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A SURVEY OF EXTREME WINDS IN SOME FJORDS IN HORDALAND

UTARBEIDET AV

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A/S NORWEGIAN OFFSHORE CONCRETE STRUCTURES (NOCS)

OPPDRAGSNR.

SAMMENDRAG

The general pattern of strong winds in the area is briefly discussed based on available data from Bergen Airport, Flesland, and Hellisøy lighthouse. The 1 min mean wind speed in open areas near the coast will probably be around 40 m/s.^{x)} A brief, and mainly qualitative discussion of 5 areas are given. Further details depend upon analysis of wind records.

^{x)} return period 100 years

UNDERSKRIFT

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A SURVEY OF EXTREME WINDS IN SOME FJORDS IN HORDALAND

1. INTRODUCTION.

The examination of extreme wind conditions in some specified fjords in Hordaland was ordered by A/S NOCS in their letter to Vervarslinga på Vestlandet dated 15 March 1985 (Annex 1) and the task was further defined and expanded with the telex dated 28 March to DNMI (Annex 2).

It was agreed on telephone that this task could be solved within the existing service for climatic loadings for engineering purposes established as a cooperation between DNMI and The Norwegian Research Institute of Electricity Supply (EFI).

The intention of NOCS was that the present report should be based on existing data and knowledge without doing any further time consuming analysis of data and topography. For this reason the present report must be considered as preliminary until eventual further studies are performed.

A map covering the areas is shown in Figure 1.

2. AVAILABLE DATA.

2.1 Stations and records.

Two weather stations in the area are equipped with anemographs:

1. Flesland (Bergen Airport) 48 masl.
2. Hellisøy lighthouse 20 masl.

Flesland has a fairly good and homogenous record of both gusts and 10 minute means from 1956 on. The data from Hellisøy are more doubtful. There has been instrumental failures and other errors in the data, and special topographical effects influence the representativity of the data [1, 2]. The record of 10 min. means from 1963 on is probably the best one. Other weather stations in the area observe the wind force manually according to the Beaufort's scale.

Extreme analysis are performed on 10 min. means from Hellisøy for the period 1962-83 [2] and on gust wind speeds from Flesland for the period 1957-72 [3].

2.2 General wind conditions.

Tables 1-6 show the frequency distributions of wind forces and directions for Flesland and Hellisøy for January, July and for all observations in the period. It is seen that strong winds occur in the sector SE-NNW, with SE-S being the most frequent directions. It can also be seen that northerly winds have somewhat higher frequency in summer due to the sea-breeze effect. The expected sharp drop in wind forces inside the coastline is seen when comparing Flesland and Hellisøy.

2.3 Estimated extreme speeds.

Gumbel's distribution of extremes is applied on 16 yearly maxima of wind gusts recorded at Flesland. With 100 years return period this method gives a wind speed of 45 m/s. The reduction factor to 1 minute mean is stipulated to 0.88 [4] which results in 40 m/s. The reference height is 10 m.

As mentioned in Section 2.1 there are some doubtful properties of the Hellisøy data. Because of the central position of Hellisøy with respect to the actual areas, an example of extreme wind calculation will be given.

The 10 min. mean wind speed with return period 100 years is calculated to 38 m/s. However, the reference height is not well defined. The anemometer height is 13 m and the ground level is 23 masl. In [2] it is suggested that in the sector SE-W-NNW the anemometer reading may represent 36 masl instead of 13 m above ground. If this is true, the 100 year value should be reduced to 32-34 m/s 10 masl, or 36-38 m/s for the 1 min. mean. This is not in correspondence with the Flesland results, as Hellisøy is expected to have the highest value. The reasons for this discrepancy will not be discussed here, it should only be noted that there are of course also uncertainties in the reductions made above both for Hellisøy and Flesland.

However, it seems reasonable to assume that the 1 min. mean wind speed should lie between 35 and 40 m/s. In the following sections it is assumed a value of 40 m/s near the

coast line. Generally, the mean wind decreases rapidly with the distance from the coast line, but topographic effects may alter this pattern.

2.4 Other return periods.

Based on the Hellisøy and Flesland studies, the following reduction factors can be applied on the "100 year" value to get other return periods (the method is not defined for return period 1 year):

| | | | | | | |
|------------------------|-----|-----|------|-----|------|------|
| Return period (years): | 2 | 5 | 10 | 20 | 50 | 100 |
| Reduction factor: | 0.7 | 0.8 | 0.85 | 0.9 | 0.95 | 1.00 |

2.5 Directional and seasonal variations.

Analysis of directional and seasonal variations are not performed. The values given in section 2.3 are maximum yearly or autumn-winter values most likely to occur from SE-S and secondly from NW-N. From other investigations it is reasonable to believe that the corresponding values are about 3-5 m/s lower from SW-W and 10-15 m/s lower from NE-E.

Summer values may be of the order 5-10 m/s lower than the yearly values.

Further quantifications of directional and seasonal variations cannot be done without further analysis of the records from Flesland and (perhaps) Hellisøy. Such analysis includes manual readings of anemograms.

2.6 Variation with height.

The values given above refer to the standard level 10 m above the surface. For practical purposes the vertical wind profile can be expressed with the "power law":

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

where: v_z is the wind speed at height z ,

v_{10} is the wind speed at height 10 m, and

α is an exponent varying with roughness, and will probably be in the range 0.15-0.20 for 1 min. means in this area.

It must be stressed that local conditions may seriously alter the wind profile, but such effects are not possible to evaluate generally for the areas and can only be done (eventually) for specific locations.

3. DISCUSSION OF THE AREAS

3.1 General.

The following discussion is based on a brief map survey and is therefore mainly qualitative. A more detailed study for specific locations can eventually be based on detailed maps (scale 1:50000) and local inspections if necessary.

The fjords north of Bergen are typically oriented SE-NW or parallel with the strongest winds. This is of course not favourable. Because of channelling effects near parallel high level winds will be turned into the fjord direction.

For transverse winds the downwind terrain is often as important as the upwind terrain. E.g. a high level area will often lead to reduced wind speed on its upwind side.

The areas 1-5 are marked in Figure 1.

3.2 Tvibergøy (Area 1).

The area around Tvibergøy is open to all directions and the heights on the outer part of the Lindås-peninsula are lower than 200 m. The maximum wind speed will probably be close to 40 m/s. The directional variations will be as outlined in 2.5.

3.3 Austfjorden (Area 2).

For the SE-NW directions the wind will be a little weaker than at Tvibergøy. In the central part of the fjord S-SW (and NE) wind will be significantly reduced because of the heights up 700-800 m towards NE. This means that with the same return period SW winds may be of the order 10 m/s lower compared with the SE-direction.

Austfjorden is probably the most sheltered of the actual areas.

3.4 Mangerfjorden (Area 3).

Mangerfjorden seems to be the most windexposed of the five areas. It lies close to the coast line with only the low islands of Øygarden outside. No special reductions from topographical effects can be expected.

3.5 Davangervågen (Area 4).

This area is a little more sheltered than Mangerfjorden, and the wind conditions are probably comparable with Flesland.

3.6 Fusafjorden (Area 5).

Fusafjorden is oriented SW-NE or normal to the strongest winds. However, the fjord is open and wide, especially the southern part. Compared with Flesland, Fusafjorden will probably have weaker SE-winds and somewhat stronger SW winds, but the deviations will be relatively small.

4. FURTHER ANALYSIS

As pointed out in previous sections, more quantitative evaluations must be based on:

1. Further analysis of wind data, which also means reading the anemograms for special events. Probably the most valuable is to analyse the Flesland records of mean wind and gusts for the period 1957-84. From these data it would be possible to quantify the seasonal and directional distribution of the extremes.
2. Further studies of the topography. When locations are more defined, it will probably be satisfactory to study maps in scale 1:50 000, but local inspection may be desirable.

Acknowledgement.

The author is grateful to his colleagues Lars Andresen and Knut Harstveit for their valuable suggestions.

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Explanation to Tables 1-6:

| | |
|-----|--|
| HRS | hours of observation in GMT |
| N | total number of observations |
| C | frequency of calm |
| VM | mean wind velocity in m/sec |
| FM | mean wind force in Beaufort |
| DD | wind direction in dekadegrees, rounded off to the nearest of 12 main directions: 35-01, 02-24 etc. |
| F | wind force in Beaufort |
| ND | frequency of each wind direction DD |
| FDM | mean wind force in Beaufort for each wind direction DD |
| NF | frequency of each wind force F |

Table 4. Wind distribution for Helligsøy lighthouse.
January 1963-84.

| HELLISØY FYR | | JANUARY 1963-1984 | | | | | | | | | | | | | |
|--|----|-------------------------------------|-----|------|------|------|------|------|-----|-----|-----|-----|----|------|----------|
| HRS. 00,06,12,18 GMT | | N= 2697 C= 3.9% VM= 8.3M/S FM=4.4 B | | | | | | | | | | | | | |
| DD | F: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | ND | FM |
| 36N | | 0.1 | 0.5 | 0.8 | 1.6 | 1.4 | 1.2 | 0.6 | 0.3 | | | | | 6.4 | 4.7 |
| 03 | | 0.2 | 0.7 | 0.6 | 1.0 | 0.4 | 0.3 | 0.1 | | | | | | 3.3 | 3.6 |
| 06 | | 0.7 | 1.4 | 1.1 | 0.7 | 0.2 | | | | | | | | 4.2 | 2.6 |
| 09E | | 0.7 | 2.5 | 3.5 | 2.1 | 0.6 | 0.3 | | | | | | | 9.7 | 3.0 |
| 12 | | 0.4 | 1.6 | 2.6 | 4.7 | 2.5 | 1.1 | 0.3 | 0.1 | 0.0 | 0.0 | | | 13.6 | 4.0 |
| 15 | | 0.3 | 1.1 | 2.7 | 5.3 | 3.6 | 4.0 | 2.6 | 1.0 | 0.1 | | | | 20.9 | 4.8 |
| 18S | | 0.2 | 0.4 | 1.1 | 2.5 | 3.4 | 3.4 | 2.3 | 1.5 | 0.4 | 0.1 | | | 15.4 | 5.5 |
| 21 | | | 0.2 | 0.5 | 1.2 | 0.8 | 1.3 | 1.0 | 0.3 | | | | | 5.3 | 5.3 |
| 24 | | 0.1 | 0.3 | 0.4 | 1.8 | 1.1 | 1.3 | 0.7 | 0.2 | 0.1 | | | | 6.1 | 5.0 |
| 27W | | | 0.3 | 0.6 | 0.8 | 1.3 | 0.6 | 0.5 | 0.2 | 0.1 | | | | 4.4 | 4.9 |
| 30 | | 0.1 | 0.1 | 0.2 | 0.5 | 0.4 | 0.8 | 0.3 | 0.2 | 0.1 | | | | 2.7 | 5.2 |
| 33 | | 0.1 | 0.3 | 0.3 | 0.9 | 0.7 | 1.0 | 0.4 | 0.4 | 0.2 | | | | 4.2 | 5.3 |
| NF | | 2.8 | 9.4 | 14.4 | 23.5 | 16.4 | 15.5 | 8.8 | 4.2 | 1.0 | 0.1 | | | | |
| FREQUENCY OF MAX WIND FORCE BETWEEN THE HOURS OF OBSERVATION | | | | | | | | | | | | | | | |
| 19-01 | | 0.5 | 3.7 | 9.7 | 18.6 | 19.2 | 18.1 | 15.2 | 9.4 | 3.5 | 1.4 | | | | C 0.8 |
| 01-07 | | 0.6 | 3.4 | 10.0 | 19.6 | 19.6 | 17.3 | 15.2 | 9.2 | 3.7 | 0.7 | | | | 0.6 |
| 07-13 | | 0.3 | 4.0 | 8.8 | 22.9 | 16.4 | 19.1 | 16.7 | 8.1 | 2.5 | 0.7 | 0.4 | | | 0.1 |
| 13-19 | | 1.3 | 2.9 | 11.4 | 19.4 | 15.8 | 20.1 | 15.8 | 6.4 | 3.7 | 1.0 | | | | 0.1 |

Table 5. As Table 4 for July 1963-84.

| HELLISØY FYR | | JULY 1963-1984 | | | | | | | | | | | | | |
|--|----|-------------------------------------|------|------|------|------|------|-----|-----|---|----|----|----|------|----------|
| HRS. 00,06,12,18 GMT | | N= 2573 C= 7.5% VM= 5.5M/S FM=3.2 B | | | | | | | | | | | | | |
| DD | F: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | ND | FM |
| 36N | | 0.8 | 2.0 | 2.1 | 3.1 | 2.8 | 1.9 | 0.7 | 0.0 | | | | | 13.4 | 4.0 |
| 03 | | 0.3 | 0.5 | 0.3 | 0.5 | 0.2 | 0.1 | 0.0 | | | | | | 1.9 | 3.0 |
| 06 | | 0.3 | 0.3 | 0.2 | | | | | | | | | | 0.8 | 1.8 |
| 09E | | 0.4 | 0.4 | 0.2 | 0.1 | | | | | | | | | 1.1 | 1.9 |
| 12 | | 0.6 | 0.5 | 0.5 | 0.6 | 0.2 | 0.0 | | | | | | | 2.4 | 2.7 |
| 15 | | 0.7 | 0.7 | 1.0 | 1.9 | 0.7 | 0.8 | 0.2 | | | | | | 6.1 | 3.7 |
| 18S | | 1.0 | 1.8 | 2.9 | 3.6 | 1.9 | 1.4 | 0.2 | 0.0 | | | | | 12.9 | 3.7 |
| 21 | | 0.8 | 1.7 | 1.5 | 2.3 | 0.9 | 0.7 | 0.2 | 0.1 | | | | | 8.2 | 3.5 |
| 24 | | 0.9 | 1.7 | 1.7 | 1.6 | 0.6 | 0.2 | 0.0 | 0.0 | | | | | 6.8 | 3.1 |
| 27W | | 1.0 | 1.7 | 1.7 | 1.1 | 0.4 | | 0.0 | | | | | | 5.9 | 2.7 |
| 30 | | 0.9 | 2.7 | 2.0 | 2.0 | 0.7 | 0.3 | 0.2 | | | | | | 8.8 | 3.0 |
| 33 | | 1.5 | 4.0 | 4.8 | 6.3 | 3.5 | 3.0 | 0.9 | 0.1 | | | | | 24.1 | 3.8 |
| NF | | 9.2 | 18.0 | 18.9 | 23.2 | 11.8 | 8.6 | 2.4 | 0.3 | | | | | | |
| FREQUENCY OF MAX WIND FORCE BETWEEN THE HOURS OF OBSERVATION | | | | | | | | | | | | | | | |
| 19-01 | | 2.1 | 10.6 | 17.9 | 29.2 | 16.0 | 15.6 | 5.0 | 2.1 | | | | | | C 1.5 |
| 01-07 | | 3.1 | 12.3 | 21.5 | 27.2 | 16.3 | 12.7 | 4.1 | 1.7 | | | | | | 1.1 |
| 07-13 | | 2.8 | 12.4 | 18.3 | 27.8 | 17.5 | 13.2 | 6.5 | 0.9 | | | | | | 0.6 |
| 13-19 | | 1.7 | 5.9 | 21.5 | 27.3 | 19.1 | 15.8 | 7.2 | 1.4 | | | | | | |

Table 6. As Table 4 for all observations 1963-84.

| HELLISØY FYR | | | | | | | | | | | | | | YEAR | | 1963-1984 | | | | | |
|--|-----|------|------|------|------|------|------|-----|-----|-----|-----|-----|----|---------|-----|-----------|--|------------|--|----------|--|
| HRS. 00,06,12,18 GMT | | | | | | | | | | | | | | N=29318 | | C= 4.6% | | VM= 7.6M/S | | FM=3.9 8 | |
| DD | F: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | ND | FDM | | | | | | |
| 36N | 0.4 | 1.2 | 2.1 | 2.6 | 1.8 | 1.5 | 0.6 | 0.2 | 0.0 | 0.0 | | | | 10.5 | 4.2 | | | | | | |
| 03 | 0.3 | 0.7 | 0.9 | 0.8 | 0.3 | 0.1 | 0.0 | 0.0 | | | | | | 3.2 | 3.2 | | | | | | |
| 06 | 0.5 | 1.1 | 0.9 | 0.4 | 0.1 | 0.0 | 0.0 | | | | | | | 3.0 | 2.4 | | | | | | |
| 09E | 0.8 | 2.2 | 2.2 | 1.3 | 0.3 | 0.1 | 0.0 | 0.0 | | | | | | 7.0 | 2.8 | | | | | | |
| 12 | 0.5 | 1.3 | 1.9 | 2.2 | 1.1 | 0.5 | 0.1 | 0.0 | 0.0 | 0.0 | | | | 7.7 | 3.5 | | | | | | |
| 15 | 0.7 | 1.3 | 2.3 | 4.0 | 2.7 | 2.3 | 1.3 | 0.5 | 0.1 | 0.0 | 0.0 | | | 15.2 | 4.4 | | | | | | |
| 18S | 0.5 | 1.0 | 1.8 | 3.5 | 3.2 | 3.2 | 1.8 | 0.8 | 0.2 | 0.1 | 0.0 | | | 16.0 | 4.9 | | | | | | |
| 21 | 0.4 | 0.8 | 1.1 | 1.7 | 1.4 | 1.3 | 0.5 | 0.2 | 0.0 | 0.0 | | | | 7.3 | 4.4 | | | | | | |
| 24 | 0.4 | 0.8 | 1.1 | 1.5 | 1.2 | 1.0 | 0.5 | 0.1 | 0.0 | 0.0 | | | | 6.6 | 4.2 | | | | | | |
| 27W | 0.4 | 0.7 | 0.7 | 1.0 | 0.7 | 0.5 | 0.3 | 0.1 | 0.0 | 0.0 | | | | 4.5 | 3.9 | | | | | | |
| 30 | 0.4 | 0.9 | 0.7 | 0.8 | 0.5 | 0.4 | 0.3 | 0.1 | 0.0 | 0.0 | | | | 4.1 | 3.8 | | | | | | |
| 33 | 0.5 | 1.4 | 1.8 | 2.5 | 1.7 | 1.5 | 0.6 | 0.2 | 0.1 | 0.0 | | | | 10.2 | 4.2 | | | | | | |
| NF | 5.9 | 13.5 | 17.7 | 22.3 | 14.8 | 12.4 | 6.0 | 2.2 | 0.5 | 0.1 | 0.0 | | | | | | | | | | |
| FREQUENCY OF MAX WIND FORCE BETWEEN THE HOURS OF OBSERVATION | | | | | | | | | | | | | | | | | | | | | |
| 19-01 | 1.2 | 6.3 | 14.8 | 23.1 | 17.7 | 17.2 | 11.4 | 5.6 | 1.5 | 0.5 | 0.1 | | | C | 0.6 | | | | | | |
| 01-07 | 1.2 | 6.6 | 16.7 | 22.5 | 17.3 | 16.8 | 11.5 | 4.7 | 1.7 | 0.5 | 0.0 | | | | 0.5 | | | | | | |
| 07-13 | 1.2 | 7.6 | 14.7 | 22.9 | 17.2 | 17.1 | 11.3 | 5.7 | 1.5 | 0.4 | 0.1 | | | | 0.3 | | | | | | |
| 13-19 | 1.5 | 5.6 | 14.3 | 23.5 | 17.5 | 17.6 | 11.4 | 6.1 | 1.7 | 0.5 | 0.0 | 0.0 | | | 0.3 | | | | | | |
| MONTH | | | | | | | | | | | | | | | | | | | | | |
| NO. OF YEARS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | | | | | | | | | |
| | 22 | 22 | 22 | 22 | 22 | 1 | 21 | 22 | 22 | 22 | 22 | 22 | | | | | | | | | |



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Allègt. 70

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355/85
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01235 21. MRS. 85
R. Myhre jr
1985.3.21

VINDHASTIGHETER

Vi viser til hyggelig samtale med Deres Herr A. Aasen, og ber om maks forventet vindhastighet - målt over hundre år og målt som gjennomsnitt over 1 min for følgende steder i Nord Hordaland :

- a) Mangersfjorden,
- b) Davangervågen v/Hanøy,
- c) Tviborgøy sydøst av Mongstad.

Informasjonen skal brukes til dimensjonering av oppankringssystemene for betongplattformer under bygging.

Dersom fremskaffelsen av ovennevnte data er vanskelig eller krever store kostnader, ber vi Dem ta kontakt.

Med hilsen
for A/S Norwegian Offshore Concrete Structures

Jon R Myhre jr
Jon R Myhre jr

15.29
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40552 LEAS N
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ATT.: SVEIN FIKKE
FROM: ~~A/S NOCS - JON R. MYHRE JR.~~

JEG VISER TIL TELECON OG OVERSENDER UTDRAG AV FORESPURTE DATA.
SITAT.

"AS I INFORMED YOU LAST WEEK FOR DESIGN PURPOSES WE ARE INTERESTED IN THE FOLLOWING WINDDATA ON FLOATING/DEEPWATER SITE:

- WANGERSFJORD
 - TVIBERØY - SOUTHEAST OF HONGSTAD
 - AUSTFJORD - SOUTHEAST OF MAGEJORDEN
 - FUSAFJORDEN
 - DAVANGERVAAGEN
- A. ONE HOUR MEAN WIND 10 M ABOVE STILL WATER LEVEL WITH A RETURN PERIOD OF: 100, 50, 20, 10, 5, 1 YEAR.
- B. SAME AS A. BUT FOR A PERIOD MARCH-AUGUST.
- C. DIRECTIONAL SPREADING FOR A. AND B.
- D. EFFECT OF LANDSCAPE ON WIND VELOCITY/DIRECTION.
- E. VERTICAL DISTRIBUTION OF WIND VELOCITY."

SITAT SLUTT.

JEG HAAPER DET ER MULIG AA SVARE PAA DISSE SPOERSMAAL.

JEG VIL VAERE TAKKNEMLIG FOR EN OPPGAVE OVER FORUTSETNINGER, RESERVASJONER OG ANBEFALINGER FOR VIDERE STUDIER.

MED HILSEN
FOR A/S NOCS
JON R. MYHRE JR.

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DNMI - KLIMA- og VEDLIGNINGENS FAGRAPPORTER

- | | | |
|--|--|---|
| <p>1/84 NORDLIE P E: KLIMAGRANSKINGAR I NVE'S PROSJEKTRADE FOR KRAFTUTBYGGING Statusrapportar 1983, administrativ del Oppdragsgjevar: NVE-Statskraftverka</p> | <p>13/84 FIKKE S M: 132 kV KRAFTLEDNING NADDVIK - ARDALSTANGEN Is- og vindlaster 21.12.1984 Oppdragsgiver: ASV Nyset Steggje Kraft A/S</p> | <p>13/85 FIKKE S M: 132 kV KRAFTLEDNING BEIARN - OLDEREID Is- og vindlaster 09.04.1985 Oppdragsgiver: NVE-Statskraftverkene</p> |
| <p>2/84 AUNE B: ROGNMOEN BRUSTAK Eventuelle lokale klimaendringer 08.06.1984 Oppdragsgiver: Statens vegvesen, Vegsjefen i Troms</p> | <p>1/85 NORDLIE P E: KLIMAGRANSKINGAR I NVE'S PROSJEKTRADE FOR KRAFTUTBYGGING Statusrapportar 1984, administrativ del 15.01.1985 Oppdragsgjevar: NVE-Statskraftverka</p> | <p>14/85 ANDRESEN L: EKSTREM VIND PA RYGBE 10.04.1985 Oppdragsgiver: DNMI</p> |
| <p>3/84 FØRLAND E J: PAREGNELIGE EKSTREME NEDBØRVERDIER 03.07.1984 Oppdragsgiver: NVE-Hydrologisk avdeling</p> | <p>2/85 FIKKE S M, ANDRESEN L, HARSTVEIT K, SUNDE A: SKANEVIK FJORDEN. EXTREME WIND CONDITIONS 25.01.1985 Oppdragsgiver: Neptun/Norwegian Contractors</p> | <p>15/85 ROGNERUD B: CATALOGUE FOR SHIP AND BUOY DATA 10.04.1985 Oppdragsgiver: DNMI</p> |
| <p>4/84 FØRLAND E J og IDEN K A: EKSTREM NEDBØR I LØPET AV 1 - 30 DØGN Observerte og beregnede verdier for 49 stasjoner 03.07.1984 Oppdragsgiver: Vassdragsregulantenenes Forening</p> | <p>3/85 FIKKE S M, ANDRESEN L: ALFJORDEN, EXTREME WIND CONDITIONS 07.02.1985 Oppdragsgiver: Haugesund Mek. Verksted A/S</p> | <p>16/85 ROGNERUD B: SYSHIP A TAPE MANIPULATION PROGRAM 10.04.1985 Oppdragsgiver: DNMI</p> |
| <p>5/84 NORDLIE P E: E6 MOGREINA - BOKSRUD Klimavurdering av konsekvensane ved kryssing av Andselva 05.07.1984 Oppdragsgjevar: Statens vegvesen, Vegsjefen i Akershus</p> | <p>4/85 FIKKE S M: HAMNEFJELL RADJOLINJESTASJON Is- og vindlaster 11.02.1985 Oppdragsgiver: Siv.ing. Jørgen Madsen for Teledirektoratet</p> | <p>17/85 FIKKE S M: A SURVEY OF EXTREME WINDS IN SOME FJORDS IN HORDALAND 19.04.1985 Oppdragsgiver: A/S NOCS</p> |
| <p>6/84 NORDLIE P E: KLIMAENDRINGAR PA BRUNN AV IS I INDRE NORDFJORD 05.07.1984 Oppdragsgjevar: NVE-Statskraftverka</p> | <p>5/85 FIKKE S M: RL-MASTER PA LAUVVIK FJELL OG TVERRFJELLET Is- og vindlaster 11.02.1985 Oppdragsgiver: Jarlø Fabrikker A/S</p> | |
| <p>7/84 FIKKE S M: KRAFTLEDNING TIL ILULISSAT/JAKOBHAVN Meteorologiske vurderinger 25.10.1984 Oppdragsgiver: Grønlands Tekniske Organisasjon</p> | <p>6/85 FIKKE S M, JOHANSEN K: SKANEVIK FJORDEN. WAVE CONDITIONS 13.02.1985 Oppdragsgiver: Neptun/Norwegian Contractors</p> | |
| <p>8/84 FIKKE S M: KRAFTLEDNINGSTRASSEER TIL ILULISSAT/JAKOBHAVN Reiserapport etter studietur 31.08.-10.09.1984 25.10.1984 Oppdragsgiver: Grønlands Tekniske Organisasjon</p> | <p>7/85 FIKKE S M: 132 kV KRAFTLEDNING VARANGERBOTH - FINSKEBRENSEN Is- og vindlaster 15.02.1985 Oppdragsgiver: NVE-Statskraftverkene</p> | |
| <p>9/84 FIKKE S M: 22 kV KRAFTLEDNING TIL HAMNEFJELL RL-STASJON Is- og vindlaster 09.11.1984 Oppdragsgiver: Tron Horn A/S for Teledirektoratet TBE</p> | <p>8/85 FIKKE S M, JOHANSEN K: BANDSFJORDEN EXTREME WIND AND WAVE CONDITIONS 15.02.1985 Oppdragsgiver: Norwegian Contractors</p> | |
| <p>10/84 FIKKE S M: 22 kV KRAFTLEDNING TIL ISKURAS RL-STASJON Is- og vindlaster 09.11.1984 Oppdragsgiver: Tron Horn A/S for Teledirektoratet TBE</p> | <p>9/85 ANDRESEN L: VINDSKADE I MOSS Vurdering av vindforhold og hyppighet av sterke vindkast 26.02.1985 Oppdragsgiver: UNI FORSIKRING</p> | |
| <p>11/84 FIKKE S M: 300 kV KRAFTLEDNING DALE - FANA Revurdering av is- og vindlaster 29.11.1984 Oppdragsgiver: Bergenshalvøens koma. Kraftselskap</p> | <p>10/85 HARSTVEIT K, FIKKE S M: AKSLA RADJOLINJESTASJON Is- og vindlaster 06.03.1985 Oppdragsgiver: Ing. Bonde & Co. for Teledirektoratet</p> | |
| <p>12/84 FIKKE S M: 66 kV KRAFTLEDNING TROLLBERGET - BEIARN Is- og vindlaster 07.12.1984 Oppdragsgiver: Tron Horn A/S for NVE-Statskraftverkene</p> | <p>11/85 FIKKE S M: 22 kV AVGREINING TIL VIERVATN OG FOSSDALEN Is- og vindlaster 27.03.1985 Oppdragsgiver: A/S Betongmast for Ardal og Sunndal Verk</p> | |
| | <p>12/85 FIKKE S M: EIRFJELL RADJOLINJESTASJON Is- og vindlaster 09.04.1985 Oppdragsgiver: Teledirektoratet TBA</p> | |