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Second Progress Report

METEOROLOGICAL ANALYSIS

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ABSTRACT

This report contains an analysis of the data accumulated at the Enrico Fermi Power Plant site during the past winter (December, 1956 - January, February, 1957) and spring (March, April, May, 1957). The instrumentation providing these data remains the same as that described in detail in the first progress report. It consists of a 100-ft steel tower near the lake shore with the following installations: three Bendix-Friez Aerovanes for wind measurements, and four differential thermocouples, shielded and artificially ventilated, for temperature-lapse-rate measurements. A recording rain gage is also in operation.

In this report comparisons are made between the winds at the plant site, at Detroit City Airport, and at Toledo Express Airport for the same seasons, and with data for the same months for the period 1950-1954 at the Toledo Municipal Airport. Temperature-lapse-rate measurements for the winter and spring seasons are also available. These are analyzed to show relative frequency of strong lapse rate, weak lapse rate, and inversions, and the relationship between lapse rate, wind direction, and wind speed. Inversion frequencies are compared with those on the WJBK-TV tower in Detroit for part of the same period. The relationship between occurrences of measurable precipitation (.02 in. at Monroe, .01 in. at Toledo and Detroit), and wind direction during the past winter and spring is also reported on.

The existing program of weather observation and analysis at the Enrico Fermi Power Plant site is continuing, and plans are being made to conduct special diffusion studies over the lake in the summer of 1958.

INTRODUCTION

The present study is being undertaken to determine the nature and magnitude of special lake influences on the air-pollution climatology of the Monroe plant site. The special influences which may be uncovered will be either mechanical or thermal in origin: mechanical if they owe their existence to the unusual uniformity of the lake surface compared to a land surface or thermal if they owe their existence to the relative warmth of the lake surface during the cold months of the year, and to its relative coolness during the warm months.

Preliminary observations of wind directional traces have shown quite clearly that the smoothness of the lake surface leads to an intensity of mechanical turbulence which is very much less than that over ordinary land surfaces at the same wind speed. For example, it has been observed, as the wind shifts from SE, off the lake, to SSE across a point of land, that the range of variability of wind direction may be doubled or trebled. This aspect of the study has not yet been subjected to a formal analysis.

In the present report, the technique of analysis is to compare the observations at the Enrico Fermi Power Plant site with those at Toledo and Detroit, where special lake influences are absent. Observed differences are believed to be mainly due to thermal influences, which operate the following way. During the three winter months Lake Erie acts predominantly as a heat source. That is to say, most air masses will be warmed at the surface by passage over the lake although the reverse will be true for unusually warm spells such as that of 4, 5, and 6 December 1956. During March, the mean heat effect of the lake is neutral, varying from day to day. Through the remaining spring months, April and May, Lake Erie acts predominantly as a cold source, which means that most air masses will be cooled at the surface by passage over the lake. In the individual situation, whenever the lake is cold in relation to the air (cold source), a surface inversion will form over the water, whereas, whenever the lake is warm in relation to the air (heat source), a strong lapse rate will develop over the water. Actually either influence is possible at any season of the year. Strong lapse rates will increase surface wind speed and turbulence and hence promote rapid diffusion. Inversions will decrease surface wind speed and turbulence and hence inhibit diffusion.

The ability of rainfall to scavenge particulate matter from the air is also important. This aspect of air pollution was discussed in the earlier evaluation of the air-pollution climatology near Monroe, Michigan.* In the present report

*Hewson, E. W., and Baynton, H. W., Air-Pollution Climatology near Monroe, Michigan, Univ. of Mich. Eng. Res. Inst. Report 2442-1-F, Ann Arbor, March 1956.

it is investigated further by examining the relationship between precipitation occurrences and wind direction for the past winter and spring. Before considering the detailed analysis of the data, worthwhile background is provided by noting to what extent the past winter and spring were normal in the broad climatological sense. The winter season was slightly warmer than normal but January alone averaged about 5°F below normal with relatively large snow accumulations. Winds were quite typical of average winter conditions. The spring began with temperatures somewhat above normal and reached a peak of warmth toward the end of April with temperatures over 20°F above normal. Thereafter the seasonal warming trend lagged somewhat, with May temperatures averaging slightly below normal. Precipitation for the spring was about normal with deficits in March and May being made up by a large excess in April. Wind speeds through the spring were about normal but east winds were somewhat more frequent than usual in May.

ANALYSIS OF WIND DATA

The present analysis covers data collected during the winter of 1956-57, i.e., December, January, and February; and the spring of 1957, i.e., March, April, and May.

As in the first progress report (Jan., 1957), the comparison is made between wind data obtained at 102 ft at the plant site and corresponding data at Detroit City Airport, 81 ft, at Toledo Express Airport, 72 ft, and at Toledo Municipal Airport, 47 ft, for the same months of 1950 to 1954, inclusive. The locations of these four weather stations are shown in Fig. 1. The analyzed data are presented in Tables I through VIII in which there is a grouping by seasons, December, January, and February combining to give the winter picture; and March, April, and May combining to give the spring picture. Discussion of the data will follow identically the pattern set in the first progress report but each season will be treated separately.

1. WINTER SEASON

Wind directions may be grouped on the basis of their implications to population centers. Winds from the sector E, ESE, SE, SSE, and S, and the sector W, WNW, NW, NNW, N, and NNE will carry for 20 miles or more before reaching any population centers. These two groups of winds will be discussed first.

During the past winter, winds from the sector E through S were observed 15.5% of the time at the Enrico Fermi Plant site, 20.4% at Detroit, and 18.6% at Toledo Express. During the 5 successive winters beginning in 1950, these winds were observed 21.4% of the time at Toledo Municipal. In this respect the winter seems to have been fairly typical since the variations evident in the above data are about what might be expected.

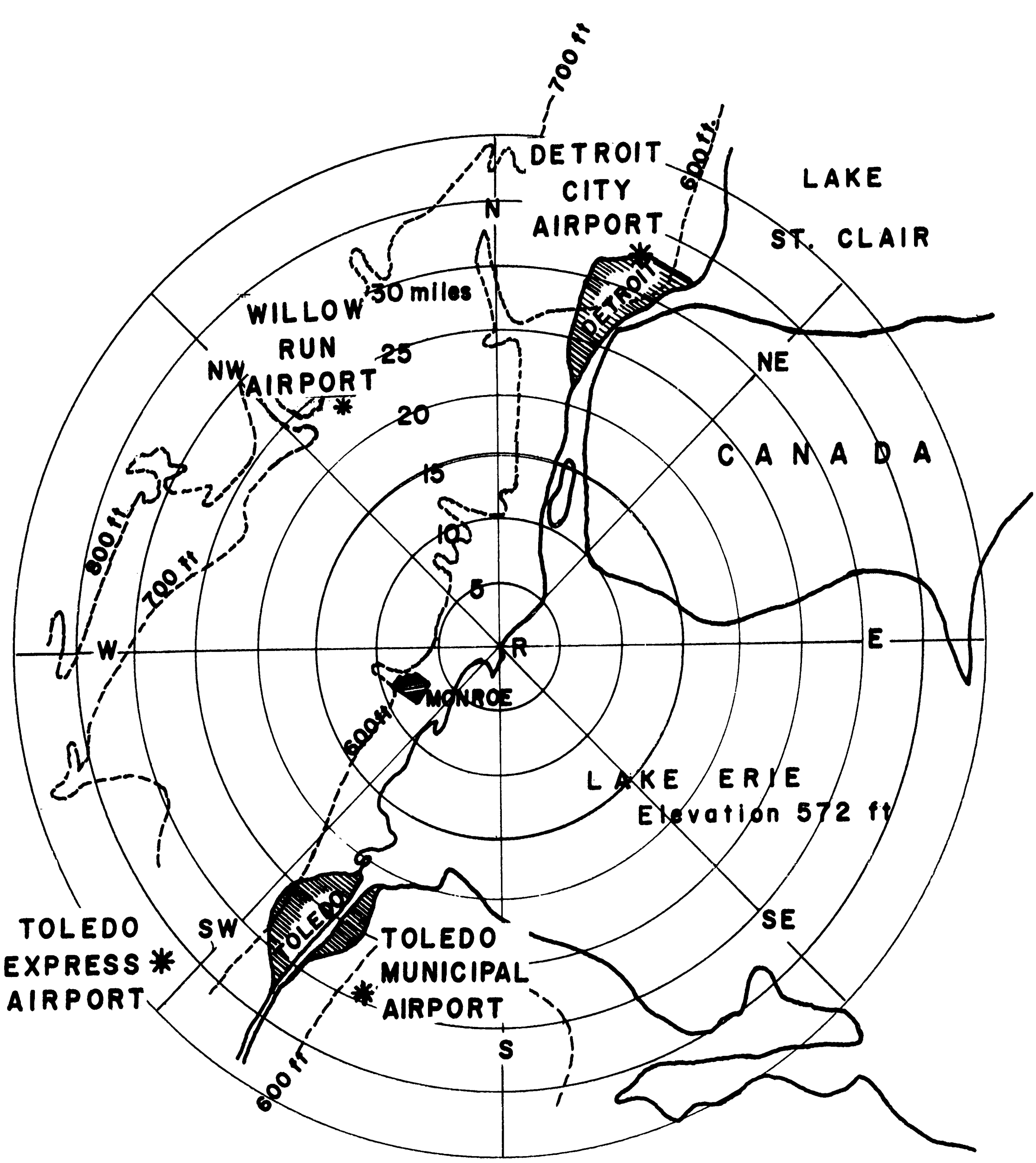


Fig. 1. Topographic map of site and surroundings.

TABLE I

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS GROUPED ACCORDING TO WIND SPEEDS

Enrico Fermi Power Plant Site
(Aerovane at height of 102 ft)
1 December 1956 - 28 February 1957
(Winter)

Wind Direction	Speed, mph 0-3	4-12	13-24	25 and Over	Total 4 and Over	Total Observations %	No.	Mean Speed mph	% of Overall Mean
N	0.2	1.7	1.1	0.6	3.4	3.5	70	14.2	107
NNE	0.2	1.3	1.7	0.4	3.4	3.6	71	14.9	112
NE	0.2	1.1	3.9	0.2	5.2	5.4	107	16.0	120
ENE	0.3	1.4	1.4		2.8	3.0	60	12.2	92
E	0.4	1.1	1.3		2.4	2.7	54	12.0	91
ESE	0.1	1.9	1.1		3.0	3.0	61	11.7	88
SE	0.3	1.7	1.1		2.8	3.0	60	11.1	84
SSE	0.2	1.2	1.0		2.2	2.3	45	12.0	90
S	0.2	2.0	2.3	0.1	4.4	4.5	90	13.3	100
SSW	0.2	3.1	6.1	0.4	9.6	9.7	192	15.2	115
SW	0.2	3.5	7.1	0.1	10.7	10.9	216	15.0	113
WSW	0.2	6.4	7.4		13.8	13.9	276	13.5	101
W	0.4	4.5	4.7	0.2	9.4	9.7	193	13.1	99
WNW	0.5	5.0	4.5	0.2	9.7	10.2	202	12.7	96
NW	0.5	4.9	2.6	0.1	7.6	8.1	161	11.2	84
NNW	0.1	3.7	2.0		5.7	5.7	113	11.6	87
Calm	0.6					0.6	11		
Totals	4.8	44.5	49.3	2.3	96.1	99.8	1982	13.3	100

TABLE II

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS
GROUPED ACCORDING TO WIND SPEEDS

Detroit City Airport
(Wind instruments at height of 81 ft)
1 December 1956 - 28 February 1957
(Winter)

Wind Direction	Speed, mph					Total Observations		Mean Speed	
	0-3	4-12	13-24	25 and Over	Total 4 and Over	%	No.	mph	% of Over-all Mean
N	0.7	6.7	3.8		10.5	11.2	243	10.4	94
NNE	0.3	2.5	1.2		3.8	4.1	88	10.2	92
NE	0.6	1.3	0.4		1.7	2.3	49	7.7	69
ENE	0.1	2.7	0.4		3.1	3.2	69	8.9	80
E	0.7	3.3	0.3		3.6	4.3	93	7.0	63
ESE	0.3	1.4	0.0		1.4	1.7	37	6.9	62
SE	0.1	2.4	0.1		2.5	2.7	58	6.6	59
SSE	0.1	3.5	0.3		3.8	3.9	85	8.0	72
S	0.5	5.1	2.1		7.3	7.8	168	10.1	91
SSW	0.0	2.0	2.8		4.9	4.9	105	12.6	113
SW	0.1	4.7	6.9	0.2	11.8	11.9	257	13.3	120
WSW	0.0	3.3	3.7		7.0	7.0	151	12.5	113
W	0.1	5.8	5.8	0.3	11.6	11.7	253	12.1	109
WNW	0.2	2.5	5.8	0.1	8.7	8.8	191	14.0	126
NW	0.5	4.4	3.6		8.1	8.6	186	11.6	104
NNW	0.2	2.2	2.8		5.0	5.2	112	12.6	113
Calm	0.7					0.7	15		
Totals	5.2	53.9	40.0	0.6	94.8	100.0	2160	11.1	100

TABLE III

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS GROUPED ACCORDING TO WIND SPEEDS

Toledo Express Airport
(Wind instruments at height of 72 ft)
1 December 1956 - 28 February 1957
(Winter)

Wind Direction	Speed, mph					Total Observations		Mean Speed	
	0-3	4-12	13-24	25 and Over	Total 4 and Over	%	No.	mph	% of Over-all Mean
N	0.3	3.1	2.0		5.2	5.5	118	10.8	104
NNE	0.1	2.1	1.4		3.6	3.7	80	11.0	106
NE	0.2	2.6	1.1		3.7	3.9	85	10.0	96
ENE	0.4	2.0	0.7		2.7	3.1	68	9.0	86
E	0.4	2.4	0.8		3.2	3.6	77	9.1	87
ESE	0.5	2.1	0.3		2.4	2.8	61	7.5	72
SE	0.4	1.9			1.9	2.3	50	6.0	58
SSE	0.6	2.5	0.2		2.7	3.3	71	7.4	71
S	0.4	4.3	1.9		6.2	6.6	142	10.0	96
SSW	0.3	2.9	3.5	0.2	6.6	6.9	148	12.6	121
SW	0.2	5.5	6.1	0.1	11.8	11.9	258	12.9	124
WSW	0.2	8.8	7.4	0.1	16.3	16.5	357	11.9	114
W	0.1	5.3	2.7		8.0	8.1	175	10.8	104
WNW		4.4	2.0		6.5	6.5	141	10.4	100
NW	0.3	4.8	1.7		6.5	6.9	148	9.9	95
NNW	0.5	3.8	1.4		5.2	5.7	123	9.5	91
Calm	2.7					2.7	58		
Totals	7.6	58.5	33.2	0.4	92.5	100.0	2160	10.4	100

TALBE IV

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS GROUPED ACCORDING TO WIND SPEEDS

Toledo Municipal Airport
(Wind instruments at height of 47 ft)
1 January 1950 - 31 December 1954
(Winter Season)

Wind Direction	Speed, mph					Total Observations		Mean Speed	
	0-3	4-12	13-24	25 and Over	Total 4 and Over	%	No.	mph	% of Over-all Mean
N	0.3	2.3	1.0		3.4	3.6	395	10.1	78
NNE	0.1	1.8	1.6	0.1	3.4	3.6	385	12.4	96
NE	0.2	1.9	1.8	0.1	3.8	4.0	432	12.3	95
ENE	0.2	2.1	2.8	0.4	5.3	5.5	591	14.3	111
E	0.3	2.6	1.4		4.0	4.3	467	10.1	78
ESE	0.2	2.0	0.6		2.5	2.8	301	9.1	71
SE	0.3	2.3	0.7		3.0	3.3	352	8.9	69
SSE	0.2	2.2	1.3		3.6	3.8	411	11.1	86
S	0.4	3.2	3.4	0.2	6.8	7.2	777	12.9	100
SSW	0.2	4.8	6.5	0.8	12.1	12.3	1330	14.5	112
SW	0.3	5.7	7.1	1.0	13.8	14.1	1524	14.1	109
WSW	0.3	5.4	6.6	1.0	12.9	13.2	1429	14.0	109
W	0.3	3.6	2.9	0.2	6.8	7.2	774	12.1	94
WNW	0.1	2.6	3.5	0.5	6.7	6.8	732	14.3	111
NW	0.2	2.1	2.7	0.2	5.0	5.3	570	13.5	105
NNW	0.1	1.2	2.2	0.1	2.6	2.7	295	12.5	97
Calm	0.5					0.5	59	0	
Totals	3.9	45.8	45.1	4.7	95.6	100.0	10824	12.9	100

TABLE V

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS GROUPED ACCORDING TO WIND SPEEDS

Enrico Fermi Power Plant Site
(Aerovane at height of 102 ft)
1 March 1957 - 31 May 1957
(Spring)

Wind Direction	Speed, mph					Total Observations		Mean Speed	
	0-3	4-12	13-24	25 and Over	Total 4 and Over	%	No.	mph	% of Over-all Mean
N	0.0	1.1	1.4		2.5	2.6	53	10.2	72
NNE	0.0	2.4	3.4	0.1	5.9	6.0	121	14.4	103
NE	0.1	1.8	4.8	0.3	6.9	7.0	142	15.9	114
ENE	0.1	2.2	6.7	1.1	10.0	10.1	205	16.5	118
E	0.1	1.6	3.7	1.7	7.0	7.2	145	13.6	97
ESE	0.0	2.6	3.4	0.1	6.1	6.2	125	14.2	102
SE	0.0	2.4	2.2	0.2	4.8	4.9	99	13.6	97
SSE	0.2	4.0	1.8	0.0	5.8	6.1	124	11.1	79
S	0.3	3.1	1.5		4.6	4.9	100	10.9	78
SSW	0.2	3.0	2.4	0.0	5.4	5.6	113	12.4	89
SW	0.1	2.7	5.1		7.8	7.9	160	14.7	105
WSW	0.3	2.9	4.4	1.6	8.9	9.3	188	16.1	115
W	0.1	3.4	2.4	0.4	6.2	6.3	128	12.8	91
WNW	0.0	3.0	6.0		9.0	9.0	183	15.0	107
NW	0.1	1.8	2.5	0.0	4.3	4.5	91	13.9	99
NNW	0.1	1.6	0.6		2.2	2.3	47	10.6	76
Calm	0.1					0.2	3		
Totals	1.8	39.6	52.3	5.5	97.4	99.9	2027	14.0	100

TABLE VI

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS GROUPED ACCORDING TO WIND SPEEDS

Detroit City Airport
(Wind instruments at height of 81 ft)
1 March 1957 - 31 May 1957
(Spring)

Wind Direction	Speed, mph 0-3	4-12	13-24	25 and Over	Total 4 and Over	Total Observations %	No.	Mean Speed mph	% of Over-all Mean
N	0.6	6.2	3.5		9.7	10.4	228	10.3	93
NNE	0.2	4.3	1.5		5.8	6.0	132	10.2	92
NE	0.8	3.3	1.9		5.2	6.0	133	9.6	86
ENE	0.2	4.6	2.0		6.6	6.8	151	10.2	92
E	0.5	7.7	1.8		9.6	10.2	224	9.5	86
ESE	0.2	2.9	0.9		3.8	4.0	88	9.9	89
SE	0.6	3.8	0.5		4.3	4.9	109	7.4	67
SSE	0.1	2.4	0.9		3.4	3.4	76	9.3	84
S	0.2	7.1	1.5		8.6	8.9	195	9.0	81
SSW		1.7	1.6		3.3	3.4	74	10.3	93
SW		1.4	3.8	1.0	6.2	6.2	137	15.0	135
WSW		1.3	2.7	0.3	4.3	4.3	96	15.6	141
W	0.4	3.8	4.0	0.4	8.3	8.6	192	13.0	117
WNW	0.1	2.1	4.7	0.3	7.1	7.2	158	14.8	133
NW	0.2	3.2	3.4		6.7	6.9	152	12.2	110
NNW		1.2	1.0		2.1	2.1	47	12.1	109
Calm	0.7					0.7	16		
Totals	4.8	57.1	35.7	2.1	95.0	100.0	2208	11.1	100

TABLE VII

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS GROUPED ACCORDING TO WIND SPEEDS

Toledo Express Airport
(Wind instrument at height of 72 ft)
1 March 1957 - 31 May 1957
(Spring)

Wind Direction	Speed, mph					Total Observations		Mean Speed	
	0-3	4-12	13-24	25 and Over	Total 4 and Over	%	No.	mph	% of Over-all Mean
N	0.1	3.4	1.5		4.8	4.9	109	9.9	82
NNE	0.2	3.3	2.3		5.6	5.8	129	11.2	92
NE	0.3	4.0	1.7		5.7	5.9	131	10.0	83
ENE	0.1	4.6	4.3	0.1	9.0	9.1	202	12.2	101
E	0.3	5.0	4.3	0.4	9.8	10.1	222	12.5	103
ESE	0.4	3.2	0.6		3.8	4.2	92	8.6	71
SE	0.2	1.6	0.4		1.9	2.1	47	9.0	74
SSE	0.1	2.6	1.6		4.3	4.4	97	11.5	95
S		3.8	2.2		6.0	6.0	133	10.9	90
SSW		2.2	2.0	0.1	4.3	4.3	94	12.9	107
SW		2.5	5.4	0.6	8.5	8.6	189	15.4	127
WSW	0.2	3.8	4.8	1.6	10.1	10.4	229	16.3	135
W	0.1	4.9	2.8	0.2	8.0	8.1	178	11.9	98
WNW	0.2	4.3	3.2		7.6	7.7	171	11.4	94
NW	0.2	2.7	1.9		4.6	4.8	106	11.0	91
NNW	0.2	1.9	1.0		2.9	3.1	69	9.7	80
Calm	0.5					0.5	10		
Totals	3.1	53.8	40.0	3.0	96.9	100.0	2208	12.1	100

TABLE VIII

PERCENTAGE FREQUENCY OF OCCURRENCE OF WINDS IN VARIOUS DIRECTIONS
GROUPED ACCORDING TO WIND SPEEDS

Toledo Municipal Airport
(Wind instruments at height of 47 ft)
1 January 1950 - 31 December 1954
(Spring Season)

Wind Direction	Speed, mph					Total Observations		Mean Speed	
	0-3	4-12	13-24	25 and Over	Total 4 and Over	%	No.	mph	% of Over-all Mean
N	0.3	2.9	1.0		3.9	4.2	468	9.1	72
NNE	0.1	1.9	1.2		3.1	3.2	351	11.1	87
NE	0.2	3.0	2.7		5.8	6.0	667	11.8	93
ENE	0.2	4.1	6.5	0.7	11.2	11.4	1258	14.6	115
E	0.4	3.8	3.0	0.1	6.9	7.3	811	11.4	90
ESE	0.2	2.2	0.7		3.0	3.2	350	9.4	74
SE	0.3	2.3	0.5		2.7	3.0	332	8.4	66
SSE	0.2	1.8	0.9	0.1	2.7	2.9	323	11.0	87
S	0.3	2.9	1.8	0.2	4.9	5.3	582	11.7	92
SSW	0.2	3.1	3.5	0.4	7.0	7.2	796	13.7	108
SW	0.4	4.8	4.4	0.7	9.8	10.2	1127	13.3	105
WSW	0.3	4.2	5.4	0.9	10.4	10.8	1189	14.3	113
W	0.2	3.6	3.7	0.4	7.7	8.0	881	13.4	106
WNW	0.3	2.4	4.7	0.4	7.6	7.8	865	14.9	117
NW	0.1	2.2	3.1	0.3	5.6	5.8	636	14.0	110
NNW	0.2	1.7	0.8	0.1	2.6	2.8	307	10.6	83
Calm	0.9					0.9	97	0	
Totals	3.9	46.9	43.9	4.3	95.2	100.0	11040	12.7	100

Winds from the sector W through NNE were observed 40.8% of the time at the plant site, 49.6% at Detroit, and 36.4% at Toledo Express. During the 5 winters 1950-54, these same winds were observed 29.2% of the time at Toledo Municipal. Winds from this sector appear to have been more frequent than usual during the past winter.

Combining the two groups of directions gives a total of 56.3% at the plant site, 70.0% at Detroit, 55.0% at Toledo Express, and 50.6% at Toledo Municipal. For reasons discussed in the first progress report, the data for Detroit do not appear to be representative. Based on the plant site and Toledo Express figures, which are in good agreement, it follows that, 55.6% of the time, winds from the plant site would have carried 20 miles or more before reaching population centers. The remaining wind directions are discussed in relation to the implicated population centers.

ENE - Monroe.—During ENE winds Monroe is downwind from the plant site. ENE winds occurred at 3.0% of the time at the plant site, 3.2% at Detroit, 3.1% at Toledo Express, in comparison with 5.3% at Toledo Municipal for the earlier 5-year period, thus confirming the infrequency of these winds at this season.

SSW - Detroit River communities.—SSW winds blow from the plant site towards the Detroit River communities. The corresponding percentages of SSW winds are: plant site, 9.7; Detroit, 4.9; Toledo Express, 6.9; and Toledo Municipal for 5 years, 12.1. Without including the Detroit data which may be unrepresentative, SSW winds appear to have been less frequent than usual.

SW and WSW - Ontario shores.—SW and WSW winds at the plant site cross Lake Erie to Ontario. However, with the lake acting as a heat source, strong lapse rates would tend to develop in crossing the lake, and good diffusion conditions would result. The following percentages of winds from SW and WSW were observed: 24.8% at the plant site, 18.9% at Detroit, 28.4% at Toledo Express, and 26.7 at Toledo Municipal in the earlier 5-year period.

Wind speeds at the plant site, Detroit, and Toledo Express have been compared for evidence of special lake influences. Figure 1 indicates that winds from the sector bounded by NE through SSE have a water trajectory prior to reaching the aerovane at the plant site, whereas, for all other directions at the plant site, and without exception at Detroit and Toledo, the winds experience a land trajectory. Direct comparisons between wind speeds for corresponding directions at the three stations are meaningless because of different heights of anemometer exposure and differences in instrumentation. However, if mean wind speeds for each direction are first expressed as a percentage of the overall mean wind speed for all directions, comparisons may then be made. For example, during the spring of 1957 the mean wind speed at the plant site was 14.0 miles/hr. The mean wind speed for WNW winds was 15.0 miles/hr or 107% of 14.0 miles/hr. Computations of this sort have been made for all wind directions for the three stations and appear as the last column of Tables I through VIII (see also Figs. 2 and 3).

The results of the analysis are presented in Fig. 4. Toledo and Detroit have been combined into a single curve for comparison purposes. At the plant site,

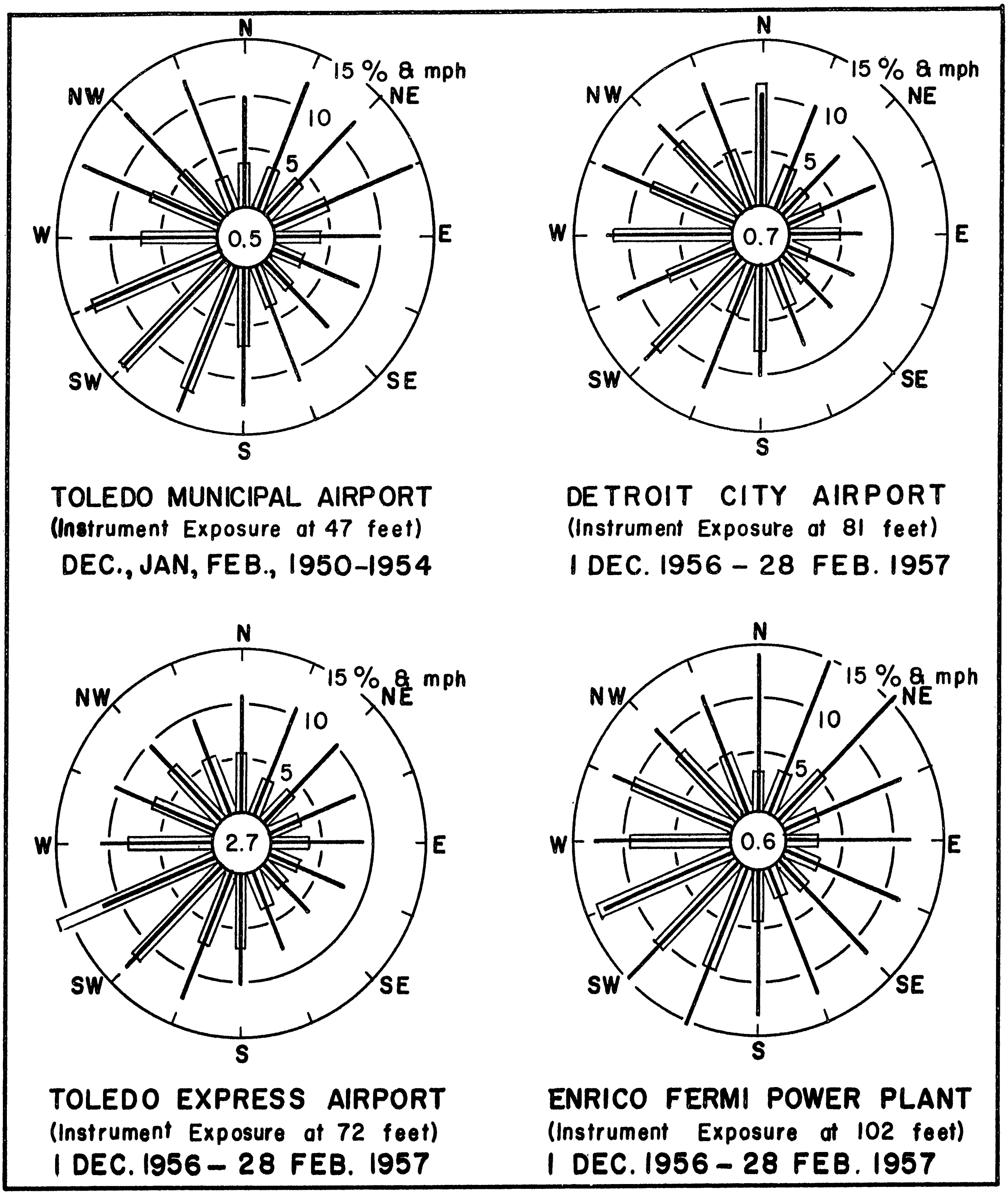


Fig. 2. Percentage frequency of occurrence of winds from 16 directions (rectangles) and corresponding wind speed in mph (heavy lines) at Municipal and Express Airports at Toledo, Ohio, Detroit City Airport and Enrico Fermi Power Plant, Winter. Percent of calms in center.

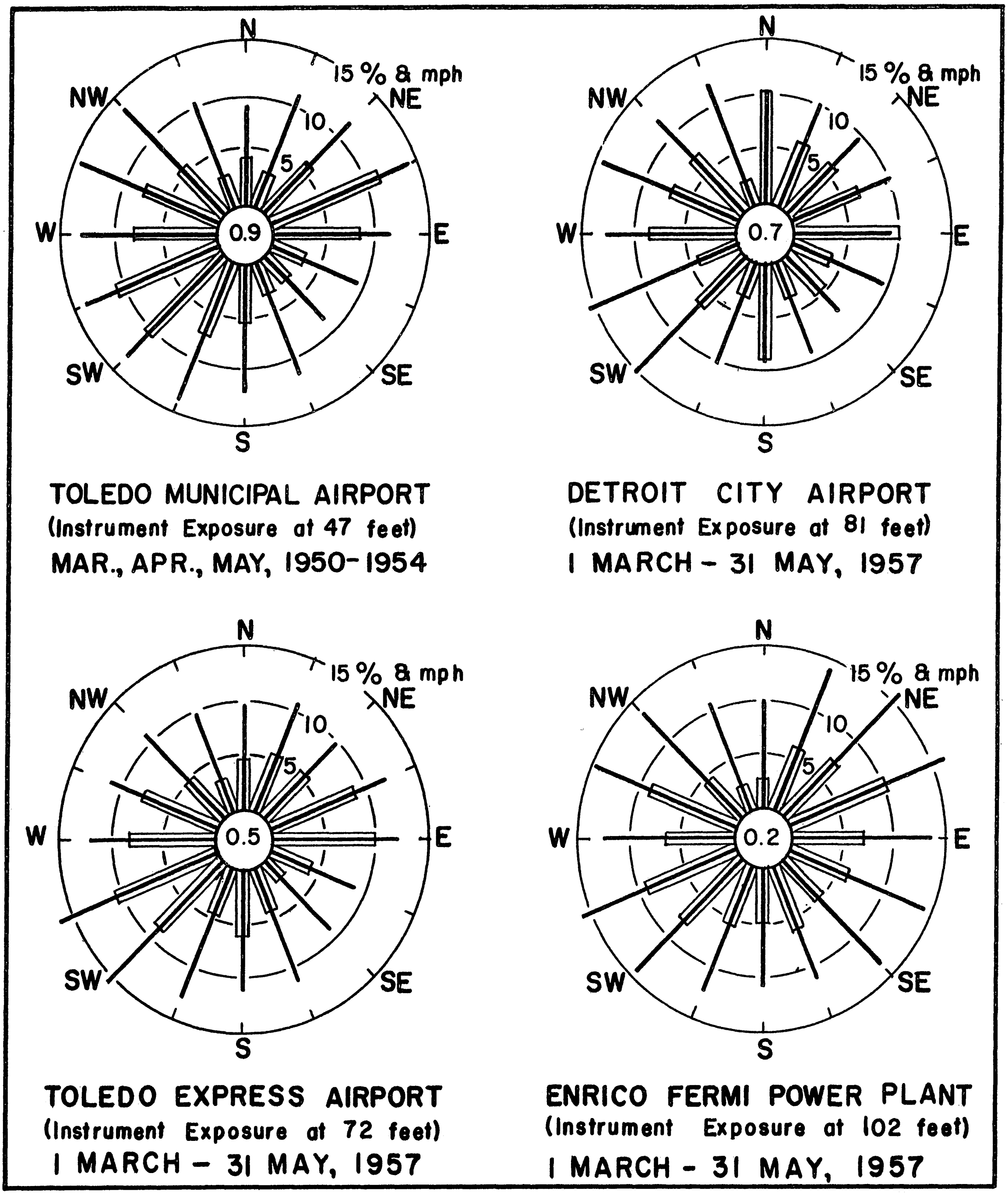


Fig. 3. Percentage frequency of occurrence of winds from 16 directions (rectangles) and corresponding wind speed in mph (heavy lines) at Municipal and Express Airports of Toledo, Ohio, Detroit City Airport and Enrico Fermi Power Plant, Spring. Percent of calms in center.

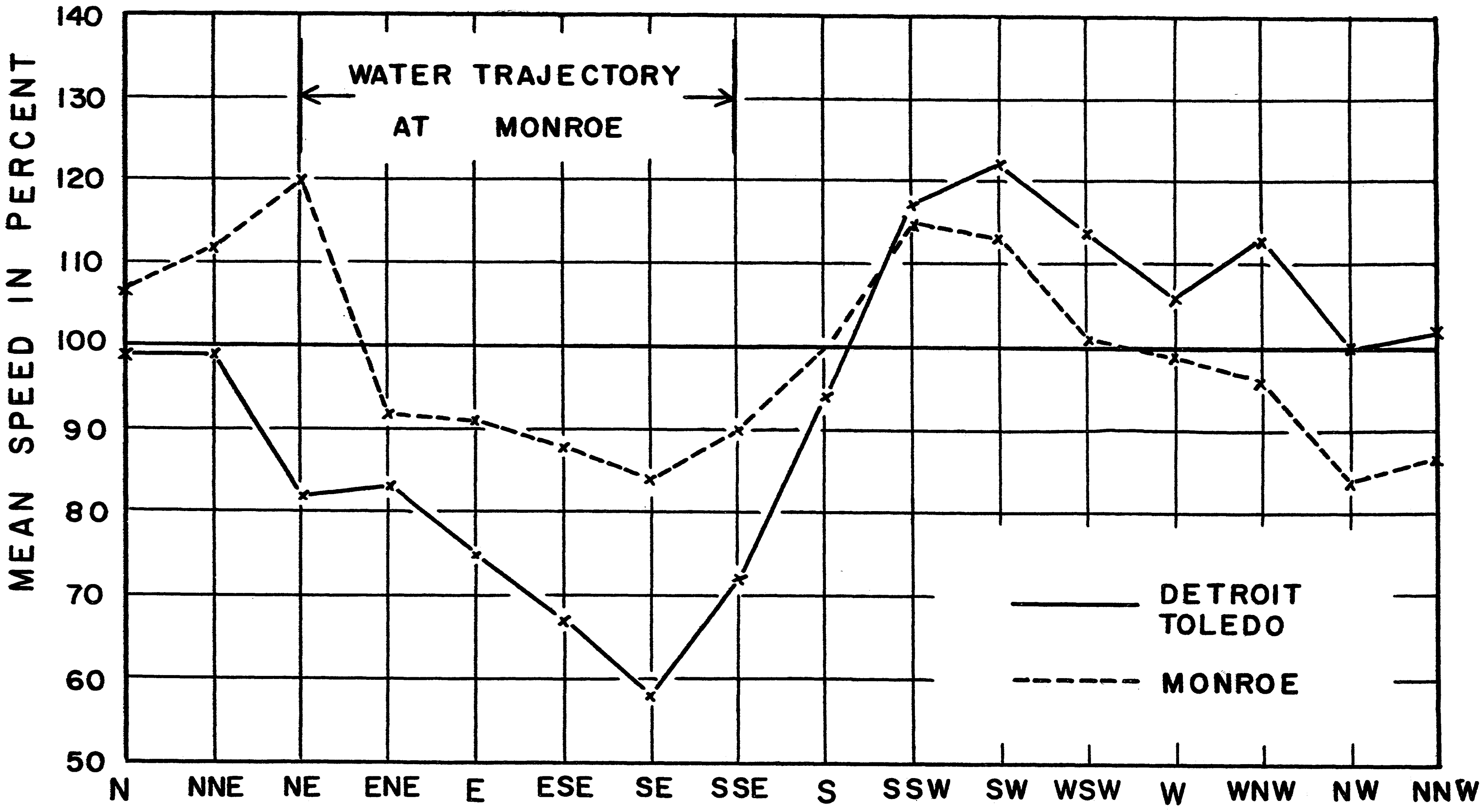


Fig. 4. Mean wind speed at Enrico Fermi Power Plant site and Detroit-Toledo combined, for various directions, expressed as a percentage of the overall mean winter wind speed.

those winds which are off the lake are seen to be relatively stronger than the same winds at Detroit and Toledo. Both the tendency for strong lapse rates over the lake in winter and the smoothness of the lake surface contribute to this result. However, it remains for later analysis to show whether the same result is obtained in the summer when inversions over the lake become the rule.

SPRING SEASON

During the spring of 1957, the percentages of winds from the sector E through S were as follows: plant site, 29.3; Detroit, 31.4; Toledo Express, 26.8. These may be compared to 21.7 at Toledo Municipal for the 5 springs 1950-54. The high frequency of E during May has contributed to the high totals obtained in 1957. The percentages of winds from the sector W through NNE were as follows: plant site, 30.7; Detroit, 41.2; Toledo Express, 34.4. These are in fair agreement with the 5-year average of 31.8 at Toledo Municipal. Combining these two groups, the percentages are as follows: plant site, 59.9; Detroit, 72.6; Toledo Express, 61.2; and for the 5-year period at Toledo Municipal, 53.5. Thus it is seen that these wind directions were unusually frequent during the spring of 1957.

ENE - Monroe.—The frequencies of these winds were as follows: plant site, 10.1; Detroit, 6.8; Toledo Express, 9.1. This is two to three times as frequent as the same wind direction in the past winter but compares closely to the 11.4 for spring during the 5-year period at Toledo Municipal.

SSW - Detroit River communities.—Winds from the SSW were observed 5.6% at the plant site, 3.4 at Detroit, 4.3 at Toledo Express, or in general rather less than the 5-year average of 7.2% at Toledo Municipal.

SW, WSW - Ontario shores.—The frequencies of these winds were as follows: plant site, 17.2; Detroit, 10.5; Toledo Express, 19.0, or somewhat less than the 5-year average of 21.0 at Toledo Municipal. However, disregarding the Detroit data which do not appear to be representative, the values are fairly typical of spring. Since the lake surface is relatively cold during the latter part of the spring, poor diffusion conditions would often occur as these winds carried across the lake.

Wind speeds were compared, in the manner described earlier for the winter analysis, in an attempt to detect special lake influences. In Fig. 5 winds off the lake at the plant site are again seen to be stronger than the corresponding winds at Detroit and Toledo combined. The effect of the smoothness of the lake surface evidently outweighs the influence of inversions over the relatively cold lake surface. Since the latter effect will be more pronounced in summer, this type of comparison may then yield different results.

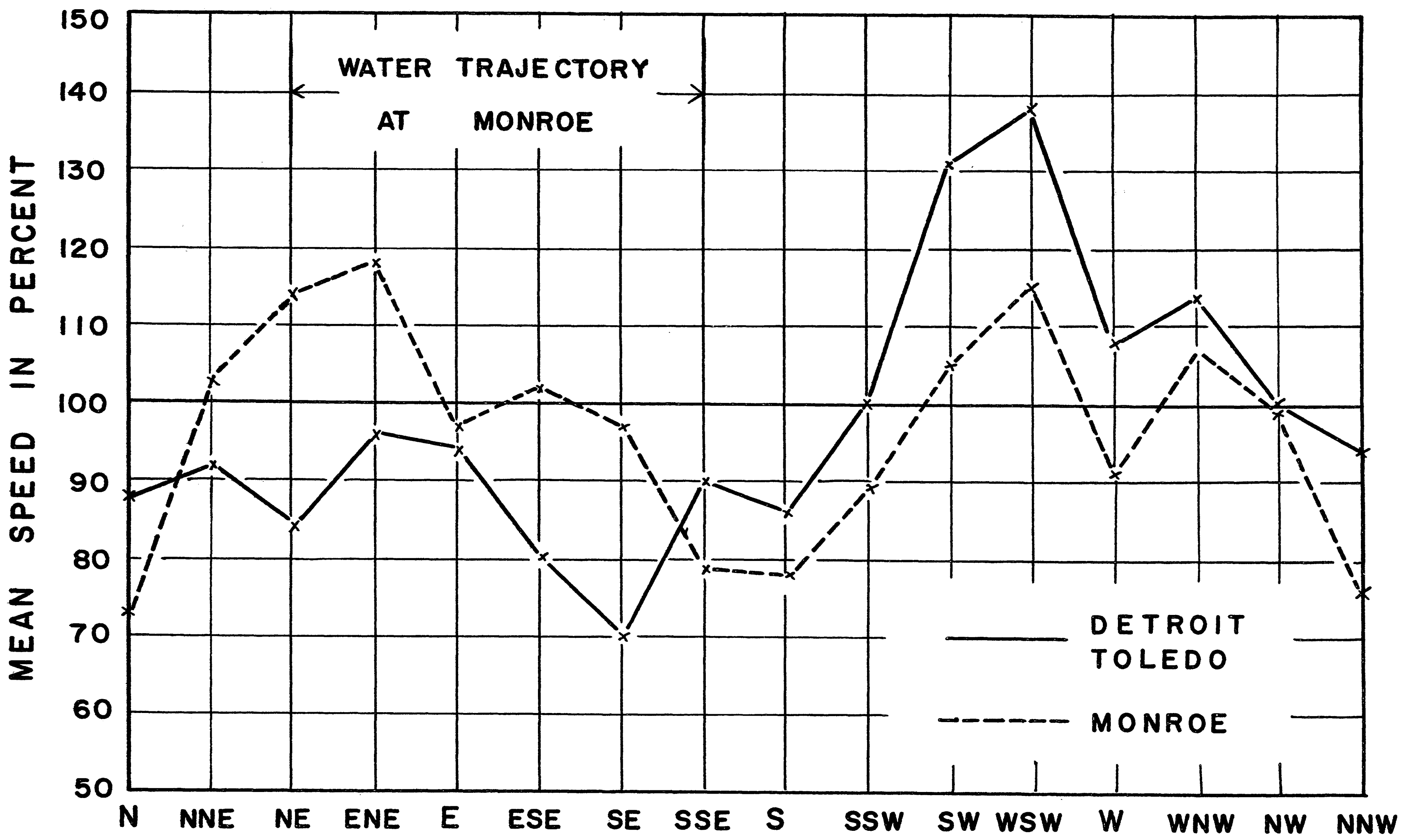


Fig. 5. Mean wind speed at Enrico Fermi Power Plant site and Detroit-Toledo combined, for various directions, expressed as a percentage of the overall mean spring wind speed.

ANALYSIS OF TEMPERATURE-LAPSE-RATE DATA

1. CLASSIFICATION OF LAPSE-RATE DATA

The temperature-lapse-rate data were recorded at the 100-ft meteorological tower on the Enrico Fermi Plant site. Lapse rates during each hour are classified as strong, weak, or inversions. Strong lapse rates are those values in excess of the dry adiabatic lapse rate; positive lapse rates that are less than the dry adiabatic rate are classified as weak; and negative lapse rates, i.e., temperature increasing with height, are classified as inversions.

Generally speaking, strong lapse rates, weak lapse rates, and inversions are associated with above average, average, and below average diffusion conditions, respectively. Strong lapse rates are indicative of turbulent air motion and hence indicate good diffusion conditions. Inversions tend to suppress turbulent air motion and thus inhibit diffusion.

The moderating influence of Lake Erie at the Enrico Fermi Plant site has been previously discussed on a theoretical basis. To evaluate this influence, temperature-lapse-rate data from the WJBK-TV tower, in the northwest section of Detroit, have been compared with the data recorded at the Enrico Fermi Plant site.

Tables IX and X summarize the lapse-rate data from the two sites. At both locations inversions were observed more frequently in winter than in spring. The incidence of inversions at the Detroit tower site is greater during both winter and spring than that experienced at the Enrico Fermi Plant site.

2. INVERSION CONDITIONS

The duration of inversions is also important. In the compilation of data for the tables of continuous inversions (Tables XI-XIV) an occurrence of one hour of weak lapse rate within a group of inversions was not considered a break in the continuous inversion. For example, six continuous hours of inversions followed by a one-hour weak lapse rate and then five more hours of inversions would be considered twelve hours of continuous inversions. This interpretation assumes that one hour of weak lapse rate would not materially alter the diffusion regime.

During winter, inversions lasting more than five hours are more frequent at the Detroit location but the average length of the inversions is considerably longer at the Enrico Fermi Plant site. Spring conditions indicate a slight change from the winter situation in that both the frequency of occurrence and the average length of these inversions is greater at the Enrico Fermi Plant site.

The most important difference between the two sites is the frequency of inversions persisting for over 25 hr in duration at the Enrico Fermi Plant site. Inversions of 30-, 40-, and 60-hr duration are important and careful consideration is required to estimate their frequency and extreme values.

TABLE IX

SUMMARY OF TEMPERATURE-LAPSE-RATE DATA
AT THE ENRICO FERMI POWER PLANT SITE

1 December 1956 - 28 February 1957 and 1 March 1957 - 31 May 1957

	Winter	Spring	Total
Total hours	2160	2208	4368
Number missing hours	516	168	684
Number hourly observations	1644	2040	3684
Percent missing data	23.9%	7.6%	15.7%
Percent inversions	20.9	18.3	19.4
Percent strong lapse	31.4	72.0	53.9
Percent weak lapse	47.7	9.7	26.7
	100.0%	100.0%	100.0%

TABLE X

SUMMARY OF TEMPERATURE-LAPSE-RATE DATA (INVERSIONS)
AT THE WJBK-TV TOWER, DETROIT

1 December 1956 - 28 February 1957 and 1 March 1957 - 31 May 1957

	Winter	Spring	Total
Total hours	2160	2208	4368
Number missing hours	664	426	1090
Number hourly observations	1496	1782	3278
Percent missing data	30.7%	19.3%	25.0%
Number hours inversions	393	388	781
Percent inversions	26.3%	21.8%	23.8%

TABLE XI

FREQUENCY OF CONTINUOUS INVERSIONS
AT THE ENRICO FERMI POWER PLANT SITE

1 December 1956 - 28 February 1957
(Winter)

Duration, hr					
6 to 12		13 to 24		25 and Over	
Hr	Mean Speed, mph	Hr	Mean Speed, mph	Hr	Mean Speed, mph
8	13	18	9	58	17
6	6	14	9	43	14
12	3	16	12		
10	12	16	18		
6	7	18	9		
10	7	20	6		
8	13	17	5		

Total number of inversions over 5 hr in duration = 16
Total hours of continuous inversions over 5 hr in duration = 280
Average length of continuous inversions over 5 hr in duration = 17.5

TABLE XII

FREQUENCY OF CONTINUOUS INVERSIONS
AT THE WJBK-TV TOWER, DETROIT

1 December 1956 - 28 February 1957
(Winter)

Duration, hr		
6 to 12	13 to 24	25 and Over
7	16	
8	15	
6	17	
11	14	
7	13	
7	15	
7	20	
7	19	
10	19	
7	16	
9	15	
11		
10		

Total number of inversions over 5 hr in duration = 24
Total hours of continuous inversions over 5 hr in duration = 286
Average length of continuous inversions over 5 hr in duration = 11.9

TABLE XIII

FREQUENCY OF CONTINUOUS INVERSIONS
AT THE ENRICO FERMI POWER PLANT SITE

1 March 1957 - 31 May 1957
(Spring)

Duration, hr					
6 to 12		13 to 24		25 and Over	
Hr	Mean Speed, mph	Hr	Mean Speed, mph	Hr	Mean Speed, mph
10	9	19	11	34	17
7	8	13	20	26	9
12	14	18	12		
8	16	19	16		
6	13	17	8		
6	14	15	7		
6	8	14	11		
6	10				
6	12				
6	13				
6	10				
6	6				
9	7				
9	10				
7	17				

Total number of inversions over 5 hr in duration = 24

Total hours of continuous inversions over 5 hr in duration = 285

Average length of continuous inversions over 5 hr in duration = 11.9

TABLE XIV

FREQUENCY OF CONTINUOUS INVERSIONS
AT THE WJBK-TV TOWER, DETROIT

1 March 1957 - 31 May 1957
(Spring)

Duration, hr		
6 to 12	13 to 24	25 and Over
9	14	
7	13	
6	14	
12	14	
7	15	
11		
11		
7		
11		
9		
9		
11		
11		
11		
10		
11		
12		
6		
9		
8		
12		
9		
7		
9		
9		

Total number of inversions over 5 hr in duration = 30
Total hours of continuous inversions over 5 hr in duration = 304
Average length of continuous inversions over 5 hr in duration = 10.1

3. ASSOCIATION OF LAPSE RATES WITH WIND DIRECTIONS

The association of lapse rates with wind directions is summarized in Tables XV and XVI. The first grouping of columns indicates the frequency of observed strong, weak, and inversion lapse rates associated with the winds from the indicated compass directions. The remaining columns provide relative frequency data and are classified in two ways. The first grouping is based on the relative frequency of occurrence within a given category for a specified direction. For example, 0.9% of the observations of strong lapse rates, during the winter period, were associated with winds from a north direction (Table XV). The second classification indicates the percent of the total observed data that had the characteristics of a north wind and a strong lapse rate. For example, in 0.2% of all the observations a north wind occurred simultaneously with a strong lapse rate (Table XV).

Figures 6 and 7 are a graphic representation of the relative frequency of occurrence of winds associated with inversions and noninversions during the winter and spring months at the Enrico Fermi Plant site. The original data for these graphs are summarized in Tables XVII and XVIII.

ANALYSIS OF PRECIPITATION DATA

Since the cessation of most of the heavy blasting at the Enrico Fermi Plant site, it is now possible to make an analysis of the precipitation data that are being collected. The first progress report outlined the precipitation instrumentation that is being used at the plant site. It might be well to mention at this time that the weighing rain gage at the Enrico Fermi Plant site has a threshold value of 0.02 in. These data are being compared with those of Toledo Express whose tipping-bucket rain gage has a threshold value of 0.01 in. As a result, there may be some differences when comparing the number of observations of measurable precipitation. The weighing rain gage at the Enrico Fermi Plant site is being used because it operates successfully without attention during freezing weather whereas other types of rain gages freeze and become inoperative or require constant attention. The Toledo Express data are being used as a basis of comparison since the original evaluation of the air-pollution climatology near Monroe, Michigan, used climatological data from Toledo Municipal.

The analysis of the precipitation data will be divided into the winter and spring seasons as has been done with the other weather elements. Tables XIX through XXIV present the precipitation data from the Enrico Fermi Plant site and the Toledo Express for the same period, and five years of data from Toledo Municipal for the same seasons (see also Figs. 8 and 9). These tables show, for 16 wind directions, the number of hours that measurable rain occurred, the hours of precipitation as a percentage of the total number of hours of precipitation, and also the hours of precipitation as a percentage of the total numbers of hours in the season.

TABLE XV

THE ASSOCIATION OF TEMPERATURE LAPSE RATES WITH WIND DIRECTION
AT THE ENRICO FERMI POWER PLANT SITE

1 December 1956 - 28 February 1957
(Winter)

Wind Direction	Hourly Lapse Rates			Compass Totals	Percent Frequency of Lapse Rates					
					Observations Within Categories			Total Observations		
	S	W	I		S	W	I	S	W	I
N	3	42	12	57	0.9	5.4	3.5	0.2	2.6	0.7
NNE	7	43	12	62	1.4	5.5	3.5	0.4	2.6	0.7
NE	19	65	9	93	3.7	8.3	2.6	1.2	4.0	0.5
ENE	19	22	15	56	3.7	2.8	4.4	1.2	1.3	0.9
E	16	14	18	48	3.1	1.8	5.2	1.0	0.9	1.1
ESE	21	21	19	61	4.1	2.7	5.5	1.3	1.3	1.2
SE	7	22	32	61	1.4	2.8	9.3	0.4	1.3	1.9
SSE	7	13	20	40	1.4	1.6	5.8	0.4	0.8	1.2
S	32	23	19	74	6.2	2.9	5.5	1.9	1.4	1.2
SSW	53	65	52	170	10.3	8.3	15.2	3.2	4.0	3.2
SW	82	49	49	180	15.9	6.2	14.3	5.0	3.0	3.0
WSW	120	108	29	257	23.2	13.7	8.4	7.3	6.6	1.8
W	47	69	23	139	9.1	8.8	6.7	2.9	4.2	1.4
WNW	41	86	11	138	7.9	11.0	3.2	2.5	5.2	0.7
NW	19	80	13	112	3.7	10.2	3.8	1.2	4.9	0.8
NNW	17	59	9	85	3.3	7.5	2.6	1.0	3.6	0.5
Calm	6	4	1	11	1.2	0.5	0.3	0.4	0.2	0.1
Totals	516	785	343	1644	100.5	100.0	99.8	31.5	47.9	20.9

Code: S = A lapse rate in excess of the dry adiabatic lapse rate.
W = A positive lapse rate that is less than the dry adiabatic lapse rate.
I = A temperature increase with height.

TABLE XVI

THE ASSOCIATION OF TEMPERATURE LAPSE RATES WITH WIND DIRECTION AT THE ENRICO FERMI POWER PLANT SITE

1 March 1957 - 31 May 1957
(Spring)

Wind Direction	Hourly Lapse Rates			Compass Totals	Percent Frequency of Lapse Rates					
					Observations Within Categories			Total Observations		
	S	W	I		S	W	I	S	W	I
N	44	3	7	54	3.0	1.5	1.9	2.2	0.1	0.3
NNE	105	4	14	123	7.1	2.0	3.8	5.1	0.2	0.7
NE	126	5	6	137	8.6	2.5	1.6	6.2	0.2	0.3
ENE	194	4	4	202	13.2	2.0	1.1	9.5	0.2	0.2
E	129	7	8	144	8.8	3.5	2.1	6.3	0.3	0.4
ESE	99	9	25	133	6.7	4.5	6.7	4.9	0.4	1.2
SE	50	7	43	100	3.4	3.5	11.5	2.4	0.3	2.1
SSE	40	11	63	114	2.7	5.6	16.9	2.0	0.5	3.1
S	24	16	58	98	1.6	8.1	15.5	1.2	0.8	2.8
SSW	51	13	47	111	3.5	6.6	12.6	2.5	0.6	2.3
SW	121	39	22	182	8.2	19.7	5.9	5.9	1.9	1.1
WSW	132	23	24	179	9.0	11.6	6.4	6.5	1.1	1.2
W	99	21	14	134	6.7	10.6	3.8	4.9	1.0	0.7
WNW	156	15	19	190	10.6	7.6	5.1	7.6	0.7	0.9
NW	74	12	7	93	5.0	6.1	1.9	3.6	0.6	0.3
NNW	25	9	11	45	1.7	4.5	2.9	1.2	0.4	0.5
Calm	0	0	1	1	0.0	0.0	0.3	0.0	0.0	0.0
Totals	1469	198	373	2040	99.8	99.9	100.0	72.0	9.3	18.1

Code: S = A lapse rate in excess of the dry adiabatic lapse rate.
W = A positive lapse rate that is less than the dry adiabatic lapse rate.
I = A temperature increase with height.

TABLE XVII

MEAN WIND SPEEDS ASSOCIATED WITH INVERSION AND NONINVERSIONS AT THE ENRICO FERMI POWER PLANT SITE

1 December 1956 - 28 February 1957
(Winter)

Wind Direction	Inversion		Noninversion	
	Occurrence, %	Mean Speed, mph	Occurrence, %	Mean Speed, mph
N	0.7	5.8	2.7	15.9
NNE	0.7	7.0	3.0	16.5
NE	0.5	10.9	5.1	16.5
ENE	0.9	12.8	2.5	12.0
E	1.1	11.8	1.8	12.1
ESE	1.2	11.8	2.6	11.6
SE	1.9	10.2	1.8	12.1
SSE	1.2	10.7	1.2	13.0
S	1.2	11.6	3.3	13.8
SSW	3.2	14.2	7.2	16.6
SW	3.0	15.8	8.0	14.8
WSW	1.8	14.1	13.9	13.5
W	1.4	11.2	7.1	13.4
WNW	0.7	9.1	7.7	13.0
NW	0.8	7.4	6.0	11.7
NNW	0.5	6.2	4.6	12.1
Calm	0.1		0.6	
Period Total	20.9		79.1	
Period Average		11.7		13.6

TABLE XVIII

MEAN WIND SPEEDS ASSOCIATED WITH INVERSION AND NONINVERSIONS
AT THE ENRICO FERMI POWER PLANT SITE

1 March 1957 - 31 May 1957
(Spring)

Wind Direction	Inversion		Noninversion	
	Occurrence, %	Mean Speed, mph	Occurrence, %	Mean Speed, mph
N	0.3	6.9	2.3	10.7
NNE	0.7	7.7	5.3	15.3
NE	0.3	8.0	6.4	16.3
ENE	0.2	9.0	9.7	16.7
E	0.4	11.5	6.7	13.7
ESE	1.2	16.0	5.3	13.8
SE	2.1	14.7	2.8	12.8
SSE	3.1	12.2	2.5	10.0
S	2.8	11.0	2.0	10.8
SSW	2.3	10.7	3.1	13.6
SW	1.1	12.4	7.8	15.2
WSW	1.2	9.0	7.6	17.1
W	0.7	10.0	5.9	13.1
WNW	0.9	10.9	8.4	15.5
NW	0.3	7.0	4.2	14.4
NNW	0.5	8.5	1.7	11.3
Calm				
Period Total	18.1		81.7	
Period Average		11.4		14.6

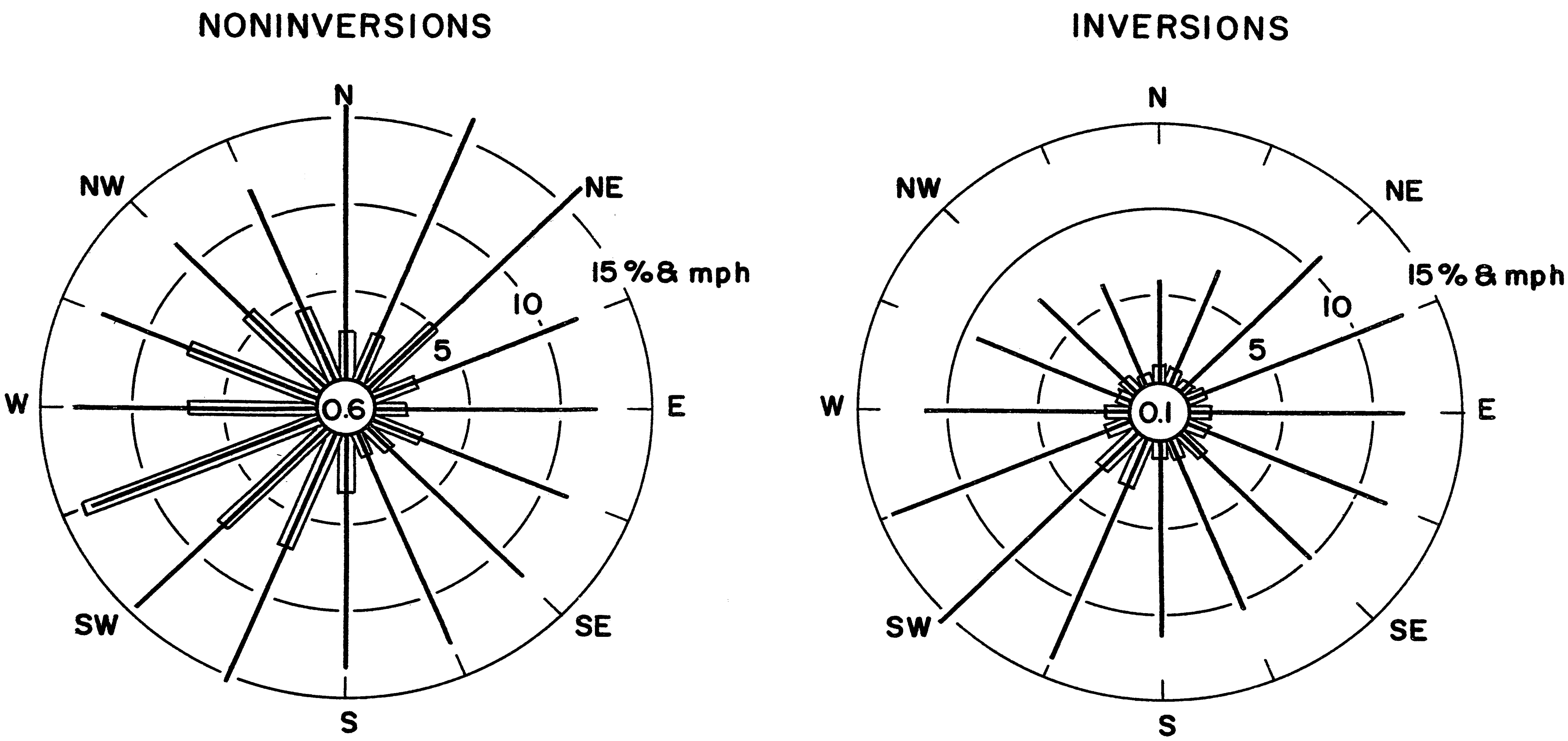


Fig. 6. Percentage frequency of occurrence of winds associated with inversions and noninversions from 16 directions (rectangles) and corresponding wind speeds in mph (heavy lines) at Enrico Fermi Power Plant site, Winter (December 1, 1956 - February 28, 1957). Percentage of calms in center.

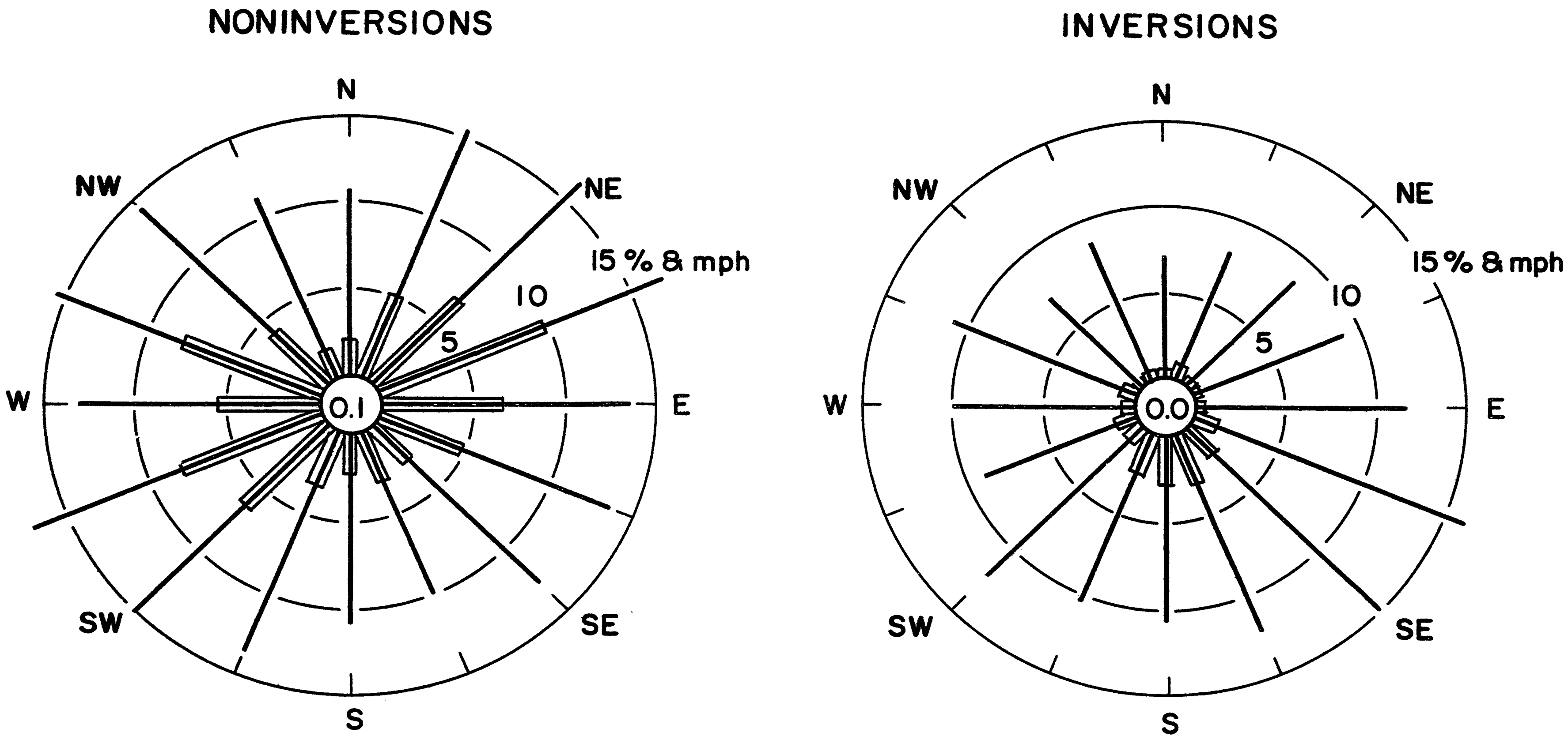


Fig. 7. Percentage frequency of occurrence of winds associated with inversions and noninversions from 16 directions (rectangles) and corresponding wind speeds in mph (heavy lines) at Enrico Fermi Power Plant site, Spring (March 1, 1957 - May 31, 1957). Percentage of calms in center.

TABLE XIX

THE ASSOCIATION OF PRECIPITATION WITH WIND
AT THE ENRICO FERMI POWER PLANT SITE

1 December 1956 - 28 February 1957
(Winter)

Wind Direction	Average Wind Speed, mph	Average Wind Speed During Precipitation, mph	No. of Observations During Precipitation	Hours of Precipitation as Percentage of	
				Total Hours of Precipitation	Total Hours
N	14.2	20.6	9	7.6	0.4
NNE	14.9	17.8	14	11.9	0.6
NE	16.0	22.4	17	14.4	0.8
ENE	12.2	9.1	8	6.8	0.4
E	12.0	7.1	7	5.9	0.3
ESE	11.7	10.8	4	3.4	0.2
SE	11.1	11.0	5	4.2	0.2
SSE	12.0	14.0	1	0.8	0.1
S	13.3	14.4	5	4.2	0.2
SSW	15.2	15.9	14	11.9	0.6
SW	15.0	8.0	3	2.5	0.1
WSW	13.5	11.1	15	12.7	0.7
W	13.1	6.8	6	5.1	0.3
WNW	12.7	7.3	3	2.5	0.1
NW	11.2	12.7	3	2.5	0.1
NNW	11.6	18.5	4	3.4	0.2
Calm	0.0	0.0	0	0.0	0.0
Totals	13.3	14.5	118	100.0	5.3

TABLE XX

THE ASSOCIATION OF PRECIPITATION WITH WIND AT THE TOLEDO EXPRESS AIRPORT

1 December 1956 - 28 February 1957 (Winter)

Wind Direction	Average Wind Speed, mph	Average Wind Speed During Precipitation, mph	No. of Observations During Precipitation	Hours of Precipitation as Percentage of	
				Total Hours of Precipitation	Total Hours
N	10.0	13.3	22	12.5	1.0
NNE	11.0	12.2	20	11.4	0.9
NE	10.0	13.1	14	8.0	0.6
ENE	9.0	11.0	9	5.1	0.4
E	9.1	7.6	8	4.5	0.4
ESE	7.5	4.8	3	1.7	0.1
SE	6.0	5.7	3	1.7	0.1
SSE	7.4	6.2	5	2.8	0.2
S	10.0	11.3	11	6.3	0.5
SSW	12.6	12.8	21	11.9	1.0
SW	12.9	12.4	18	10.2	0.8
WSW	11.9	9.7	16	9.1	0.7
W	10.8	9.2	5	2.8	0.2
WNW	10.4	8.5	8	4.5	0.4
NW	9.9	6.8	6	3.4	0.3
NNW	9.5	10.5	5	2.8	0.2
Calm	0.0	0.0	2	1.1	0.1
Totals	10.4	9.7	176	100.0	7.9

TABLE XXI

THE ASSOCIATION OF PRECIPITATION WITH WIND AT THE TOLEDO MUNICIPAL AIRPORT

1 January 1950 - 31 December 1954
(Winter Season)

Wind Direction	Average Wind Speed, mph	No. of Observations During Precipitation	Hours of Precipitation as Percentage of	
			Total Hours of Precipitation	Total Hours
N	12.1	78	7.1	0.7
NNE	15.9	81	7.4	0.7
NE	13.6	75	6.8	0.7
ENE	16.7	136	12.4	1.3
E	12.0	73	6.7	0.7
ESE	11.9	46	4.2	0.4
SE	11.1	57	5.2	0.5
SSE	13.9	60	5.5	0.6
S	14.6	116	10.6	1.1
SSW	15.2	114	10.4	1.1
SW	16.9	77	7.0	0.7
WSW	15.7	47	4.3	0.4
W	12.4	26	2.4	0.2
WNW	14.5	32	2.9	0.3
NW	14.3	47	4.3	0.4
NNW	13.5	29	2.6	0.3
Calm	0.0	2	0.2	0.0
Totals	14.3	1096	100.0	10.1

TABLE XXII

THE ASSOCIATION OF PRECIPITATION WITH WIND
AT THE ENRICO FERMI POWER PLANT SITE

1 March 1957 - 31 May 1957
(Spring)

Wind Direction	Average Wind Speed, mph	Average Wind Speed During Precipitation, mph	No. of Observations During Precipitation	Hours of Precipitation as Percentage of	
				Total Hours of Precipitation	Total Hours
N	10.2	5.3	3	1.6	0.1
NNE	14.4	14.3	9	4.7	0.4
NE	15.9	15.3	9	4.7	0.4
ENE	16.5	18.9	36	18.7	1.6
E	13.6	25.5	38	19.7	1.7
ESE	14.2	15.7	8	4.1	0.4
SE	13.6	17.1	20	10.4	0.9
SSE	11.1	13.5	12	6.2	0.5
S	10.9	9.7	6	3.1	0.3
SSW	12.4	12.4	8	4.1	0.4
SW	14.7	14.5	10	5.2	0.5
WSW	16.1	14.8	9	4.7	0.4
W	12.8	15.5	2	1.0	0.1
WNW	15.0	17.2	20	10.4	0.9
NW	13.9	12.0	3	1.6	0.1
NNW	10.6	0.0	0	0.0	0.0
Calm	0.0	0.0	0	0.0	0.0
Totals	14.0	17.7	193	100.0	8.7

TABLE XXIII

THE ASSOCIATION OF PRECIPITATION WITH WIND
AT THE TOLEDO EXPRESS AIRPORT

1 March 1957 - 31 May 1957
(Spring)

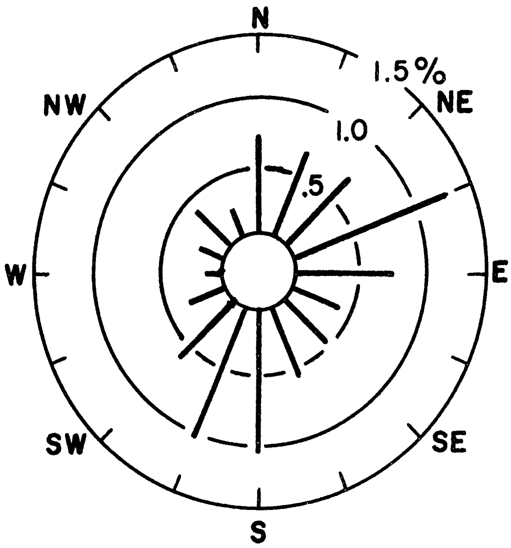
Wind Direction	Average Wind Speed, mph	Average Wind Speed During Precipitation, mph	No. of Observations During Precipitation	Hours of Precipitation as Percentage of Total Hours of Precipitation	Hours of Precipitation as Percentage of Total Hours
N	9.9	12.0	1	0.5	0.1
NNE	11.2	9.0	16	7.9	0.7
NE	10.0	9.5	16	7.9	0.7
ENE	12.2	11.4	30	14.9	1.4
E	12.5	14.2	54	26.7	2.4
ESE	8.6	8.6	6	3.0	0.3
SE	9.0	9.3	4	2.0	0.2
SSE	11.5	12.4	14	6.9	0.6
S	10.9	10.1	14	6.9	0.6
SSW	12.9	14.3	12	5.9	0.5
SW	15.4	12.3	10	5.0	0.5
WSW	16.3	11.5	4	2.0	0.2
W	11.9	10.0	3	1.5	0.1
WNW	11.4	10.6	10	5.0	0.5
NW	11.0	11.5	8	4.0	0.4
NNW	9.7				
Calm					
Totals	12.1	13.1	202	100.0	9.2

TABLE XXIV

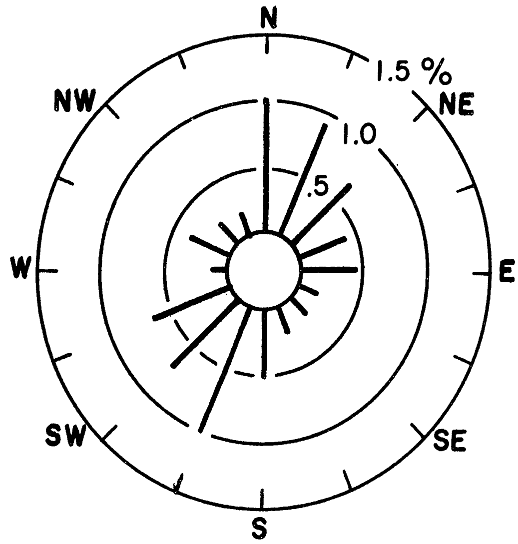
THE ASSOCIATION OF PRECIPITATION WITH WIND
AT THE TOLEDO MUNICIPAL AIRPORT

1 January 1950 - 31 December 1954
(Spring Season)

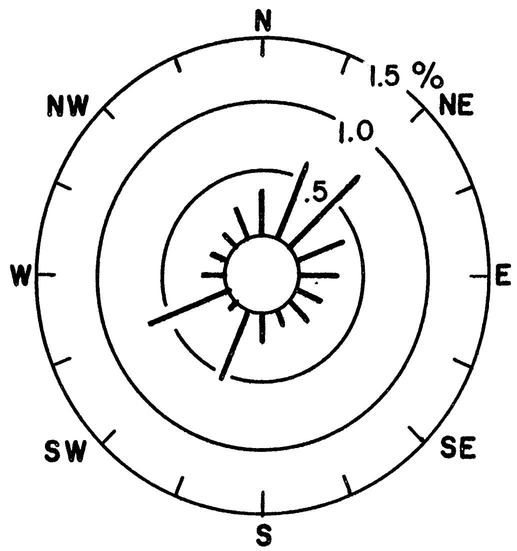
Wind Direction	Average Wind Speed, mph	No. of Observations During Precipitation	Hours of Precipitation as Percentage of	
			Total Hours of Precipitation	Total Hours
N	13.3	26	2.7	0.2
NNE	14.0	34	3.5	0.3
NE	13.9	69	7.1	0.6
ENE	16.3	193	19.8	1.7
E	13.4	98	10.1	0.9
ESE	14.5	44	4.5	0.4
SE	11.6	40	4.1	0.4
SSE	14.0	49	5.0	0.4
S	14.6	49	5.0	0.4
SSW	15.4	73	7.5	0.7
SW	14.8	84	8.6	0.8
WSW	16.4	46	4.7	0.4
W	14.3	45	4.6	0.4
WNW	15.5	57	5.9	0.5
NW	16.6	40	4.1	0.4
NNW	11.5	23	2.4	0.2
Calm	0.0	4	0.4	0.0
Totals	14.7	974	100.0	8.8



TOLEDO MUNICIPAL AIRPORT
DEC., JAN., FEB., 1950-1954



TOLEDO EXPRESS AIRPORT
1 DEC. 1956 – 28 FEB. 1957



ENRICO FERMI POWER PLANT
1 DEC. 1956 – 28 FEB. 1957

Fig. 8. Percentage of total winds associated with precipitation from each direction at Enrico Fermi Power Plant site, Toledo Express Airport, and Toledo Municipal Airport, Winter.

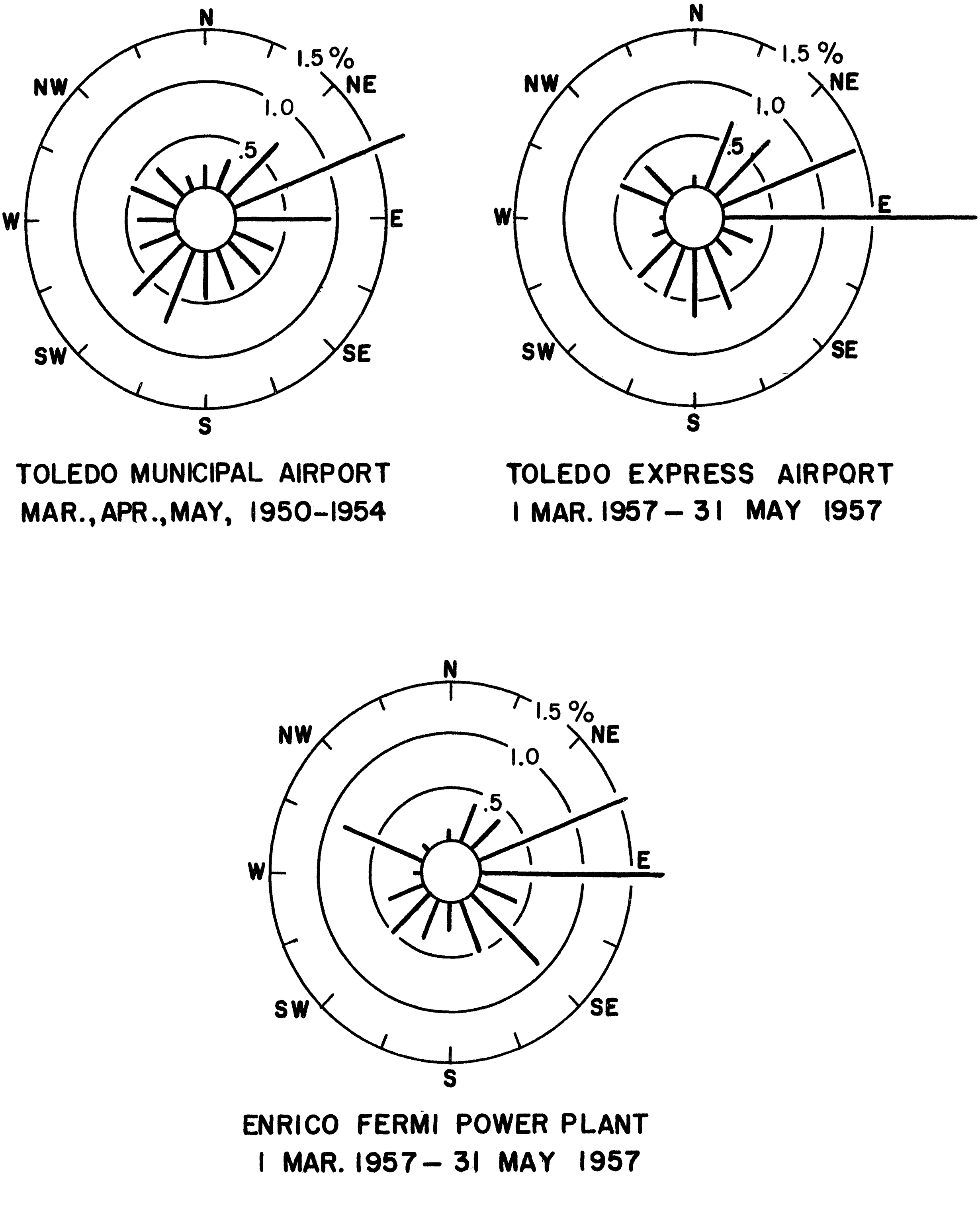


Fig. 9. Percentage of total winds associated with precipitation from each direction at Enrico Fermi Power Plant site, Toledo Express Airport, and Toledo Municipal Airport, Spring.

1. WINTER SEASON

A grouping of wind direction will be used as in previous sections. The winds from the E, ESE, SE, SSE, and S and from the W, WNW, NW, NNW, N, and NNE travel 15-20 miles from the Enrico Fermi Plant site before reaching any population center. Over a 15- to 20-mile trajectory the scavenging action of precipitation removes a substantial proportion of suspended particulate matter.* These two groups of wind directions and precipitation occurred 2.7% of the time during the winter season at the Enrico Fermi Plant site, 3.1% at Toledo Express and 5.9% at Toledo Municipal for the 5-year period. The Enrico Fermi Plant site and Toledo Express figures are less than those of the Toledo Municipal because this winter was a relatively dry one; rainfall was 0.98 in. less than the normal over the three-month period. This suggests that precipitation combined with these winds would usually be more frequent than this year.

ENE - Monroe.—ENE winds blow from the plant site, a distance of 8 miles to Monroe. Rainfall removes a significant amount of suspended particulate matter in an 8-mile trajectory. ENE winds together with rain occurred 0.4% of the time this past winter at the plant site, and 0.6% at Toledo Express in comparison with 1.3% at Toledo Municipal for the 5-year period.

SSW - Detroit River communities.—The plant site is SSW of the Detroit River communities from 10-30 miles distance. Precipitation and SSW winds occurred 0.6% of the time at the Enrico Fermi Plant site, 1.0% at Toledo Express, and 1.1% at Toledo Municipal for the 5-year period.

Ontario shores.—The near shore of Ontario extends from a point 10 miles NE of the plant site to a point 18 miles ENE of the plant site. Winds from the SW to WSW travel from the plant site to this shore. Precipitation and SW or WSW winds occurred 0.8% of the time at the Enrico Fermi Plant site during the winter season, and 1.5% at Toledo Express in comparison with 1.1% at Toledo Municipal for the 5-year period.

2. SPRING SEASON

The spring season of 1957 was also relatively dry; March precipitation was 1.75 in. below normal, April, 0.99 in. above normal, and May, 0.76 in. below normal for a total spring deficit of 1.52 in. The same method of wind groupings will be used as previously.

The winds from E through SE to S and W through NW to NNE together with rain occurred 3.8% of the time at the Enrico Fermi Plant site, and 4.1% at Toledo Express in comparison with 2.5% at Toledo Municipal for the 5-year period.

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*For a more detailed and theoretical account of the scavenging effect of rainfall, see Greenfield, S. M., "Rain Scavenging of Radioactive Particulate Matter from the Atmosphere," J. Meteorology, 14, 115-125 (1957), in particular Fig. 1.

ENE - Monroe.—The combination of precipitation and ENE winds occurred 1.6% of the time at the plant site, 1.4% at Toledo Express and 1.7% at Toledo Municipal for the 5-year period.

NE - Beaches.—Towards the end of spring, the beaches become a population center. During NE winds they are downwind from the plant site. In the spring of 1957, NE winds together with rain occurred 0.4% of the time at the Enrico Fermi Plant site, and 0.7% at Toledo Express, compared with 0.6% at Toledo Municipal in the 5-year period.

SSW - Detroit River communities.—At the Enrico Fermi Plant site the combination of precipitation and SSW winds occurred 0.4% of the time, 0.5% at Toledo Express, and 0.7% at Toledo Municipal for the 5-year period.

SW and WSW - Ontario shores.—The combination of these winds and precipitation occurred 0.9% at the Enrico Fermi Plant site, and 0.7% at Toledo Express in comparison with 1.2% at Toledo Municipal for the 5-year period.

CONCLUSIONS

Twofold evidence of the special lake influences on the Enrico Fermi Plant site has come to light in the analysis to date. First it has been shown that winds become relatively stronger over the lake in winter and spring. This is a favorable influence on diffusion. Secondly it has been shown that surface temperature inversions lasting longer than a day are not unusual at the plant site, whereas such lengthy inversions are not observed at all at Detroit. This is an unfavorable influence upon diffusion. The diffusion studies over the lake, planned for the summer of 1958, will help reveal the implications of these prolonged inversions.

The special influences noted above must be identified with winter and spring, and since they are for a single year, they are not necessarily typical of these seasons. Similar analyses must be performed on summer and fall data to determine the special influences for these seasons, while data for subsequent years will reveal whether the findings for the first winter and spring are typical.