TECHNICAL

REPORT

A METEOROLOGICAL EVALUATION OF THE COMBINED WIND AND ICE LOADINGS FOR A PORTION OF THE GULL ISLAND TRANSMISSION LINE

MRI 74 R-1255

Submitted to

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Contract No. 133-14110-1

Date September 20, 1974

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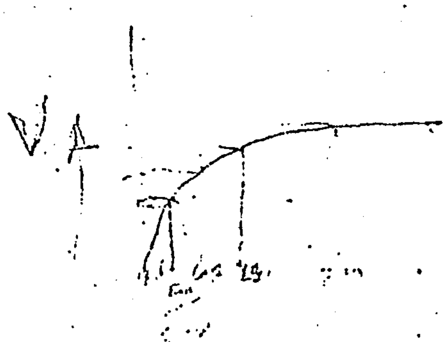
SUMMARY

A meteorological study was conducted to determine the extreme values of transverse ice and wind loading likely to be experienced along the proposed transmission line route between Holyrood and the northern Humber Valley. Analysis of data was in three phases: Completion of transverse ice and wind loadings for 10-, 25-, 50-, and 75-year return periods at six stations in Newfoundland; extrapolation of these values to the proposed route; and comparison of the results with computations based on values obtained in the November 1973 report. Also looked at were loadings in conjunction with wet snow on the conductors.

Highest transverse wind loads generally occurred with rime ice. Maximum transverse loads are expected to reach 4.9 lbs/linear ft in a 25-year return period near the isthmus. This is much less than the 9.35 lbs/linear ft estimated in the previous report by assuming independence of individual maximum wind and ice loadings. If it is assumed that wind gusts are 50 percent greater than the hourly wind values, then the maximum load becomes 11.0 lbs/linear ft.

Wet snow will occur occassionally, but the associated loadings (a maximum of 2.9 lbs/linear ft at Gander) are not great enough to be the limiting design values.

Combined wind and ice loads were computed using the winds and ice as independent variables, but using only winds which had occurred during or immediately following icing storms. These combined loads based on hourly winds were significantly lower than those derived in the November 1973 report. Combined loads based on gust-condition ice-storm wind speeds were found to be quite similar to the values in the 1973 report which were based on annual maximum hourly wind speeds.



I. INTRODUCTION

Teshmont Consultants Ltd., is in the process of designing a transmission line for the Newfoundland and Labrador Power Commission. The proposed line will extend from the Gull Island Hydro Site southwest of Goose Bay, Labrador to near Holyrood on the Avalon Peninsula of Newfoundland. This proposed route traverses some of the most severe wind and icing areas known to exist in North America. In recognition of the need for quantitative meteorological information on which to base the design, Meteorology Research, Inc., (MRI) was commissioned to conduct a meteorological study of the proposed routes. This study was completed in November 1973. Combined wind and ice loadings were expressed as wind speeds in miles per hour with glaze and rime ice in radial inches and pounds of ice per foot of conductor. These values were derived by treating the maximum ice loads and maximum winds as independent variables and using the same probabilities for each to develop combined probabilities. It was suggested in the 11 June 1974 meeting with representatives of the Natural Energy Board and of Energy, Mines, and Resources that the winds and ice are not always independent variables and that using equal probabilities for each might not always result in the maximum load.

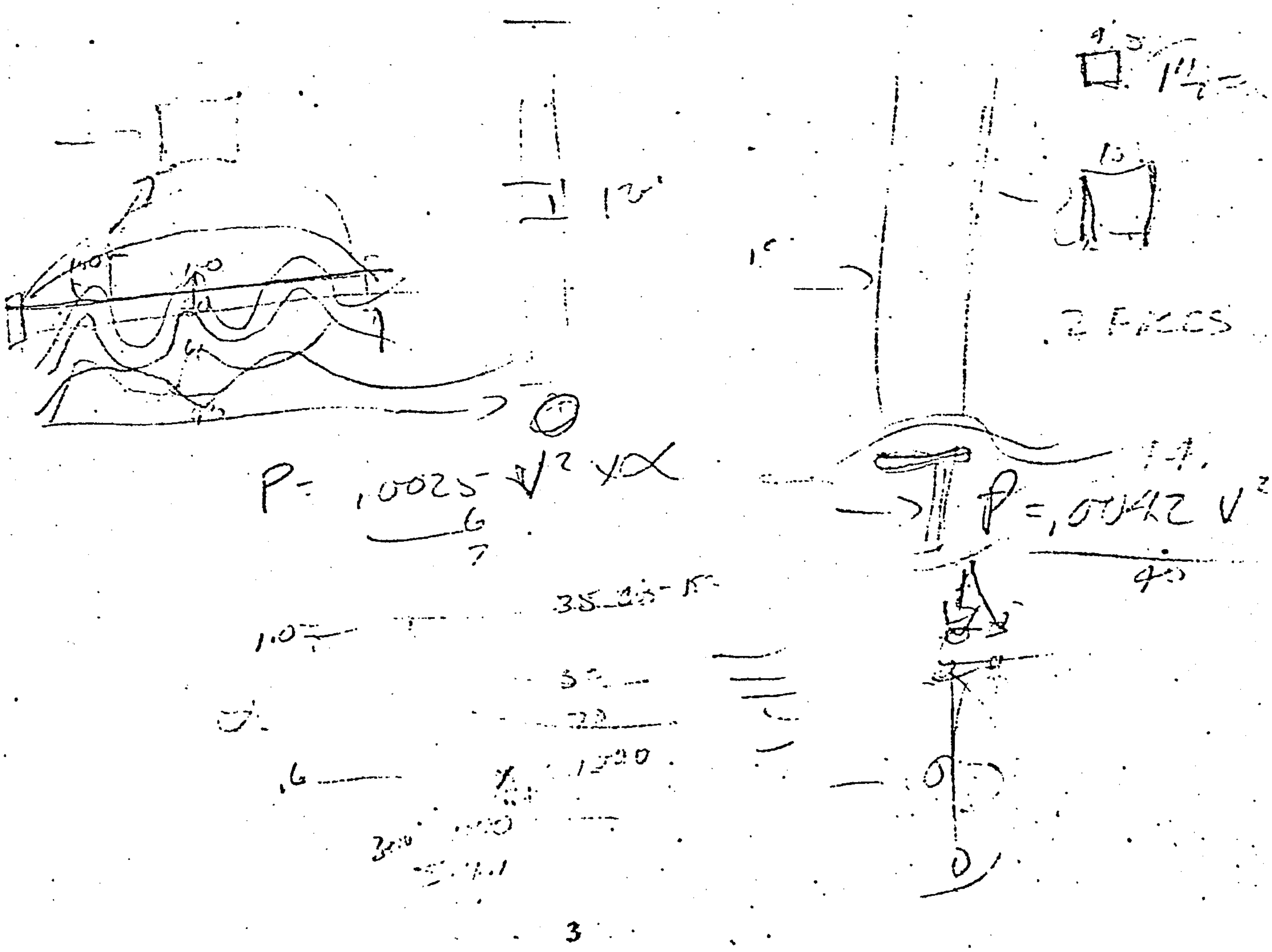
A study was conducted to review the individual storm data for several Newfoundland stations, to determine at what point during the storm the maximum transverse wind load would have occurred and what that value was, and to develop return period values for the maximum combined loadings expressed in terms of transverse wind load on the iced conductor. This method of approach has the advantage of being based directly on actual storm data and avoiding the debatable use of combined probabilities.

This report presents the results of that study. The scope of the study is presented in Section II. Data sources are described in Section III. The method of handling wind data is discussed in Section IV. Combined wind and ice loadings at individual stations are analyzed in Section V, and the results are extrapolated to the proposed route and compared with values obtained from the November 1973 report in Section VI. Section VII deals with treating individual wind and ice loads as independent variables, where only those winds occurring during ice storms were considered. Finally, conclusions are summarized in Section VIII.

II. SCOPE OF STUDY

This transmission line study consisted of analysis of actual storm data to determine potential transverse wind loads on ice covered transmission lines proposed for eastern and central Newfoundland. The maximum transverse wind load on ice covered conductors which would have occurred during or immediately following each of the glaze or rime producing storms identified in the climatological records were computed for stations near the planned route east of the Humber Valley. The maximum transverse wind loading for each year of record for each station was identified and return period probabilities developed. These values were then extrapolated to the route segments used in the November 1973 study for comparison with the values derived by the joint probability method. Combined wind and ice loadings similar to those presented in the November 1973 report, but based only on wind speeds recorded during icing storms, were also derived and extrapolated to the route segments.

This portion of the route was selected for the study because the available station data are more representative of the route than the sections north and west of the Humber Valley.



III. DATA SOURCES

The basic data available for study of the proposed transmission line route came from long-term records at a number of locations in the area. Observations of wind speed and direction, temperature, precipitation, and cloud conditions are reported by these stations to the Atmospheric Environment Service (AES). These data form the basis of the route study but are not normally available in the form required for this type analysis. In previous projects, the AES has developed for us special computer programs to condense the long periods of data into more usable forms for this analysis. These were used once again in this project.

Listings of hourly observations during periods of potential accumulations of glaze ice, rime ice, or wet snow were generated by the AES. The criteria used to generate these listings include:

- Rime icing: Cloud ceiling 1000 ft or less and ambient temperature 25 to 38°F. (Only ceilings at or below line level were considered in the actual analysis.)

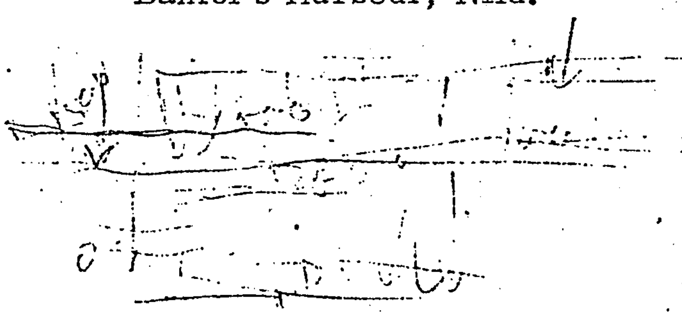
- Glaze icing: Precipitation at or below 35°F. (Only periods of freezing rain were considered in the actual analysis.)

- Wet snow: Temperature greater than 28°F with moderate or heavy snow lasting at least six hours.

In all cases, these listings were continued for six hours following the last hour that met these criteria.

The six stations for which data were analyzed and their length of record included:

St. John's-Torbay, Nfld.	1953-1971
Argentia, Nfld.	1953-1969
Gander, Nfld.	1953-1971
Buchans, Nfld.	1953-1964
Deer Lake, Nfld.	1966-1971
Daniel's Harbour, Nfld.	1966-1971



IV. WIND DATA

When used for maximum wind speeds, "hourly-wind" values are usually conservative. The hourly-wind recorded in the hourly weather observation consists of a one-minute average wind speed observed during the 10 minutes prior to the hour. Thus, if the actual maximum one-minute average does not occur in that ten minutes, it is not recorded. Wind gust records are normally available only for locations with full scale weather facilities.

In order to account for these gust values, a gust factor was employed, equal to G/V, where G is the maximum gust speed and V is the maximum sustained wind speed. Many studies have been made to determine this gust factor, which usually decreases with increasing wind speed. Sissenwine et al. (1973) calculated gust factors that ranged from about 1.3 for a one-minute steady wind speed of 20 knots down to 1.2 at 70 knots. Boyd (1970) developed a formula used by the AES to calculate speeds of wind gusts where

$$G = 5.8 + 1.29\ V$$

This formula results in gust factors ranging from 1.58 at 20 knots to 1.37 at 70 knots. For this study a constant gust factor of 1.5 was used, which would correspond to a steady wind speed according to Boyd's formula of 24 knots. This was found to be typical of those wind speeds associated with the highest transverse wind loads on the ice-coated transmission lines.

Should 1.43 JK

40 su = 34.5 knots G = 5.8 + 1.29 × 34.5 = 5.8 + 44.5 = 50.3
G/SU Ratio = 1.46.

47 su mph = 40.5 knots G = 5.8 + 1.29 × 40.5 = 5.8 + 52.2 = 58.0

G/SU ratio = 1.43

24 knots = G = 5.8 + 1.29 × 24 = 5.8 + 31.0 = 36.8 knots

G/SU Ratio = 1.53

V. COMBINED WINDS AND ICING

Of extreme importance to the design engineer is the maximum effect on towers and conductors resulting from the combined loadings of the weight of the ice plus the pressure of the wind on the increased surface area. The determination of this combined effect is complicated in any specific case by several factors. The accretion rate of both glaze and rime ice is a function of wind speed; the faster the wind, the more rapidly ice will build up. To determine the maximum combination, it is necessary to know when during the storm the strongest wind occurred and how much ice had accumulated at that time. If the strongest wind occurred early in the storm, the greatest combined effect may have occurred later with a lesser wind speed and a greater surface area and weight of ice. Superimposed on this is the effect of wind direction both on accretion rate and transverse and longitudinal wind loadings. Going beyond this, we have the problem of how long the ice can be expected to stay on the conductors. The longer the ice stays on, the greater the vulnerability to high winds not associated with the storm which caused the ice.

In the original study a review of both the glaze and rime producing storm periods at the reporting stations revealed no pattern to the time within the storm period that the maximum wind occurred. The peak wind time appeared to have occurred randomly throughout the icing period and up to at least six hours subsequent to the termination of icing conditions. As was discussed in that report, how long the ice will stay on the conductors will vary with each storm. In some cases, the temperature rises immediately and the melting and cracking process starts. At the other extreme, a prolonged cold period may result in the ice remaining for several days or in some locations perhaps weeks.

Developing return period probabilities for maximum combined wind and ice loadings is a necessary but controversial area of effort. Several methods of arriving at these combined loading probabilities have been proposed and used by various people with no method being completely accepted as valid by all concerned. In this report, we have computed the maximum transverse wind load on the ice covered conductors which would have occurred during or immediately following each of the glaze and rime producing storms identified. The maximum transverse wind loading for each year was identified for the entire period of record for each station and return period probabilities developed as had been done for maximum wind speeds, glaze icing, and rime icing in the November 1973 study. The maximum combined wind and wet snow loadings that might have occurred over the entire period of record for each station were also computed. Loadings were computed for winds being perpendicular to the conductors. Computations were based on the relationship of $W_H = (0.0025\ V^2)D/12$ where W_H is the transverse wind load in pounds per linear foot, V is wind speed in miles per hour, and D is the total diameter of conductor and ice in inches.

This method has the advantage of being based on actual combined loads rather than joint probabilities of yearly maximum winds and icing loads occurring simultaneously. All computations were based on the winds being perpendicular to a 2.0-inch diameter conductor.

A. Combined Wind and Glaze Ice Loadings

Figures 1 through 6 show the return period plots of transverse wind loads of glaze-covered transmission lines for the six stations based on hourly wind speeds. Figures 7 through 12 are the corresponding plots computed using wind gusts calculated with the 1.5 gust factor. The extracted values for 10-, 25-, 50-, and 75-year return periods are listed in Table I.

On the return period plots for Buchans (Figs. 4 and 10), the 2.81 lbs/lin ft value based on hourly winds and the 6.32 lbs/lin ft value based on gust speeds (denoted by x's on the plots) are from a March 24, 1962 storm. The solid lines are drawn for all twelve plotted values. If we eliminate those extreme values and plot the next highest values for that year (1.41 and 3.17 lbs/lin ft, on February 12) the dashed lines result and the March values become 1000-year storms. (Use of these graphs beyond 100 years is debatable.) In Table I the values in parentheses are from the dashed curves.

B. Combined Wind and Rime Ice Loadings

Maximum transverse wind loads for transmission lines coated with rime were computed at specific elevations above the stations that are representative of the proposed route. Figures 13 through 17 show the return period plots using hourly winds for 300 ft above St. John's-Torbay, 300 ft above Gander, 300 and 800 ft above Buchans, and 1000 ft above Daniel's Harbour. Figures 18 through 22 show return period plots using the 1.5 gust factor. The extracted 10-, 25-, 50-, and 75-year return period values are listed in Table II.

C. Combined Wind and Wet Snow Loadings

Table III lists the maximum wind and wet snow loading at each of the six stations. Wet snow is not expected to be a major problem in Newfoundland. Although several of the values in Table III appear high, there were only 20 occurrences of wet snow storms lasting at least six hours among all six stations, eleven of which occurred at Argentia.

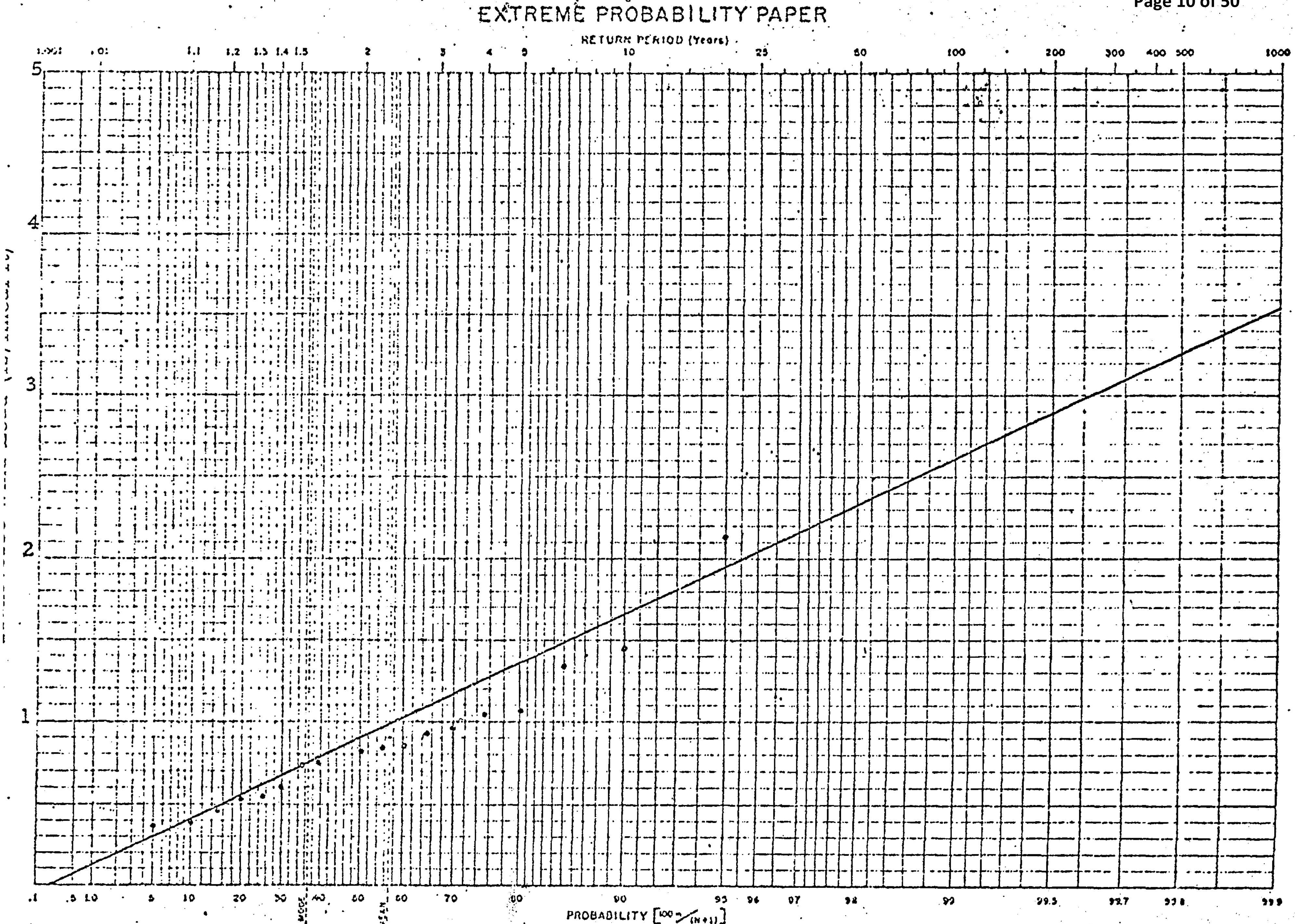


Fig. 1. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT TORBAY, NFLD BASED ON HOURLY WIND DATA

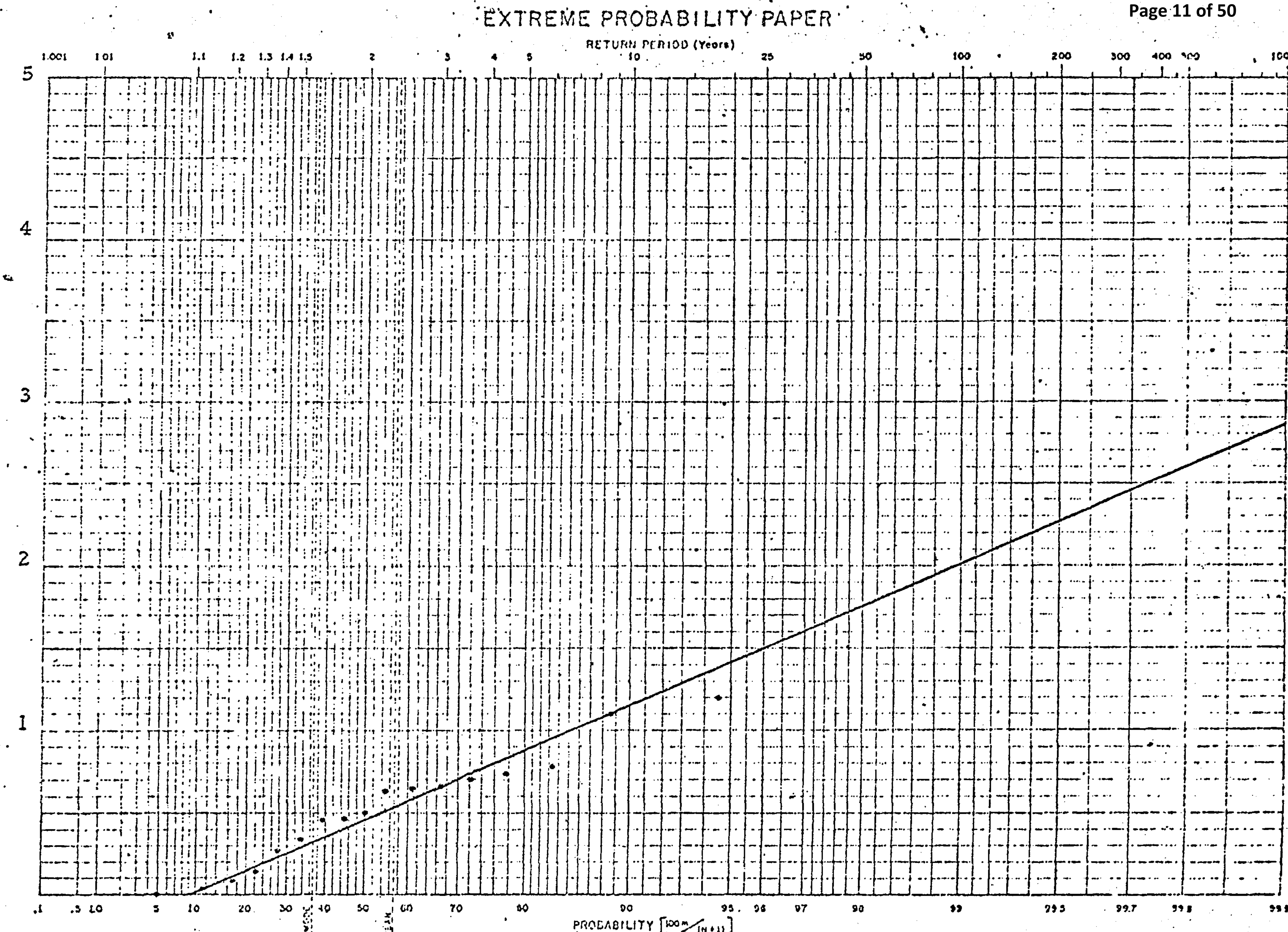


Fig. 2. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L LINE AT ARGENTIA, NFLD BASED ON HOURLY WIND DATA.

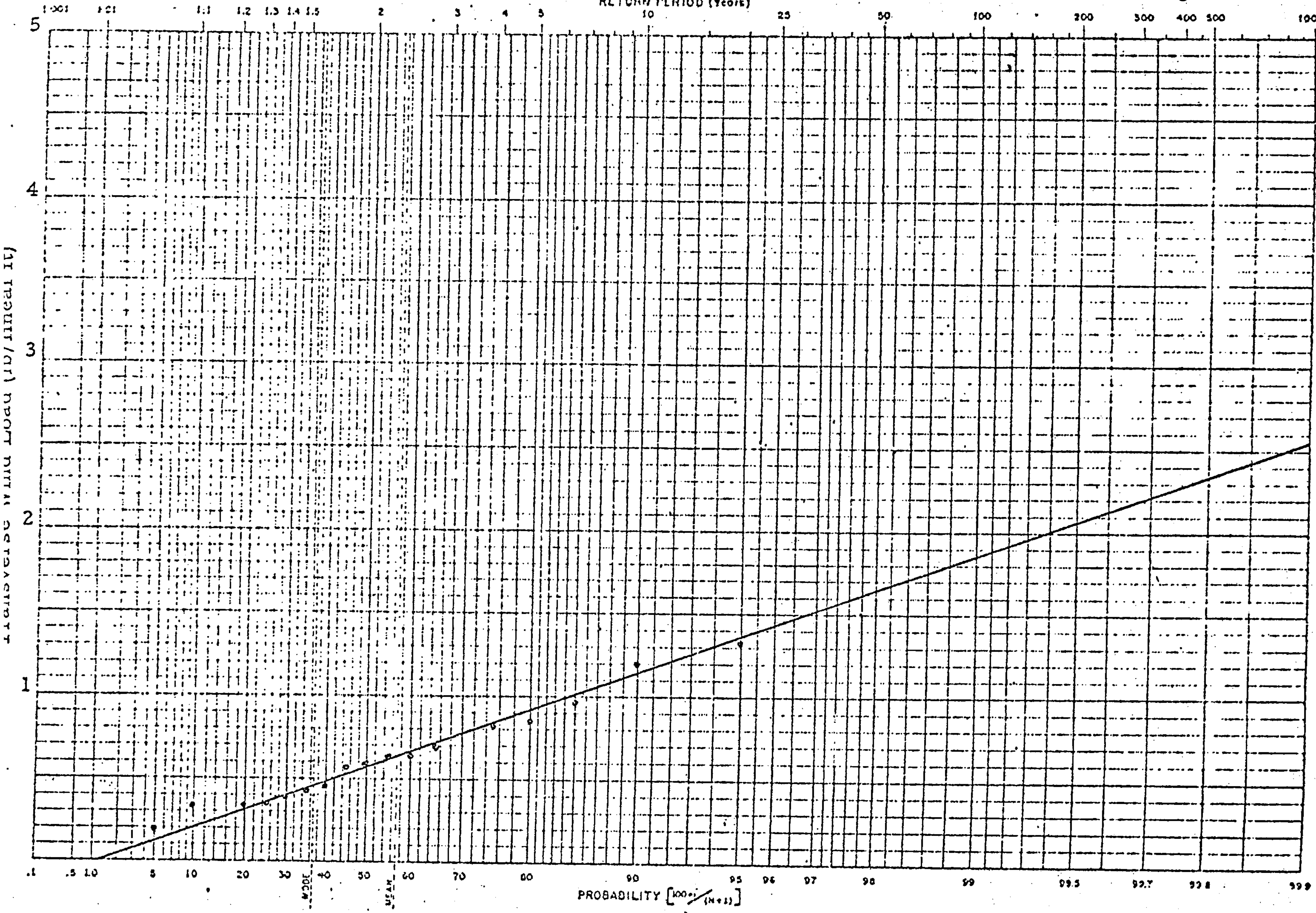


Fig. 3. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT GANDER, NFLD BASED ON HOURLY WIND DATA

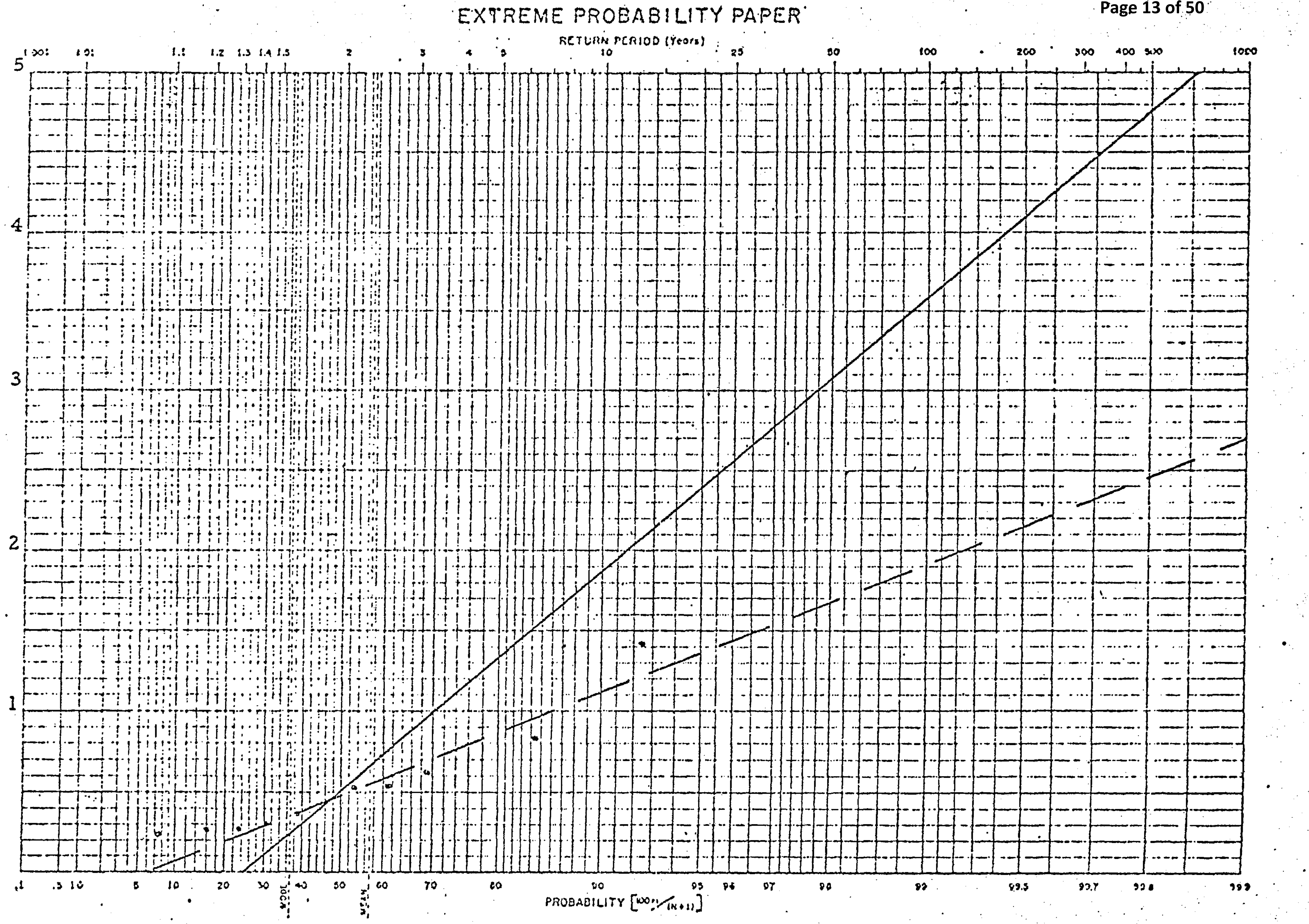


Fig. 4. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT BUCHANS, NFLD BASED ON HOURLY WIND DATA

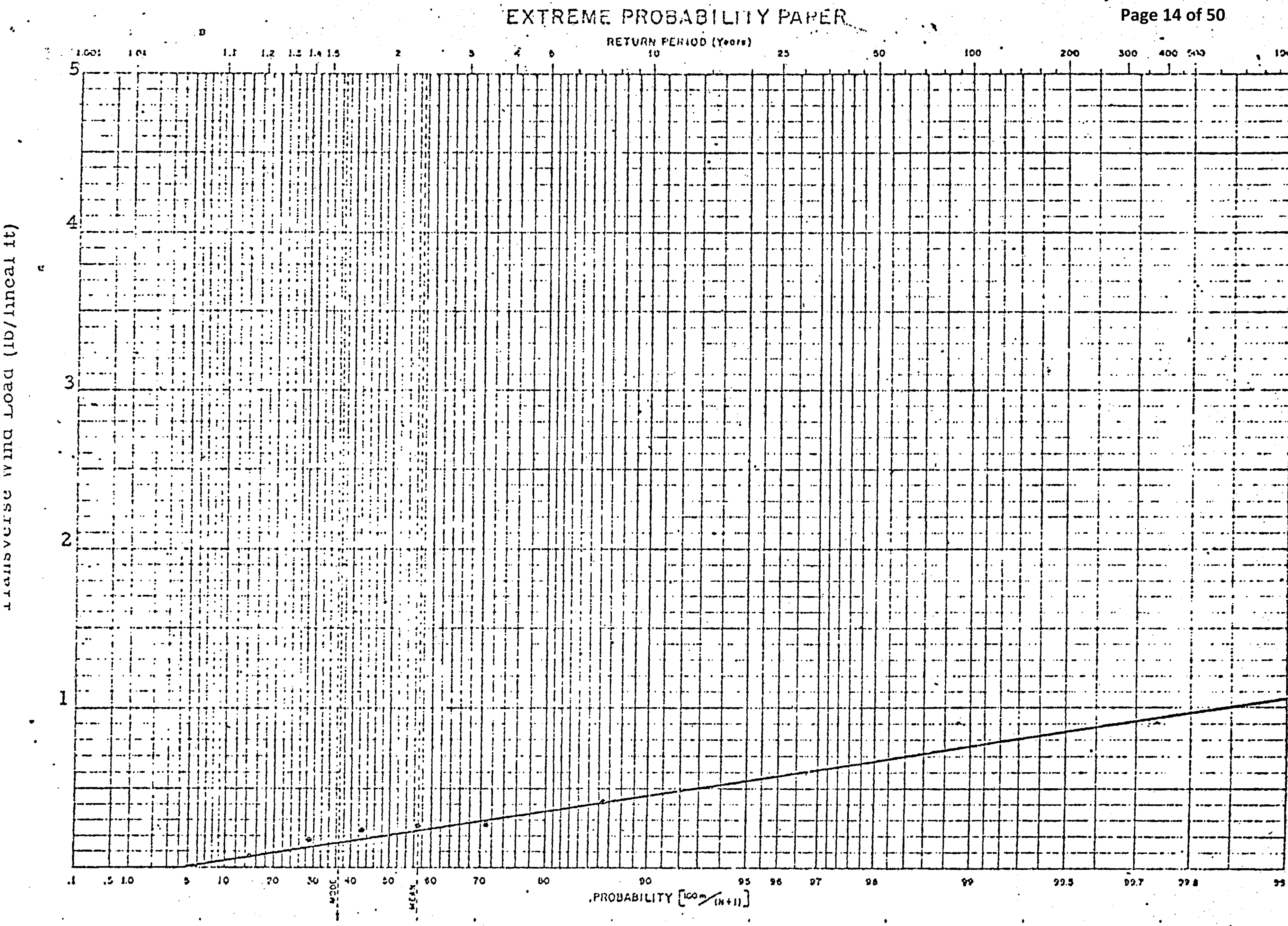


Fig. 5. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L FOR DEER LAKE, NFLD BASED ON HOURLY WIND DATA

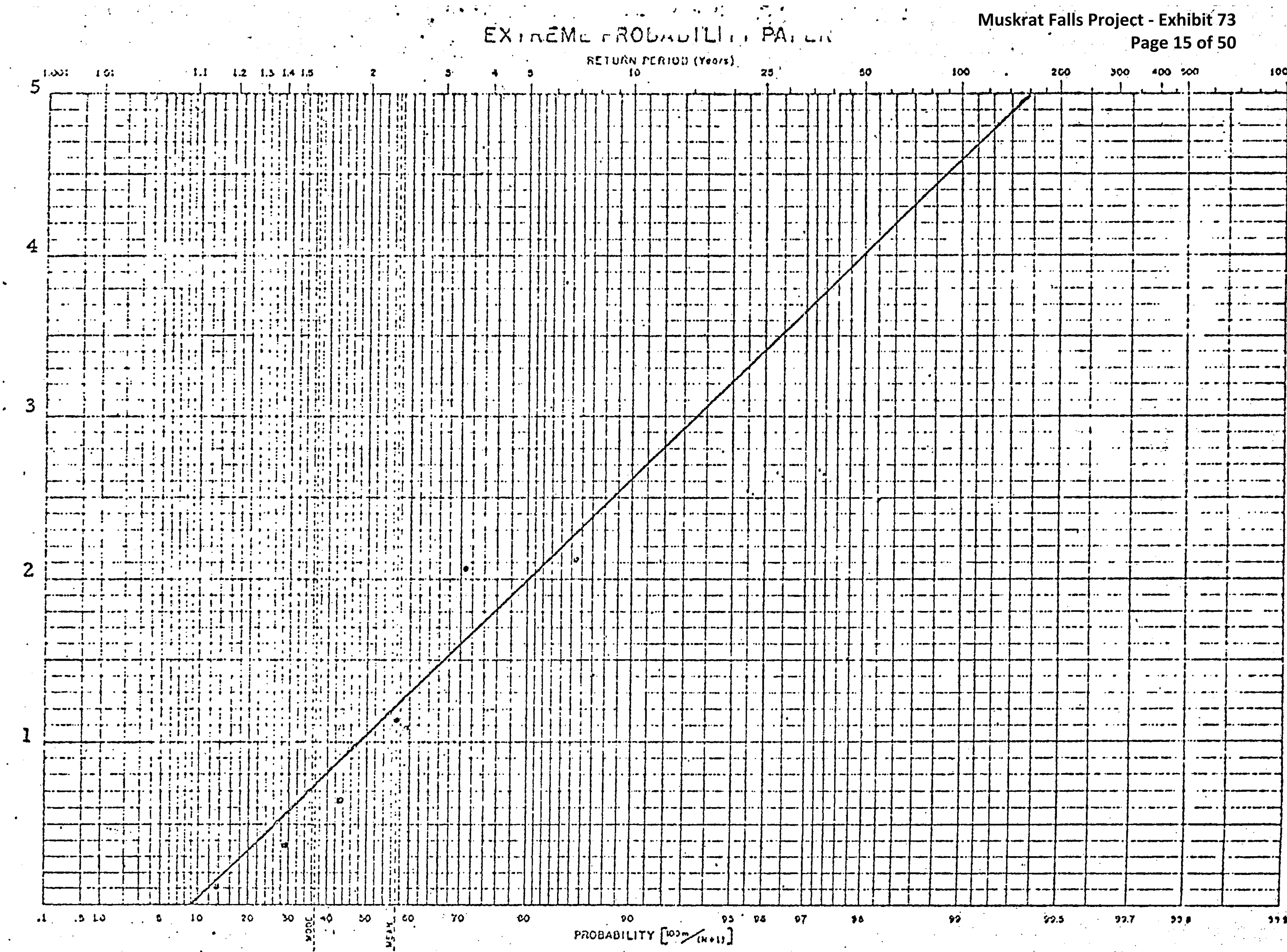


Fig. 6. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT DANIEL'S HARBOUR, NFLD BASED ON HOURLY WIND DATA

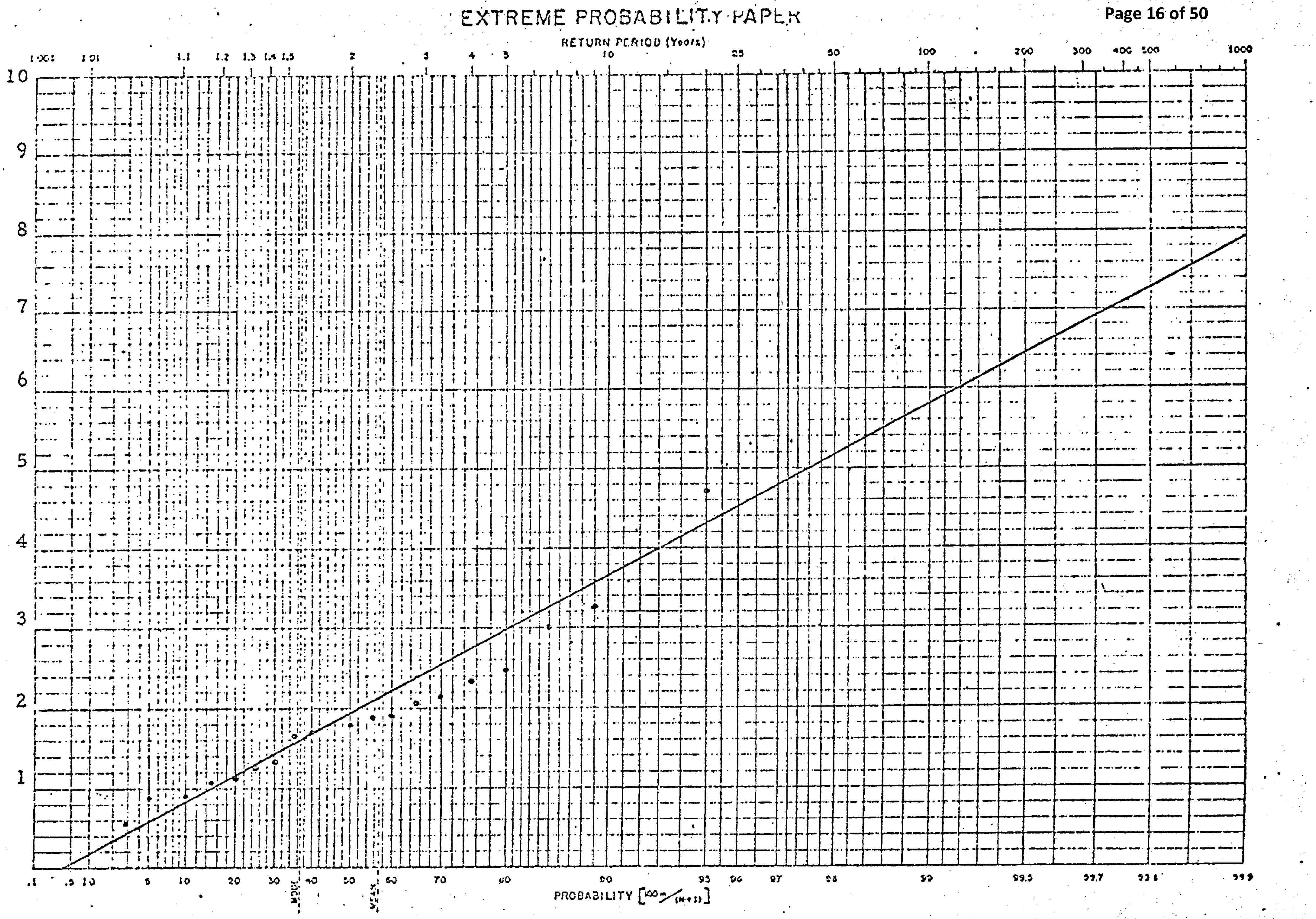


Fig. 7. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT TORBAY, NFLD BASED ON WIND GUSTS

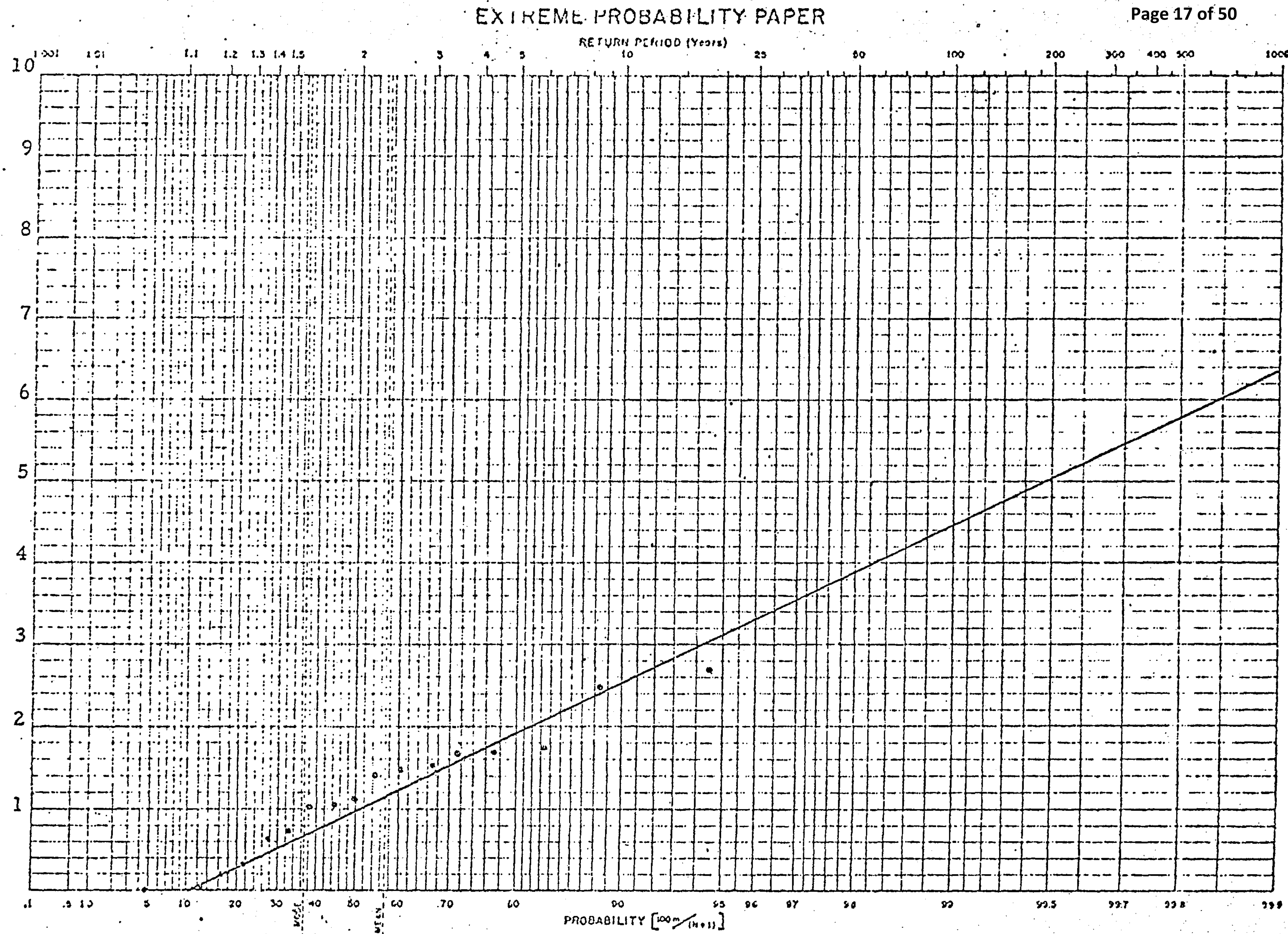


Fig. 8. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT ARGENTIA, NFLD BASED ON WIND GUSTS

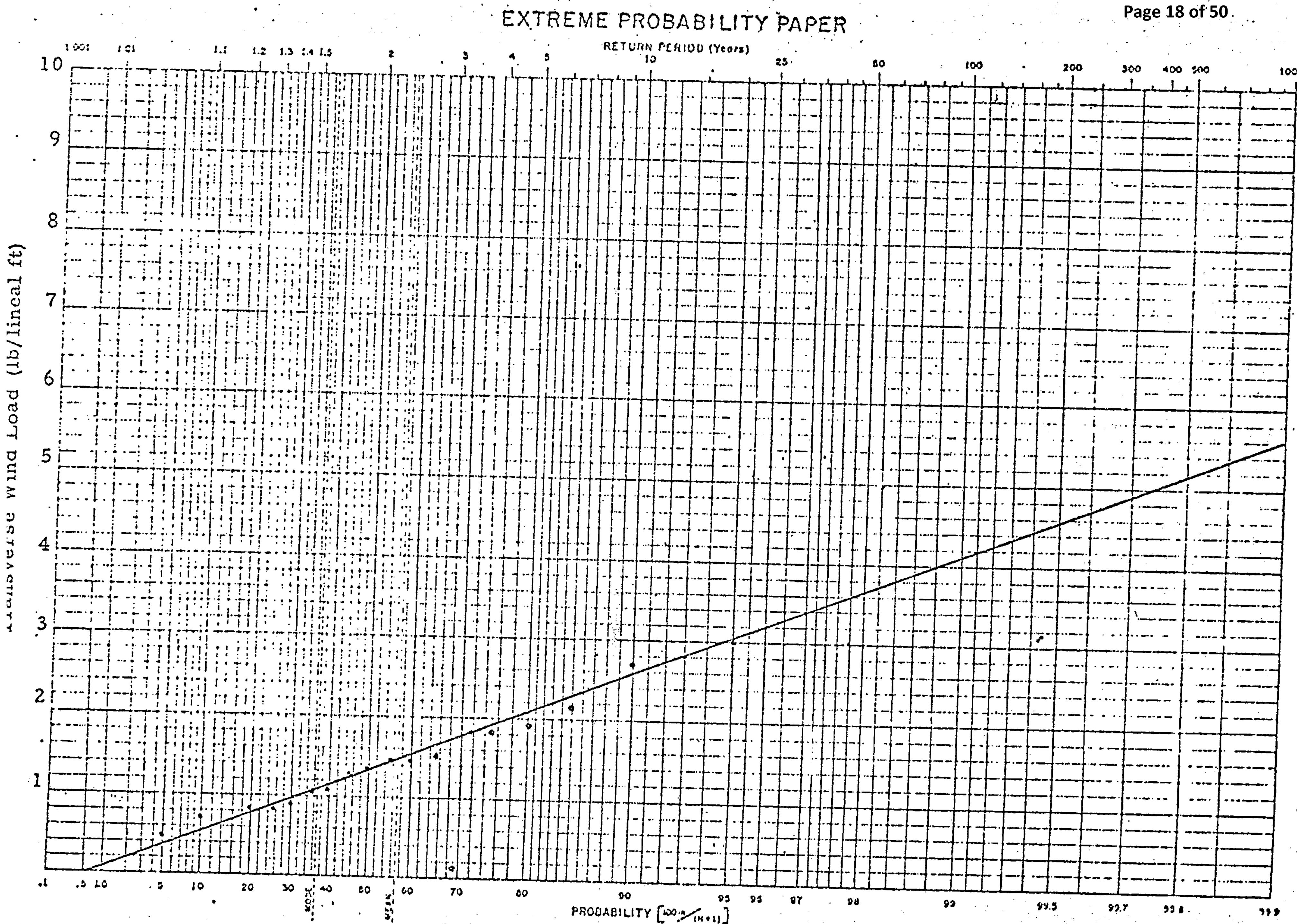


Fig. 9. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT GANDER, NFLD BASED ON WIND GUSTS

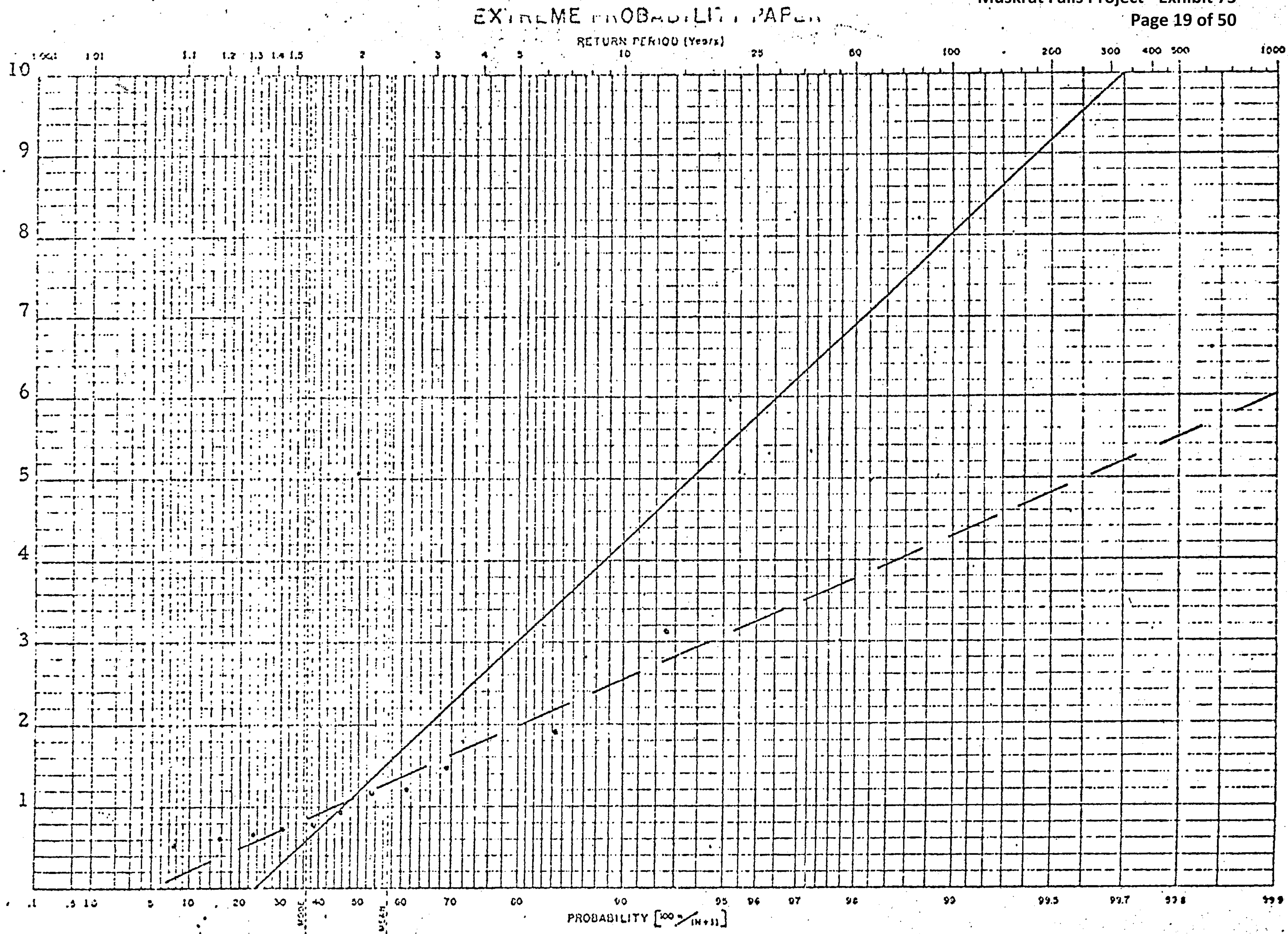


Fig. 10. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT BUCHANS, NFLD BASED ON WIND GUSTS

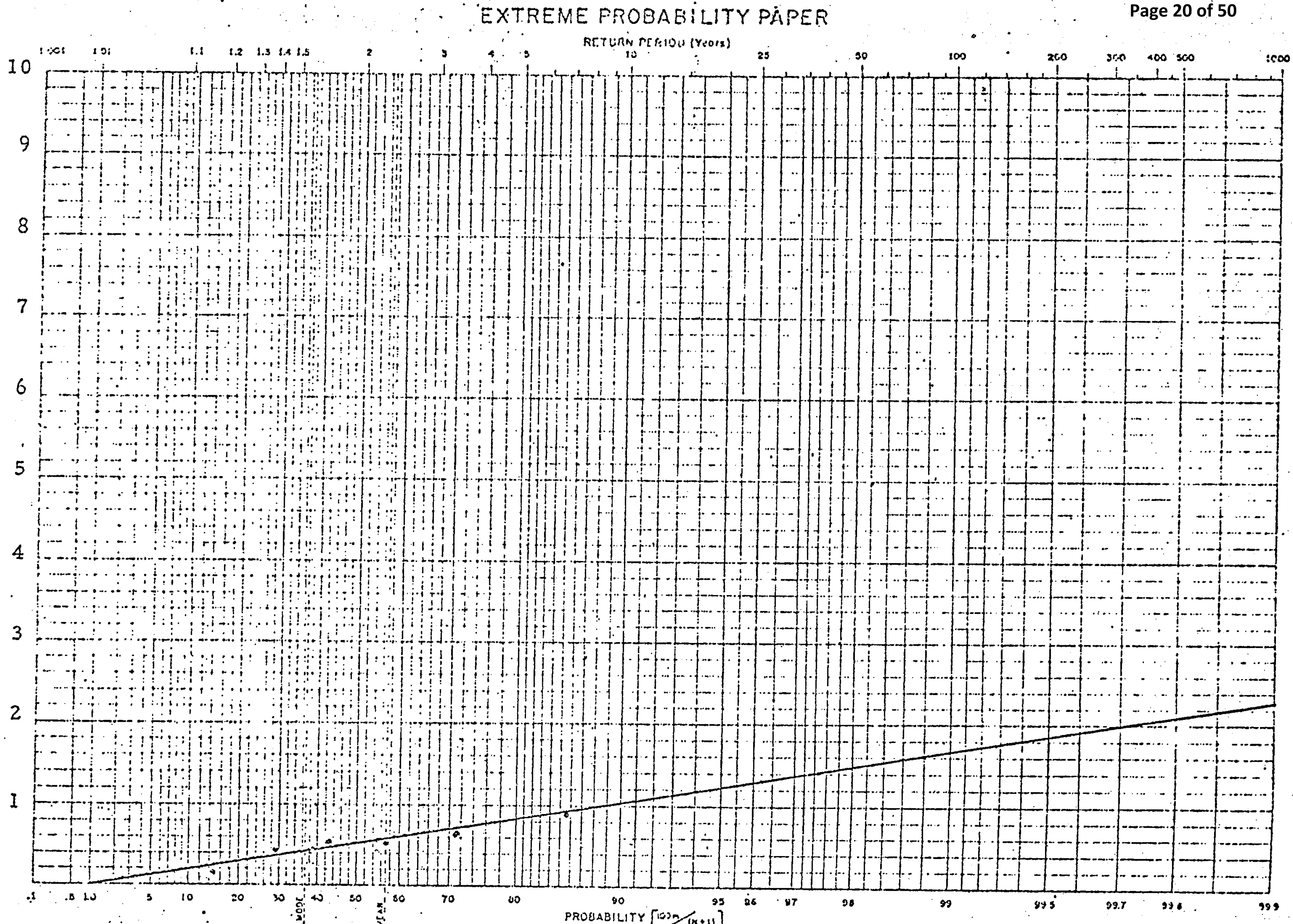


Fig. 11. TRANSVERSE WIND LOAD FOR GLAZE-COVERED T/L AT DEER LAKE, NFLD BASED ON WIND GUSTS

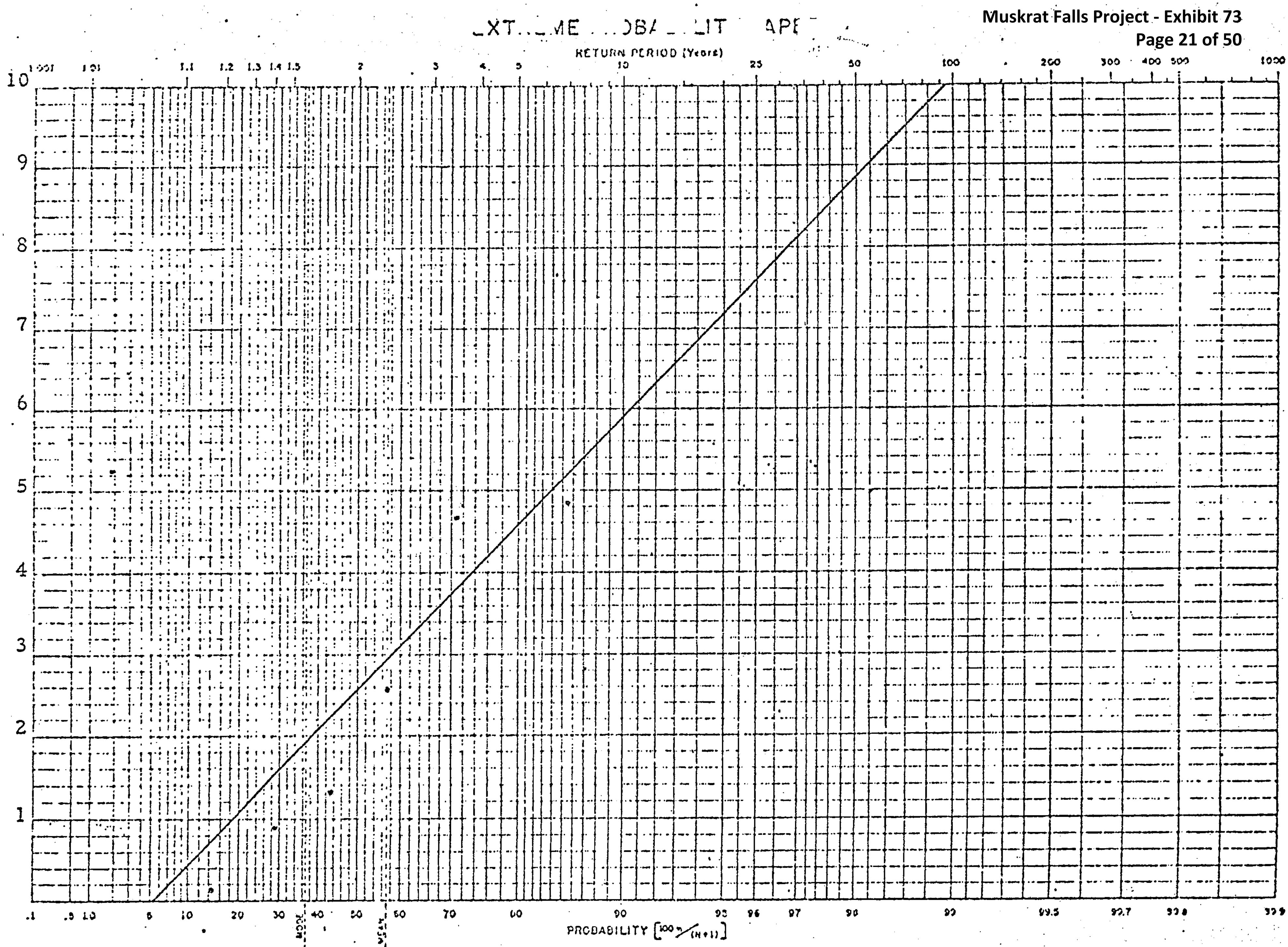


Fig. 12. TRANSVERSE WIND LOADS FOR GLAZE-COVERED T/L AT DANIEL'S HARBOUR, NFLD BASED ON WIND GUSTS

Table 1

RETURN PERIOD VALUES OF TRANSVERSE
WIND LOADS FOR GLAZE-COVERED T/L

Location	Return Period Amounts (lbs/linear ft)							
	10-year		25-year		50-year		75-year	
	Sustained Wind	Wind Gusts	Sustained Wind	Wind Gusts	Sustained Wind	Wind Gusts	Sustained Wind	Wind Gusts
St. John's-Torbay	1.7	3.6	2.1	4.5	2.3	5.2	2.5	5.7
Argentia	1.2	2.5	1.5	3.3	1.8	4.0	1.9	4.5
Gander	1.2	2.6	1.4	3.2	1.7	3.7	1.8	4.2
Buchans	1.9	4.2	2.6	5.8	3.1	7.0	3.4	7.7
	(1.1)	(2.5)	(1.4)	(3.2)	(1.7)	(3.8)	(1.8)	(4.1)
Deer Lake	0.5	1.0	0.6	1.3	0.7	1.5	0.7	1.6
Daniel's Harbour	2.6	5.9	3.4	7.6	4.0	8.9	4.4	9.6

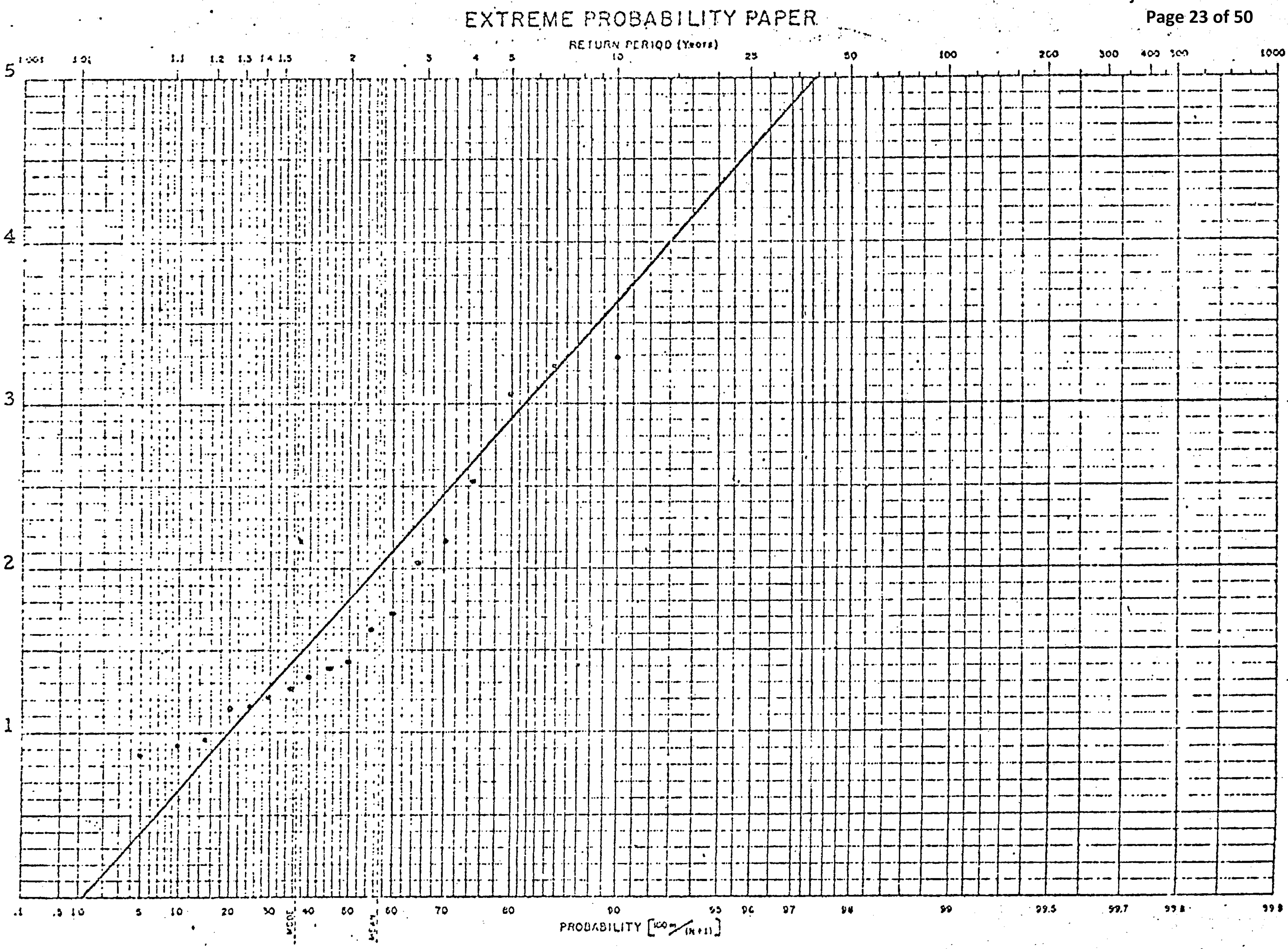


Fig. 13. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 300 FT ABOVE TORBAY, NFLD BASED ON HOURLY WIND DATA

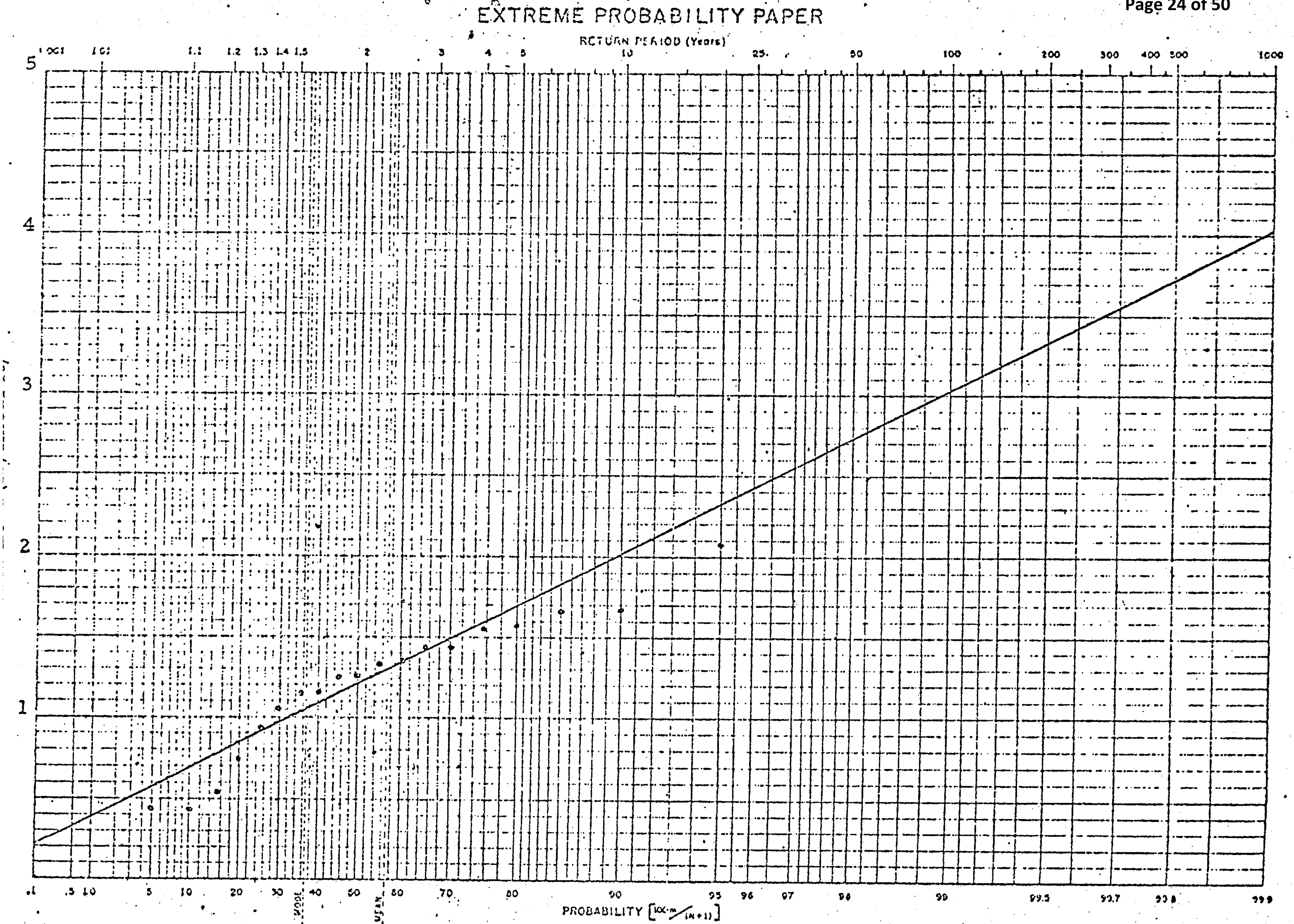


Fig. 14. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 300 FT ABOVE GANDER, NFLD BASED ON HOURLY WIND DATA

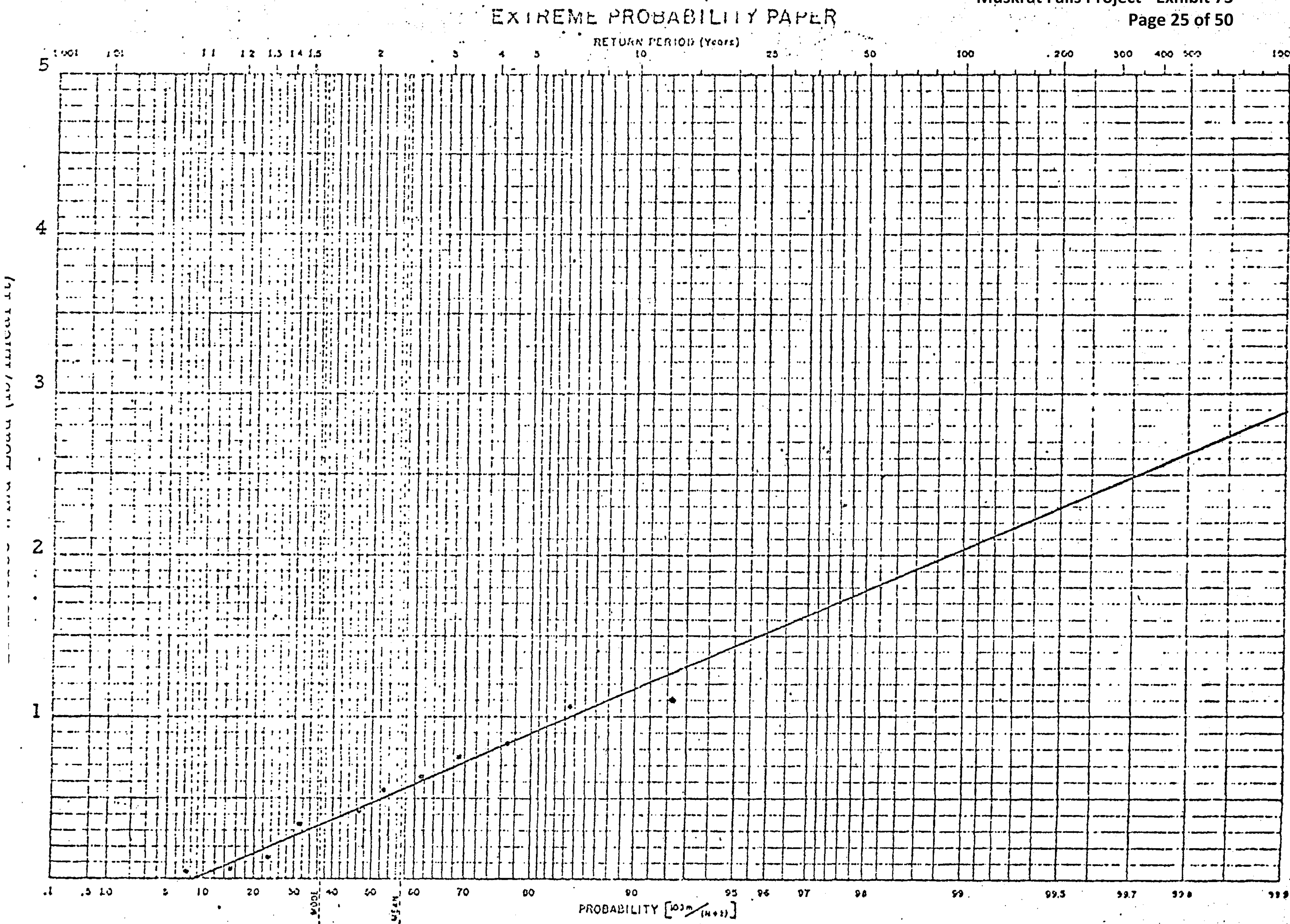


Fig. 15. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 300 FT ABOVE BUCHANS, NFLD BASED ON HOURLY WIND DATA

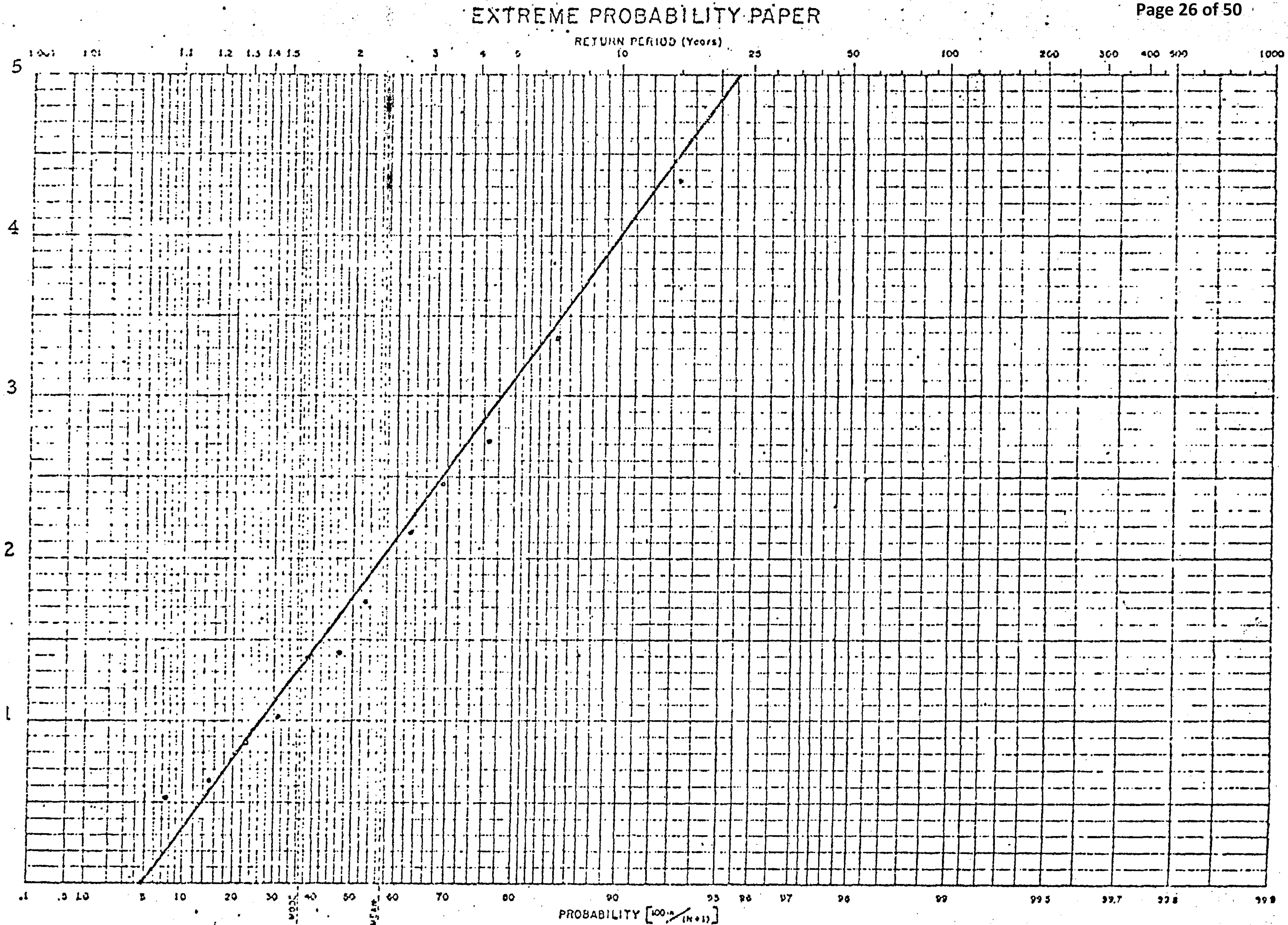


Fig. 16. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 800 FT ABOVE BUCHANS, NFLD BASED ON HOURLY WIND DATA

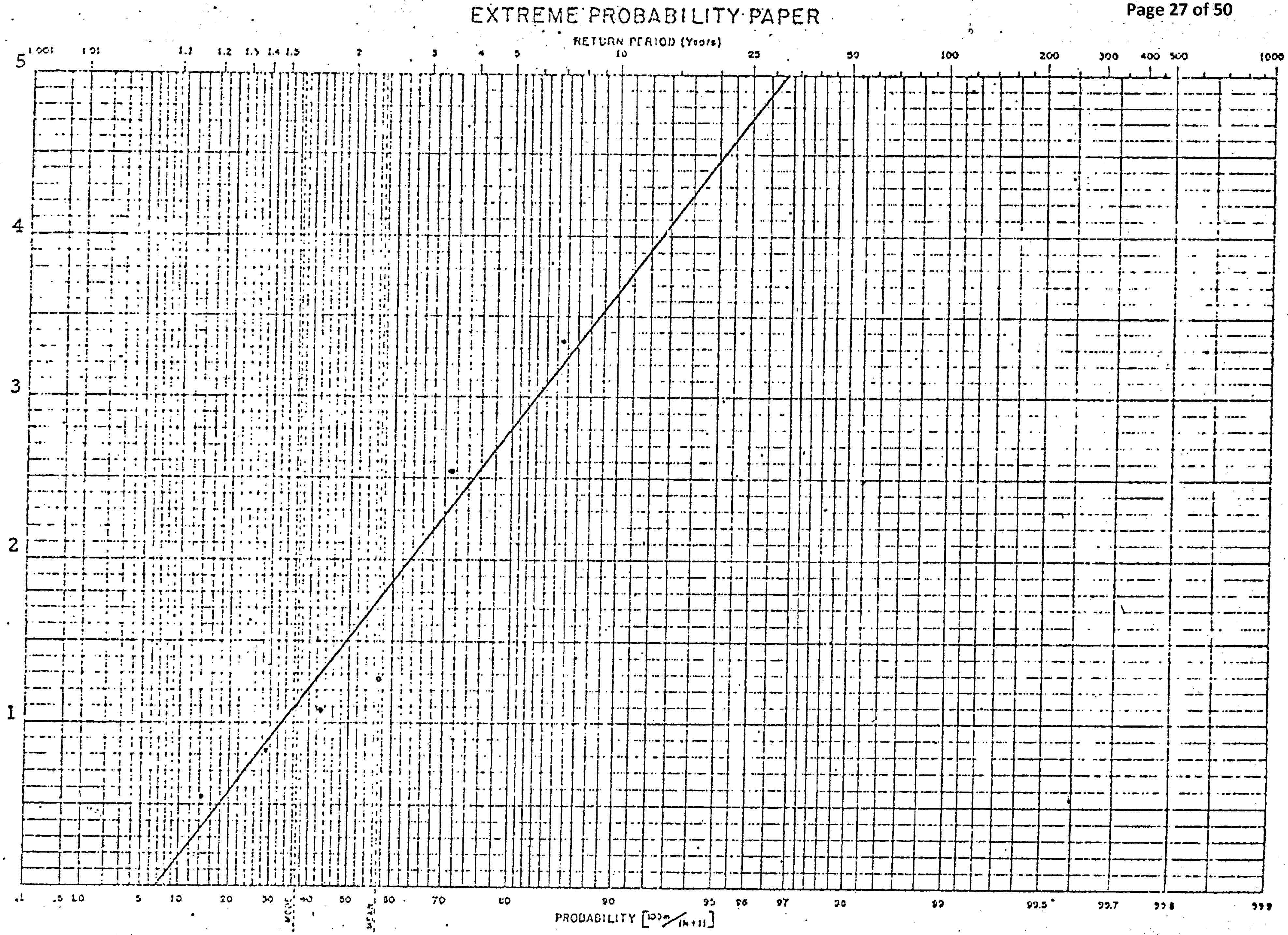


Fig. 17. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 1000 FT ABOVE DANIEL'S HARBOUR, NFLD BASED ON HOURLY WIND DATA

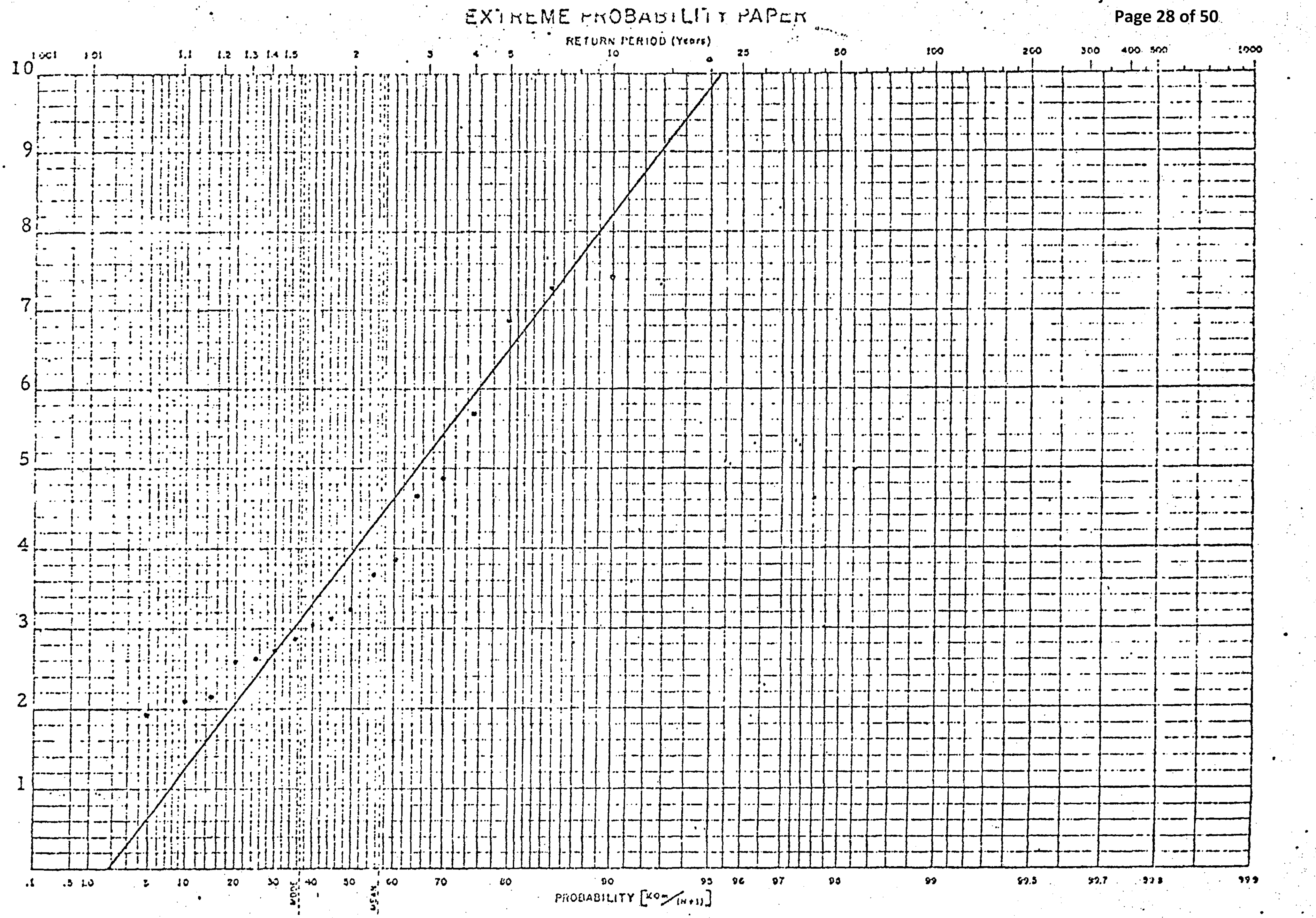


Fig. 18. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 300 FT ABOVE TORBAY, NFLD BASED ON WIND GUSTS

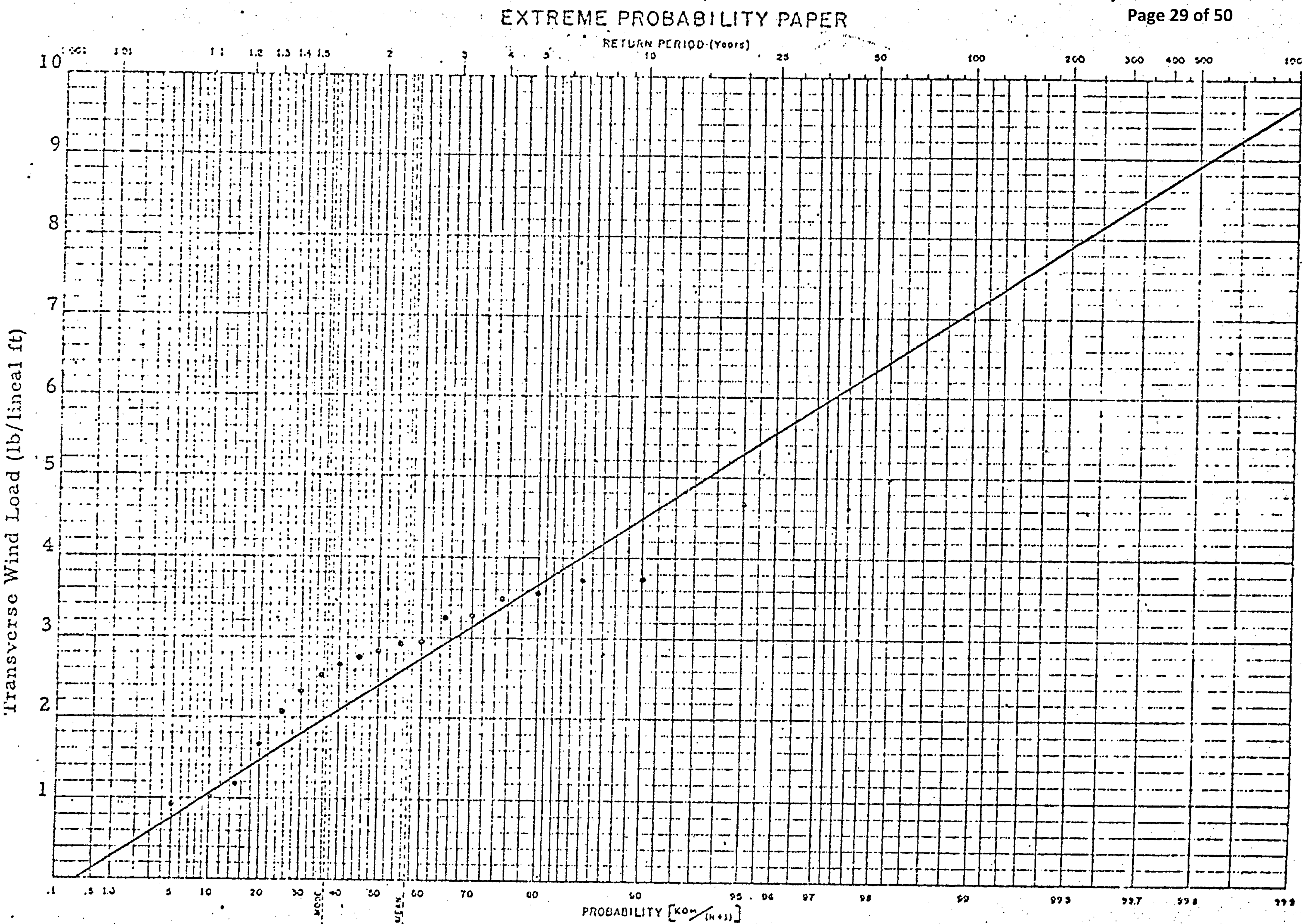


Fig. 19. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 300 FT ABOVE GANDER, NFLD BASED ON WIND GUSTS

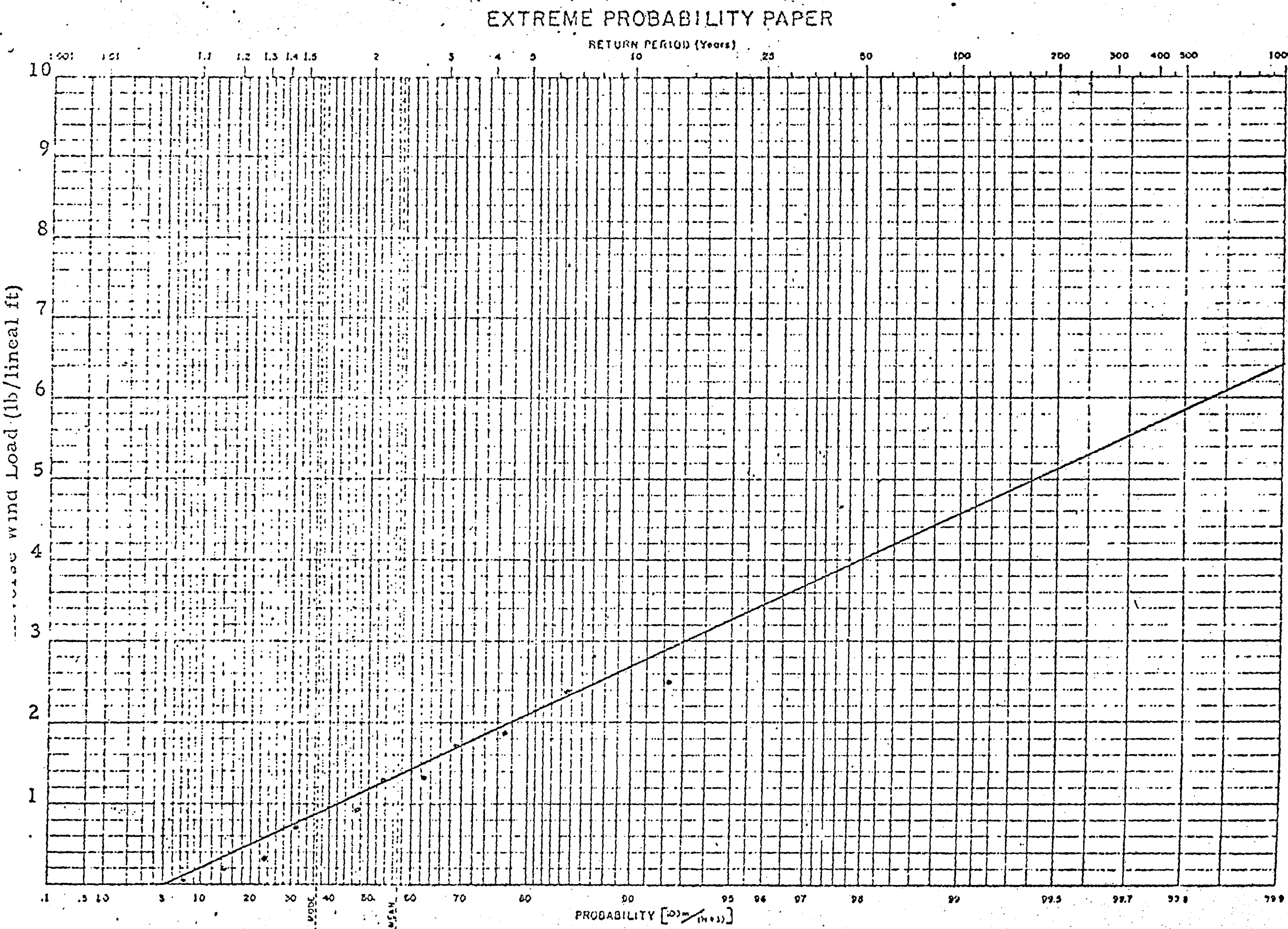


Fig. 20. TRANSVERSE WIND LOADS FOR RIME COVERE...
BASED ON WIND ...

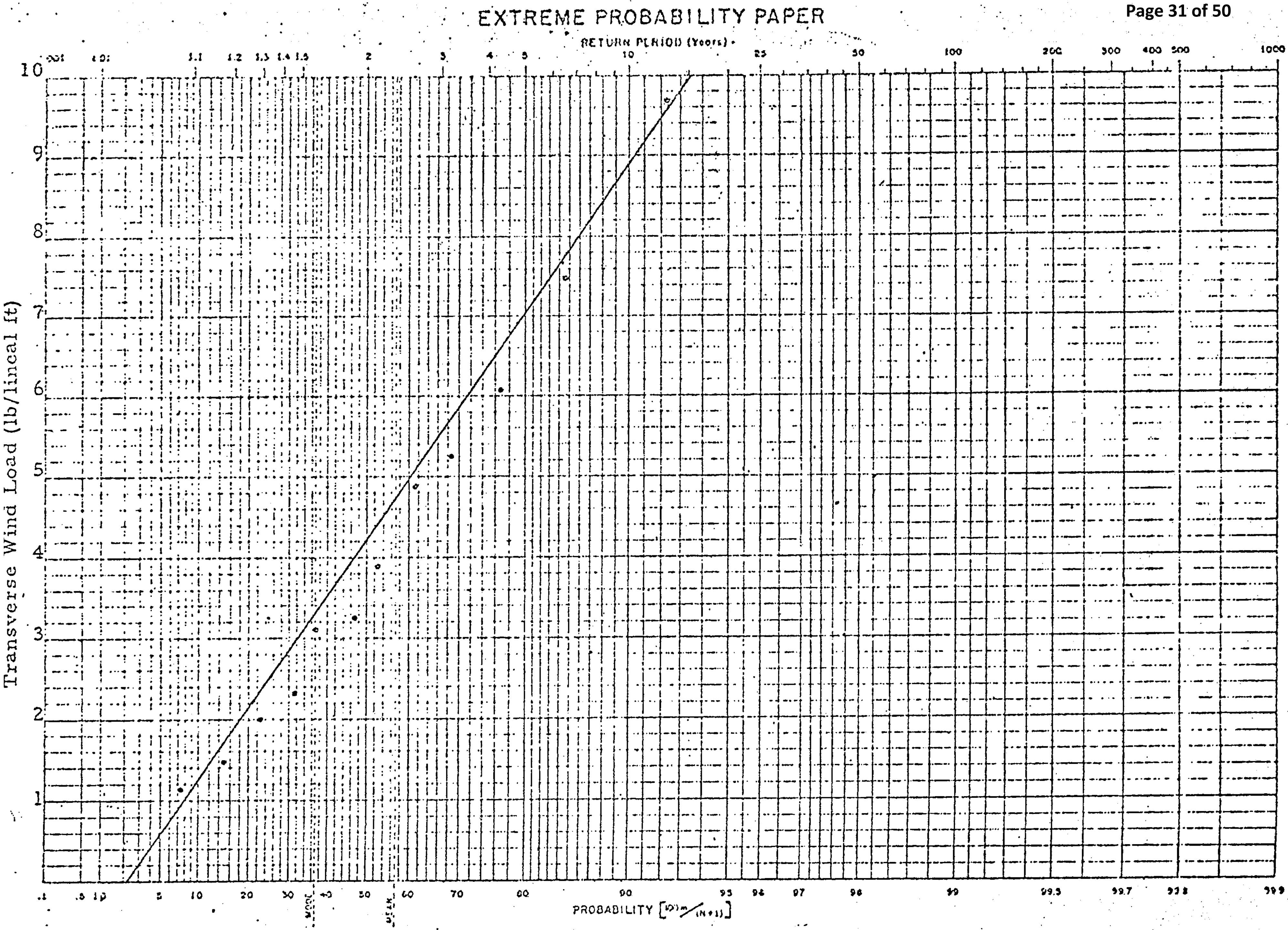


Fig. 21. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 800 FT ABOVE BUCHANS, NFLD BASED ON WIND GUSTS

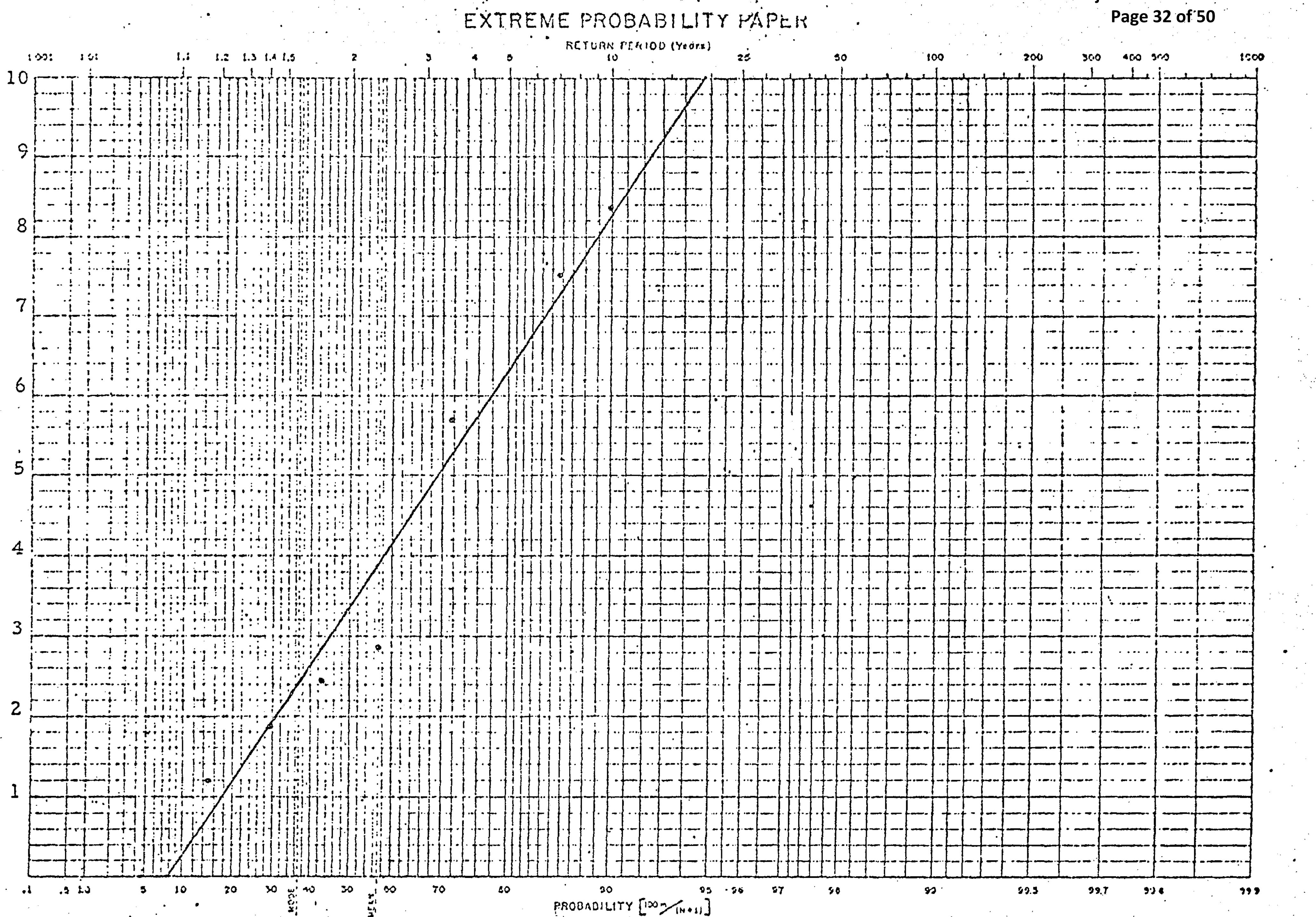


Fig. 22. TRANSVERSE WIND LOADS FOR RIME COVERED T/L 1000 FT ABOVE DANIEL'S HARBOUR, NFLD BASED ON WIND GUSTS

Table II

RETURN PERIOD VALUES OF TRANSVERSE WIND LOADS FOR RIME-COVERED T/L

Location	Return Period Amounts (lbs/linear ft)							
	10-year		25-year		50-year		75-year	
	Sustained Wind	Wind Gusts	Sustained Wind	Wind Gusts	Sustained Wind	Wind Gusts	Sustained Wind	Wind Gusts
300 ft above Torbay	3.6	8.2	4.6	10.3	5.3	11.9	5.7	12.8
300 ft above Gander	2.0	4.5	2.5	5.5	2.7	6.3	2.9	6.8
300 ft above Buchans	1.2	2.7	1.5	3.4	1.8	4.0	1.9	4.6
800 ft above Buchans	4.0	8.9	5.1	11.4	6.0	13.4	6.4	14.6
1000 ft above Daniels Harbour	3.7	8.3	4.7	10.7	5.7	12.9	6.2	13.9

Table III

MAXIMUM TRANSVERSE WIND LOADS
DUE TO WET SNOW ON CONDUCTORS

Location	Period of Record	No. of Wet Snow Storms ≥ 6 Hrs	Date of Maximum Load	Duration of Wet Snow	Average Wind Speed	Maximum Wind Speed	Wet Snow Diameter	Transverse Wind Load (lbs/lin ft)	
	Yrs			(hrs)	(mph)	(mph)	(in.)	Sustained Winds	Wind Gusts
St. John's - Torbay	19	2	5-1-55	6	35	40	4.7	1.6	3.5
Gander	19	4	3-5-60	9	41	45	6.8	2.9	6.5
Buchans	12	1	3-19-64	6	33	37	4.7	1.3	3.0
Daniel's Harbour	6	1	1-11-69	6	13	24	3.0	0.4	0.8
Deer Lake	6	1	10-23-69	7	20	20	3.8	0.3	0.7
Argentia	17	11	12-18-65	6	39	46	5.1	2.3	5.1

VI. TRANSVERSE WIND LOADING PROBABILITIES OF ICE-COATED TRANSMISSION LINES BY LINE SEGMENT

A. Loadings Derived From the November 1973 Report

In the November 1973 report, individual wind and ice loadings were assumed to be independent variables. Thus the probability of their occurring simultaneously becomes a product of their individual probabilities. For a given combined probability there are many possible combinations of individual probabilities, the product of which would equal the selected combined probability. It was assumed that the probabilities of both variables were equal, and therefore the individual probabilities were equal to the square root of the combined value. The combined wind and ice loads (both glaze and rime) for the 10-, 25-, 50-, and 75-year return periods at each of the five line segments between Holyrood and the north end of Humber Valley were used to compute the corresponding transverse wind loads of iced transmission lines. Table IV lists these results.

B. Loadings Derived From Actual Storm Data

Table V lists the 10-, 25-, 50-, and 75-year return period values for transverse wind loads based on actual storm data as extrapolated to the proposed route. A comparison of glaze and rime ice loadings in Tables I and II indicates that the transverse wind loads in conjunction with rime ice is generally larger than that with glaze ice. Therefore the values in Table V are all associated with rime ice. The loadings for wind gusts are also presented. The values computed from the November 1973 report (Table IV) generally lie between those values computed from hourly winds and wind gusts.

All segment values have been computed for a level 80 feet above the most exposed terrain in the segment.

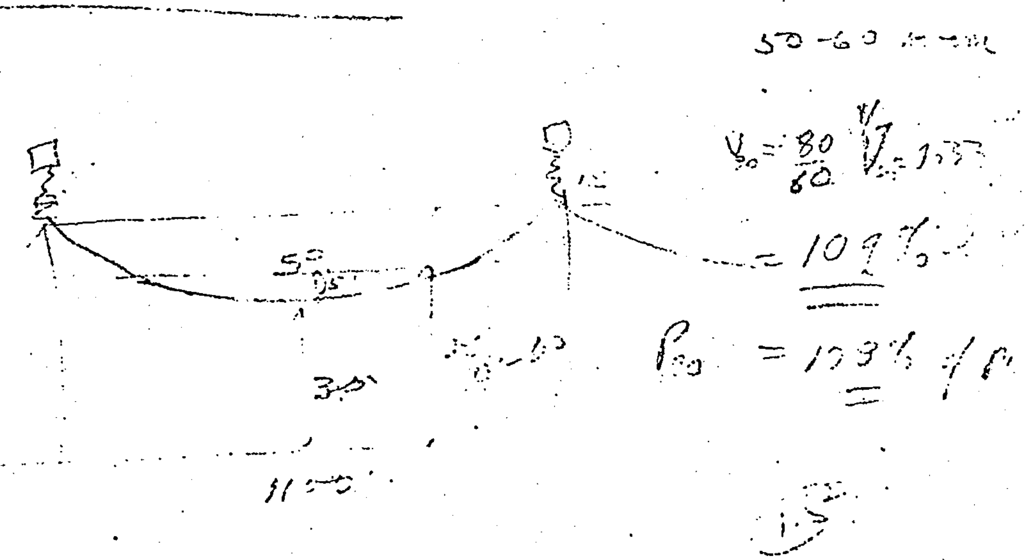


Table IV

TRANSVERSE WIND LOADS (lbs/linear ft)
FOR GLAZE AND RIME COVERED T/L
ASSUMING INDEPENDENCE OF WINDS AND ICING

Segment No.		Return Period in Years							
		10		25		50		75	
		Glaze	Rime	Glaze	Rime	Glaze	Rime	Glaze	Rime
1	Holyrood to Whitbourne (<500 ft)	5.1	5.5	7.2	8.2	9.2	10.6	10.1	12.2
2	Whitbourne to 10 miles west of Clarenville (<500 ft)	6.9	6.9	9.4	10.3	11.7	13.1	12.9	15.6
3	10 miles west of Clarenville to Grand Falls (≤800 ft)	3.8	3.8	5.6	5.5	7.1	7.4	8.0	8.4
4	(800-1200 ft elevations west of Gander Lake)	5.5	5.6	7.5	7.8	9.6	10.1	10.9	11.5
20	Grand Falls to north end of Humber Valley	5.5	5.6	7.5	7.8	9.6	10.1	10.9	11.5

Table V

TRANSVERSE WIND LOADS (lbs/linear ft) OF RIME COVERED T/L USING ACTUAL STORM DATA

Segment No.		Return Period in Years							
		10		25		50		75	
		Hourly Winds	Wind Gusts	Hourly Winds	Wind Gusts	Hourly Winds	Wind Gusts	Hourly Winds	Win Gus
1	Holyrood to Whitborne (<500 ft)	3.6	8.1	4.6	10.3	5.3	11.9	5.7	12
2	Whitbourne to 10 miles west of Clarenville (<500 ft)	4.0	9.0	4.9	11.0	5.6	12.6	6.0	13
3	10 miles west of Clarenville to Grand Falls (≤800 ft)	2.3	5.2	2.7	6.1	3.0	6.8	3.2	7
4	(800-1200 ft elevations west of Gander Lake	3.8	8.6	4.6	10.3	5.2	11.7	5.6	12
20	Grand Falls to north end of Humber Valley	3.8	8.6	4.6	10.3	5.2	11.7	5.6	12

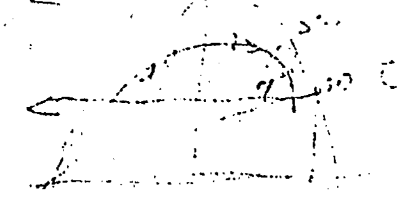
VII. COMBINED WIND SPEED AND ICE LOADS BY LINE SEGMENT

This report has presented transverse wind loads for ice-coated transmission lines for 10-, 25-, 50-, and 75-year return periods using predicted loadings from actual storm data. This probably represents the most accurate method of obtaining return period loadings directly. However, it has been pointed out that, for tower loading design, wind speed and ice thickness values will both be required. There is no reliable method of extracting the individual wind or icing data that are responsible for the combined loading return period values. Transverse wind loads are a function of both wind speed and ice diameter. A particular value of transverse wind load can result from many different combinations of wind speed and diameter. In the previous report, as described in Section VI, individual ice and wind loadings were treated as independent variables. In that study, the wind speeds used to generate return period values were annual maximum hourly wind speeds, without regard to when they occurred. The resultant transverse wind loads, shown in Table IV, were quite large.

Obtaining transverse wind loads by assuming independence of individual wind and ice loads is a valid method of approach. However, it is more realistic to use only those winds that occurred during icing situations. The rime ice storm data for St. John's-Torbay and Gander were isolated, and maximum wind speeds during ice storm for each year extracted. Return period values for these wind speeds were generated, as represented in Figs. 23 through 26. The 10-, 25-, 50-, and 75-year values were extracted from the figures and presented in Table VI.

The return period plots of wind speed, both hourly values, and wind gusts, were then extrapolated to conductor level for the five line segments. The return period values for rime and glaze icing along the proposed route were taken from the November 1973 report. The combined wind and ice loads were obtained using the method described in Section VI, and the results presented in Tables VII through X.

Caution should be exercised when comparing the transverse wind loads of ice-coated transmission lines as presented in Table V with the combined wind and ice loads listed in Tables VII through X. The former were derived from actual storm combined values, the latter, while also based on storm data, assumed individual wind and ice loads to be independent of each other. Examination of the storm data indicates that the largest transverse wind loads do not usually result from a combination of the highest winds with the heaviest icing. Since the loads are proportional to the square of the wind speed, storms relatively short in



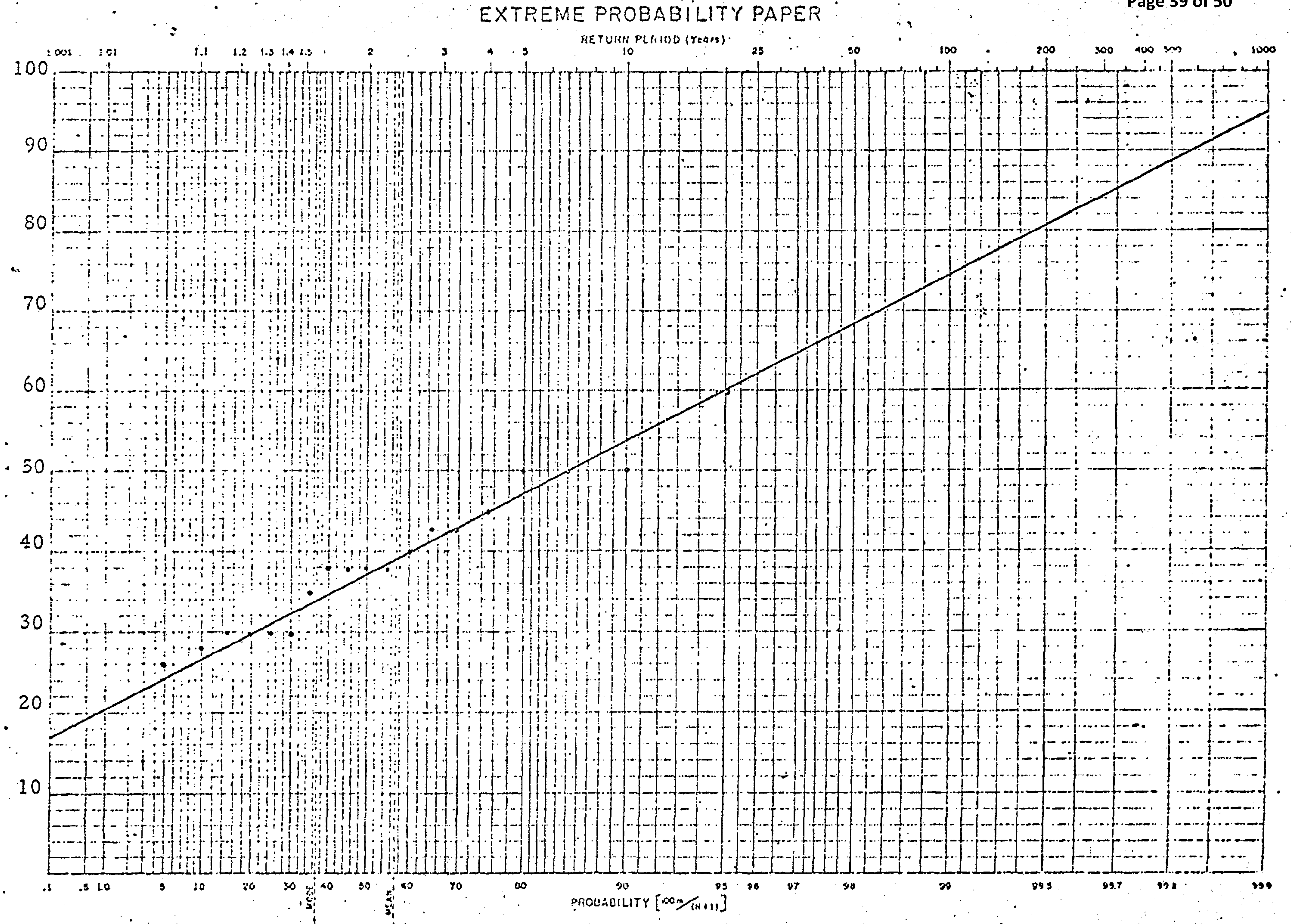


Fig. 23. WIND SPEED PROBABILITIES DURING RIMING CONDITIONS FOR ST. JOHN'S-TORBAY, NFLD

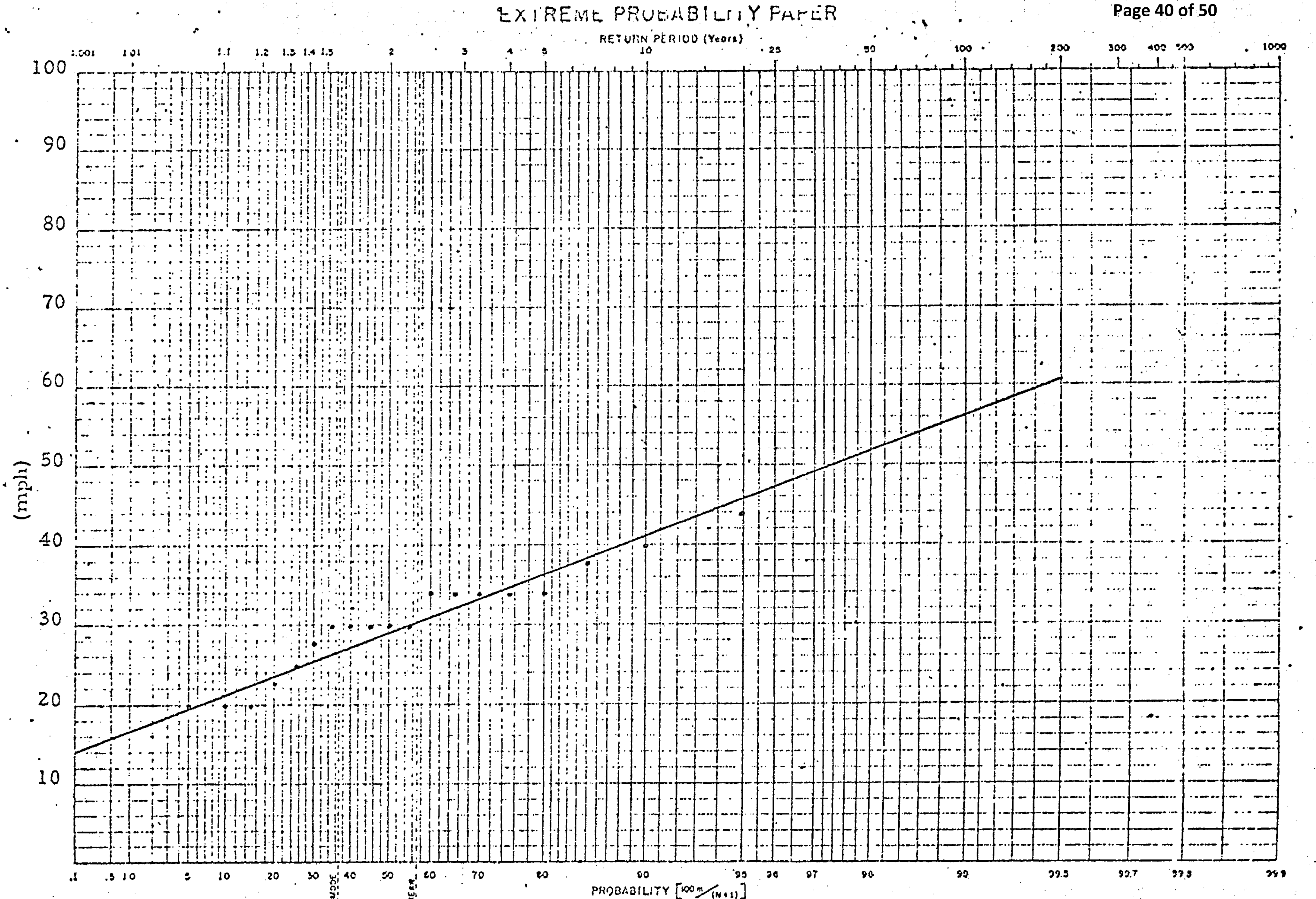


Fig. 24. WIND SPEED PROBABILITIES DURING GLAZE ICING CONDITIONS FOR ST. JOHN'S-TORBAY, NFL

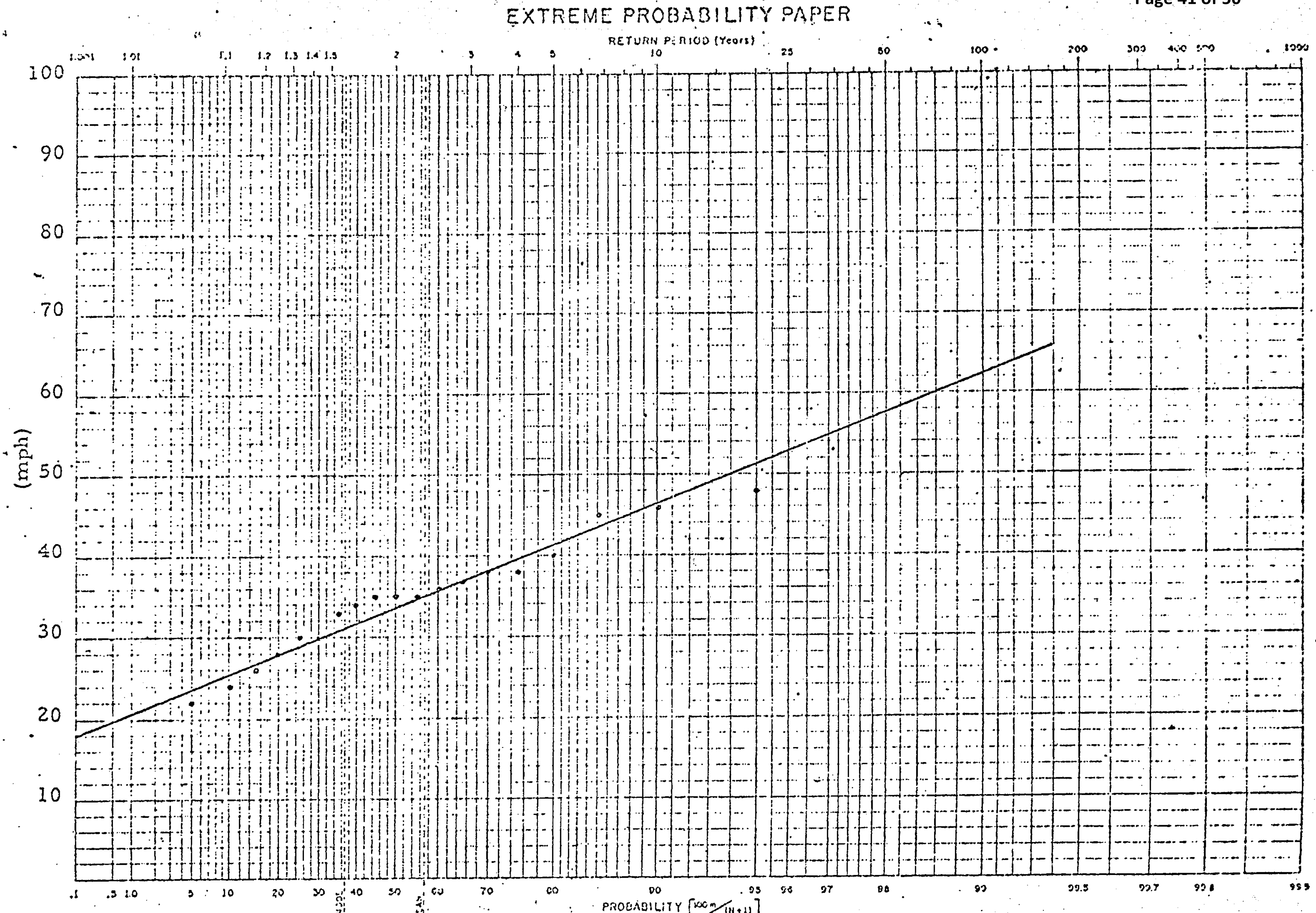


Fig. 25. WIND SPEED PROBABILITIES DURING RIMING CONDITIONS FOR GANDER, NFLD

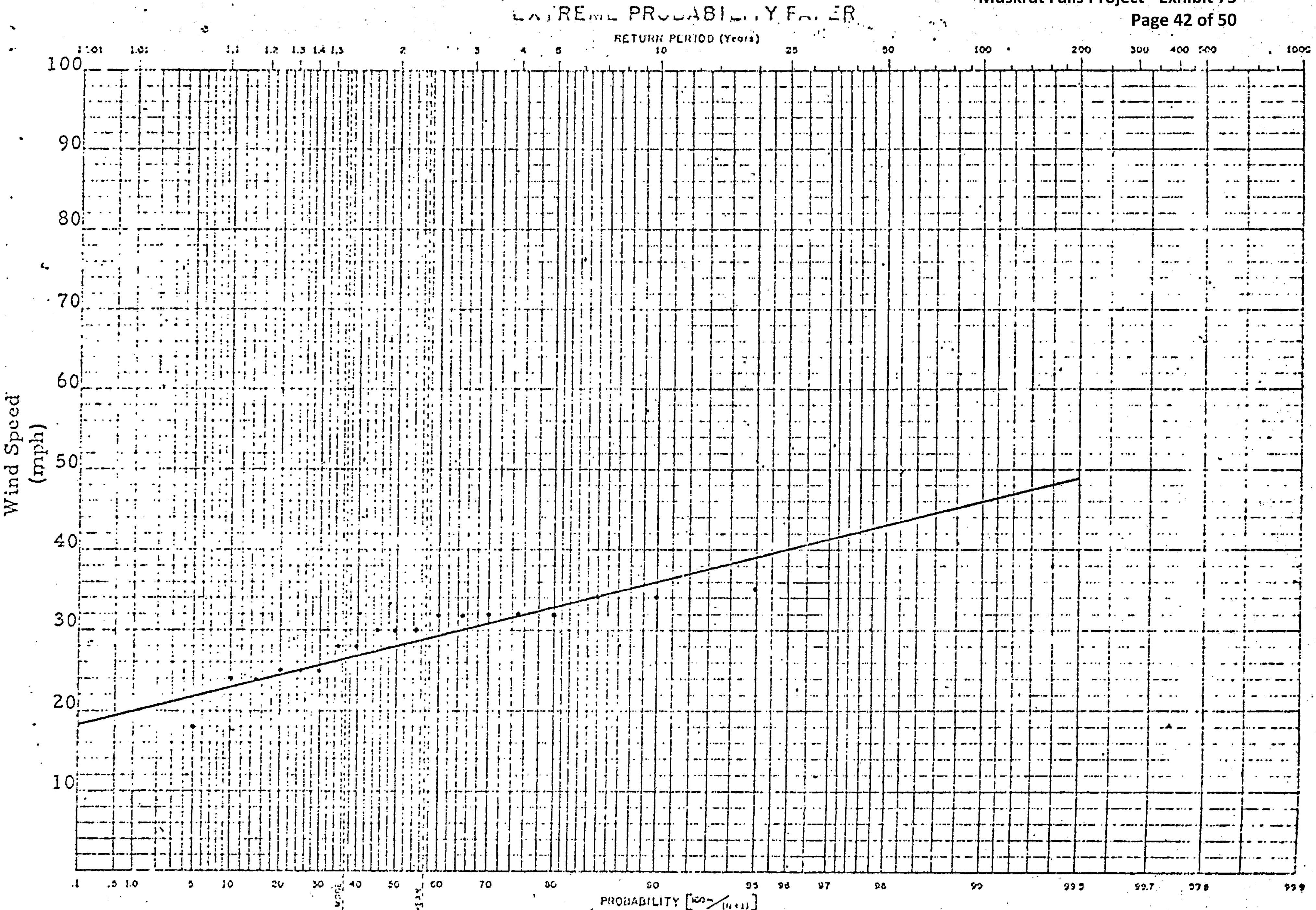


Fig. 26. WIND SPEED PROBABILITIES DURING GLAZE ICING CONDITIONS FOR GANDER, NFLD

Table VI

RETURN PERIOD VALUES OF
MAXIMUM WIND SPEEDS
DURING GLAZE AND RIME ICE STORMS
(mph)

LOCATION	RETURN PERIODS							
	10-yr		25-yr		50-yr		75-yr	
	Glaze	Rime	Glaze	Rime	Glaze	Rime	Glaze	Rime
St. John's-Torbay	41	54	47	62	52	69	55	72
Gander	36	46	40	54	43	58	45	61

Table VII

10-YEAR RETURN PERIOD VALUES

Segment	Maximum Icing Wind Speeds		Maximum Ice Loads				Combined Wind and Ice Loads					
			Glaze		Rime		Wind Speeds		Glaze		Rime	
	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ft (0.5)	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ (0.
1	51	76	2.9	17.4	3.8	15.0	40	60	2.2	11.3	2.4	7.
2	54	81	3.5	23.6	4.3	18.4	43	64	2.8	16.5	2.8	9.
3	47	70	2.4	12.9	3.1	10.8	36	54	1.7	7.7	1.7	4.
4	54	81	2.7	15.5	3.5	13.1	43	64	2.0	9.8	2.1	5.
20	54	81	2.7	15.5	3.5	13.1	43	64	2.0	9.8	2.1	5.

Table VIII

25-YEAR RETURN PERIOD VALUES

egment	Maximum Icing Wind Speeds		Maximum Ice Loads				Combined Wind and Ice Loads					
			Glaze		Rime		Wind Speeds		Glaze		Rime	
	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ft (0.5)	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ft (0.5)
1	60	90	3.4	22.5	5.0	23.8	44	66	2.5	13.8	3.0	10.2
2	62	93	4.0	29.4	5.5	28.1	47	70	3.1	19.4	3.5	13.1
3	54	81	2.9	17.4	4.0	16.3	40	60	2.1	10.5	2.0	5.4
4	62	93	3.2	20.4	4.4	19.2	47	70	2.3	12.1	2.4	7.2
20	62	93	3.2	20.4	4.4	19.2	47	70	2.3	12.1	2.4	7.2

Table IX

50-YEAR RETURN PERIOD VALUES

Segment	Maximum Icing Wind Speeds		Maximum Ice Loads				Combined Wind and Ice Loads					
			Glaze		Rime		Wind Speeds		Glaze		Rime	
	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ft (0.5)	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ft (0.5)
1	66	99	3.8	27.0	5.7	29.9	48	72	2.8	16.5	3.4	12.5
2	68	102	4.4	34.5	6.2	34.6	51	76	3.4	22.5	3.9	15.7
3	62	93	3.3	21.4	4.7	21.4	44	66	2.3	12.1	2.4	7.2
4	68	102	3.6	24.7	5.1	24.6	51	76	2.6	14.7	2.8	9.1
20	68	102	3.6	24.7	5.1	24.6	51	76	2.6	14.7	2.8	9.1

Table X

75-YEAR RETURN PERIOD VALUES

Segment	Maximum Icing Wind Speeds		Maximum Ice Loads				Combined Wind and Ice Loads					
	Wind Speeds		Glaze		Rime		Wind Speeds		Glaze		Rime	
	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ft (0.5)	Sustained (mph)	Gusts (mph)	Rad. in.	lb/ft (0.9)	Rad. in.	lb/ft (0.5)
1	70	105	3.9	28.2	6.3	35.6	50	75	2.9	17.4	3.7	14.4
2	72	108	4.5	35.8	6.8	40.7	53	79	3.4	22.5	4.3	18.4
3	66	99	3.4	22.5	5.1	24.6	46	69	2.4	12.9	2.6	8.1
4	72	108	3.7	25.8	5.5	28.1	53	79	2.7	15.5	2.9	9.7
20	72	108	3.7	25.8	5.5	28.1	53	79	2.7	15.5	2.9	9.7

duration (thus resulting in light icing) in conjunction with high wind speeds can produce the largest transverse wind load for a given year. Conversely, storms lasting a very long time, but with less severe winds, may result in the largest transverse wind load for a given year.

In all cases, the segment icing wind values were extrapolated from the rime ice storm winds, which were approximately 25 percent higher than the winds associated with glaze ice storms. (See Table VI.) As stated earlier, wind speed is the dominating factor in determining transverse wind loads for ice-covered conductors and towers.

VIII. CONCLUSIONS

The principal conclusions of the study are the following:

- Transverse wind loads were generally greater with rime ice than with glaze ice.

- Transverse wind loads derived from the November 1973 report were larger than those computed from actual storm data using hourly winds; however, using a 1.5 gust factor with the storm data results in loads larger than the earlier report.

- Combined wind and ice loads computed using the wind and ice as independent variables, as in the November 1973 report, but using only ice storm winds, result in gust-condition load values similar to the sustained-wind load values in the November report.

- Highest transverse wind loads can be expected along the isthmus west of St. John's. Lowest values occur along the segment south of Gander.

- Wet snow is not expected to be a problem east of Humber Valley; there were a total of only 20 occurrences of wet snow lasting at least six hours at the stations in the area of the proposed route.

- Much of these proposed transmission line routes are through areas of sparse, if any, recorded weather data. Some of the line segments used for loading estimation are quite long. Local variations within the segments could be large.

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