.30E-03	4.30E-03	4.30E-03	1.29E-02
Cs-137	1.11E-07	1.11E-07	1.11E-07	3.33E-07
Pu-239 (b)	1.06E-04	1.06E-04	1.06E-04	3.19E-04

(a) Includes unidentified beta-gamma.
(b) Includes unidentified alpha.

Table A-12

Annual Doses to the Maximum Individual from Reactor-Specific Sources

	ORGAN DOSE COMMITMENT, mrem							
ATMOSPHERIC RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
K Reactor SRP E 41000 N 53500	2.36E-01	1.71E-01	1.58E-01	1.71E-01	1.72E-01	1.71E-01	1.71E-01	1.71E-01
L Reactor SRP E 50460 N 45910	1.88E-01	1.38E-01	1.28E-01	1.38E-01	1.39E-01	1.38E-01	1.38E-01	1.38E-01
P Reactor SRP E 64800 N 43800	2.13E-01	1.53E-01	1.42E-01	1.53E-01	1.55E-01	1.53E-01	1.53E-01	1.53E-01

	ORGAN DOSE COMMITMENT, mrem							
LIQUID RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
K Reactor	4.67E-07	2.29E-02	2.25E-02	2.25E-02	2.24E-02	2.39E-02	2.24E-02	2.24E-02
L Reactor	4.67E-07	4.69E-03	4.30E-03	4.32E-03	4.21E-03	5.67E-03	4.21E-03	4.21E-03
P Reactor	4.67E-07	5.37E-03	4.98E-03	5.00E-03	4.89E-03	6.35E-03	4.89E-03	4.89E-03

PARAMETER SPECIFICATIONS:

Release Data:	Estimated annual values	Dose Factors:	DOE ICRP 30
Release Height:	62 m	Dose Codes:	GASPAR and LADTAP
Met Data:	60-m H Area (1982 - 1986)	River Flow Rate:	10400 cfs

Table A-13
Annual Doses to the Offsite Population from Atmospheric Releases
Single Reactor Operation

ATMOSPHERIC RELEASES	ORGAN DOSE COMMITMENT, person-rem							
	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Pathway								
Plume	2.71E+00	1.02E+00	1.02E+00	1.02E+00	1.02E+00	1.02E+00	1.03E+00	1.02E+00
Ground	1.08E-05	8.87E-06	8.87E-06	8.87E-06	8.87E-06	8.87E-06	8.87E-06	8.87E-06
Inhalation	3.31E+00	3.31E+00	3.32E+00	3.31E+00	3.31E+00	3.32E+00	3.31E+00	3.31E+00
Veget. foods	1.59E+00	1.59E+00	1.38E+00	1.59E+00	1.66E+00	1.60E+00	1.59E+00	1.59E+00
Cow milk	4.55E-01	4.55E-01	3.85E-01	4.55E-01	4.64E-01	4.55E-01	4.55E-01	4.55E-01
Meat	4.11E-01	4.11E-01	2.96E-01	4.11E-01	4.13E-01	4.11E-01	4.11E-01	4.11E-01
Total	8.48E+00	6.79E+00	6.40E+00	6.79E+00	6.87E+00	6.81E+00	6.80E+00	6.79E+00
Estimated Health Effects (a)				2.71E-03				

PARAMETER SPECIFICATIONS;			
Release Data:	Estimated annual values	Dose Factors:	DOE ICRP 30
Release Height:	62 m	Dose Code:	GASPAR
Met Data:	60-m H Area (1982-1986)		

(a) Health effects estimates are based on 400 fatal cancers per 1E+06 person-rem as proposed for use in 40 CFR Part 61.

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Table A-14

Annual Doses to the Offsite Population from Liquid Releases

K Reactor Operation

ORGAN DOSE COMMITMENT, person-rem

	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Population								
Port Wentworth		4.16E+00	4.15E+00	4.14E+00	4.14E+00	4.26E+00	4.14E+00	4.14E+00
Beaufort-Jasper		2.44E+00	2.43E+00	2.42E+00	2.42E+00	2.49E+00	2.42E+00	2.42E+00
Fish-sport		5.37E-03	4.55E-03	4.66E-03	4.48E-03	6.74E-03	4.48E-03	4.49E-03
Fish-comml		4.11E-04	3.48E-04	3.57E-04	3.43E-04	5.16E-04	3.43E-04	3.44E-04
Salt water invert.		1.48E-05	1.84E-05	1.30E-05	1.06E-05	4.99E-05	1.07E-05	1.10E-05
Shoreline	3.88E-06			3.30E-06	3.30E-06			
Swimming	0.00E+00			2.14E-09	2.14E-09			
Boating	0.00E+00			2.94E-08	2.94E-08			
Total	3.88E-06	6.61E+00	6.58E+00	6.57E+00	6.56E+00	6.76E+00	6.56E+00	6.56E+00
Estimated Health Effects (a)				2.63E-03				

Year:	2000	Beaufort-Jasper Population:	117000
80-km-radius Population:	852000	Port Wentworth Population:	200000
Release Height, ft:	200	River Flow Rate, cfs:	10400
Release Point:	SRS center	Dose Factors	DOE ICRP 30
Meteorological Data:	H-Area 1982-86	Dose Codes	LADTAP2 and GASPAR

(a) Health effects estimates are based on 400 fatal cancers per 1E+06 person-rem as proposed for use in 40 CFR Part 61.

Table A-15

Annual Doses to the Offsite Population from Liquid Releases

L REACTOR OPERATION

ORGAN DOSE COMMITMENT, person-rem

	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Population								
Port Wentworth		8.06E-01	7.91E-01	7.85E-01	7.77E-01	8.98E-01	7.77E-01	7.77E-01
Beaufort-Jasper		4.72E-01	4.63E-01	4.59E-01	4.55E-01	5.25E-01	4.55E-01	4.55E-01
Fish-sport		1.73E-03	9.07E-04	1.02E-03	8.42E-04	3.10E-03	8.45E-04	8.50E-04
Fish-comml		1.33E-04	6.94E-05	7.83E-05	6.45E-05	2.37E-04	6.47E-05	6.51E-05
Salt water invert.		6.20E-06	9.78E-06	4.42E-06	1.99E-06	4.13E-05	2.13E-06	2.37E-06
Shoreline	3.88E-06			3.30E-06	3.30E-06			
Swimming	0.00E+00			2.14E-09	2.14E-09			
Boating	0.00E+00			2.94E-08	2.94E-08			
Total	3.88E-06	1.28E+00	1.25E+00	1.25E+00	1.23E+00	1.43E+00	1.23E+00	1.23E+00
Estimated Health Effects (a)				4.98E-04				

Year:	2000	Beaufort-Jasper Population:	117000
80-km-radius Population:	852000	Port Wentworth Population:	200000
Release Height, ft:	200	River Flow Rate, cfs:	10400
Release Point:	SRS center	Dose Factors	DOE ICRP 30
Meteorological Data:	H-Area 1982-86	Dose Codes	LADTAP2 and GASPAR

(a) Health effects estimates are based on 400 fatal cancers per 1E+06 person-rem as proposed for use in 40 CFR Part 61.

Table A-16

Annual Doses to the Offsite Population from Liquid Releases

P REACTOR OPERATION	ORGAN DOSE COMMITMENT, person-rem							
	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Population								
Port Wentworth		9.31E-01	9.16E-01	9.10E-01	9.02E-01	1.02E+00	9.02E-01	9.02E-01
Beaufort-Jasper		5.45E-01	5.36E-01	5.33E-01	5.28E-01	5.98E-01	5.28E-01	5.28E-01
Fish-sport		1.87E-03	1.04E-03	1.16E-03	9.78E-04	3.23E-03	9.81E-04	9.86E-04
Fish-comml		1.43E-04	7.98E-05	8.87E-05	7.49E-05	2.48E-04	7.51E-05	7.55E-05
Salt water invert.		6.52E-06	1.01E-05	4.74E-06	2.31E-06	4.16E-05	2.45E-06	2.69E-06
Shoreline	3.88E-06			3.30E-06	3.30E-06			
Swimming	0.00E+00			2.14E-09	2.14E-09			
Boating	0.00E+00			2.94E-08	2.94E-08			
Total	3.88E-06	1.48E+00	1.45E+00	1.44E+00	1.43E+00	1.62E+00	1.43E+00	1.43E+00
Estimated Health Effects (a)				5.78E-04				

Year:	2000	Beaufort-Jasper Population:	117000
80-km-radius Population:	852000	Port Wentworth Population:	200000
Release Height, ft:	200	River Flow Rate, cfs:	10400
Release Point:	SRS center	Dose Factors	DOE ICRP 30
Meteorological Data:	H-Area 1982-86	Dose Codes	LADTAP2 and GASPAR

(a) Health effects estimates are based on 400 fatal cancers per 1E+06 person-rem as proposed for use in 40 CFR Part 61.

Table A-17
Distribution of Cesium Transport Dose by Source

	Total Transport		F.M.C.-200 Areas 27.5%		P.B.-K Area 3.5%		S.C.-L Area 40.3%		L.T.R.-P Area 28.7%	
	0.51 Ci		0.140 Ci		0.018 Ci		0.206 Ci		0.146 Ci	
Organ	Max.Ind. mrem	Pop. per.-rem	Max.Ind. mrem	Pop. per.-rem	Max.Ind. mrem	Pop. per.-rem	Max.Ind. mrem	Pop. per.-rem	Max.Ind. mrem	Pop. per.-rem
Skin	3.39E-04	2.82E-03	9.32E-05	7.76E-04	1.19E-05	9.87E-05	1.37E-04	1.14E-03	9.73E-05	8.09E-04
Bone Mar.	2.70E-01	1.07E+00	7.43E-02	2.93E-01	9.45E-03	3.73E-02	1.09E-01	4.30E-01	7.75E-02	3.06E-01
Liver	2.93E-04	0.00E+00	8.06E-05	0.00E+00	1.03E-05	0.00E+00	1.18E-04	0.00E+00	8.41E-05	0.00E+00
E.D.E	2.81E-01	1.11E+00	7.73E-02	3.07E-01	9.84E-03	3.90E-02	1.13E-01	4.49E-01	8.06E-02	3.20E-01
Thyroid	2.70E-01	1.07E+00	7.43E-02	2.94E-01	9.45E-03	3.74E-02	1.09E-01	4.31E-01	7.75E-02	3.07E-01
Bone Surf.	2.70E-01	1.07E+00	7.43E-02	2.93E-01	9.45E-03	3.73E-02	1.09E-01	4.30E-01	7.75E-02	3.06E-01
Lung	2.70E-01	1.07E+00	7.43E-02	2.93E-01	9.45E-03	3.73E-02	1.09E-01	4.30E-01	7.75E-02	3.06E-01
GI-LLI	2.92E-01	1.16E+00	8.03E-02	3.18E-01	1.02E-02	4.04E-02	1.18E-01	4.66E-01	8.38E-02	3.32E-01

F.M.C — Four Mile Creek
P.B. — Pen Branch
S.C. — Steel Creek
L.T.R. — Lower Three Runs

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Table A-18
Summary of Doses from Cesium-137 Transport in the Savannah River

LIQUID RELEASES	ORGAN DOSE COMMITMENT							
	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	3.39E-04	2.70E-01	2.93E-04	2.81E-01	2.70E-01	2.70E-01	2.70E-01	2.92E-01
Population, person-rem								
Port Wentworth	-	1.95E-01	0.00E+00	2.03E-01	1.95E-01	1.95E-01	1.95E-01	2.11E-01
Beaufort-Jasper	-	1.14E-01	0.00E+00	1.19E-01	1.14E-01	1.14E-01	1.14E-01	1.23E-01
Fish-sport	-	7.04E-01	0.00E+00	7.34E-01	7.04E-01	7.04E-01	7.04E-01	7.63E-01
Fish-commercial	-	5.39E-02	0.00E+00	5.62E-02	5.39E-02	5.39E-02	5.39E-02	5.84E-02
Salt water invertebrates	-	1.34E-05	0.00E+00	1.40E-05	1.34E-05	1.34E-05	1.34E-05	1.45E-05
Shoreline	2.82E-03	-	-	2.42E-03	2.42E-03	-	-	-
Swimming	0.00E+00	-	-	7.13E-07	7.13E-07	-	-	-
Boating	0.00E+00	-	-	9.77E-06	9.77E-06	-	-	-
Total	2.82E-03	1.07E+00	0.00E+00	1.11E+00	1.07E+00	1.07E+00	1.07E+00	1.16E+00
Estimated Health Effects (a)				4.46E-04				

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Table A-19
Composite Doses from Operation of K-, L-, and P-Reactors

LIQUID RELEASES	ORGAN DOSE COMMITMENT Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	1.40E-06	3.30E-02	3.18E-02	3.18E-02	3.15E-02	3.59E-02	3.15E-02	3.15E-02
Population, person-rem								
Port Wentworth	-	5.90E+00	5.86E+00	5.84E+00	5.82E+00	6.18E+00	5.82E+00	5.82E+00
Beaufort-Jasper	-	3.45E+00	3.43E+00	3.42E+00	3.40E+00	3.61E+00	3.40E+00	3.40E+00
Fish-sport	-	8.99E-03	6.50E-03	6.85E-03	6.30E-03	1.31E-02	6.31E-03	6.33E-03
Fish-comml	-	6.88E-04	4.97E-04	5.24E-04	4.82E-04	1.00E-03	4.83E-04	4.84E-04
Salt water invert.	-	2.76E-05	3.83E-05	2.22E-05	1.49E-05	1.33E-04	1.53E-05	1.60E-05
Shoreline	1.17E-05	-	-	9.91E-06	9.91E-06	-	-	-
Swimming	0.00E+00	-	-	6.44E-09	6.44E-09	-	-	-
Boating	0.00E+00	-	-	8.82E-08	8.82E-08	-	-	-
Total	1.17E-05	9.36E+00	9.30E+00	9.27E+00	9.23E+00	9.80E+00	9.23E+00	9.23E+00
Estimated Health Effects (a)				3.71E-03				

ATMOSPHERIC RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	4.12E-01	3.42E-01	3.18E-01	3.42E-01	3.45E-01	3.43E-01	3.42E-01	3.42E-01
Population, person-rem								
Plume	7.57E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.12E+00	4.11E+00
Ground	3.24E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05	2.66E-05
Inhalation	9.93E+00	9.94E+00	9.94E+00	9.94E+00	9.94E+00	9.96E+00	9.94E+00	9.93E+00
Veget. foods	4.76E+00	4.76E+00	4.13E+00	4.77E+00	4.97E+00	4.78E+00	4.76E+00	4.76E+00
Cow milk	1.36E+00	1.36E+00	1.15E+00	1.37E+00	1.39E+00	1.36E+00	1.36E+00	1.36E+00
Meat	1.23E+00	1.23E+00	8.86E-01	1.23E+00	1.24E+00	1.23E+00	1.23E+00	1.23E+00
Total	2.49E+01	2.14E+01	2.02E+01	2.14E+01	2.16E+01	2.15E+01	2.14E+01	2.14E+01
Estimated Health Effects (a)				8.56E-03				

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Table A-20
Composite Doses from Operation of Existing Support Facilities

ORGAN DOSE COMMITMENT

LIQUID RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	1.14E-04	1.63E-01	6.94E-02	1.41E-01	1.44E-01	3.08E-01	1.25E-01	1.32E-01
Population, person-rem								
Port Wentworth	-	1.15E+01	1.20E+01	9.90E+00	1.02E+01	2.98E+01	8.58E+00	8.58E+00
Beaufort-Jasper	-	6.71E+00	7.03E+00	5.79E+00	5.97E+00	1.74E+01	5.02E+00	5.02E+00
Fish-sport	-	2.77E-01	2.40E-02	2.39E-01	2.44E-01	4.17E-01	2.15E-01	2.32E-01
Fish-comml	-	2.12E-02	1.84E-03	1.83E-02	1.87E-02	3.19E-02	1.65E-02	1.78E-02
Salt water invert.	-	8.24E-04	1.95E-03	5.68E-04	2.50E-04	9.65E-03	2.57E-05	2.61E-05
Shoreline	9.44E-04	-	-	7.98E-04	7.98E-04	-	-	-
Swimming	0.00E+00	-	-	2.16E-07	2.16E-07	-	-	-
Boating	0.00E+00	-	-	2.96E-06	2.96E-06	-	-	-
Total	9.44E-04	1.85E+01	1.91E+01	1.59E+01	1.64E+01	4.77E+01	1.38E+01	1.38E+01
Estimated Health Effects (a)				6.36E-03				

ATMOSPHERIC RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	6.75E-01	2.33E-01	2.37E-01	3.12E-01	2.81E+00	3.78E-01	2.35E-01	2.66E-01
Population, person-rem								
Plume	6.09E+01	3.63E-01	3.63E-01	3.63E-01	3.63E-01	3.63E-01	1.21E+00	3.63E-01
Ground	2.67E-01	1.75E-01	1.75E-01	1.75E-01	1.75E-01	1.75E-01	1.75E-01	1.75E-01
Inhalation	9.53E+00	1.02E+01	1.13E+01	1.01E+01	9.75E+00	1.76E+01	1.06E+01	9.53E+00
Veget. foods	4.38E+00	4.72E+00	4.74E+00	7.47E+00	9.83E+01	8.19E+00	4.39E+00	4.88E+00
Cow milk	1.25E+00	1.25E+00	1.11E+00	1.62E+00	1.35E+01	1.25E+00	1.25E+00	1.25E+00
Meat	1.08E+00	1.08E+00	8.51E-01	1.36E+00	5.24E+00	1.09E+00	1.08E+00	2.91E+00
Total	7.74E+01	1.78E+01	1.85E+01	2.11E+01	1.27E+02	2.87E+01	1.87E+01	1.91E+01
Estimated Health Effects (a)				8.44E-03				

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Table A-21
Composite Doses from New Support Facilities

	ORGAN DOSE COMMITMENT							
LIQUID RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	3.39E-05	1.21E-01	9.25E-02	1.11E-01	1.01E-01	1.63E-01	1.01E-01	1.38E-01
Population, person-rem								
Port Wentworth	-	1.75E+01	1.69E+01	1.68E+01	1.63E+01	2.16E+01	1.63E+01	1.75E+01
Beaufort-Jasper	-	1.02E+01	9.90E+00	9.80E+00	9.54E+00	1.26E+01	9.54E+00	1.03E+01
Fish-sport	-	8.74E-02	2.03E-02	6.97E-02	5.22E-02	1.44E-01	5.22E-02	1.23E-01
Fish-comml	-	6.69E-03	1.56E-03	5.30E-03	3.99E-03	1.10E-02	3.99E-03	9.18E-03
Salt water invert.	-	2.24E-04	3.93E-04	4.17E-04	4.23E-05	1.87E-03	4.23E-05	3.40E-03
Shoreline	2.82E-04	-	-	2.39E-04	2.39E-04	-	-	-
Swimming	0.00E+00	-	-	4.23E-07	4.23E-07	-	-	-
Boating	0.00E+00	-	-	5.80E-06	5.80E-06	-	-	-
Total	2.82E-04	2.78E+01	2.68E+01	2.67E+01	2.59E+01	3.44E+01	2.59E+01	2.79E+01
Estimated Health Effects (a)				1.07E-02				

ATMOSPHERIC RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	6.15E-03	6.35E-03	6.14E-03	6.42E-03	9.09E-03	6.46E-03	6.32E-03	6.47E-03
Population, person-rem								
Plume	-	-	-	-	-	-	-	-
Ground	2.91E-02	2.49E-02	2.49E-02	2.49E-02	2.49E-02	2.49E-02	2.49E-02	2.49E-02
Inhalation	2.87E-01	2.88E-01	2.88E-01	2.88E-01	2.88E-01	2.92E-01	2.88E-01	2.88E-01
Veget. foods	1.20E-01	1.27E-01	1.20E-01	1.29E-01	2.26E-01	1.30E-01	1.25E-01	1.28E-01
Cow milk	3.35E-02	3.50E-02	3.34E-02	3.54E-02	4.81E-02	3.50E-02	3.49E-02	3.51E-02
Meat	2.58E-02	2.62E-02	2.56E-02	2.67E-02	3.06E-02	2.62E-02	2.62E-02	3.15E-02
Total	4.95E-01	5.01E-01	4.92E-01	5.04E-01	6.18E-01	5.08E-01	4.99E-01	5.08E-01
Estimated Health Effects (a)				2.02E-04				

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Table A-22
Composite Doses from Operation of Two Reactors at Vogtle Electric Generating Plant

ORGAN DOSE COMMITMENT

LIQUID RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	1.55E-04	4.29E-03	5.24E-03	1.57E-02	3.43E-03	3.06E-03	3.81E-03	8.26E-02
Population, person-rem								
Port Wentworth	-	4.80E-01	5.20E-01	5.10E-01	4.80E-01	4.41E-01	4.72E-01	6.79E-01
Beaufort-Jasper	-	2.81E-01	3.04E-01	2.99E-01	2.81E-01	2.58E-01	2.76E-01	3.97E-01
Fish-sport	-	4.36E-03	6.24E-03	2.96E-02	1.63E-03	1.76E-03	3.29E-03	1.78E-01
Fish-comml	-	3.28E-04	4.71E-04	2.15E-03	1.17E-04	1.32E-04	2.49E-04	1.29E-02
Salt water invert.	-	3.24E-04	4.57E-04	4.40E-04	3.02E-05	2.33E-04	1.90E-04	1.82E-03
Shoreline	1.29E-03	-	-	1.10E-03	1.10E-03	-	-	-
Swimming	0.00E+00	-	-	5.11E-06	5.11E-06	-	-	-
Boating	0.00E+00	-	-	7.00E-05	7.00E-05	-	-	-
Total	1.29E-03	7.66E-01	8.31E-01	8.42E-01	7.64E-01	7.01E-01	7.52E-01	1.27E+00
Estimated Health Effects (a)				3.37E-04				

ATMOSPHERIC RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem	7.24E-03	5.90E-03	6.36E-03	5.85E-03	6.42E-03	9.13E-03	5.66E-03	5.64E-03
Population, person-rem								
Plume	1.02E-02	3.69E-03	3.69E-03	3.69E-03	3.69E-03	3.69E-03	3.83E-03	3.69E-03
Ground	6.14E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07	5.04E-07
Inhalation	9.38E-03	9.62E-03	1.00E-02	9.54E-03	9.40E-03	1.24E-02	9.38E-03	9.38E-03
Veget. foods	3.90E-03	4.00E-03	4.17E-03	3.99E-03	4.46E-03	5.22E-03	3.90E-03	3.90E-03
Cow milk	1.09E-03	1.09E-03	1.09E-03	1.09E-03	1.16E-03	1.09E-03	1.09E-03	1.09E-03
Meat	8.37E-04	8.37E-04	8.37E-04	8.37E-04	8.50E-04	8.37E-04	8.37E-04	8.37E-04
Total	2.54E-02	1.92E-02	1.98E-02	1.92E-02	1.96E-02	2.32E-02	1.90E-02	1.89E-02
Estimated Health Effects (a)				7.68E-06				

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Table A-23
Summary of Maximum Individual Doses

ORGAN DOSE COMMITMENT

LIQUID RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Max. Individual, mrem								
Reactors	1.40E-06	3.30E-02	3.18E-02	3.18E-02	3.15E-02	3.59E-02	3.15E-02	3.15E-02
Cs-137 Transport	3.39E-04	2.70E-01	2.93E-04	2.81E-01	2.70E-01	2.70E-01	2.70E-01	2.92E-01
Support Facilities	1.14E-04	1.63E-01	6.94E-02	1.41E-01	1.44E-01	3.08E-01	1.25E-01	1.32E-01
New Facilities	3.39E-05	1.21E-01	9.25E-02	1.11E-01	1.01E-01	1.65E-01	1.01E-01	1.38E-01
Vogtle Electric Generating Plant	1.55E-04	4.29E-03	5.24E-03	1.57E-02	3.43E-03	3.06E-03	3.81E-03	8.26E-02
Total	6.43E-04	5.91E-01	1.99E-01	5.81E-01	5.50E-01	7.82E-01	5.31E-01	6.76E-01

ATMOSPHERIC RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Surface	Lung	GI-LLI
Max. Individual, mrem								
Reactors	4.12E-01	3.42E-01	3.18E-01	3.42E-01	3.45E-01	3.43E-01	3.42E-01	3.42E-01
Support Facilities	6.75E-01	2.33E-01	2.37E-01	3.12E-01	2.81E+00	3.78E-01	2.35E-01	2.66E-01
New Facilities	6.15E-03	6.35E-03	6.14E-03	6.42E-03	9.09E-03	6.46E-03	6.32E-03	6.47E-03
Vogtle Electric Generating Plant	7.24E-03	5.90E-03	6.36E-03	5.85E-03	6.42E-03	9.13E-03	5.66E-03	5.64E-03
Total	1.10E+00	5.87E-01	5.68E-01	6.66E-01	3.17E+00	7.37E-01	5.89E-01	6.20E-01
Cumulative Max. Indiv. Dose	1.10E+00	1.18E+00	7.67E-01	1.25E+00	3.72E+00	1.52E+00	1.12E+00	1.30E+00

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Table A-24
Summary of Population Doses

LIQUID RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
	ORGAN DOSE COMMITMENT							
Population, person-rem								
Reactors	1.17E-05	9.36E+00	9.30E+00	9.27E+00	9.23E+00	9.80E+00	9.23E+00	9.23E+00
Cs-137 Transport	2.82E-03	1.07E+00	0.00E+00	1.11E+00	1.07E+00	1.07E+00	1.07E+00	1.16E+00
Support Facilities	9.44E-04	1.85E+01	1.91E+01	1.59E+01	1.64E+01	4.77E+01	1.38E+01	1.38E+01
New Facilities	2.84E-04	2.78E+01	2.68E+01	2.67E+01	2.59E+01	3.44E+01	2.59E+01	2.79E+01
Vogtle Electric Generating Plant	1.29E-03	7.66E-01	8.31E-01	8.42E-01	7.64E-01	7.01E-01	7.52E-01	1.27E+00
Total	5.35E-03	5.75E+01	5.60E+01	5.38E+01	5.34E+01	9.37E+01	5.07E+01	5.34E+01

ATMOSPHERIC RELEASES	Skin	Bone Marrow	Liver	Effect. D.E.	Thyroid	Bone Surface	Lung	GI-LLI
Population, person-rem								
Reactors	2.49E+01	2.14E+01	2.02E+01	2.14E+01	2.16E+01	2.15E+01	2.14E+01	2.14E+01
Support Facilities	7.74E+01	1.78E+01	1.85E+01	2.11E+01	1.27E+02	2.87E+01	1.87E+01	1.91E+01
New Facilities	4.95E-01	5.01E-01	4.92E-01	5.04E-01	6.18E-01	5.08E-01	4.99E-01	5.08E-01
Vogtle Electric Generating Plant	2.54E-02	1.92E-02	1.98E-02	1.92E-02	1.96E-02	2.32E-02	1.90E-02	1.89E-02
Total	1.03E+02	3.97E+01	3.92E+01	4.30E+01	1.49E+02	5.07E+01	4.06E+01	4.10E+01
Cumulative Population Dose	1.03E+02	9.72E+01	9.52E+01	9.69E+01	2.03E+02	1.44E+02	9.14E+01	9.44E+01
Cumulative Estimated Health Effects				3.87E-02				

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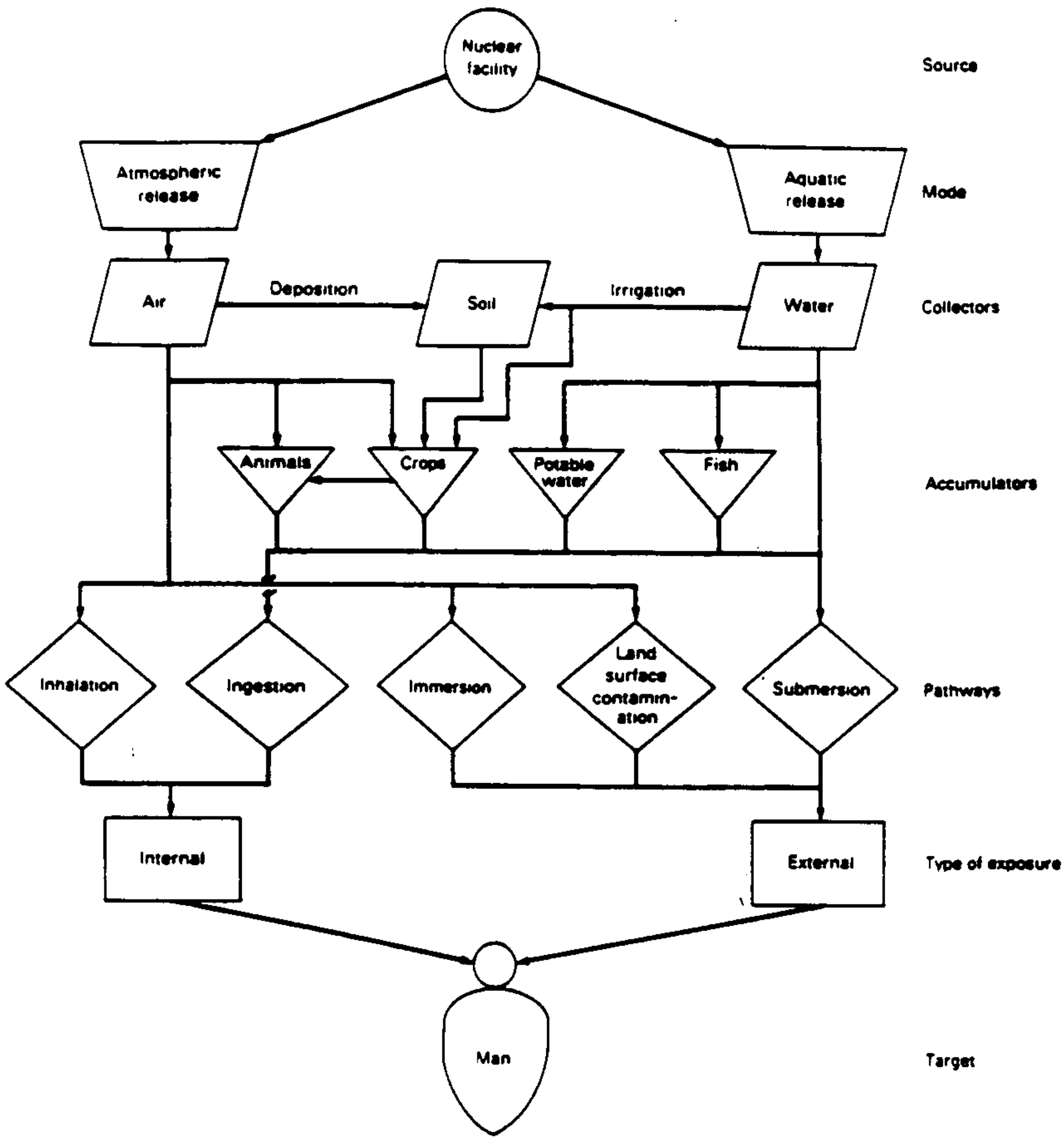


FIGURE A-1. Exposure Pathways Considered in Radiological Impact Assessments

APPENDIX B

RADIOCESIUM AND RADIOCOBALT INVENTORY AND TRANSPORT

This appendix discusses the existing releases of radiocesium and radiocobalt to Indian Grave/Pen Branch (K Reactor), Steel Creek (L Reactor) and Lower Three Runs Creek (P and R Reactors) systems; it also examines the transport offsite and predicts the concentrations in the Savannah River below SRS.

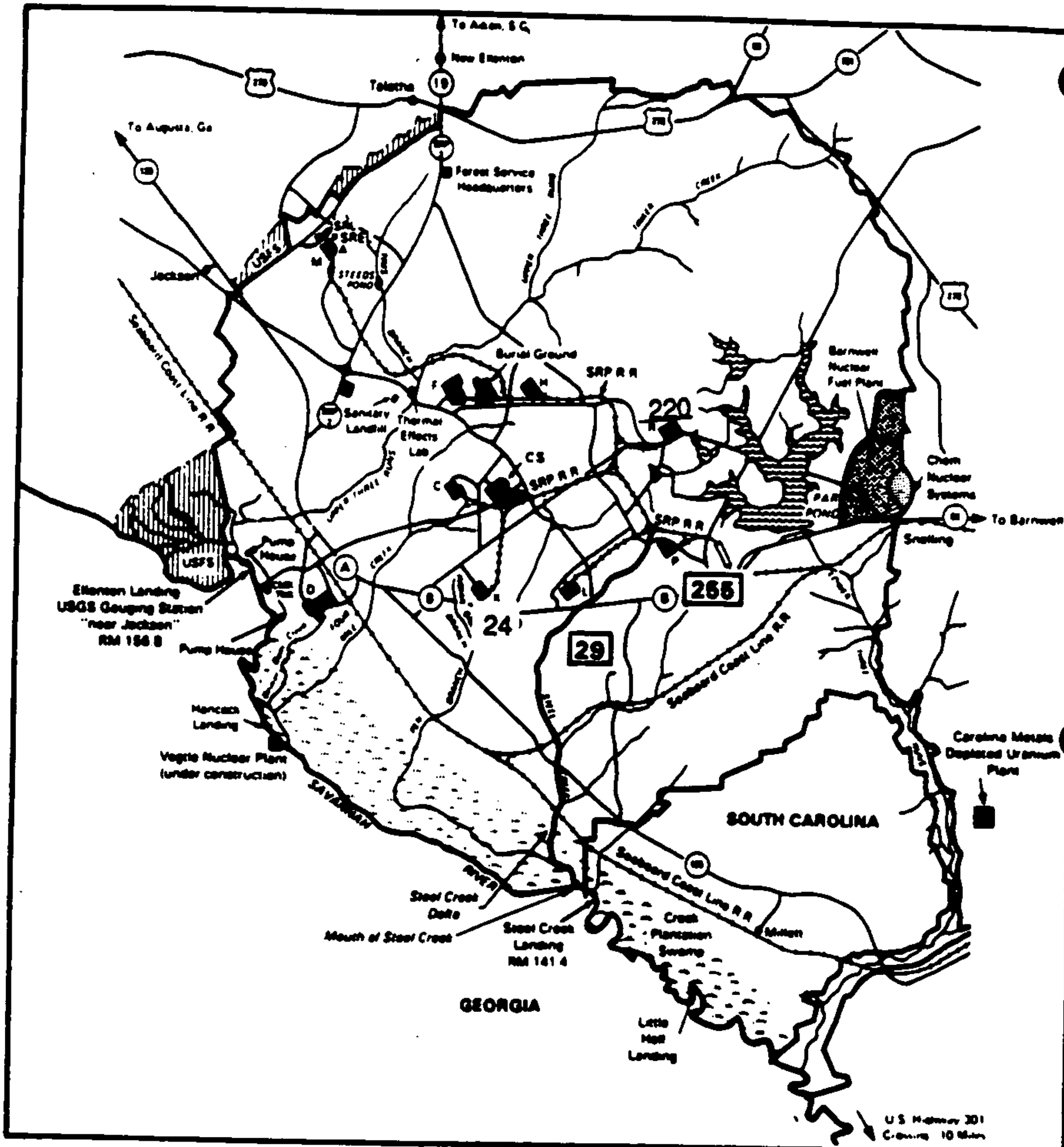
Releases of Radiocesium and Radiocobalt

The principal sources of radiocesium (Cs-137 and Cs-134) and radiocobalt (Co-60) in the streams at the Savannah River Site (SRS) have been reactor effluent discharges to onsite streams and releases from the chemical separations facilities in F and H Areas. From 1955 through 1985, about 600 curies of Cs-137, 0.5 curie of Cs-134, and 66 curies of Co-60 were discharged to all onsite streams (Zeigler and Lawrimore, 1988). Due to radioactive decay about 330 Ci of Cs-137, 2.2 Ci of Co-60, and 0.02 Ci of Cs-134 remain from the original releases. The focus of this appendix will be on Cs-137 transport.

About 529 Ci of the 600 Ci of Cs-137 were released to the streams that K, L, P, and R Reactors discharge to SRS streams (Figure B-1). The sources of these releases were heat exchanger cooling water, spent fuel storage, and disassembly basin effluents and process water from K, L, P, and R Reactors. Most of the releases occurred in the 1960's, prior to installation of sand filters in the early 1970's and deionizers in the early 1980's for processing basin effluents and removal of leaking fuel elements (Figure B-2). Approximately 13.2, 163.6, and 116.4 Ci of Cs-137 remain from the discharges to Indian Grave/Pen Branch, Steel Creek, and Lower Three Runs Creek, respectively (Table B-1).

Sorption Onto Sediments

Most of the Cs-137 that has been discharged to onsite creeks by SRS operations and fallout from offsite weapons because associated with the silts and clays found in stream bed, floodplain, and suspended solids in the onsite streams. This extensive Cs-137 removal by sediments in SRS streams is shown by comparing the amount of Cs-137 released to the amount in transport below SRS (Figure B-2). The principal mechanisms for this association were, cation and sorption processes with clay (primarily kaolinite) and other minerals and naturally occurring organic material. A distribution coefficient of 3960 (K_d) measure for sediments from Four Mile Creek and Steel Creek (Kiser, 1979), and the studies conducted by Prout (1958) demonstrate the affinity of Cs-137 for the sediments and suspended solids in the creek systems. Cs-137 concentrations in the sediment of Pen Branch, Steel Creek, and Lower Three Runs Creek varied between 91 and 0.43 pCi/g (DPSPU-88-30-1, 1988).



Legend

0 5 10 15 kilometers

C, K, R, L, P	Reactor Areas (C, P, K are operating)	Road A = Highway 125
F, H	Separations Areas	
M	Fuel and Target Fabrication	
D	Heavy Water Production	
A	Savannah River Laboratory and Administration Area	Note: See Table D-1 for listing of the annual releases to Steel Creek.
CS	Central Shop	
RM	River Mile	

FIGURE B-1. Savannah River Plant Site Showing Total Radiocesium Releases to Steel Creek from L and P Areas

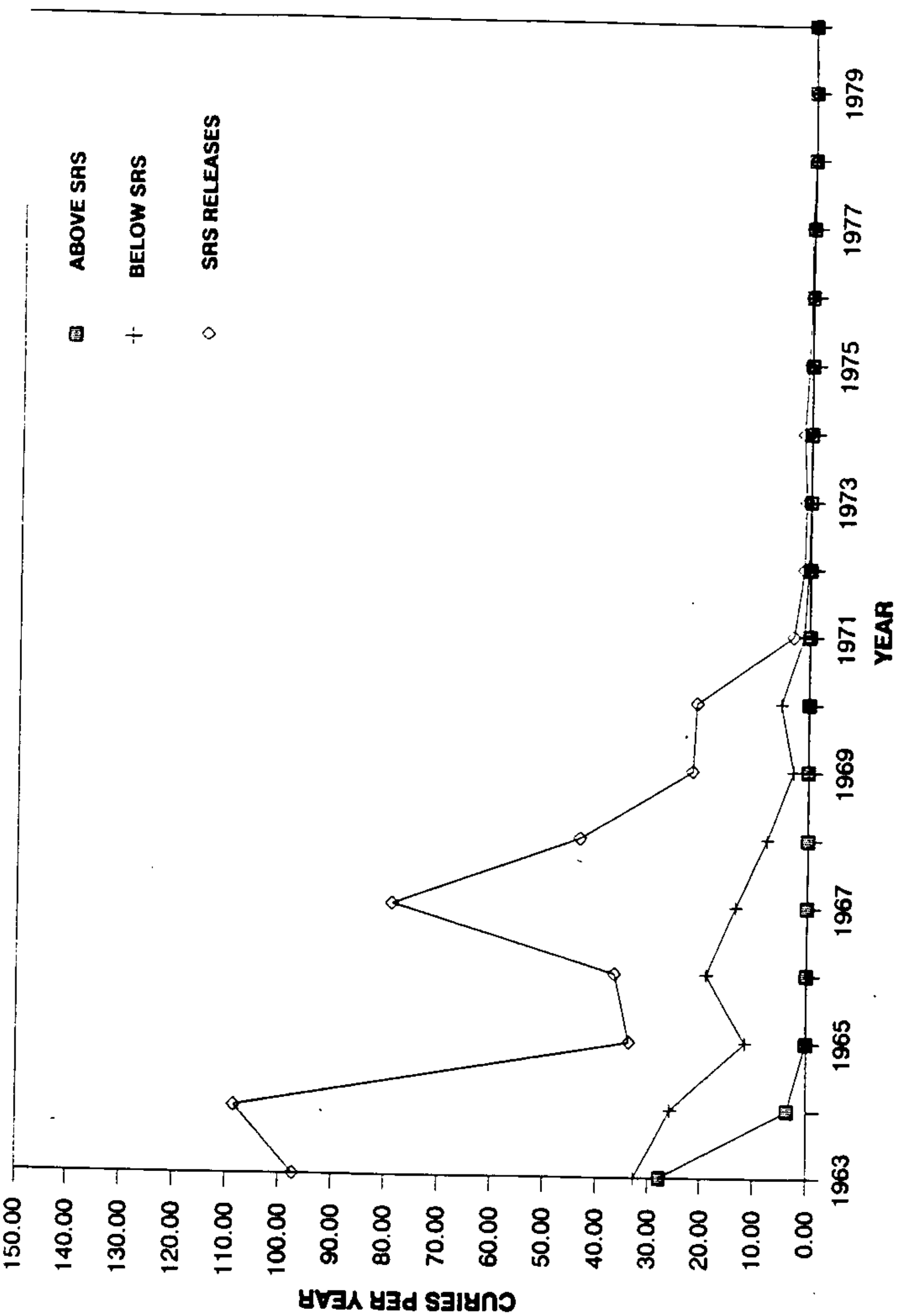


FIGURE B-2. Cs-137 Releases from the Savannah River Site

TABLE B-1

Cs-137 and Co-60 Discharges from K, L, P, and R Reactors

Creek System	Release	Decay Corrected
Cs-137		
Pen Branch		
K Reactor	24.4	13.2
Steel Creek		
L Reactor	29.4	16.3
P Reactor	254.7	147.3
Total	284.1	163.6
Lower Three Runs		
R Reactor	220.1	116.4
Total	528.6	293.2
Co-60		
Pen Branch		
K Reactor	16.8	0.7
Steel Creek		
L Reactor	14.9	0.5
P Reactor	11.7	0.3
Total	26.6	
Lower Three Runs	10.5	0.3
R Reactor	53.9	1.8

As a result of these affinities, resuspension, transport deposition of sediment and sorption control the distribution of Cs-137 within the creeks, deltas, and the Savannah River swamp. The resuspension, transport, and deposition of sediment are governed by the hydraulic properties of the sediment and streambeds, and by the creeks' flow regimes. Almost all sediment redistribution occurred between 1955 and 1968, the period of major reactor discharges. Since 1968, little change has occurred in the sedimentation patterns or in the channel/delta configurations (Ruby, Reinhart, and Reel, 1981).

Cs-137 remobilization from SRS streams to the Savannah River is governed primarily by desorption processes and secondarily by suspended sediment transport (Hayes, 1982).

Inventory of Cs-137

The decay corrected amount of Cs-137 released to onsite streams (Pen Branch, Steel Creek, and Lower Three Runs Creek) from 1955 through 1985 totaled 293.2 curies (Table B-1). The Cs-137 inventory remaining in the onsite creek systems was estimated by two methods: (1) by comparing the Pen Branch and Lower Three Runs to the extensively sampled Steel Creek system, and (2) simple mass balance (amount released minus amount in transport at Highway 301 below SRS).

Steel Creek has been the most extensively sediment sampled creek on SRS for Cs-137 distribution (in preparation of L-Reactor restart). Studies of Cs-137 distribution in Steel Creek based on sediment core samples up to one meter in length, categorized by soil type, sample depth interval, and creek location were used to estimate an inventory of 62.1 Ci Cs-137 (1980) in Steel Creek above Steel Creek Delta (DOE, 1985). Including Steel Creek Delta a total of about 76 Ci remains in the Steel Creek system on SRS. This 76 Ci is about 38 percent of the 163.6 Ci (decay corrected) of Cs-137 that was released to Steel Creek. Assuming that the Cs-137 transport processes in the other creeks are similar to that of Steel Creek, then the about 38 percent of the original amount released to each of the creeks should remain in that creek's system (Table B-2).

The second method uses a mass balance approach (Du Pont, 1985, DOE/EIS-0108, 1984). The amount of Cs-137 remaining in an onsite stream was calculated by multiplying the total Cs-137 released to the stream between 1960 and 1980 by 76 percent (Table B-2). The 76 percent value was calculated by comparing release data to the amount in transport at Highway 301 [(total amount released - amount in transport)/total amount released] (Du Pont, 1985).

Based on the two methods between 111 and 221 curies of Cs-137 remain in the Steel Creek, Indian Grave/Pen Branch, and Lower Three Runs Creek systems.

TABLE B-2

Cs-137 Inventory in Indian Grave/Pen Branch, Steel Creek, and Lower Three Runs Creek Systems

	Released Ci Decay Corrected	Comparison to Steel Creek, Ci	Mass Balance, Balance, Ci
Indian Grave/Pen Branch	13.2	5.1	8.5
Steel Creek	163.6	62.1	124.3
Lower Three Runs Creek	116.4	44.2	88.5

Remobilization of Cs-137 from SRS Creeks

Cs-137 concentrations in the Savannah River below SRS reflect contributions from: Cs-137 remobilized from sediments in the SRS stream systems, SRS facilities releases, fallout, and power reactor discharges.

The highest Cs-137 concentrations in the Savannah River occurred in the mid 1960's when releases from SRS were high and additional Cs-137 was added to the river from nuclear weapons fallout (Figure B-3). Highest river Cs-137 concentrations coincided with the highest SRS releases (Figure B-3). Since 1974, less than 1 Ci per year of Cs-137 has been released to SRS creeks and the Cs-137 concentration in the Savannah River below SRS now averages about 0.1 pCi/L (Figure B-4). To measure Cs-137 concentrations reliably at these low concentrations requires the concentrating of Cs-137 from about 400 liters of river water prior to counting.

The primary source of Cs-137 to the river now from SRS is the remobilization of Cs-137 from sediments in the SRS stream system (Hayes, 1982). Cs-137 concentrations in the river below SRS vary around 0.1 pCi/L and have remained below 0.2 pCi/L, except for the first month right after L-Reactor restart (solid vertical line in Figure B-3). Lower Cs-136 to Cs-134 ratios indicate that the higher concentrations in the river during the spring of 1986 were a result of fallout from the Chernobyl accident.

SRS reactor operation does not appear to affect the remobilization of Cs-137 from Cs-137 sediments in the SRS stream system to the Savannah River. SRS reactors have not operated since the summer of 1988 and Cs-138 concentrations in the river below SRS have remained around 0.1 pCi/L.

The restart of K, L, and P Reactors will result in little change from the present in the remobilization of Cs-137 from SRS stream systems. This is based on extensive measurements of Cs-137 concentrations in the Savannah River below SRS at Highway 301 during reactor operation and the effect of L-Reactor restart. Cs-137 concentrations will remain at or near their present levels, 0.05 to 0.2 pCi/L in the Savannah River below SRS, providing no other changes or releases occur other than reactor restart.

The current annual averaged Cs-137 concentrations in the river below SRS are less than 0.5 percent of the EPA Cs-137 annual averaged drinking water standard of 200 pCi/L. It is expected that the annual average Cs-137 concentration will remain below 0.5 percent of the EPA standard following K-, L-, and P-Reactor restart, providing no other changes or releases occur other than reactor restart.

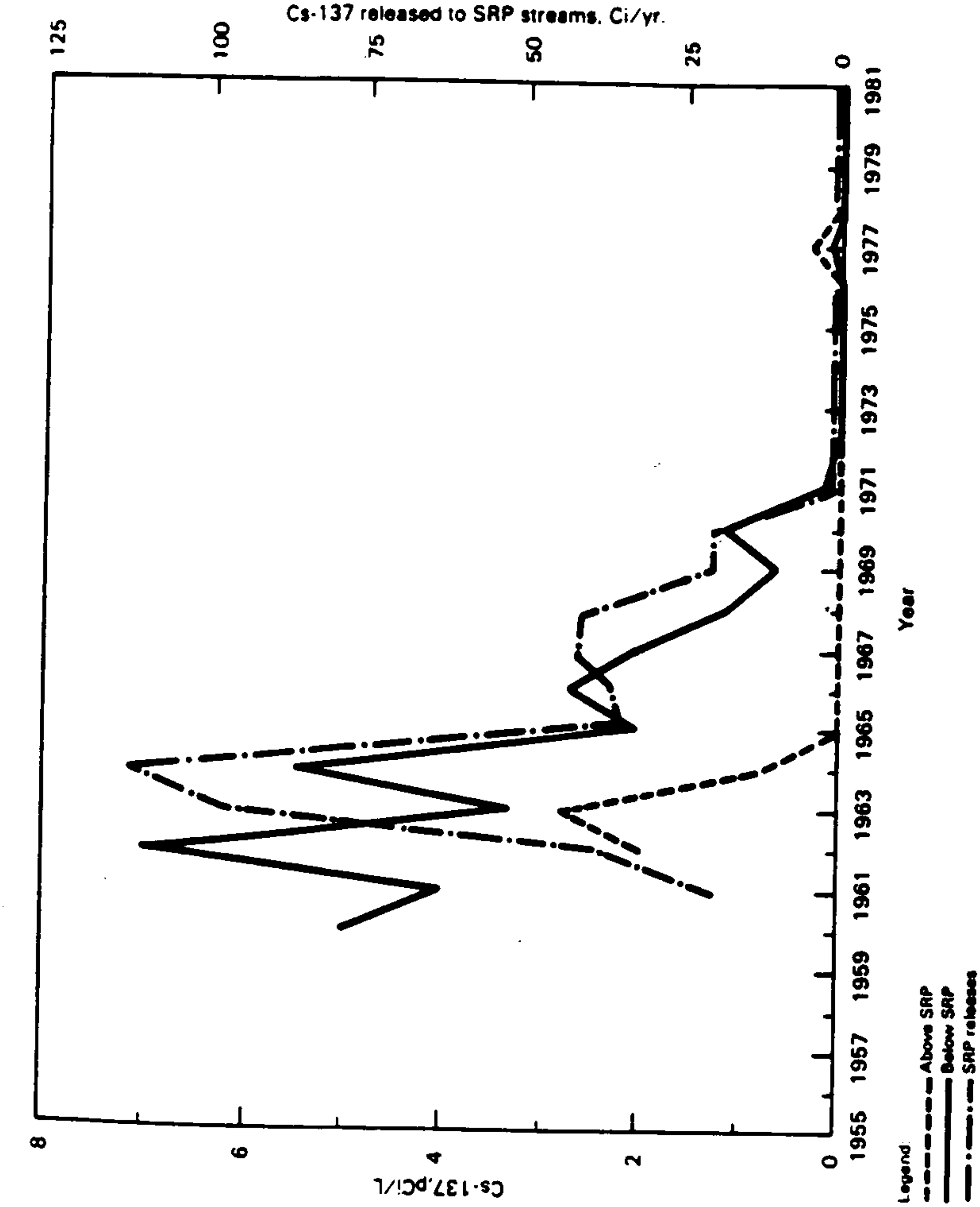


FIGURE B-3. Cs-137 Concentrations in the Savannah River, 1960-1980

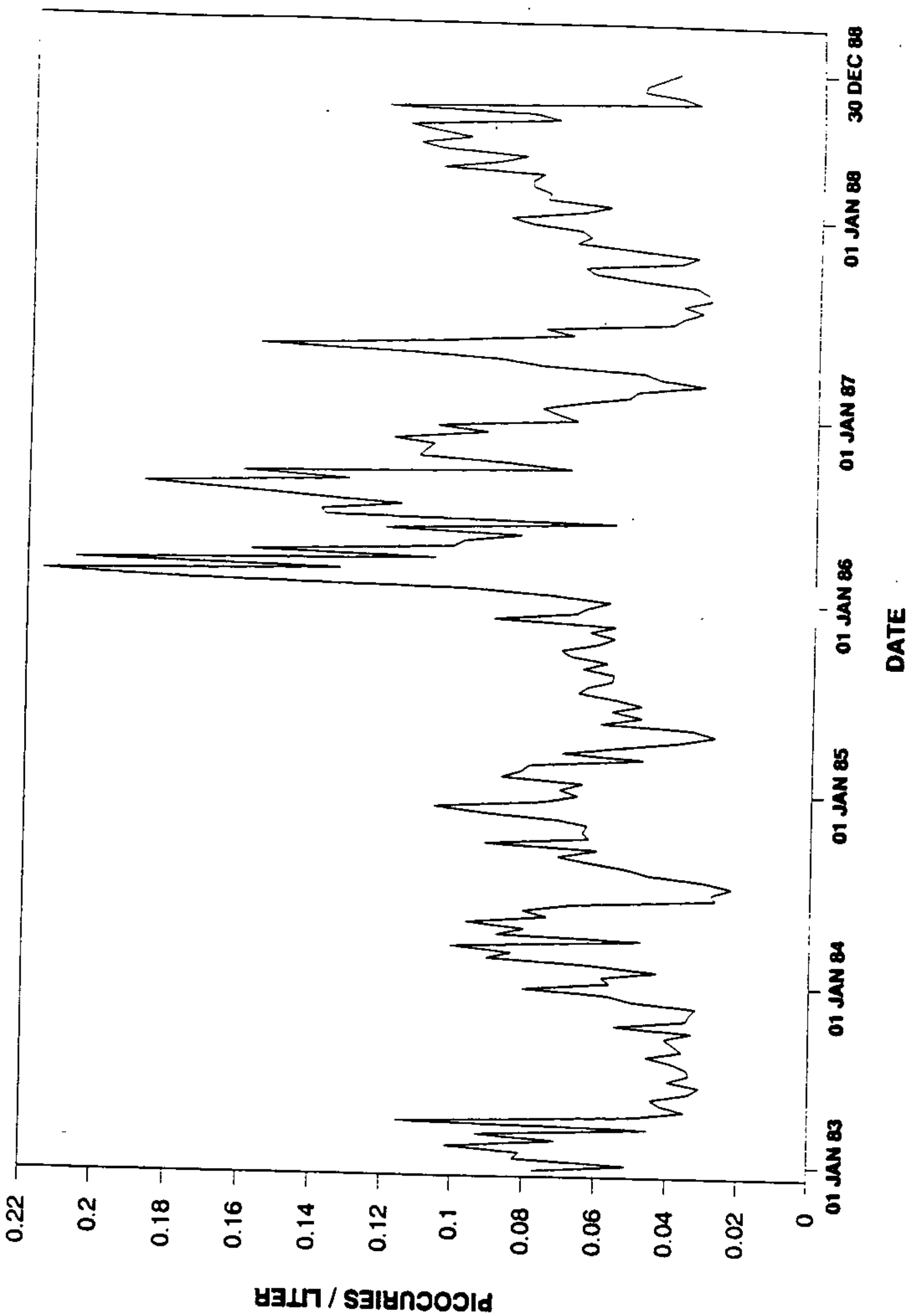


FIGURE B-4. Cs-137 Concentrations at Highway 301

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APPENDIX C

Facilities at the Savannah River Site

Major facilities at the SRS are briefly described in the following:

- **Nuclear Production Reactors (100 Areas).** Three production reactors (K, L, and P) of the five originally constructed are currently operating at SRS. The R reactor was placed in standby condition in 1964 and is now permanently shut down. The C reactor was shut down in 1985 and placed in standby in 1987.

- **Chemical Separations Facilities (200 Areas).** The chemical separations facilities consist of two main operating areas 200-F and 200-H. These areas occupy 364 acres and 395 acres, respectively. Each main area has a large shielded "canyon" building for processing irradiated materials (fuel and/or targets); a waste concentration and storage system; power houses; and service facilities. In addition, F area contains the main analytical laboratory, the plutonium metallurgical building, the FMF, and the PUFF facility. In the canyon buildings, irradiated fuel and target materials undergo solvent extraction and ion exchange processes to separate desired products (i.e., plutonium) from waste fission products. Further processing is performed in unshielded facilities where the products can be converted from solution to solid form for shipment offsite. The H Area contains the tritium processing buildings, the receiving basin for offsite fuel (RBOF), the resin regeneration facility, and the effluent treatment facility. These areas are major sources of radioactive liquid and solid wastes that are stored onsite.

  The purpose of the separations programs is to operate and maintain chemical processing facilities for the recovery of U-235 from spent reactor fuel; separation of Pu-239 from irradiated, depleted uranium targets; conversion of Pu-239 to metal, separation and recovery of Np-237 and Pu-238; and fabrication of Pu-238 heat sources.

- **Fuel and Target Fabrication (300 Area).** The 300-M Area occupies approximately 114 acres. The fuel fabrication facility processes uranium, aluminum, lithium, and other materials into fuel and target elements to be irradiated in the production reactors. The processes are primarily metallurgical ones such as casting, extrusion, welding, and magneforming. Effluent from the fabrication process is treated in the M Area effluent treatment facility prior to discharge to the environment.

- **Heavy Water Rework Plant (400 Area).** The 400-D Area occupies 445 acres. Prior to shutdown in 1982, heavy water (D_2O) was extracted from river water by a hydrogen sulfide extraction process with final purification by distillation. At present, the rework unit of the heavy water plant is operating to purify the reactor moderator (heavy water). Also located in the area is a large coal-fired plant (484-D), a drum-cleaning facility where 50-gallon drums used for heavy water storage and transport are cleaned, and an analytical laboratory for analyses of D_2O samples.

- **Savannah River Laboratory.** The SRL has primary responsibility for conducting research and development activities to support production at the SRS. Laboratory operations are conducted in the Technical (700) Area, TNX-CMX semiworks area near the Savannah River (600-T Area), and in the B-Area. The purpose of the SRL is to support current and anticipated nuclear material production of the SRS in a way that develops and ensures the use of safe, high quality, cost-effective, and environmentally sound technologies.

- **TNX-CMX Semiworks Area (600-T Area).** The TNX-CMX semiworks area is located near the Savannah River approximately 1 mile west of the Heavy Water Rework Area (400-D). The purpose of the CMX-TNX facilities is to study chemical processing problems and test production-scale equipment. Analyses are conducted with nonradioactive surrogates of radioactive materials. The test equipment includes dissolvers for uranium metal and other nuclear materials, evaporators, mixer-settlers for solvent extraction, centrifuges, tanks, pumps, large furnaces, vacuum equipment, and distillation equipment. This facility is also used as a pilot plant for the Defense Waste Processing Facility (DWPF).

- **Defense Waste Processing Facility (200-S Area).** A new facility under construction, the DWPF, is located in S Area. Its purpose is to incorporate radioactive materials into a borosilicate glass matrix that can be shipped to a federal repository. The 200-S Area in which the DWPF is located, occupies approximately 492 acres.

- **Saltstone (200-Z Area).** A new facility for the processing and storage of decontaminated salt is located in Z Area. In this area, low-level, salt-containing liquid which is a by product of the liquid waste disposal process will be incorporated in a cement matrix for storage in engineered trenches.

- **F&H Effluent Treatment Facility (F&H ETF).** A facility in 200-H area which started operation in November 1988 to treat liquid mixed wastes containing low-level radioactive materials and nonradioactive chemicals. The operation of this facility allows discontinuation of use of seepage basins in the 200-Areas. Decontaminated liquid effluent from the ETF is discharged to a surface stream on the SRS.

- **Fuels Materials Facility (FMF).** A facility to produce fuel materials for the U. S. Navy nuclear propulsion program. This facility was shut down in September 1989 and is being placed on standby.

- **Plutonium Fuel Form Facility (PuFF).** A facility to produce encapsulated plutonium oxide (F Area).

- **Consolidated Incineration Facility (CIF).** A facility for the incineration of radioactively contaminated combustible materials (H Area).

- **Replacement Tritium Facility (RTF).** A tritium processing facility to replace one of the existing processing facilities (H Area).

- **300M Effluent Treatment Facility (300M ETF).** A facility to treat effluent from the fabrication process in the M Area prior to discharge to the environment (M Area).

Other facilities within 40 kilometers of the SRS are:

- **Chem-Nuclear Systems, Inc. (CNSI).** Chem-Nuclear Systems, Inc., a subsidiary of Waste Management Systems, is the largest commercial low-level radioactive waste disposal facility in the country. The facility is located in Barnwell County, South Carolina, on 308 acres near the eastern SRS boundary. CNSI facilities include a burial site, transportation and maintenance units, and facilities for waste solidification and decontamination. The facility was licensed for operation in 1971, with only solid wastes being accepted.

- **Vogtle Electric Generating Plant (VEGP).** The Vogtle Electric Generating Plant is located across the Savannah River (in Georgia) about 7 kilometers SSW of the SRS Heavy Water Rework Area (400 Area). It is a two-unit pressurized water reactor (PWR) nuclear power plant. Commercial operation of Unit 1 began on May 31, 1987, and Unit 2 began operating on May 17, 1989. Each unit is rated at a power level of 3411 MWt.

- **Plant Wilson** is located approximately 5000 feet ESE of the VEGT along River Road. The existing combustion plant is a peak power station owned and operated by Georgia Power Company. The plant consists of six combustion turbines with a total rated capacity of 351.6 MWe.

- **Carolina Metals, Inc.** Carolina Metals, Inc., is located in Barnwell County near Boiling Springs. This facility converts depleted uranium hexafluoride into uranium metal for use in radiation shields, armor-piercing shells, and aircraft counterweights.

- **Transnuclear, Inc.** Transnuclear, Inc., located in Aiken County, South Carolina, transports high-level and low-level radioactive wastes and maintains temporary onsite storage of materials to be transported. The materials are transported from various industrial and military facilities nationwide. High-level wastes are sent to SRS while low-level wastes are sent to CNSI.

APPENDIX D

Description of Nonradiological Air Quality Modeling

Ambient concentrations of the nonradiological air pollutants emitted from SRS facilities were calculated with the Industrial Source Complex (ISC) atmospheric dispersion model. This model has been designated by the Environmental Protection Agency (EPA) as a preferred model for regulatory applications which require a refined air impact analyses for complicated source geometry in simple terrain (EPA, 1986).

The ISC model is a steady state Gaussian dispersion model that can calculate ground-level ambient pollutant concentrations from combinations of point and area emissions sources within an industrial complex. Computational features of the model include the capability to estimate plume rise due to the momentum and bouancy of the effluent and to simulate downwash of the effluent into the aerodynamic wake of adjacent buildings. Detailed descriptions of the computational methods are given in the ISC users manual (EPA, 1987). The model calculates ambient concentrations on a user-specified grid of receptor locations for selected averaging intervals ranging from one hour to one year. The meteorological input required by ISC consists of sequential hourly averages of wind speed, wind direction, temperature, Pasquill-Gifford (P-G) stability class, and mixing depth.

The modelling results summarized in Chapters 4 and 6 were based on meteorological data collected from the onsite meteorological tower network during the five years from 1982 through 1986. The onsite data consisted of hourly averaged values of wind speed, wind direction, temperature, and sigma-azimuth (standard deviation of the horizontal component of the wind direction fluctuations). Hourly values of P-G stability class were determined from the sigma-azimuth data using the classification scheme given in NRC (1980). The onsite meteorological monitoring program is described in Chapter 1. Mixing height data were determined from Athens, Georgia radiosonde data and surface observations taken at the Augusta, Georgia, National Weather Service office at Bush Field Airport. The airport site is about 15 miles northwest of SRS.

To satisfy ISC data completeness requirements, a composite data base was prepared. Hourly averaged wind speed, wind direction, and sigma azimuth data from the H-Area meteorological tower were used as the base data set. The H-Area data were selected because the tower is located near the center of the SRS. Joint frequency distributions of wind speed and wind direction by P-G stability class for the H-Area tower data are given in Appendix A. Hours for which H-Area tower data were missing or failed quality assurance tests were filled with valid data from the C, F, K, P, A, and D-Area towers, respectively. Quality assurance checks that were applied to these data are described in Chapter 1 and in Laurinat (1987). Hourly averaged temperature data were from the 36-m level of the WJBF television tower. Missing hours were supplied with data from the 18-m and 91-m levels, respectively.

The composite onsite data base resulted in valid data for about 94 percent of the hours over the 5-year period of record. The remaining six percent of the hours were filled with surface data collected by the National Weather Service Office at Bush Field. Determination of P-G classes for the airport data was based on the method outlined by Turner (1970). This method gives P-G classes based on observed wind speeds and solar insolation. Hourly values of mixing depth were interpolated from the twice daily Athens, GA mixing height data according to the method recommended in EPA (1987).

Source data required by ISC consists of hourly emission rates, height of the release, effluent exit velocity and temperature, stack diameter, and facility grade elevation and dimensions. Average hourly emission rates were determined from the annual emissions summarized in Chapter 4 and 6. Other source characteristics were taken from routine emissions inventory reports provided to South Carolina Department of Health and Environmental Control.

Hourly emission rates for the powerhouse facilities were varied by season. The magnitude of this variation was based on reported monthly coal consumption. For the D-Area powerhouse, emission rates were adjusted to be 50 percent higher during the winter months (December, January, and February) than during the summer months (June, July, and August). For the A-, H-, K-, and P-Area powerhouses, the seasonal variation was 20 percent.

The model was executed using the standard ISC regulatory default options. These options include:

- Default wind speed profile exponents to adjust measured wind speeds to a value appropriate for the release height.
- Default vertical potential temperature gradients to compute plume rise,
- Modified dispersion coefficients to account for effects of bouyant plumes.

These options are described in more detail in EPA (1987).

Concentrations were calculated on a cartesian receptor grid. The regular array consisted of grid points generally located at 1.2 kilometer increments extending up to 18 km from the approximate center of the site. Additional offsite receptor locations were placed in areas that were suspected to have relatively high concentrations. Suspect areas were determined from the results of preliminary ISC model runs. Receptors were also placed at the locations of the onsite air monitoring stations. Elevations of all sources and receptors were included in the calculations. All terrain elevation data were interpolated from U.S. Geological Survey 1:48000 scale maps.

REFERENCES FOR APPENDIX D

EPA (Environmental Protection Agency). Guideline on Air Quality Models (Revised), EPA-450/2-78-027R, Research Triangle Park, NC (1986).

EPA (Environmental Protection Agency). Industrial Source Complex (ISC) Dispersion Model User's Guide - Second Edition (Revised), EPA-450/4-88-002a, Research Triangle Park, NC (1987).

Laurinat, J. E. Average Wind Statistics for SRP Area Meteorological Towers, DPST-87-341, E. I. du Pont de Nemours and Company, Savannah River Laboratory, Aiken, SC (1987).

NRC (Nuclear Regulatory Commission). Meteorological Programs in Support of Nuclear Power Plants, Proposed Revision 1 to Regulatory Guide 1.23 (1980).

Turner, D. B. Workbook of Atmospheric Dispersion Estimates, PB-191482, U.S. Department of Health, Education, and Welfare, Cincinnati, OH (1970).

APPENDIX E

7Q10

FOR THE SAVANNAH RIVER

AND THE SAVANNAH RIVER SITE STREAMS

Log-Pearson Type III Duration-Frequency Analysis
Station: 021970000
Savannah River at Augusta, GA

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/54	End Date:	3/31/86

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
727.156	888.701	-0.454

Mean Logs	Standard Deviation Logs	Skew Logs
3.752	0.072	-0.862

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	2227.402	-	-
0.0005	2000.000	2587.479	-	-
0.0010	1000.000	2764.851	-	-
0.0020	500.000	2958.310	-	-
0.0050	200.000	3243.051	-	-
0.0100	100.000	3484.724	-	-
0.0200	50.000	3754.264	-	-
0.0250	40.000	3848.033	-	-
0.0400	25.000	4058.665	-	-
0.0500	20.000	4165.712	-	-
0.1000	10.000	4534.159	-	-
0.2000	5.000	4977.395	-	-
0.3000	3.333	5290.854	-	-
0.4000	2.500	5552.153	-	-
0.4296	2.328	5624.096	-	-
0.5000	2.000	5789.341	-	-
0.5704	1.753	5950.601	-	-
0.6000	1.667	6018.391	-	-
0.7000	1.429	6253.165	-	-
0.8000	1.250	6512.714	-	-
0.9000	1.111	6842.630	-	-
0.9500	1.053	7086.783	-	-
0.9600	1.042	7152.918	-	-
0.9750	1.026	7276.985	-	-
0.9800	1.020	7329.690	-	-
0.9900	1.010	7472.742	-	-
0.9950	1.005	7590.611	-	-
0.9980	1.002	7717.218	-	-
0.9990	1.001	7795.833	-	-
0.9995	1.001	7862.740	-	-
0.9999	1.000	7983.541	-	-

SAVANNAH RIVER AT AUGUSTA, GA

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	2	1	1	1	1	1	0	0	0
2	0	0	0	1	1	1	1	1	1	0	0	0
3	0	0	0	1	1	1	1	1	1	0	0	0
4	0	0	0	1	1	1	1	1	1	0	0	0
5	0	0	0	1	1	1	1	1	1	0	0	0
6	0	0	0	1	1	1	1	1	1	0	0	0
7	0	0	0	1	1	1	1	1	1	0	0	0
8	0	0	0	1	1	1	1	1	1	0	0	0
9	0	0	0	1	1	1	1	1	1	0	0	0
10	0	0	0	1	1	1	1	1	1	0	0	0
11	0	0	0	1	1	1	1	1	1	0	0	0
12	0	0	0	1	1	[illegible]	1	1	1	0	0	0
13	0	0	0	1	1	1	1	1	1	0	0	0
14	0	0	0	1	1	1	1	1	1	0	0	0
15	0	0	0	1	1	1	1	1	1	0	0	0
16	0	0	0	1	1	1	1	1	1	0	0	0
17	0	0	0	1	1	1	1	1	1	0	0	0
18	0	0	0	1	1	1	1	1	1	0	0	0
19	0	0	0	1	1	1	1	1	1	0	0	0
20	0	0	0	1	1	1	1	1	1	0	0	0
21	0	0	0	1	1	1	1	1	1	0	0	0
22	0	0	0	1	1	1	1	1	1	0	0	0
23	0	0	0	1	1	1	1	1	1	0	0	0
24	0	0	0	1	1	1	1	1	1	0	0	0
25	0	0	0	1	1	1	1	1	1	0	0	0
26	0	0	0	1	1	1	1	1	1	0	0	0
27	0	0	0	1	1	1	1	1	1	0	0	0
28	0	0	0	1	1	1	1	1	1	0	0	0
29	0	-	0	1	1	1	1	1	1	0	0	0
30	0	-	0	1	1	1	1	1	1	0	0	0
31	0	-	0	-	1	-	1	1	-	0	-	0

SAVANNAH RIVER AT AUGUSTA, GA

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	1/30/55	4237.143	1
2	2/10/56	4177.143	0
3	4/22/56	4828.571	0
4	8/08/57	5690.000	0
5	10/23/58	5551.429	0
6	6/27/59	5401.429	0
7	6/13/60	5664.286	0
8	12/02/61	5108.571	0
9	6/30/62	5381.429	0
10	4/22/63	5805.714	0
11	6/06/64	6842.857	0
12	7/22/65	6605.714	0
13	10/10/66	6247.143	0
14	5/15/67	6018.571	0
15	1/13/69	6014.286	0
16	11/09/69	6174.282	0
17	12/09/70	5758.571	0
18	4/17/71	6338.571	0
19	11/29/72	6025.714	0
20	11/29/73	5748.571	0
21	9/26/74	6241.429	0
22	8/05/75	7325.714	0
23	9/08/76	7244.710	0
24	10/18/77	6772.857	0
25	9/12/78	6298.571	0
26	9/14/79	6738.571	0
27	10/08/80	6177.143	0
28	12/03/81	3745.714	0
29	7/31/82	5467.143	0
30	11/10/83	5025.714	0
31	12/11/84	5375.714	0
32	5/31/85	5025.714	0
33	10/30/86	3937.143	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 021970320
Savannah River Near Jackson, SC

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/72	End Date:	3/31/85

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
6085.438	987.981	-1.005

Mean Logs	Standard Deviation Logs	Skew Logs
3.778	0.078	-1.410

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	1736.005	-	-
0.0005	2000.000	2170.319	-	-
0.0010	1000.000	2391.924	-	-
0.0020	500.000	2638.280	-	-
0.0050	200.000	3007.870	-	-
0.0100	100.000	3326.282	-	-
0.0200	50.000	3684.367	-	-
0.0250	40.000	3809.276	-	-
0.0400	25.000	4089.768	-	-
0.0500	20.000	4232.008	-	-
0.1000	10.000	4717.564	-	-
0.2000	5.000	5286.717	-	-
0.3000	3.333	5673.694	-	-
0.4000	2.500	5982.971	-	-
0.4296	2.328	6065.635	-	-
0.5000	2.000	6250.971	-	-
0.5704	1.753	6425.030	-	-
0.6000	1.667	6496.094	-	-
0.7000	1.429	6731.400	-	-
0.8000	1.250	6969.994	-	-
0.9000	1.111	7235.476	-	-
0.9500	1.053	7400.756	-	-
0.9600	1.042	7440.506	-	-
0.9750	1.026	7508.943	-	-
0.9800	1.020	7535.515	-	-
0.9900	1.010	7599.909	-	-
0.9950	1.005	7644.185	-	-
0.9980	1.002	7682.726	-	-
0.9990	1.001	7701.906	-	-
0.9995	1.001	7715.399	-	-
0.9999	1.000	7733.341	-	-

W8908052

SAVANNAH RIVER NEAR JACKSON, SC

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	2	2	3	0	1	0	0	0	0	0	1
2	0	2	2	4	1	1	0	0	0	0	0	1
3	0	1	2	4	1	2	0	0	0	0	0	0
4	0	1	2	4	1	1	0	0	0	0	0	0
5	0	1	1	4	0	1	0	1	0	0	0	0
6	0	1	0	4	1	1	0	1	0	0	0	0
7	0	1	0	5	1	1	0	1	0	0	0	0
8	0	1	1	5	1	1	0	1	0	0	0	0
9	0	1	2	5	1	1	1	1	0	0	0	0
10	0	1	2	5	1	2	1	1	0	0	0	0
11	0	1	1	5	1	1	0	1	0	0	0	0
12	0	1	0	5	1	1	0	0	0	0	0	0
13	0	1	1	4	0	0	0	0	0	0	0	0
14	0	1	1	4	0	1	0	0	0	0	0	1
15	0	1	1	4	0	1	0	0	0	0	0	1
16	0	1	2	3	0	1	0	0	0	0	0	1
17	0	2	2	3	0	1	0	0	0	0	0	1
18	0	3	3	3	0	1	0	0	0	0	0	1
19	0	1	3	3	0	1	0	0	0	0	0	1
20	0	1	3	3	1	1	0	0	0	0	0	0
21	1	2	4	2	1	0	0	0	0	0	0	0
22	1	2	4	2	1	0	0	0	0	0	0	0
23	1	2	4	2	0	0	0	0	0	0	0	0
24	1	2	4	1	0	0	0	0	0	0	0	0
25	1	2	4	1	0	0	0	0	0	0	0	0
26	2	3	3	1	0	0	0	0	0	0	0	0
27	2	1	3	1	0	0	0	0	0	0	0	0
28	1	1	3	1	0	0	0	0	0	0	0	0
29	1	-	3	1	0	0	0	0	0	0	0	0
30	1	-	2	0	0	0	0	0	0	0	0	0
31	2	-	3	-	0	-	0	0	-	0	-	0

SAVANNAH RIVER NEAR JACKSON, SC

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	10/03/72	6565.714	5
2	10/22/73	6492.857	37
3	5/10/74	6821.429	25
4	8/04/75	7225.714	25
5	8/16/76	7144.710	32
6	10/18/77	6774.286	36
7	12/17/78	6072.857	8
8	9/15/79	6922.857	31
9	12/14/80	6244.286	26
10	12/04/81	3772.857	0
11	9/02/82	5412.857	4
12	11/10/83	5140.000	22
13	12/12/84	5625.724	14
14	6/01/85	4980.000	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197500
Savannah River at Burtons Ferry BR Near Millhaven, GA

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/54	End Date:	3/31/85

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
6219.024	905.733	0.167

Mean Logs	Standard Deviation Logs	Skew Logs
3.789	0.063	-0.036

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	3533.336	-	-
0.0005	2000.000	3771.988	-	-
0.0010	1000.000	3888.558	-	-
0.0020	500.000	4015.584	-	-
0.0050	200.000	4203.285	-	-
0.0100	100.000	4364.210	-	-
0.0200	50.000	4546.513	-	-
0.0250	40.000	4610.835	-	-
0.0400	25.000	4757.382	-	-
0.0500	20.000	4833.115	-	-
0.1000	10.000	5101.587	-	-
0.2000	5.000	5444.991	-	-
0.3000	3.333	5705.635	-	-
0.4000	2.500	5937.359	-	-
0.4296	2.328	6003.879	-	-
0.5000	2.000	6161.708	-	-
0.5704	1.753	6323.363	-	-
0.6000	1.667	6393.837	-	-
0.7000	1.429	6651.024	-	-
0.8000	1.250	6964.037	-	-
0.9000	1.111	7420.496	-	-
0.9500	1.053	7817.924	-	-
0.9600	1.042	7937.316	-	-
0.9750	1.026	8178.315	-	-
0.9800	1.020	8288.475	-	-
0.9900	1.010	8616.427	-	-
0.9950	1.005	8926.917	-	-
0.9980	1.002	9316.889	-	-
0.9990	1.001	9599.661	-	-
0.9995	1.001	9873.915	-	-
0.9999	1.000	10484.820	-	-

SAVANNAH RIVER AT BURTONS FERRY BR NEAR MILLHAVEN, GA

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	12	12	12	12	12	12	12	11	11	12	12	12
2	12	12	12	12	12	12	12	11	11	12	12	12
3	12	12	12	12	12	12	12	11	11	12	12	12
4	12	12	12	12	12	12	12	11	11	12	12	12
5	12	12	12	12	12	12	12	11	11	12	12	12
6	12	12	12	12	12	12	12	11	11	12	12	12
7	12	12	12	12	12	12	12	11	11	12	12	12
8	12	12	12	12	12	12	12	11	11	12	12	12
9	12	12	12	12	12	12	12	11	11	12	12	12
10	12	12	12	12	12	12	12	11	11	12	12	12
11	12	12	12	12	12	12	12	11	11	12	12	12
12	12	12	12	12	12	12	12	11	11	12	12	12
13	12	12	12	12	12	12	12	11	11	12	12	12
14	12	12	12	12	12	12	12	11	11	12	12	12
15	12	12	12	12	12	12	12	11	11	12	12	12
16	12	12	12	12	12	12	12	11	11	12	12	12
17	12	12	12	12	12	12	12	11	11	12	12	12
18	12	12	12	12	12	12	12	11	11	12	12	12
19	12	12	12	12	12	12	12	11	11	12	12	12
20	12	12	12	12	12	12	11	11	11	12	12	12
21	12	12	12	12	12	12	11	11	11	12	12	12
22	12	12	12	12	12	12	11	11	11	12	12	12
23	12	12	12	12	12	12	11	11	11	12	12	12
24	12	12	12	12	12	12	11	11	11	12	12	12
25	12	12	12	12	12	12	11	11	11	12	12	12
26	12	12	12	12	12	12	11	11	11	12	12	12
27	12	12	12	12	12	12	11	11	11	12	12	12
28	12	12	12	12	12	12	11	11	11	12	12	12
29	12	2	12	12	12	12	11	11	11	12	12	12
30	12	-	12	12	12	12	11	11	11	12	12	12
31	12	-	12	-	12	-	11	11	-	12	-	12

W8908052

SAVANNAH RIVER AT BURTONS FERRY BR NEAR MILLHAVEN, GA

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	12/23/54	4924.286	0
2	1/29/56	4808.571	0
3	7/23/56	5364.286	0
4	8/07/57	5928.571	0
5	9/27/58	5577.143	0
6	5/03/59	5670.000	0
7	11/28/60	6350.000	0
8	10/16/61	5871.429	0
9	10/27/62	6352.857	0
10	6/11/63	6528.571	0
11	6/07/64	7831.429	0
12	11/04/65	7630.000	0
13	10/12/66	7294.286	0
14	5/16/67	7008.571	0
15	10/29/68	7134.286	0
16	10/24/69	6984.286	0
17	9/24/70	7117.143	187
18	3/31/72	-	366
19	3/31/73	-	365
20	3/31/74	-	365
21	3/31/75	-	365
22	3/31/76	-	366
23	3/31/77	-	365
24	3/31/78	-	365
25	3/31/79	-	365
26	3/31/80	-	366
27	3/31/81	-	365
28	3/31/82	-	365
29	9/03/82	5676.647	110
30	11/12/83	5438.571	0
31	12/27/84	6090.000	0
32	9/26/85	6018.571	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 02198500
Savannah River Near Clyo, GA

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/54	End Date:	3/31/86

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
6782.467	1028.054	-0.135

Mean Logs	Standard Deviation Logs	Skew Logs
3.826	0.068	-0.147

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	3250.290	-	-
0.0005	2000.000	3597.905	-	-
0.0010	1000.000	3766.999	-	-
0.0020	500.000	3950.433	-	-
0.0050	200.000	4219.450	-	-
0.0100	100.000	4447.741	-	-
0.0200	50.000	4703.270	-	-
0.0250	40.000	4792.574	-	-
0.0400	25.000	4994.248	-	-
0.0500	20.000	5097.445	-	-
0.1000	10.000	5457.319	-	-
0.2000	5.000	5903.176	-	-
0.3000	3.333	6230.121	-	-
0.4000	2.500	6512.200	-	-
0.4296	2.328	6591.662	-	-
0.5000	2.000	6777.483	-	-
0.5704	1.753	6963.786	-	-
0.6000	1.667	7043.742	-	-
0.7000	1.429	7329.058	-	-
0.8000	1.250	7662.607	-	-
0.9000	1.111	8122.498	-	-
0.9500	1.053	8497.992	-	-
0.9600	1.042	8606.398	-	-
0.9750	1.026	8819.198	-	-
0.9800	1.020	8913.807	-	-
0.9900	1.010	9185.944	-	-
0.9950	1.005	9430.809	-	-
0.9980	1.002	9721.503	-	-
0.9990	1.001	9921.083	-	-
0.9995	1.001	10106.026	-	-
0.9999	1.000	10489.252	-	-

SAVANNAH RIVER NEAR CLYO, GA

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	2	1	1	1	1	1	0	0	0
2	0	0	0	1	1	1	1	1	1	0	0	0
3	0	0	0	1	1	1	1	1	1	0	0	0
4	0	0	0	1	1	1	1	1	1	0	0	0
5	0	0	0	1	1	1	1	1	1	0	0	0
6	0	0	0	1	1	1	1	1	1	0	0	0
7	0	0	0	1	1	1	1	1	1	0	0	0
8	0	0	0	1	1	1	1	1	1	0	0	0
9	0	0	0	1	1	1	1	1	1	0	0	0
10	0	0	1	1	1	1	1	1	1	0	0	0
11	0	0	0	1	1	1	1	1	0	0	0	0
12	0	0	0	1	1	1	1	1	1	0	0	0
13	0	0	0	1	1	1	1	1	1	0	0	0
14	0	0	0	1	1	1	1	1	1	0	0	0
15	0	0	0	1	1	1	1	1	1	0	0	0
16	0	0	0	1	1	1	1	1	1	0	0	0
17	0	0	0	1	1	1	1	1	1	0	0	0
18	0	0	0	1	1	1	1	1	1	0	0	0
19	0	0	0	1	1	1	1	1	1	0	0	0
20	0	0	0	1	1	1	1	1	1	0	0	0
21	0	0	0	1	1	1	1	1	1	0	0	0
22	0	0	0	1	1	1	1	1	1	0	0	0
23	0	0	0	1	1	1	1	1	1	0	0	0
24	0	0	0	1	1	1	1	1	1	0	0	0
25	0	0	0	1	1	1	1	1	1	0	0	0
26	0	0	0	1	1	1	1	1	1	0	0	0
27	0	0	0	1	1	1	1	1	1	0	0	0
28	0	0	0	1	1	1	1	1	1	0	0	0
29	0	-	0	1	1	1	1	1	1	0	0	0
30	0	-	0	1	1	1	1	1	1	0	0	0
31	0	-	0	-	1	-	1	1	-	0	-	0

SAVANNAH RIVER NEAR CLYO, GA

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	12/25/54	5438.571	1
2	9/26/55	5657.143	0
3	7/08/56	5831.429	0
4	8/10/57	6088.571	0
5	10/14/58	5017.143	0
6	5/06/59	6274.286	0
7	11/06/60	6810.000	0
8	10/17/61	6302.857	0
9	8/11/62	6888.571	0
10	6/12/63	7682.857	0
11	7/09/64	8294.286	0
12	11/04/65	8242.857	0
13	10/13/66	7361.429	0
14	5/17/67	7293.714	0
15	9/23/69	7097.143	0
16	12/01/69	7237.139	0
17	10/01/70	6981.429	0
18	10/03/71	8375.714	0
19	10/19/72	7222.857	0
20	10/24/73	7902.857	0
21	10/09/74	7470.000	0
22	8/23/75	8484.286	0
23	8/31/76	7954.286	0
24	10/20/77	7098.571	0
25	9/25/78	6581.429	0
26	10/29/79	7897.143	0
27	8/29/80	6254.286	0
28	12/06/81	4844.286	0
29	9/04/82	6045.714	0
30	11/12/83	5867.143	0
31	12/27/84	6338.571	0
32	9/27/85	5317.143	0
33	10/25/86	4765.714	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197300
Upper Three Runs Near New Ellenton

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/66	End Date:	3/31/86

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
80.789	16.174	-0.655

Mean Logs	Standard Deviation Logs	Skew Logs
1.898	0.096	-1.041

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	20.703	-	-
0.0005	2000.000	25.919	-	-
0.0010	1000.000	28.610	-	-
0.0020	500.000	31.630	-	-
0.0050	200.000	36.221	-	-
0.0100	100.000	40.242	-	-
0.0200	50.000	44.847	-	-
0.0250	40.000	46.475	-	-
0.0400	25.000	50.180	-	-
0.0500	20.000	52.085	-	-
0.1000	10.000	58.743	-	-
0.2000	5.000	66.914	-	-
0.3000	3.333	72.760	-	-
0.4000	2.500	77.652	-	-
0.4296	2.328	78.999	-	-
0.5000	2.000	82.090	-	-
0.5704	1.753	85.097	-	-
0.6000	1.667	86.358	-	-
0.7000	1.429	90.697	-	-
0.8000	1.250	95.428	-	-
0.9000	1.111	101.290	-	-
0.9500	1.053	105.470	-	-
0.9600	1.042	106.572	-	-
0.9750	1.026	108.599	-	-
0.9800	1.020	109.442	-	-
0.9900	1.010	111.669	-	-
0.9950	1.005	113.425	-	-
0.9980	1.002	115.215	-	-
0.9990	1.001	116.268	-	-
0.9995	1.001	117.123	-	-
0.9999	1.000	118.550	-	-

UPPER THREE RUNS NEAR NEW ELLENTON

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	1	1	1	0	1	1	0	0	0
2	0	0	0	1	1	1	0	1	1	0	0	0
3	0	0	0	1	1	1	0	1	1	0	0	0
4	0	0	0	1	1	1	0	1	1	0	0	0
5	0	0	0	1	1	1	0	1	1	0	0	0
6	0	0	0	1	1	1	0	1	1	0	0	0
7	0	0	0	1	1	1	0	1	1	0	0	0
8	0	0	0	1	1	1	0	1	1	0	0	0
9	0	0	0	1	1	1	0	1	1	0	0	0
10	0	0	1	1	1	0	0	1	1	0	0	0
11	0	0	0	1	1	0	0	1	1	0	0	0
12	0	0	0	1	1	0	0	1	1	0	0	0
13	0	0	0	1	1	0	0	1	1	0	0	0
14	0	0	0	1	1	0	0	1	1	0	0	0
15	0	0	0	1	1	0	0	1	1	0	0	0
16	0	0	0	1	1	0	0	1	1	0	0	0
17	0	0	0	1	1	0	0	1	1	0	0	0
18	0	0	0	1	1	0	0	1	1	0	0	0
19	0	0	0	1	1	0	0	1	1	0	0	0
20	0	0	0	1	1	0	0	1	1	0	0	0
21	0	0	0	1	1	0	0	1	1	0	0	0
22	0	0	0	1	1	0	0	1	1	0	0	0
23	0	0	0	1	1	0	0	1	1	0	0	0
24	0	0	0	1	1	0	0	1	1	0	0	0
25	0	0	0	1	1	0	0	1	1	0	0	0
26	0	0	0	1	1	0	0	1	1	0	0	0
27	0	0	0	1	1	0	0	1	1	0	0	0
28	0	0	0	1	1	0	0	1	1	0	0	0
29	0	-	0	1	1	0	0	1	1	0	0	0
30	0	-	0	1	1	0	0	1	1	0	0	0
31	0	-	0	-	1	-	0	1	-	0	-	0

UPPER THREE RUNS NEAR NEW ELLENTON

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	8/28/66	101.286	70
2	6/30/67	92.857	0
3	9/20/68	72.714	0
4	8/24/69	70.429	0
5	10/01/70	78.714	0
6	6/25/71	91.000	0
7	6/12/72	94.571	0
8	7/21/73	101.714	0
9	6/13/74	92.714	0
10	6/30/75	98.000	0
11	8/03/76	90.714	0
12	7/15/77	92.857	0
13	6/28/78	90.571	0
14	10/13/79	83.857	0
15	2/23/81	81.143	0
16	6/15/81	64.143	0
17	9/03/82	57.286	0
18	8/17/83	55.429	0
19	6/14/84	73.571	0
20	9/22/85	68.000	0
21	10/01/86	45.000	0

W8908052

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197310
Upper Three Runs Above Road C (SRS)

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/74	End Date:	3/31/85

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
135.655	16.092	0.303
Mean Logs	Standard Deviation Logs	Skew Logs
2.130	0.051	0.218

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	91.810	-	-
0.0005	2000.000	95.382	-	-
0.0010	1000.000	97.145	-	-
0.0020	500.000	99.082	-	-
0.0050	200.000	101.971	-	-
0.0100	100.000	104.475		-
0.0200	50.000	107.341	-	-
0.0250	40.000	108.361	-	-
0.0400	25.000	110.698	-	-
0.0500	20.000	111.915	-	-
0.1000	10.000	116.274	-	-
0.2000	5.000	121.957	-	-
0.3000	3.333	126.353	-	-
0.4000	2.500	130.321	-	-
0.4296	2.328	131.471	-	-
0.5000	2.000	134.219	-	-
0.5704	1.753	137.060	-	-
0.6000	1.667	138.308	-	-
0.7000	1.429	142.909	-	-
0.8000	1.250	148.608	-	-
0.9000	1.111	157.118	-	-
0.9500	1.053	164.724	-	-
0.9600	1.042	167.045	-	-
0.9750	1.026	171.782	-	-
0.9800	1.020	173.971	-	-
0.9900	1.010	180.572	-	-
0.9950	1.005	186.943	-	-
0.9980	1.002	195.114	-	-
0.9990	1.001	201.117	-	-
0.9995	1.001	207.117	-	-
0.9999	1.000	220.740	-	-

W8908052

UPPER THREE RUNS ABOVE ROAD C (SRS)

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	1	1	1	0	0	0	0	0	0
2	0	0	0	1	1	1	0	0	0	0	0	0
3	0	0	0	1	1	1	0	0	0	0	0	0
4	0	0	0	1	1	1	0	0	0	0	0	0
5	0	0	0	1	1	0	0	0	0	0	0	0
6	0	0	0	1	1	0	0	0	0	0	0	0
7	0	0	0	1	1	0	0	0	0	0	0	0
8	0	0	0	1	1	0	0	0	0	0	0	0
9	0	0	0	1	1	0	0	0	0	0	0	0
10	0	0	1	1	1	0	0	0	0	0	0	0
11	0	0	0	1	1	0	0	0	0	0	0	0
12	0	0	0	1	1	0	0	0	0	0	0	0
13	0	0	0	1	1	0	0	0	0	0	0	0
14	0	0	0	1	1	0	0	0	0	0	0	0
15	0	0	0	1	1	0	0	0	0	0	0	0
16	0	0	0	1	1	0	0	0	0	0	0	0
17	0	0	0	1	1	0	0	0	0	0	0	0
18	0	0	0	1	1	0	0	0	0	0	0	0
19	0	0	0	1	1	0	0	0	0	0	0	0
20	0	0	0	1	1	0	0	0	0	0	0	0
21	0	0	0	1	1	0	0	0	0	0	0	0
22	0	0	0	1	1	0	0	0	0	0	0	0
23	0	0	0	1	1	0	0	0	0	0	0	0
24	0	0	0	1	1	0	0	0	0	0	0	0
25	0	0	0	1	1	0	0	0	0	0	0	0
26	0	0	0	1	1	0	0	0	0	0	0	0
27	0	0	0	1	1	0	0	0	0	0	0	0
28	0	0	0	1	1	0	0	0	0	0	0	0
29	0	-	0	1	1	0	0	0	0	0	0	0
30	0	-	0	1	1	0	0	0	0	0	0	0
31	0	-	0	-	1	-	0	0	-	0	-	0

UPPER THREE RUNS ABOVE ROAD C (SRS)

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	10/08/74	155.857	65
2	6/30/75	156.714	0
3	8/03/76	145.143	0
4	7/16/77	133.857	0
5	9/18/78	129.286	0
6	8/16/79	146.000	0
7	8/01/80	126.143	0
8	9/27/81	116.714	0
9	9/04/82	122.143	0
10	8/17/83	117.571	0
11	9/22/84	158.857	0
12	9/21/85	119.[illegible]71	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197315
Upper Three Runs At Road A (SRS)

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/74	End Date:	3/31/85

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
163.500	27.714	-0.269
Mean Logs	**Standard Deviation Logs**	**Skew Logs**
2.208	0.076	-0.408

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	71.746	-	-
0.0005	2000.000	80.348	-	-
0.0010	1000.000	84.570	-	-
0.0020	500.000	89.177	-	-
0.0050	200.000	95.982	-	-
0.0100	100.000	101.800	-	-
0.0200	50.000	108.358	-	-
0.0250	40.000	110.661	-	-
0.0400	25.000	115.882	-	-
0.0500	20.000	118.564	-	-
0.1000	10.000	127.974	-	-
0.2000	5.000	139.748	-	-
0.3000	3.333	148.460	-	-
0.4000	2.500	156.029	-	-
0.4296	2.328	158.170	-	-
0.5000	2.000	163.190	-	-
0.5704	1.753	169.244	-	-
0.6000	1.667	170.419	-	-
0.7000	1.429	178.210	-	-
0.8000	1.250	187.376	-	-
0.9000	1.111	200.117	-	-
0.9500	1.053	210.606	-	-
0.9600	1.042	213.648	-	-
0.9750	1.026	219.640	-	-
0.9800	1.020	222.312	-	-
0.9900	1.010	230.025	-	-
0.9950	1.005	236.999	-	-
0.9980	1.002	245.323	-	-
0.9990	1.001	251.045	-	-
0.9995	1.001	256.407	-	-
0.9999	1.000	267.538	-	-

UPPER THREE RUNS AT ROAD A (SRS)

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	1	1	2	2	2	1	1	2	1	0	0
2	0	1	1	2	2	2	1	1	2	1	0	0
3	0	1	1	2	2	2	1	1	2	1	0	0
4	0	1	1	2	2	2	1	2	2	1	0	0
5	0	1	1	2	2	2	1	2	1	1	0	0
6	0	1	1	2	2	1	1	2	1	1	0	0
7	0	1	1	2	2	1	1	2	1	1	0	0
8	0	1	1	2	2	1	1	2	1	1	0	0
9	0	1	1	2	2	1	1	2	1	1	0	0
10	0	1	1	2	2	1	1	2	1	1	0	0
11	1	1	1	2	2	1	1	2	1	1	0	0
12	1	1	1	2	2	1	1	2	1	1	0	0
13	1	1	1	2	2	1	1	2	1	1	0	0
14	1	1	1	2	2	1	1	2	1	1	0	0
15	1	1	1	2	2	1	1	2	1	1	0	0
16	1	1	1	2	2	1	1	2	1	1	0	0
17	1	1	1	2	2	1	1	2	1	1	0	0
18	1	1	1	2	2	1	1	2	1	1	0	0
19	1	1	1	2	2	1	1	2	1	1	0	0
20	1	1	1	2	2	1	1	2	1	1	0	0
21	1	1	1	2	2	1	1	2	1	1	0	0
22	1	1	1	2	2	1	1	2	1	1	0	0
23	1	2	1	2	2	1	1	2	1	1	0	0
24	1	2	1	2	2	1	1	2	1	1	0	0
25	1	2	1	2	2	1	1	2	1	1	0	0
26	1	2	1	2	2	1	1	2	1	1	0	0
27	1	1	1	2	2	1	1	2	1	0	0	0
28	1	1	1	2	2	1	1	2	1	0	0	0
29	1	-	1	2	2	1	1	2	1	0	0	0
30	1	-	1	2	2	1	1	2	1	0	0	0
31	1	-	1	-	2	-	1	2	-	0	-	0

UPPER THREE RUNS ABOVE ROAD C (SRS)

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	6/26/74	185.429	66
2	6/30/75	195.857	0
3	8/04/76	196.714	0
4	7/16/77	165.143	80
5	10/26/78	191.143	212
6	7/13/79	171.143	34
7	7/31/80	145.286	0
8	9/28/81	130.143	0
9	9/04/82	149.143	0
10	8/17/83	123.714	0
11	6/14/84	182.286	0
12	6/23/85	126.000	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197326
Beaver Dam Creek at 400-D (SRS)

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/74	End Date:	3/31/85

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
57.440	18.028	-0.780

Mean Logs	Standard Deviation Logs	Skew Logs
1.731	0.185	-2.136

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	1.424	-	-
0.0005	2000.000	2.935	-	-
0.0010	1000.000	4.006	-	-
0.0020	500.000	5.465	-	-
0.0050	200.000	8.231	-	-
0.0100	100.000	11.211	-	-
0.0200	50.000	15.255	-	-
0.0250	40.000	16.840	-	-
0.0400	25.000	20.730	-	-
0.0500	20.000	22.873	-	-
0.1000	10.000	31.002	-	-
0.2000	5.000	41.884	-	-
0.3000	3.333	49.822	-	-
0.4000	2.500	56.251	-	-
0.4296	2.328	57.955	-	-
0.5000	2.000	61.711	-	-
0.5704	1.753	65.121	-	-
0.6000	1.667	66.467	-	-
0.7000	1.429	70.664	-	-
0.8000	1.250	74.378	-	-
0.9000	1.111	77.624	-	-
0.9500	1.053	79.040	-	-
0.9600	1.042	79.301	-	-
0.9750	1.026	79.673	-	-
0.9800	1.020	79.791	-	-
0.9900	1.010	80.013	-	-
0.9950	1.005	80.114	-	-
0.9980	1.002	80.169	-	-
0.9990	1.001	80.185	-	-
0.9995	1.001	80.192	-	-
0.9999	1.000	80.198	-	-

BEAVER DAM CREEK AT 400-D (SRS)

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	1	1	1	0	0	1	1	0	0
2	0	0	0	1	1	1	0	0	1	0	0	0
3	0	0	0	1	1	1	0	0	1	0	0	1
4	0	0	0	1	1	1	0	0	0	0	0	1
5	0	0	0	1	1	1	0	0	0	0	0	0
6	0	0	0	1	1	1	0	0	0	0	0	0
7	0	0	0	1	1	1	0	0	0	0	0	0
8	0	0	0	1	1	1	0	0	0	0	0	0
9	0	0	0	1	1	1	0	0	0	0	0	0
10	0	0	0	1	1	1	0	0	1	0	0	0
11	0	0	0	1	1	1	0	0	1	0	0	0
12	0	0	0	1	1	0	0	0	1	0	0	0
13	0	0	0	1	1	0	0	0	1	0	0	0
14	0	0	0	1	1	0	0	0	1	0	0	0
15	0	0	0	1	1	0	0	0	1	0	0	0
16	0	0	0	1	1	0	0	0	1	0	0	0
17	0	0	0	1	1	0	0	0	1	0	0	0
18	0	0	0	1	1	0	0	1	1	0	0	0
19	0	0	0	1	1	0	0	1	1	0	0	0
20	0	0	0	1	1	0	0	1	1	0	0	0
21	0	0	0	1	1	0	0	1	1	0	0	0
22	0	0	0	1	1	0	0	1	1	0	0	0
23	0	0	0	1	1	0	0	1	1	0	0	0
24	0	0	0	1	1	0	0	1	1	0	0	0
25	0	0	0	1	1	0	0	1	1	0	0	0
26	0	0	0	1	1	0	0	1	1	0	0	0
27	0	0	0	1	1	0	0	1	1	0	0	0
28	0	0	0	1	1	0	0	1	1	0	0	0
29	0	-	0	1	1	0	0	1	1	0	0	0
30	0	-	0	1	1	0	0	1	1	0	0	0
31	0	-	0	-	1	-	0	1	1	0	-	0

BEAVER DAM CREEK AT 400-D (SRS)

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	1/14/75	16.286	112
2	12/23/75	57.429	2
3	2/08/77	50.571	0
4	1/26/78	45.857	0
5	2/13/79	50.143	0
6	1/31/80	50.571	0
7	11/19/80	78.571	0
8	1/08/72	62.571	0
9	10/23/82	72.571	0
10	6/29/83	49.571	0
11	11/17/84	74.000	0
1.	10/12/85	81.143	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197342
Savannah River Site (Site 7)

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/73	End Date:	3/31/85

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
7.571	1.566	0.633
Mean Logs	**Standard Deviation Logs**	**Skew Logs**
0.871	0.088	0.310

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	3.992	-	-
0.0005	2000.000	4.227	-	-
0.0010	1000.000	4.346	-	-
0.0020	500.000	4.480	-	-
0.0050	200.000	4.684	-	-
0.0100	100.000	4.865	-	-
0.0200	50.000	5.079	-	-
0.0250	40.000	5.156	-	-
0.0400	25.000	5.335	-	-
0.0500	20.000	5.430	-	-
0.1000	10.000	5.779	-	-
0.2000	5.000	6.253	-	-
0.3000	3.333	6.635	-	-
0.4000	2.500	6.991	-	-
0.4296	2.328	7.096	-	-
0.5000	2.000	7.351	-	-
0.5704	1.753	7.620	-	-
0.6000	1.667	7.740	-	-
0.7000	1.429	8.192	-	-
0.8000	1.250	8.771	-	-
0.9000	1.111	9.677	-	-
0.9500	1.053	10.529	-	-
0.9600	1.042	10.797	-	-
0.9750	1.026	11.355	-	-
0.9800	1.020	11.619	-	-
0.9900	1.010	12.433	-	-
0.9950	1.005	13.247	-	-
0.9980	1.002	14.333	-	-
0.9990	1.001	15.167	-	-
0.9995	1.001	16.014	-	-
0.9999	1.000	18.044	-	-

SAVANNAH RIVER SITE (SITE 7)

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	0	0	1	0	0	1	0	0	0	0	0
2	1	0	0	0	0	0	1	1	0	0	0	0
3	1	0	0	0	0	0	0	1	1	0	0	0
4	1	0	0	0	0	0	0	1	1	0	0	0
5	1	0	0	0	0	0	0	1	0	0	0	0
6	1	0	0	0	0	0	0	1	0	0	0	0
7	0	0	0	0	0	1	0	1	0	0	0	1
8	0	0	0	0	0	1	0	1	0	0	0	1
9	0	0	0	0	0	1	0	1	0	0	0	1
10	0	0	0	0	0	1	0	1	0	0	0	1
11	0	0	0	0	0	1	0	1	0	0	0	1
12	0	0	0	0	0	1	0	1	0	0	0	1
13	0	0	0	0	0	1	0	1	0	0	0	1
14	0	0	0	0	0	1	0	1	0	0	0	1
15	0	0	0	0	0	1	0	1	0	0	0	1
16	0	0	0	0	0	1	0	1	0	0	0	1
17	0	0	0	0	0	1	0	1	0	0	0	1
18	0	0	0	0	0	1	0	1	0	0	0	1
19	0	0	0	0	0	1	0	1	0	0	0	1
20	0	0	0	0	0	1	0	1	0	0	0	1
21	0	0	0	0	0	1	0	1	0	0	0	1
22	0	0	0	0	0	1	0	1	0	0	0	1
23	0	0	0	0	0	1	0	1	0	0	0	1
24	0	0	0	0	0	1	0	1	0	0	0	1
25	0	0	0	0	0	1	0	1	0	0	0	1
26	0	0	0	0	0	1	0	1	0	0	0	1
27	0	0	0	0	0	1	0	1	0	0	0	1
28	0	0	0	0	0	1	0	1	0	0	0	1
29	0	-	0	0	0	1	0	1	0	0	0	1
30	0	-	0	0	0	1	0	1	0	0	0	1
31	0	-	0	-	0	-	0	0	-	0	-	1

SAVANNAH RIVER SITE (SITE 7)

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	10/17/73	9.943	30
2	7/11/74	7.529	0
3	7/03/75	7.457	56
4	8/28/76	6.957	0
5	6/05/77	6.314	0
6	10/04/78	6.843	2
7	8/16/79	7.743	2
8	9/07/80	5.471	0
9	10/01/81	6.086	0
10	7/02/82	8.971	0
11	7/09/83	8.600	0
12	10/09/84	10.571	0
13	9/23/85	5.943	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 021973471
Pen Branch at Road B, at Savannah River Site, S

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/84	End Date:	3/31/85

INPUT DATA STATISTICS

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	10/09/84	3.857	1
2	9/09/85	1.386	0

Number of positive annual values too few to calculate skew.

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197348
Pen Branch at Road A-13 (SRS)

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/74	End Date:	3/31/86

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
71.700	28.212	0.543

Mean Logs	Standard Deviation Logs	Skew Logs
1.825	0.172	0.098

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	16.655	-	-
0.0005	2000.000	19.372	-	-
0.0010	1000.000	20.801	-	-
0.0020	500.000	22.440	-	-
0.0050	200.000	25.027	-	-
0.0100	100.000	27.048	-	-
0.0200	50.000	30.297	-	-
0.0250	40.000	31.366	-	-
0.0400	25.000	33.904	-	-
0.0500	20.000	35.272	-	-
0.1000	10.000	40.444	-	-
0.2000	5.000	47.841	-	-
0.3000	3.333	54.083	-	-
0.4000	2.500	60.119	-	-
0.4296	2.328	61.940	-	-
0.5000	2.000	66.426	-	-
0.5704	1.753	71.263	-	-
0.6000	1.667	73.453	-	-
0.7000	1.429	81.272	-	-
0.8000	1.250	93.071	-	-
0.9000	1.111	111.423	-	-
0.9500	1.053	129.523	-	-
0.9600	1.042	135.373	-	-
0.9750	1.026	147.793	-	-
0.9800	1.020	153.752	-	-
0.9900	1.010	172.586	-	-
0.9950	1.005	192.001	-	-
0.9980	1.002	218.723	-	-
0.9990	1.001	239.830	-	-
0.9995	1.001	261.776	-	-
0.9999	1.000	316.274	-	-

PEN BRANCH AT ROAD A-13 (SRS)

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3	3	3	4	4	5	5	6	4	5	4	4
2	3	3	3	4	4	5	4	4	4	5	3	4
3	3	3	3	4	3	4	4	5	4	4	3	3
4	3	3	3	4	3	4	4	5	4	4	3	3
5	3	3	3	4	3	4	5	5	4	4	3	2
6	4	3	3	4	3	3	4	4	4	4	3	2
7	4	3	3	4	4	2	4	4	4	4	3	2
8	3	3	3	4	4	2	4	3	5	3	3	2
9	3	3	3	4	4	2	5	3	5	3	3	2
10	3	3	3	4	4	2	5	3	5	3	3	3
11	3	3	3	4	4	3	5	4	5	3	4	3
12	3	3	3	4	4	3	5	4	5	3	4	3
13	3	3	3	4	4	4	5	4	5	4	4	3
14	3	3	3	4	4	4	5	4	5	4	4	3
15	3	3	3	4	4	4	5	4	5	4	4	3
16	3	3	3	4	4	4	5	4	5	5	4	3
17	3	3	3	4	4	4	5	4	5	5	4	3
18	3	3	3	4	4	5	5	4	5	5	4	3
19	3	3	3	4	4	5	5	4	5	5	4	3
20	3	3	3	4	4	5	5	4	5	5	4	3
21	3	3	3	4	4	5	5	4	5	5	4	3
22	3	3	3	4	4	5	5	4	5	5	4	3
23	3	3	3	4	4	5	5	4	5	5	4	3
24	3	4	3	4	4	5	5	4	5	5	4	3
25	3	4	3	4	4	5	5	4	5	5	4	3
26	3	3	3	4	5	5	5	4	5	5	4	3
27	3	3	3	4	5	5	5	4	5	5	4	3
28	3	3	3	4	5	5	5	4	5	5	4	3
29	3	0	3	4	5	5	6	4	5	5	4	3
30	3	-	3	4	5	5	6	4	5	5	4	3
31	3	-	3	-	5	-		4	-	5	-	3

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PEN BRANCH AT ROAD A-13 (SRS)

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	3/31/75	-	359
2	3/31/76	-	366
3	11/01/76	100.286	214
4	9/19/77	44.429	49
5	8/20/76	62.000	2
6	7/23/79	40.286	59
7	6/05/80	42.857	215
8	1/27/82	95.857	0
9	10/12/82	122.857	107
10	7/08/83	79.000	32
11	11/26/84	51.714	0
12	1/29/86	77.714	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 021973565
Steel Creek at Road A at Savannah River Site, SC

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/85	End Date:	3/31/85

INPUT DATA STATISTICS

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	9/16/85	11.643	1

Number of positive annual values too few to calculate skew.

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Log-Pearson Type III Duration-Frequency Analysis
Station: 02197359
Steel Creek at Old Hattiesville Bridge (SRS)

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/74	End Date:	3/31/86

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
71.700	28.212	0.543
Mean Logs	**Standard Deviation Logs**	**Skew Logs**
1.825	0.172	0.098

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	5.996	-	-
0.0005	2000.000	7.132	-	-
0.0010	1000.000	7.717	-	-
0.0020	500.000	8.377	-	-
0.0050	200.000	9.391	-	-
0.0100	100.000	10.295	-	-
0.0200	50.000	11.356	-	-
0.0250	40.000	11.739	-	-
0.0400	25.000	12.628	-	-
0.0500	20.000	13.095	-	-
0.1000	10.000	14.794	-	-
0.2000	5.000	17.051	-	-
0.3000	3.333	18.817	-	-
0.4000	2.500	20.419	-	-
0.4296	2.328	20.883	-	-
0.5000	2.000	21.993	-	-
0.5704	1.753	23.139	-	-
0.6000	1.667	23.641	-	-
0.7000	1.429	25.846	-	-
0.8000	1.250	27.751	-	-
0.9000	1.111	31.074	-	-
0.9500	1.053	33.971	-	-
0.9600	1.042	34.839	-	-
0.9750	1.026	36.589	-	-
0.9800	1.020	37.386	-	-
0.9900	1.010	39.747	-	-
0.9950	1.005	41.962	-	-
0.9980	1.002	44.711	-	-
0.9990	1.001	46.678	-	-
0.9995	1.001	48.562	-	-
0.9999	1.000	52.666	-	-

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STEEL CREEK AT OLD HATTIESBRIDGE (SRS)

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	1	1	2	0	0	0	1	1	1	1	2
2	0	2	1	0	0	0	0	1	1	1	1	2
3	0	2	1	0	0	0	0	1	1	1	1	1
4	0	2	1	0	0	0	0	1	1	1	1	1
5	0	1	1	0	0	0	0	1	1	1	1	0
6	0	0	1	0	0	0	0	1	1	1	0	0
7	0	0	1	0	0	0	1	2	0	1	0	0
8	0	1	1	0	0	0	1	1	0	0	0	0
9	0	1	1	0	0	0	1	1	0	0	0	0
10	0	1	1	0	0	0	1	1	0	0	0	0
11	1	1	1	0	0	0	1	2	0	0	1	0
12	1	1	1	0	0	0	1	1	0	0	2	0
13	1	1	1	0	0	0	1	1	0	0	2	0
14	1	1	1	0	0	0	1	1	0	0	2	0
15	1	1	1	0	0	0	1	1	0	0	2	0
16	1	1	1	0	0	0	1	1	0	0	2	0
17	1	1	1	0	0	0	1	1	0	0	2	0
18	1	1	1	0	0	0	1	1	0	0	2	0
19	1	1	1	0	0	0	1	2	0	0	2	0
20	1	1	1	0	0	0	1	2	0	0	2	0
21	1	1	1	0	0	0	1	1	0	1	2	0
22	1	1	1	0	0	0	1	1	0	1	2	0
23	1	1	1	0	0	0	1	1	0	1	2	0
24	1	2	1	0	0	0	1	1	1	1	2	0
25	1	2	1	0	0	0	2	1	1	1	2	0
26	1	1	1	0	0	0	2	1	1	1	2	0
27	1	1	1	0	0	0	1	1	1	1	2	0
28	1	1	1	0	0	0	1	1	1	1	2	0
29	1	-	1	0	0	0	1	1	1	1	2	0
30	1	-	1	0	0	0	1	1	1	1	2	0
31	1	-	1	-	0	-	1	1	-	1	-	0

STEEL CREEK AT OLD HATTIESVILLE BRIDGE (SRS)

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	11/23/76	18.000	1
2	6/30/75	24.429	2
3	8/27/76	27.857	21
4	7/07/77	24.571	0
5	6/28/78	16.143	2
6	6/27/79	14.000	12
7	6/06/80	21.429	189
8	5/20/81	14.371	1
9	5/09/82	25.571	0
10	6/15/83	33.429	0
11	6/15/84	27.429	0

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197380
Lower Three Runs Below Par Pond (SRS)

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/74	End Date:	3/31/82

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
6.158	4.848	1.392

Mean Logs	Standard Deviation Logs	Skew Logs
0.659	0.381	-0.449

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	0.074	-	-
0.0005	2000.000	0.133	-	-
0.0010	1000.000	0.173	-	-
0.0020	500.000	0.227	-	-
0.0050	200.000	0.331	-	-
0.0100	100.000	0.448	-	-
0.0200	50.000	0.616	-	-
0.0250	40.000	0.686	-	-
0.0400	25.000	0.867	-	-
0.0500	20.000	0.974	-	-
0.1000	10.000	1.436	-	-
0.2000	5.000	2.240	-	-
0.3000	3.333	3.036	-	-
0.4000	2.500	3.895	-	-
0.4296	2.328	4.169	-	-
0.5000	2.000	4.873	-	-
0.5704	1.753	5.671	-	-
0.6000	1.667	6.045	-	-
0.7000	1.429	7.544	-	-
0.8000	1.250	9.661	-	-
0.9000	1.111	13.337	-	-
0.9500	1.053	17.102	-	-
0.9600	1.042	18.333	-	-
0.9750	1.026	20.954	-	-
0.9800	1.020	22.210	-	-
0.9900	1.010	26.160	-	-
0.9950	1.005	30.168	-	-
0.9980	1.002	35.535	-	-
0.9990	1.001	39.631	-	-
0.9995	1.001	43.745	-	-
0.9999	1.000	53.315	-	-

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LOWER THREE RUNS BELOW PAR POND (SRS)

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1	1	2	2	2	2	1	2	1	1	1	1
2	1	1	2	3	2	2	2	2	1	1	1	1
3	1	1	1	3	2	2	2	2	1	1	1	1
4	1	1	1	3	2	2	2	2	1	1	1	1
5	1	1	1	3	2	2	2	2	1	1	1	1
6	1	1	1	3	2	2	2	1	1	1	1	1
7	1	1	2	3	2	2	2	1	1	0	1	1
8	1	1	1	3	1	2	2	1	1	0	1	1
9	1	1	1	3	1	2	2	2	1	0	1	1
10	1	1	1	3	1	2	2	2	1	1	1	1
11	1	1	1	3	1	2	2	2	1	1	1	1
12	1	1	1	3	1	2	2	2	1	1	1	1
13	1	1	1	3	2	2	2	2	1	1	1	1
14	1	1	1	3	2	2	2	2	1	1	1	1
15	1	1	1	3	2	2	2	2	1	1	1	1
16	1	1	1	3	2	2	2	2	1	1	1	1
17	1	1	1	3	2	2	2	2	1	1	1	1
18	1	1	1	3	2	2	2	2	1	1	1	1
19	1	1	1	3	2	2	2	2	1	1	1	1
20	1	2	1	3	2	2	2	2	1	1	1	1
21	1	2	1	3	2	2	2	2	1	1	1	1
22	1	2	1	3	2	2	2	2	1	1	1	1
23	1	2	1	3	2	2	2	1	1	1	1	1
24	1	2	1	3	2	2	2	1	1	1	1	1
25	1	2	1	3	2	3	2	1	1	1	1	1
26	1	2	1	3	2	3	2	1	1	1	1	1
27	1	2	1	3	2	2	2	1	1	1	1	1
28	1	2	1	3	2	1	2	1	1	1	1	1
29	1	-	1	3	2	1	2	1	2	1	1	1
30	1	-	1	3	2	1	2	1	2	1	1	1
31	1	-	1	-	2	-	2	1	-	1	-	1

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LOWER THREE RUNS BELOW PAR POND (SRS)

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	11/22/74	4.186	111
2	3/06/76	16.714	66
3	8/27/76	6.571	0
4	7/25/77	5.071	0
5	10/02/78	3.900	0
6	10/22/79	10.329	0
7	7/12/80	6.214	0
8	11/23/81	1.133	0
9	9/07/82	1.300	179

W8908052

Log-Pearson Type III Duration-Frequency Analysis
Station: 02197400
Lower Three Runs Near Snelling, SC

Mode:	Minimum	Duration:	7 Days
Start Date:	4/01/74	End Date:	3/31/86

INPUT DATA STATISTICS

Mean	Standard Deviation	Skew
27.516	12.488	1.166

Mean Logs	Standard Deviation Logs	Skew Logs
1.402	0.185	0.412

DURATION-FREQUENCY CHARACTERISTICS

Non-Exceedance Probability	Recurrence Interval	Parameter Value	Adjusted Probability	Adjusted Parameter Value
0.0001	10000.000	7.426	-	-
0.0005	2000.000	8.226	-	-
0.0010	1000.000	8.653	-	-
0.0020	500.000	9.149	-	-
0.0050	200.000	9.943	-	-
0.0100	100.000	10.686	-	-
0.0200	50.000	11.603	-	-
0.0250	40.000	11.947	-	-
0.0400	25.000	12.772	-	-
0.0500	20.000	13.222	-	-
0.1000	10.000	14.960	-	-
0.2000	5.000	17.541	-	-
0.3000	3.333	19.805	-	-
0.4000	2.500	22.069	-	-
0.4296	2.328	22.767	-	-
0.5000	2.000	24.513	-	-
0.5704	1.753	26.442	-	-
0.6000	1.667	27.330	-	-
0.7000	1.429	30.831	-	-
0.8000	1.250	35.703	-	-
0.9000	1.111	44.205	-	-
0.9500	1.053	53.212	-	-
0.9600	1.042	56.253	-	-
0.9750	1.026	62.920	-	-
0.9800	1.020	66.218	-	-
0.9900	1.010	77.066	-	-
0.9950	1.005	88.919	-	-
0.9980	1.002	106.328	-	-
0.9990	1.001	120.969	-	-
0.9995	1.001	137.020	-	-
0.9999	1.000	180.490	-	-

W8908052

LOWER THREE RUNS NEAR SNELLING, SC

MISSING DAYS SUMMARY

Day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	0	0	0	1	0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	1	0	0	0	0
3	0	0	0	0	0	0	0	1	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	1	0	0	0
8	0	0	0	0	0	0	0	0	1	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0		0	0	0	0	0	1	0	0	0	0
13	0	0	0	0	0	0	0	1	1	0	0	0
14	0	0	0	0	0	0	0	1	1	0	0	0
15	0	0	0	0	0	0	0	0	1	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0
29	0	-	0	0	0	0	0	0	0	0	0	0
30	0	-	0	-	0	0	0	0	0	0	0	0
31	0	-	0	-	0	-	0	0	-	0	-	0

LOWER THREE RUNS NEAR SNELLING, SC

INPUT DATA SUMMARY

Cycle Number	Date of Selected Value	Selected Value	Number of Missing Days in Cycle
1	10/08/74	34.000	1
2	3/06/76	57.429	0
3	7/27/76	31.571	0
4	7/15/77	33.000	0
5	7/08/78	30.714	0
6	10/16/79	42.000	0
7	7/12/80	26.286	0
8	10/03/81	15.143	0
9	10/28/82	17.286	0
10	9/29/83	16.571	0
11	9/21/84	20.286	0
12	5/14/85	18.000	0
13	7/15/86	15.429	0

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