

REFERANSESIDE

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Ekstremvind	Vindprofil
1 min. middel	Hordaland

Referat: 1 min. mean wind speeds with return period 10 years is evaluated to maximum 25 m/s in Skånvikfjorden in January - February. SE-S and SW-W probably give the strongest winds.

SKÅNEVIKFJORDEN. EXTREME WIND CONDITIONS

1. INTRODUCTION

The objects for this report was outlined in a meeting at Norwegian Contractors on January 15, 1985. According to the contingency plan there is a need for a sheltered area to go to with the "Gullfaks A"-deck during the deck transportation/ deck mating operation planned to take place in Digernessundet January 1986.

The most actual area is Skånevikfjorden SE of Halsnøy, see map in Fig. 1. Values for the 1 minute mean wind speed with 10 years return period are to be given for heights up to 150 m asl. Additionally, wave heights and currents should be evaluated as far DNMI has the competence.

On January 21 a meeting was held at DNMI to discuss the wind conditions in the area. Participants were:

- M.Sc. Alv Sunde, DNMI, Vervarslinga på Vestlandet, Bergen
- M.Sc. Lars Andresen, DNMI, Climatic Dep.
- Dr.Scient Knut Harstveit, DNMI, Climatic Dep.
- M.Sc. Svein M. Fikke, EFI/DNMI

2. WIND CONDITIONS IN THE AREA

2.1 General.

The general wind conditions in the area are outlined in earlier reports, e.g. [1]. In the present report earlier data is supplied with wind statistics from the weather station Upsangervatn, 64 m asl, near Husnes. The frequency distributions of wind forces and directions for January and February 1971-84 are given in Table 1 and for all months in Table 2. For comparison the corresponding distributions for Slåtterøy lighthouse are given in Tables 3 and 4.

Normally the 10 minutes wind speed decreases quickly with the distance from the coast line, while shorter time averages and especially gusts decrease more slowly, resulting in a

higher gustiness inland. However, special effects disturb this pattern.

In Skånevikfjorden the extreme winds in January and February most probably will be due to either of the two weather situations summarized in the subchapters 2.2 and 2.3. As can be seen from Table 1, strong NW-N winds may occur in the winter-season, but they are more seldom than strong SE-S winds and, maybe except for Høylandssundet, NW-N winds are not likely to be that strong in the extreme case at this time of the year.

2.2 SE-S gradient wind field.

In winter with high pressure over the inland, there is generally a southeasterly air flow along the western coast. This flow can be very strong resulting in strong southeasterly or easterly winds in the fjord area. Such an airflow tends to shoot downwards on the leeward side of mountains, and Skånevikfjorden is likely to be exposed to such winds. Especially when a low pressure system is approaching in the sector S-W, the wind can be very strong.

Such situations are mostly easy to forecast and they can last for many days.

2.3 Trough with sharp wind veering.

A not so frequent phenomenon is the passage of a trough (a U- or V-shaped pattern of the isobares, behind a cold front which may cause a relatively quick veering of the wind from SE via S to SW and W. This is probably the only situation which may cause strong SW to W winds in the area.

The time scale for such situations are hours (less than a day), and therefore they are not very well reflected in ordinary wind statistics.

3. EVALUATION OF EXTREMES

3.1 Skånevikfjorden.

Analysis of yearly extremes of wind gusts (3-5 s) recorded at Flesland airport, Bergen, yield a speed of 37 m/s with return period 10 years regardless direction and season. The corresponding 1 min. value will probably be 31-32 m/s. Compared with Skånevikfjorden is Flesland more open and closer to the coastline. Considering also that only the months of January and February are actual and that strong NW winds are less frequent in Skånevikfjorden, we stipulate the 1 minute mean wind speed 10 m above sea level to 25 m/s.

The strongest winds are likely to occur in the area C, see Figure 1, in SE-situations where the surface friction is lowest, due to Høylandssundet. On both sides of area C the wind speed will be somewhat lower. Which of the sides that is the best will probably depend on the actual situation, see subchapter 3.4. If the wind direction is east of SE, area B will be better. If the wind comes south of SE, area D will probably be the best and speeds above 20 m/s are not likely to occur. In situations when strong SW-W winds reach the fjord, wind speeds of the same order as for area C are expected in area A. The strength of these winds will decrease towards NE.

3.2 Vertical wind profile.

The vertical wind profile in such terrain is unknown. For 10 min. mean wind speeds this formula is often used for homogeneous terrain:

$$v_z = v_{10} \left(\frac{z}{10}\right)^\alpha \quad (1)$$

where:

v_z = wind speed z m above ground

v_{10} = wind speed 10 m above ground

α = roughness parameter depending on topography

In Skånevikfjorden α should be of the order 0.2, but since we shall estimate 1 min. means and also the extreme case, α can be set lower than 0.15, but probably not as low as 0.1. Setting $\alpha = 0.12$, we get the following speeds for heights up to 150 m:

Height (m asl)	10	50	100	150
1 min. mean wind (m/s)	25	30	33	35

It must be stressed that effects of the local topography make these values uncertain.

3.3 Local shelters.

In many cases the wind speed in area B will be somewhat reduced compared with the areas A and C, as mentioned above. Better shelters are found in Høylandssundet or area D in SW-W winds, and Akrafjorden will give shelter for all directions. However, SE winds can also be relatively strong in the outer part of Akrafjorden (area E in Fig. 1) But the 1 min. mean wind speed 10 m asl is not likely to exceed 20 m/s in this area from SE, and 15 m/s or less from other directions. 20 m/s is expected to be a maximum for all directions in area D.

Matrefjorden is closed by a power line span.

3.4 Local experiences.

An experienced ferry captain, Bernt Åkre, is contacted. He has experience from the ferry route between Utåker and Skånevik. He tells that in cases with easterly winds one "jet" comes out Akrafjorden from E. These jets converge in area D, resulting in a rather strong wind here. SW winds are weak,¹⁾ and both Høylandssundet and Akrafjorden are relatively calm in westerly winds. NW winds are often strong near the mouth of Høylandssundet, but weakens quickly towards Utåker.

1) in area D

4. OTHER ALTERNATIVES

Based upon map studies the group has looked for alternatives to Skånevikfjorden. The conclusion is that Skånevikfjorden is the best place within the same distance from Digernessundet. The only alternative is Hardangerfjorden, especially Onarheimsfjorden.

5. CURRENTS AND WAVES

Dr. Harald Svendsen, University of Bergen, is consulted about local currents. The worst condition is a narrow fjord that receives large amount of fresh water on the inside and there is a water transport (current) in the sea away from the coast. The first two conditions (narrow fjord and much fresh water) is not fulfilled in Skånevikfjorden. However, the current conditions can be very variable in the fjord. Local fishermen are probably the best source for details.

The Environment Data Center at DNMI is consulted about wave conditions. Due to moving of their offices it is impossible to include calculations of the "Fjord - Sea" model in the present report. Wave data must therefore be presented later.

Reference:

- 1 Fikke, S.M.: Wind Conditions in Vats- Yrkefjorden. Wind Tunnel Tests and Extreme Winds. Reports 11/83 for Norwegian Contractors. Blindern 1983.

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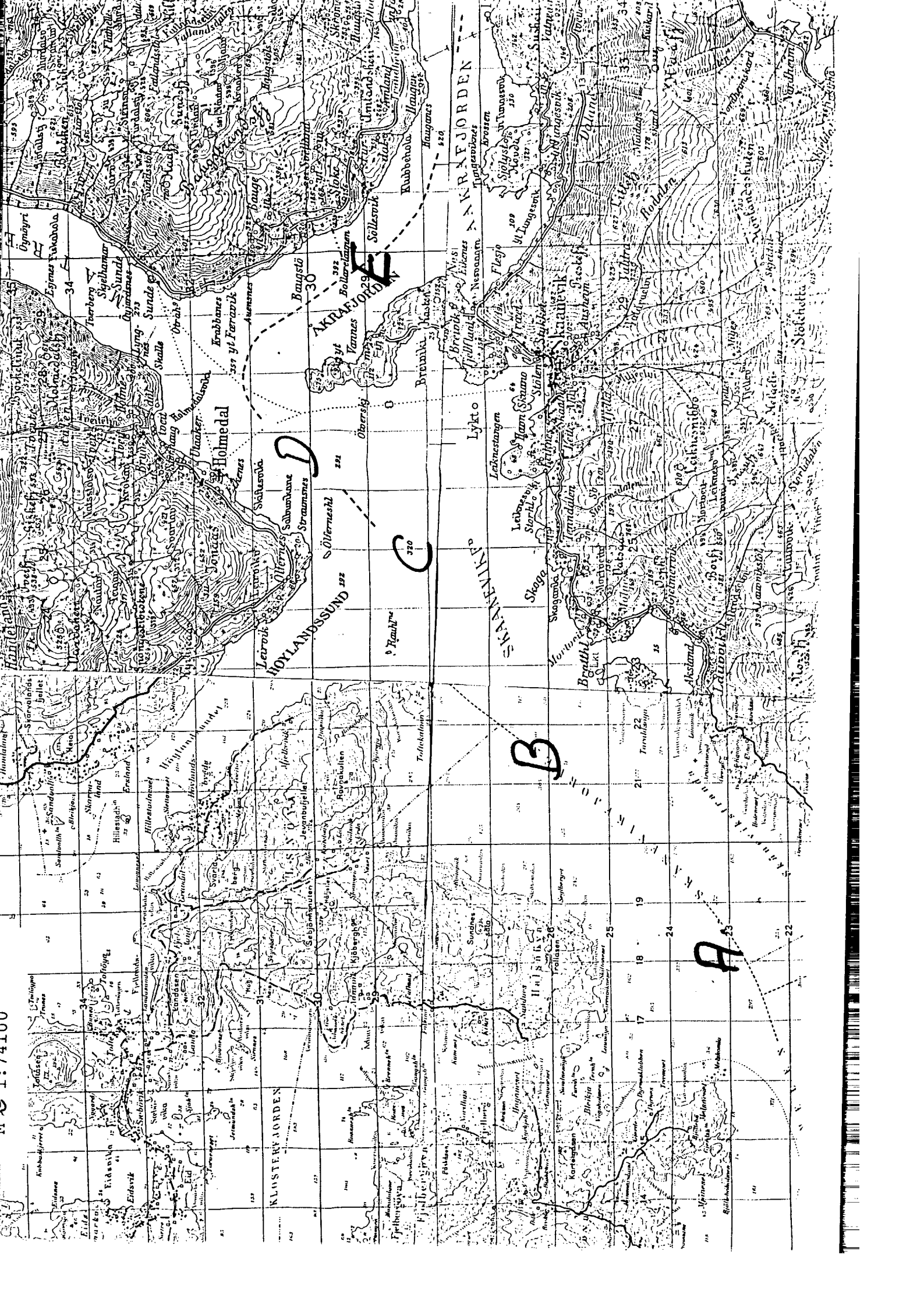


Table 2

UPSANGERVATN															
YEAR 1971-1984															
HRS. 06,12,18 GMT															
N=14247 C=25.1% VM= 2.8M/S FM=1.8 B															
DD	F=	1	2	3	4	5	6	7	8	9	10	11	12	ND	FDM
36N	5.0	2.0	2.0	0.3	3.1	0.7	0.7	0.1	0.0	0.0				15.4	2.9
03	1.0	0.2	0.2		0.1	0.0	0.0							1.5	1.7
06	0.4	0.1	0.0		0.0	0.0	0.0							0.6	1.8
09E	0.6	0.1	0.0	0.0	0.1	0.0	0.0							0.9	2.0
12	0.6	0.1	0.1	0.0	0.2	0.1	0.0							1.2	2.7
15	2.8	0.7	0.7	0.1	1.5	0.6	0.3	0.1	0.0					6.9	3.1
18S	17.5	5.5	3.7	0.4	7.9	0.6	0.3	0.1	0.0	0.0				30.5	2.0
21	3.7	1.5	1.1	0.1	1.2	0.3	0.1	0.0	0.0	0.0				8.2	2.4
24	0.3	0.6	0.4	0.1	0.5	0.1	0.0							2.4	2.7
27W	0.4	0.2	0.0	0.0	0.1	0.0								0.7	1.8
30	0.5	0.2	0.2		0.2	0.0	0.0							1.1	2.3
33	1.9	1.2	1.0	0.1	1.0	0.2	0.1	0.0						5.6	2.7
NF	35.1	13.4	10.1	1.0	10.0	2.5	1.3	0.5	0.1	0.0					

FREQUENCY OF MAX WIND FORCE BETWEEN THE HOURS OF OBSERVATION

	19-07	07-13	13-19	C
	36.6	18.2	13.4	1.7
	16.7	4.9	2.7	1.4
	0.3	0.1		
	37.4	18.6	14.2	1.2
	14.3	3.4	2.1	1.0
	0.2	0.1		
	35.1	18.6	14.8	1.3
	16.2	3.6	2.2	0.9
	0.2	0.0		

CUMULATIVE DISTRIBUTION OF CASES WITHIN A PERIOD OF CONSECUTIVE DAYS WHEN MAX. WIND FORCE OF THE DAY IS LESS THAN OR EQUAL TO 3 B FOR THE PERIOD 1971-1984

DAYS	1	2	3	4	5	6	7	8	9	10	11	12	13
WINTER	700	305	177	117	86	64	45	35	29	22	16	12	12
SPRING	747	323	193	127	90	59	46	36	27	22	20	18	11
SUMMER	756	331	200	135	100	70	58	40	32	30	24	21	17
AUTUMN	741	322	185	120	87	60	45	33	27	22	15	12	8
TOTAL	2944	1286	755	499	363	263	194	144	115	96	75	63	48

CUMULATIVE DISTRIBUTION OF CASES WITHIN A PERIOD OF CONSECUTIVE DAYS WHEN MAX. WIND FORCE OF THE DAY IS GREATER THAN OR EQUAL TO 6 B FOR THE PERIOD 1971-1984

DAYS	1	2	3	4	5	6	7	8	9	10	11	12	13
WINTER	209	72	22	8	5	1	1						
SPRING	138	50	12	4	2	1							
SUMMER	69	21	5	1									
AUTUMN	202	68	24	8	3	1							
TOTAL	618	211	63	21	10	3	1						

MONTH	1	2	3	4	5	6	7	8	9	10	11	12
NO. OF YEARS	13	13	13	13	13	12	12	13	13	14	14	13

Table 3

SLATTERØY FYR														JANUARY 1971-1984			
HRS. 06,12,18 GMT														N= 1302	C= 2.2%	VM= 7.7M/S	FM=4.1 D
DD	F:	1	2	3	4	5	6	7	8	9	10	11	12	ND	FDM		
36N		0.2	0.4	0.3	0.3	1.3	1.1	1.1	0.2	0.1				5.5	5.1		
03		0.7	0.7	0.6	0.7	0.3	0.2	0.2						3.3	3.1		
06		0.4	0.6	1.5	0.5	0.1								3.0	2.7		
09E		0.7	0.9	1.2	0.5	0.2	0.2							3.8	2.6		
12		1.5	0.9	0.9	0.6	0.3	0.2							4.5	2.5		
15		3.3	5.0	6.9	4.9	4.3	3.5	2.1	0.2	0.2				30.3	3.7		
18S		0.3	2.7	3.4	4.1	3.8	2.9	1.9	1.4	0.2				20.5	4.5		
21		0.2	0.5	0.8	0.8	1.1	1.1	1.0	0.1					5.5	4.8		
24		0.2	0.6	0.5	0.2	0.2	0.3	0.6	0.4	0.1				5.1	4.8		
27W		0.1	1.0	0.6	1.2	1.2	1.2	0.5	0.7	0.3	0.1			6.9	5.0		
30			0.1	0.4	0.4	0.8	0.2	0.5	0.2	0.2	0.1			3.0	5.6		
33		0.2	0.6	0.5	0.5	1.0	1.2	1.4	0.4	0.5	0.1			6.4	5.5		
NF		8.5	13.5	17.5	16.0	15.3	12.6	9.1	3.5	1.5	0.2						

FREQUENCY OF MAX WIND FORCE BETWEEN THE HOURS OF OBSERVATION

19-07	1.2	4.8	15.7	14.7	17.3	15.4	16.1	9.0	4.8	0.9					
07-13	3.5	6.9	17.5	12.7	21.7	13.6	11.5	8.3	2.8	1.4	0.2				
13-19	3.5	9.2	14.7	15.0	16.6	16.6	11.5	8.1	3.2	1.4					0.2

SLATTERØY FYR														FEBRUARY 1971-1984			
HRS. 06,12,18 GMT														N= 1188	C= 6.2%	VM= 5.5M/S	FM=3.2 D
DD	F:	1	2	3	4	5	6	7	8	9	10	11	12	ND	FDM		
36N		0.4	0.7	0.4	0.7	1.1	0.9	0.2						4.4	4.1		
03		0.5	0.8	0.5	0.3	0.4								2.6	2.7		
06		0.9	1.0	0.8	0.3	0.3		0.1	0.1					3.5	2.6		
09E		2.0	1.5	1.6	0.8	0.2	0.2							6.2	2.4		
12		1.6	0.9	1.0	0.2	0.1	0.2							4.0	2.2		
15		4.7	6.4	5.9	4.6	3.0	1.9	1.0	0.2					27.7	3.2		
18S		3.6	4.8	4.5	4.9	4.0	3.4	1.1	0.4	0.2				26.9	3.7		
21		0.4	0.8	0.8	0.7	0.4	0.8	0.3						4.1	3.8		
24		0.5	0.8	0.7	0.2	0.5	0.3	0.4	0.1					4.2	3.8		
27W		0.3	0.3	1.1	0.8	0.7	0.6	0.4	0.1	0.1				4.3	4.3		
30		0.2	0.5	0.5	0.3	0.3	0.5	0.3	0.1					2.5	4.1		
33		0.5	0.5	0.8	0.5	0.3	0.3	0.3	0.3					3.5	3.9		
NF		15.7	19.0	18.5	14.8	11.3	9.0	4.0	1.2	0.3							

FREQUENCY OF MAX WIND FORCE BETWEEN THE HOURS OF OBSERVATION

19-07	3.0	11.6	20.2	20.7	16.4	13.9	9.6	3.0	0.8	0.8					
07-13	5.3	12.4	22.2	18.7	17.9	13.4	5.8	2.3	0.8		0.3				0.5
13-19	7.3	12.6	20.7	18.2	14.2	13.4	7.3	3.8	0.3						0.3

