STYRELSEN FÖR

VINTERSJÖFARTSFORSKING

WINTER NAVIGATION RESEARCH BOARD

Research Report No 47

Pentti Kujala

RESULTS OF LONG-TERM ICE LOAD MEASUREMENTS ON BOARD CHEMICAL TANKER KEMIRA IN THE BALTIC SEA DURING THE WINTERS 1985 TO 1988

Sjöfartsstyrelsen
Finland

Finnish Board of Navigation

Sjöfartsverket
Sverige

Swedish Administration
of Shipping and Navigation

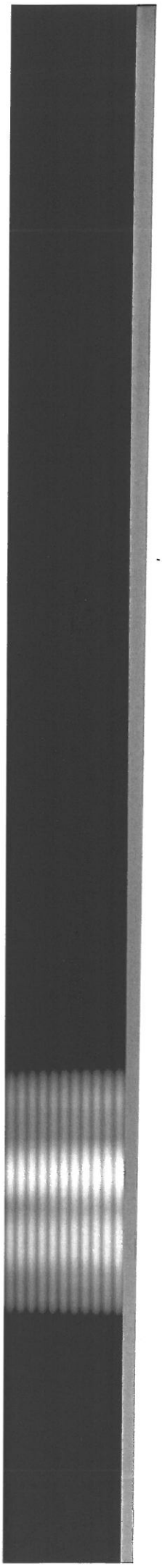
PENTTI KUJALA

RESULTS OF LONG-TERM ICE LOAD MEASUREMENTS ON BOARD CHEMICAL TANKER KEMIRA IN THE BALTIC SEA DURING THE WINTERS 1985 TO 1988

TECHNICAL RESEARCH CENTRE OF FINLAND
Ship Laboratory

HELSINKI UNIVERSITY OF TECHNOLOGY
Laboratory of Naval Architecture
and Marine Engineering

Espoo, October 1989



The Finnish Government Printing Centre
Helsinki 1989

Foreword

Earlier measurements of ice loads on a ship's hull in the Baltic were made on ice breakers. While they greatly contributed to our understanding of the nature of ice loads, the results were of course not as such representative for the ice loads on an ice going merchant ship.

In this report no 47 the Winter Navigation Research Board now presents the results of measurements made on a tanker in regular traffic on the Baltic over several winters. This study is a part of an undertaking to achieve a better basis for the design of the hull of a Baltic merchant ship.

The Winter Navigation Research Board warmly thanks mr Kujala and his colleagues for this report as well as the crew of MS KEMIRA, who greatly assisted them in their work.

Helsinki and Norrköping

October 1989

Kyösti Vesterinen

Kaj Janérus

LIST OF CONTENTS

ABSTRACT

Long-term ice load measurements on board M/S Kemira have been conducted since the winter of 1985. One area at bow, mid- and aftship were instrumented for the measurements and an automatic data collecting system was installed on board the ship. In this report the measuring system is described and the results during the winters 1985 to 1988 are presented. The ice conditions during the winters 1985 to 1988 are also described. Most of the highest loads encountered have occurred in heavily ridged ice near the Kokkola lighthouse both during navigation through the ridge and while stuck in compressing ridged ice. The maximum value measured on the bow frame is 653 kN, on the midship frame 323 kN and on the aftship frame 421 kN. When these values are compared with the design load values according to the present Baltic ice rules the difference is greatest, in relative terms, at the aftship.

1 INTRODUCTION

Level of design loads for shell structures of ships navigating in Baltic ice conditions are based on experience and damage records from ships built for these conditions. The relation between ice conditions and the level of ice-strengthening is not explicitly specified in the ice rule. One reason for this is that the characteristics of ice-induced loads in various ice conditions are not properly known.

Full-scale measurements of ice-induced loads have played an important role in developing theoretical models and statistical characteristics for ship-ice interaction in various ice conditions. The published data on measured loads are, however, mainly related to the loads on the bow of an icebreaker. No published long-term data exist on ice-induced loads on the hull of a typical ice-strengthened merchant ship navigating regularly in Baltic ice conditions.

Therefore a joint research project between Helsinki University of Technology/Laboratory of Naval Architecture and Marine Engineering and The Technical Research Centre of Finland/Ship Laboratory was started in autumn 1984 to measure ice-induced loads on a chemical tanker Kemira, which navigates regularly between Finland and Central Europe. One area at bow, mid-

and aftship was instrumented for the measurements and a automatic data collecting system was installed on board th ship. In this report the results of the measurements durin the winters 1985 to 1988 are presented. Most of the result were gathered with the automatic measuring system during th normal operation of the ship. Some manned voyages were con· ducted during the winters 1987 and 1988 to collect mor detailed data on the loads and prevailing ice conditions.

This report concentrates on presenting the main results of th measurements and the analyses conducted are limited to studie of the effect of maximum ice thickness on the measured load in various types of ice.

2 THE MEASURING SYSTEM

2.1 Description of the ship

M/S Kemira is an 8145 DWT chemical tanker regularly navigating between the ports Kokkola and Uusikaupunki on the Finnish coast and ports such as Wismar and Fredericia in Central Europe. M/S Kemira was built in 1980 to ice class 1A Super. Fig. 1 shows the ship in harbour.

Fig. 1. Chemical tanker Kemira in Kokkola harbour.

The shell structures of M/S Kemira are transversely framed up to level of 8 meters from the base line, see Fig. 2. Frame spacing is 350 mm and the thickness of shell plating is 21 mm at bow and 16 mm at mid- and aftship. The frames have L-profile with the dimensions shown in Fig. 2. The required section moduli for the transverse frames according to the present ice rules using normal strength steel are 684 cm^3, 416 cm^3 and 311 cm^3 at bow, midship and aftship respectively. The section moduli of the installed frames are 719 cm^3, 386 cm^3 and 349 cm^3.

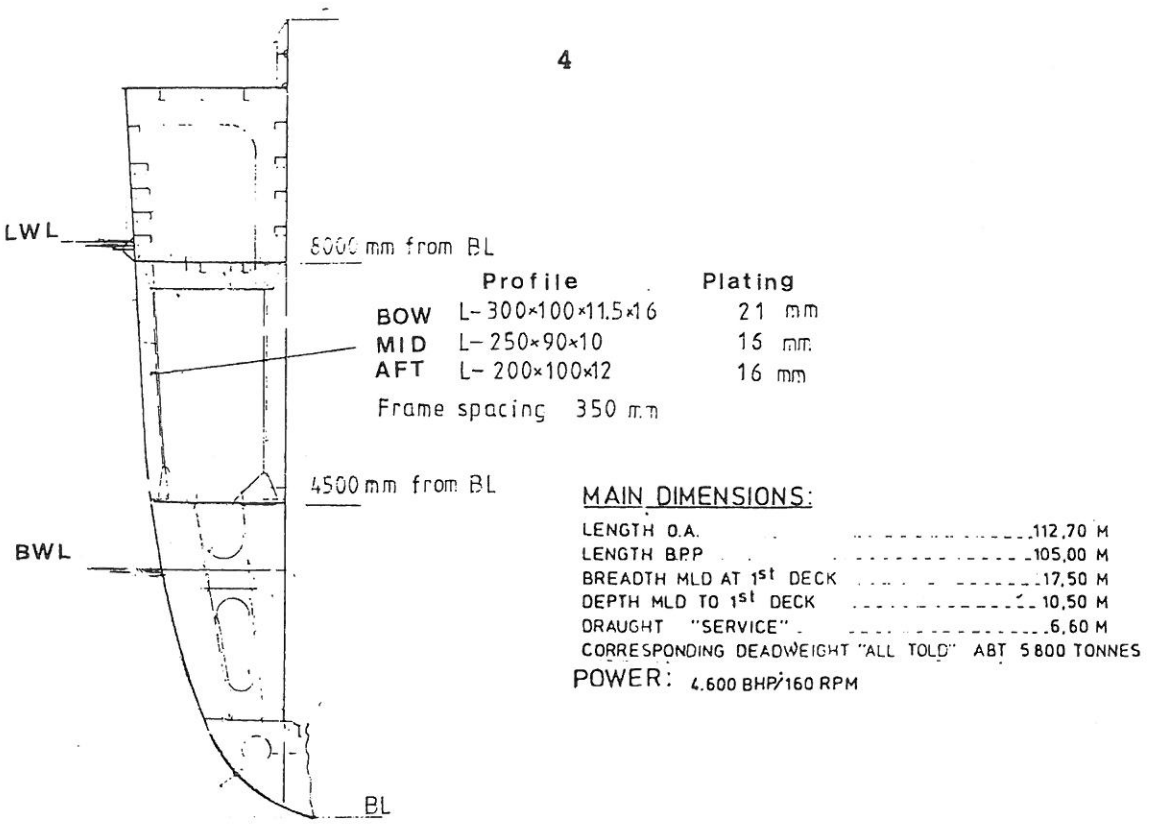
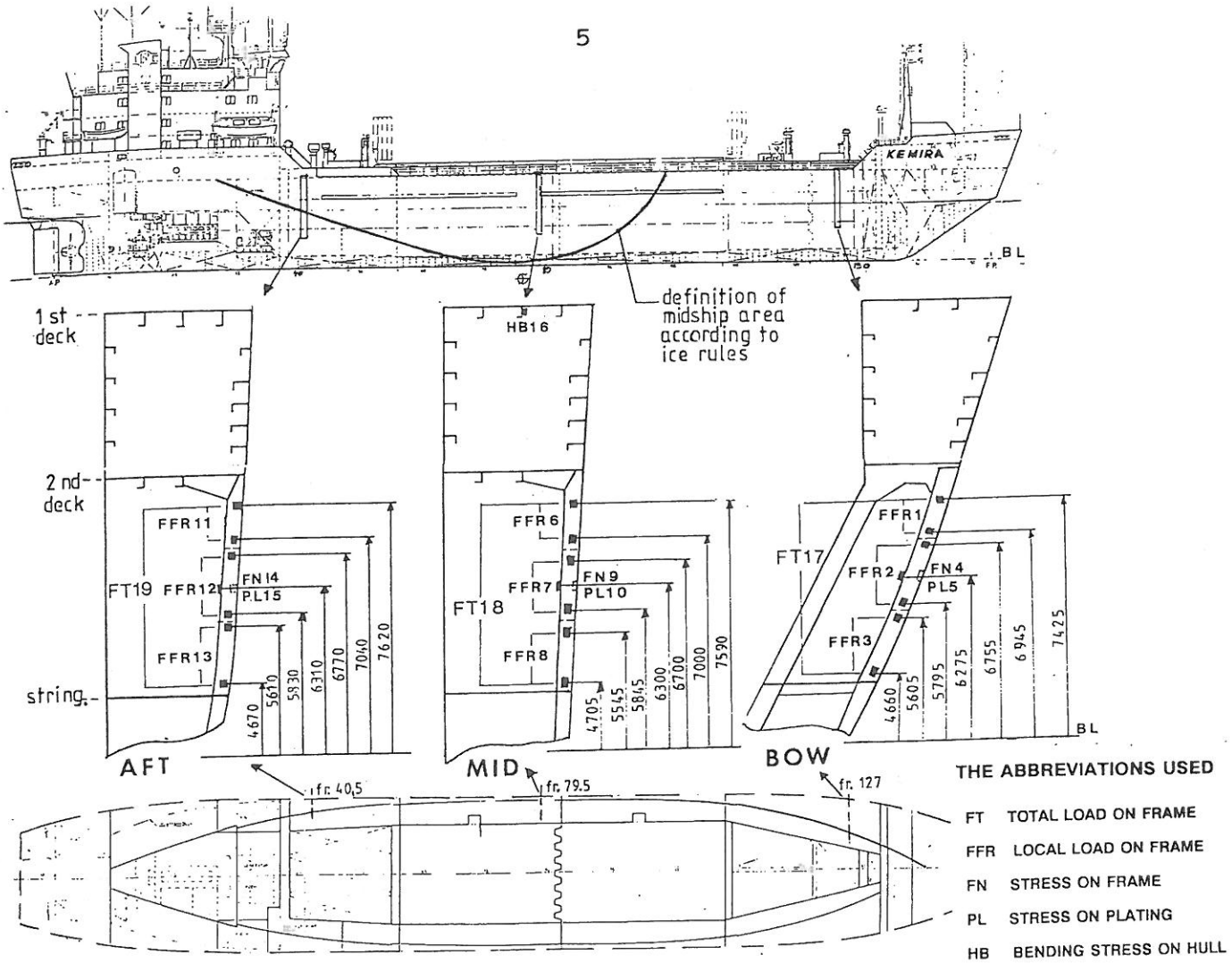


Fig. 2. Shell structures and main dimensions of M/S Kemira.

2.2 The instrumentation

A number of methods exist to instrument a ship for determination of local full-scale ice loads. Traditionally the bending stresses of the frames and plating are recorded and from these the loads required to cause the stresses are estimated e.g. by constructing a finite element model of the structure (Varsta 1977). Also local ice-induced pressures have been recorded with pressure gauges specially developed for this purpose (Korri et al. 1979, Vuorio et al. 1979). The measurements of shear strains e.g. on the web of a frame together with determination of influence coefficients enable direct recording of ice-induced loads (Riska et al., 1983). The latest installations have included separate load measuring panels, which have been attached to the bow of a ship to measure the friction between ship hull and ice (Hoffmann, 1985).

The approach of recording shear strains on the web of a frame is chosen for the present study, because the loads experienced by frames are the main interest. The general layout of the measuring system is presented in Fig. 3.



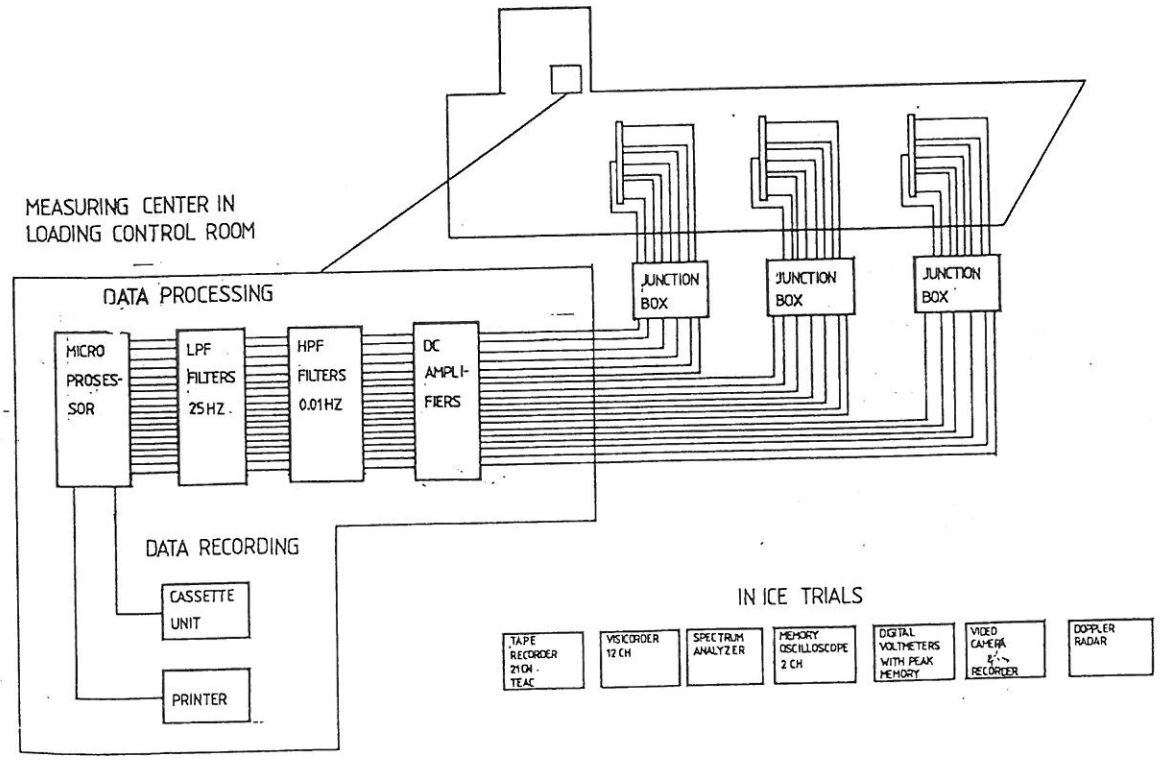


Fig. 3. Layout of the measuring system.

One frame at bow, mid- and aftship is instrumented. The definition of the various areas is taken from the ice rules (1985). As shown in Fig. 3 the frame instrumented aft is only partly on the aftship area, as the end of the tank forms the limit for the possible location of the installation.

The loads are evaluated with the shear strain gauges applying influence technique. The shear strain gauges are connected so that the load on the upper, middle and lower part of the frame, FFR, as well as the total load on a frame, FT, can be measured. The normal stress gauges on the frames, FN, and plating, PL, near the instrumented frames are installed to gather data on the stress level of the structure and to check the calibration of the shear strain gauges. Also the bending stresses of the hull at midship (HB) are registered. Consequently the system includes altogether 19 channels. The abbreviations used for the channels can be seen in Fig. 3.

In the long-term measurements, the data are collected and processed automatically by a microprocessor specially developed for this purpose (Vuorio et al., 1979). The microprocessor collects the data and prints it on a data cassette and paper tape once or twice a day i.e. in 24 or 12 hour periods.

2.3 Calibration of the measuring system

The influence coefficients for the load-measuring system are evaluated with the finite element model shown in Fig. 4. Two models are constructed, one for the midship and one for the bow ship. The scantlings of the aftship are quite similar to the scantlings at midship. Therefore the influence coefficients for the aftframe are evaluated on the basis of the results for the midship frame taking into account the differencies in the scantlings.

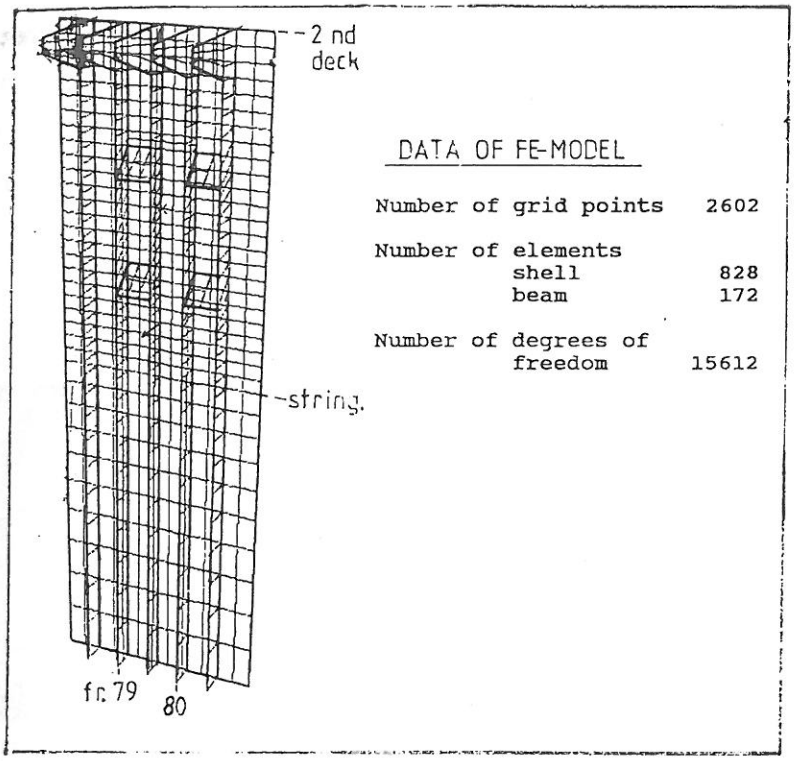


Fig. 4. The finite element model of the shell structures.

The coefficients are determined for the case of uniform ice pressure with load height 0.3 m and load length two frame spacings 0.7 m. The measuring system is not sensitive to the load height as the total load on the frame is measured by the system. The load length has an effect on the influence coefficients as the amount of the load distributed to the adjacent frames is related to the load length. The load length of two frame spacings represents continuous ice pressure loading on the instrumented frame.

The calibration of the system is based on the assumption that the load length is usually longer than two frame spacings. If the contacts are shorter than two frame spacings, the system can give figures up to 30% too small for the loads. The shorter the contact is the bigger the error. The previous full-scale measurements have, however, indicated that the length of the contact is usually a few frame spacings (Kujala et al. 1986).

The finite element calculations are checked by applying inside point force on the midship and aftship frame. The point force is generated with a hydraulic cylinder and the force

is measured with a force gauge, see Fig. 5. The results are compared with those given by the finite element in Figs 6 and 7. As can be seen from Figs. 6-7 the results are comparable within the limits of +- 10 %. The accuracy of the system is discussed further in chapter 4.4 based on some measured results.

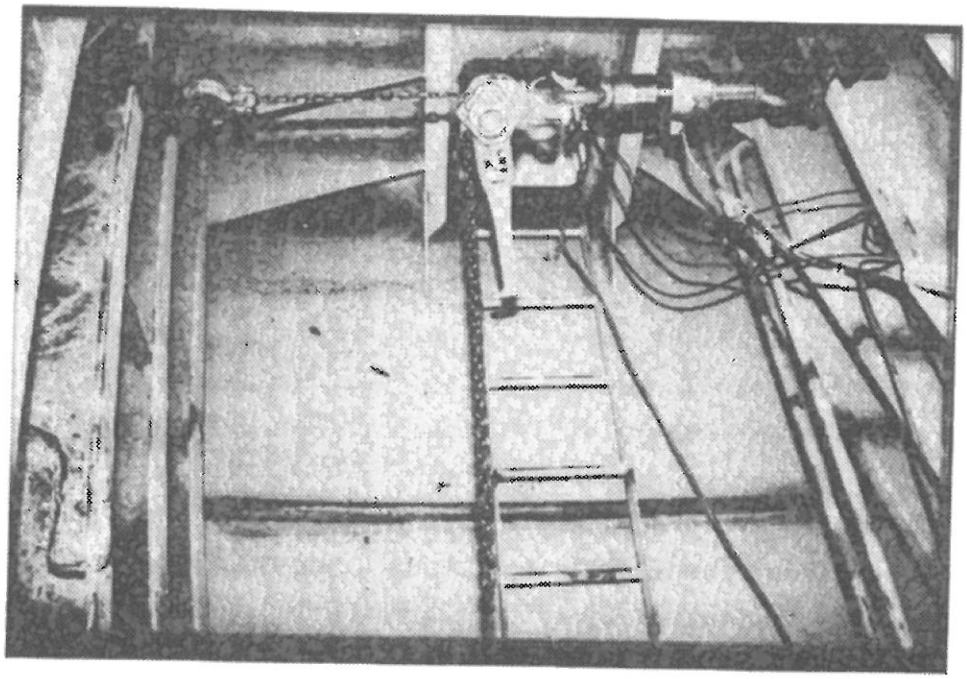


Fig. 5. The physical calibration of the midship frame.

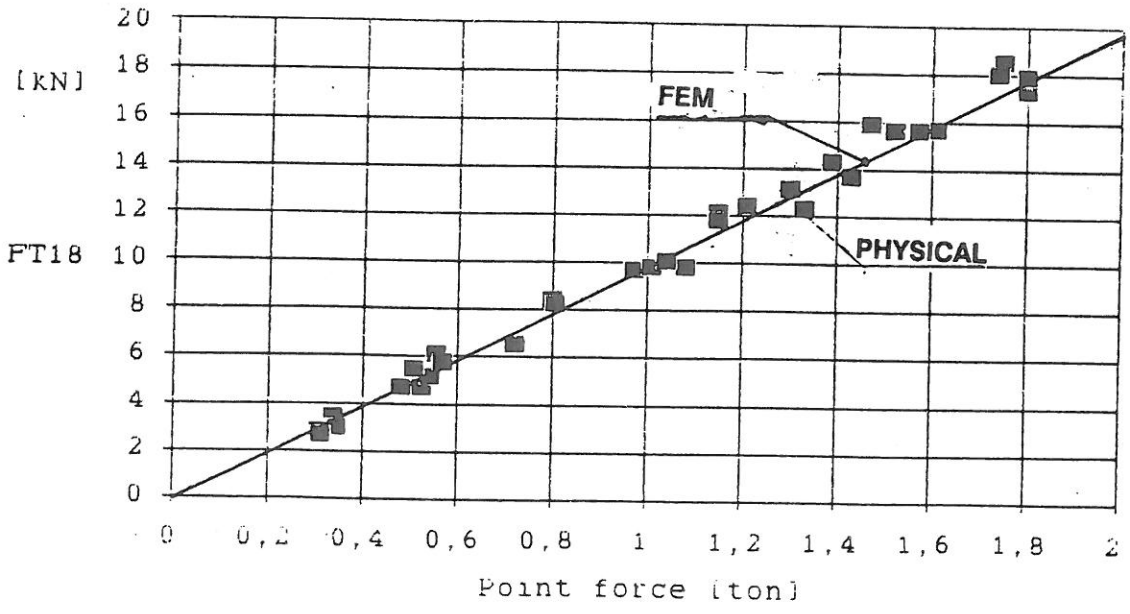


Fig. 6. Comparison of the physical calibration of the midship frame with the calibration with FEM calculations.

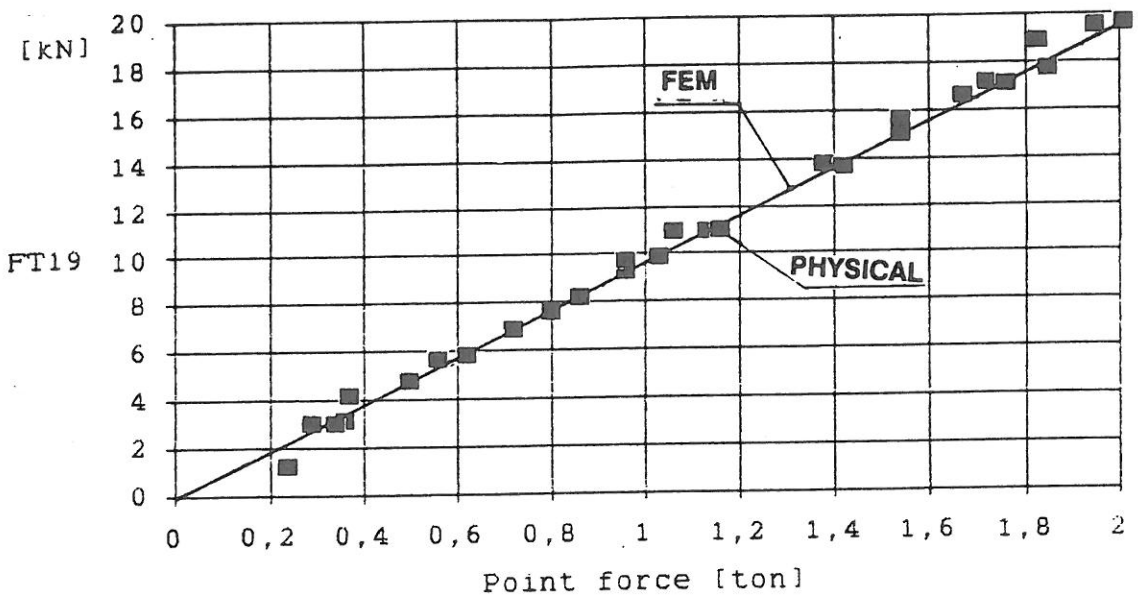


Fig. 7. Comparison of the physical calibration of the aftship frame with the calibration with FEM calculations.

3 CONDUCTED MEASUREMENTS

3.1 Description of the winters 1985 to 1988

The severeness of a winter is usually determined on the basis of the maximum ice extent during the winter. In a normal winter, the whole Bothnian Bay and Bothnian Sea are covered by ice so that the maximum ice extent is about 210 000 km^2 (Leppäranta & Seinä, 1985). Fig. 8 gives the maximum extent of ice during the winters 1830 to 1988. As can be seen winters 1985, 1986 and 1987 have been harder than an avarage winter and winter 1988 milder. In the following the development of ice conditions during the winters 1985 to 1988 are described in more detail.

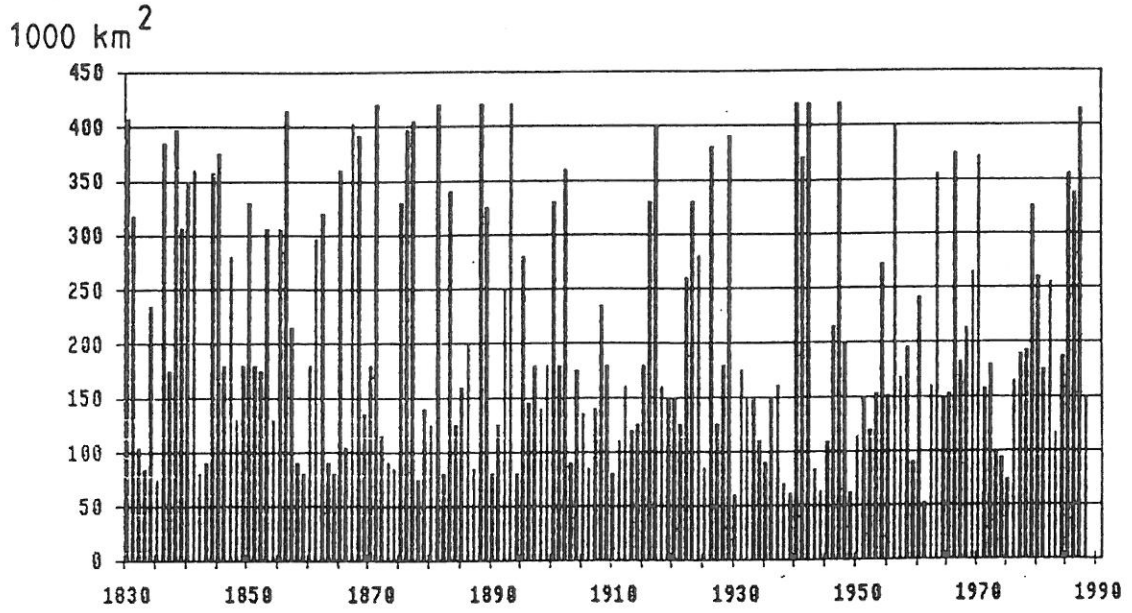


Fig. 8. The maximum extent of ice during the winters 1830 to 1988.

During the winter of 1985, the Bothnian Bay became entirely covered by ice on the 7th of January and the Bothnian Sea on the 6th of February. The most extensive conditions of the winter were reached on the 22nd of February, when the ice reached down to the southern coast of Gotland. The Bothnian Bay became ridged in late January and remained almost stationary from the beginning of February to the end of April. The ice thickness increased until early March in all the sea

areas. Appendix 1/1 gives a typical ice chart after this period. From the Baltic proper, sea ice disappeared at the beginning of April. In the Bothnian Sea melting started at the beginning of April and ice finally disappeared in the middle of May. Ice disappeared from the Bothnian Sea at the end of May.

During the winter of 1986, freezing started somewhat earlier than normal so that the Bothnian Bay became entirely covered by ice on the 30th of December and the Bothnian Sea on the 23rd of January. Thereafter the ice coverage increased fairly slowly until the 20th of February, when the maximum extent of ice was reached so that ice extended to the very northern part of the Baltic proper. The maximum ice thicknesses were reached on the 3rd of March, see appendix 1/2. The melting of ice started soon after that. The southerly winds after the middle of March pushed the ice in the Bothnian Bay to the northern part of the bay and ridged the ice left on the northern Bothnian Sea heavily. The situation remained difficult until the 10th of April, when due to the melting of ice ledges occurred in the Bothnian Sea. Finally the ice disappeared from the Bothnian Sea in the middle of May and from the Bothnian Bay at the end of May.

In the winter of 1987, freezing started fairly slowly so that the entire Bothnian Bay was covered by ice on the 5th of January. The entire Bothnian Sea was covered by ice on the 15th of January. Thereafter the ice coverage and thicknesses grew gradually until the 12th of March, when the maxima were reached, see appendix 1/3. The ice disappeared from the Baltic proper in the middle of April, from the Bothnian Sea in the middle of May and from the Bothnian Bay at the end of May.

In the winter of 1988, the entire Bothnian Bay was covered by ice on the 28th of January. The maximum ice extent was reached on the 29th of February covering just the Bothnian Bay and northern Bothnian Sea. The extent remained unaltered until late March, when the maximum ice thicknesses were reached, see appendix 1/4. The ice disappeared from the Bothnian Sea

at the beginning of April and from the Bothnian Bay in the middle of May.

For the present study the Baltic Sea is divided into four sea areas as shown in Fig. 9. During the measurements M/S Kemira did not navigate in the Gulf of Finland, therefore it is omitted from the following figures. Table 1 summarizes the maximum ice thicknesses and total sum of freezing in degrees during the measured winters in various sea areas. The sum of freezing and maximum fast ice thickness outside Kokkola represents the Bothnian Bay, outside Vaasa represents the Bothnian Sea and outside Turku represents the Baltic proper sea area.

Table 1. Summary of ice conditions during the measured winters in various sea areas.

	Sea area	Max sea ice thick. (cm)	Max fast ice thick. (cm)	Total sum of freezing (^{o}C day)
	Baltic proper	40	50	-747
1985	Bothnian Sea	60	73	-1196
	Bothnian Bay	70	95	-1356
	Baltic proper	30	50	-398
1986	Bothnian Sea	60	49	-1027
	Bothnian Bay	60	54	-1196
	Baltic proper	40	70	-807
1987	Bothnian Sea	60	70	-1181
	Bothnian Bay	70	95	-1394
	Baltic proper	0	25	-156
1988	Bothnian Sea	20	40	-556
	Bothnian Bay	40	50	-739

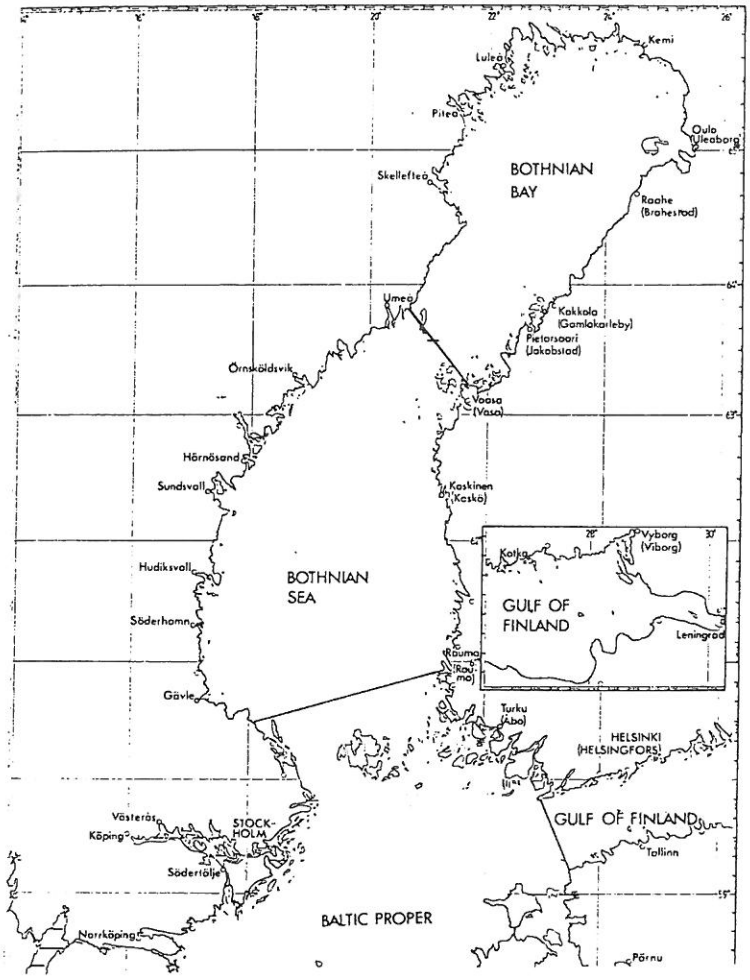


Fig. 9. The division of the Baltic Sea into various sea areas.

3.2 Automatic long-term measurements

3.2.1 General

The measuring system was installed on board M/S Kemira in autumn 1984. Thereafter the system has worked continuously during the winters of 1985 to 1988 and has measured ice-induced loads automatically during the normal operations of the ship. Appendix 2 gives the navigation schedule of the ship during the measurements conducted. Table 2 gives a summary of the measuring period and number of ice navigation days of each measured winter. Navigation day means that the measuring system has encountered ice-induced loads during that day.

Table 2. Measuring period and number of days of navigation in ice in various winters and sea areas.

Winter	Measuring period	Number of ice navigation days			
		Baltic proper	Bothnian Sea	Bothnian Bay	Total
1985	2.2-13.5	21	19	27	67
1986	1.1-29.4	22	16	26	64
1987	28.1-23.5	11	14	25	50
1988	7.1- 3.5	-	10	20	30

The measuring system has worked successfully most of the measuring time. A few problems in the output devices have, however, occurred and the results from the following periods are lost: 23.1-2.2.1986, 26.2-2.3.1986, 7.-21.3.1988, 23.-25.3.1988 and 28.3.-7.4.1988. These periods include about 5 ice days in winter 1986 and 4 ice days in winter 1988. The measuring period of the winter 1987 was shortened, because the ship spent the period 1.3 - 31.3 in harbour and shipyard because of some repair work required. The attached strain gauges have worked well except for the following problems: channel FFR 8 was damaged on the 30th of April 1987 under compressive ice (see also chapter 4.2), Pl 10 was out of order during the winter of 1986, FN 14 was found to be located on the edge of flange of the frame whereas it should have been attached on the top of web of the frame (see also chapter 4.4). When the channels FT 17-FT 19 were included in the system for the winter 1987, channels FFR 8 and FFR 13 were excluded due to lack of space in the system.

The microprosessor was programmed so that the data was printed twice a day on paper and data casette i.e. the measuring period was 12 hours starting at midnight and at noon, except for the period of 1.4-13.5.1985 when the measuring period was 24 hours. The ice navigation of the ship was followed according to the data stated in the ship's logbook during the measured 12-hour periods. The prevailing ice conditions were obtained according to the data submitted by The Institute of

Marine Research. The data gave the daily ice conditions in geographical grids with the sides 30 minutes along the parallels and 15 minutes along the meridians (BASIS, 1981). The main principles of the coding used are given in appendix 3. Appendix 4 gives a summary of the variations of the following variables during the measured 12-hour periods:

- ship's draught
- displacement
- independent navigation time
- time of icebreaker assistance or towing
- total time in ice
- total voyage in ice
- navigation sea area
- ice type
- ice thickness.

In the following, some figures of the ship operations and ice conditions encountered are presented according to the data given in appendix 4.

3.2.2 Operation profile of the ship

As shown in Fig. 3 the lowest pick-up of the measuring system is located with ship's draught 4.66 m and highest with draught 7.62 m. This restriction is due to the change of the framing system from transverse to longitudinal. The actual draught of the ship varies from 3.0 m to 8.5 m as illustrated in Fig. 10, which is based on the summary of observed draughts during the measured ice days. The measuring system covers 70 % of the draught variations at the midship, 73 % at the bow and 65 % at the aftship due to trim of the ship.

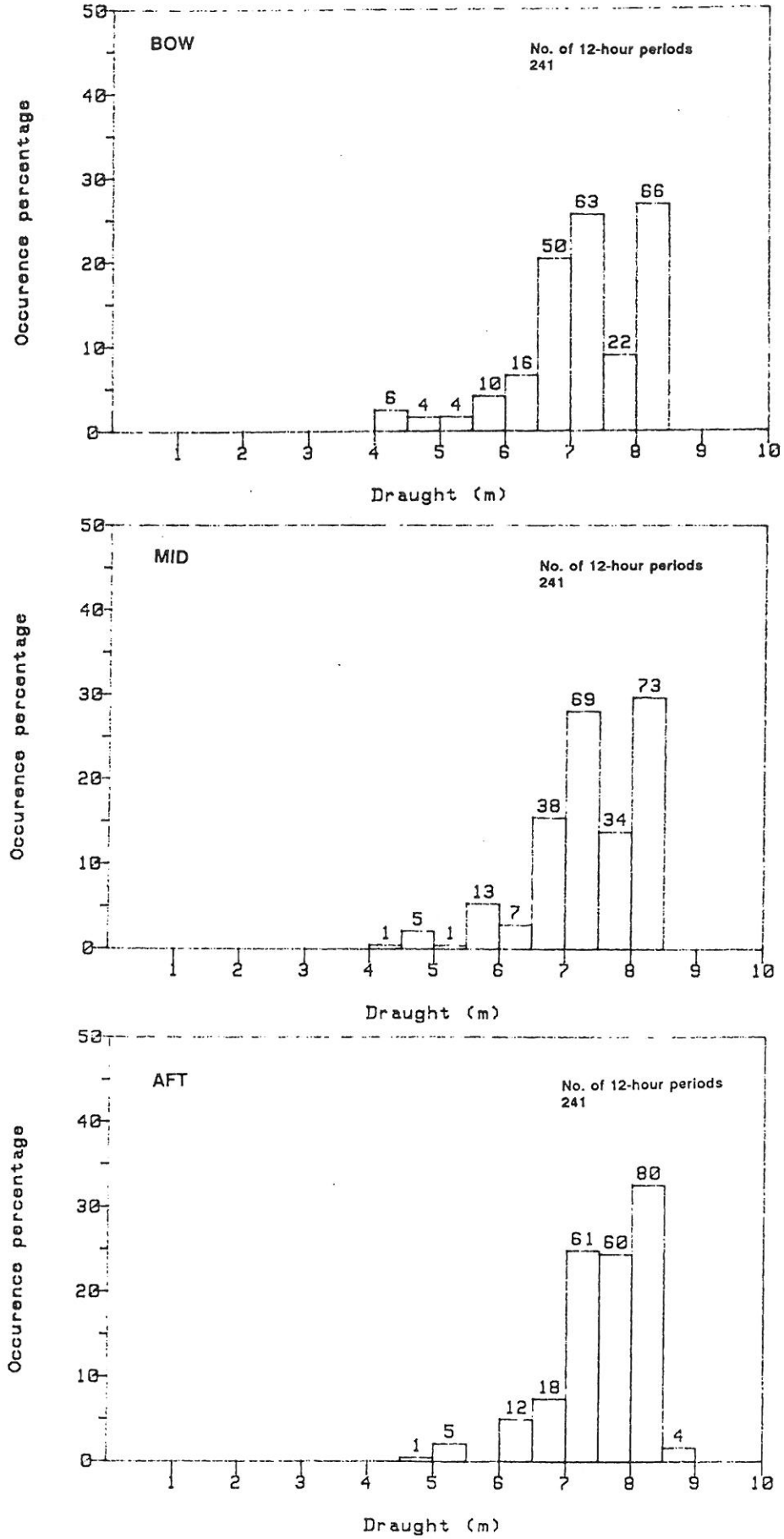


Fig. 10. The draught distribution at the bow, mid-, and aftship during the measurements 1985-1988.

Table 3 summarizes the operation profile of the ship during the measurements. Fig. 11 illustrates on a percentage basis the operation profile of the ship in various sea areas during the total measuring period and Fig. 12 similarly the profile of operations during the time in ice. Appendix 5 gives the same figures annually. As can be seen from Figs 11-12 the ship spent about 18 % of the total measuring time in ice, of which about 60 % was independent navigation, 25 % navigation with icebreaker assistance, 14 % stuck or waiting in ice and 1 % towing by icebreaker. Great variations take place in these figures annually as shown in appendix 5. In the following chapter the ice conditions encountered during the measurements are studied.

Table 3. The operation profile of M/S Kemira during the measurements.

	Time in ice [hour]					Voyage in ice [miles]	Time in open water [hour]	Time in harbour [hour]	Total meas. time [hour]
	Indepen.	IB assist.	IB towing	Stuck/Wait	Total				
Bothnian Bay									
1985	117	126	4	29,5	276,5	1950	11	561	848,5
1986	73,5	69,5	11,5	95	249,5	1230	48	443	740,5
1987	84,5	82,5	1	13	181	1848	20	514	715
1988	73,5	14	0	5,5	93	863	66	481	640
1985-1988	348,5	292	16,5	143	800	5891	145	1999	2944
Bothnian Sea									
1985	119	29	0	3	151	1460	145	163	459
1986	37	17	0	60	114	535	165	192	471
1987	58	15	0	0	73	815	148	144	365
1988	6,6	1	0	0	7,6	64	182	104	293,6
1985-1988	220,6	62	0	63	345,6	2874	640	603	1588,6
Baltic proper									
1985	172	0	0	0	172	1745	353	257	782
1986	74	0	0	2	76	755	594	112	782
1987	46,5	5,5	0	0	52	588	574	249	875
1988	0	0	0	0	0	0	813	318	1131
1985-1988	292,5	5,5	0	2	300	3088	2334	936	3570
Baltic Sea (Total)									
1985	408	155	4	32,5	599,5	5155	509	981	2089,5
1986	184,5	86,5	11,5	157	439,5	2520	807	747	1993,5
1987	189	103	1	13	306	3251	742	907	1955
1988	80,1	15	0	5,5	100,6	927	1061	903	2064,6
1985-1988	861,6	359,5	16,5	208	1445,6	11853	3119	3538	8102,6

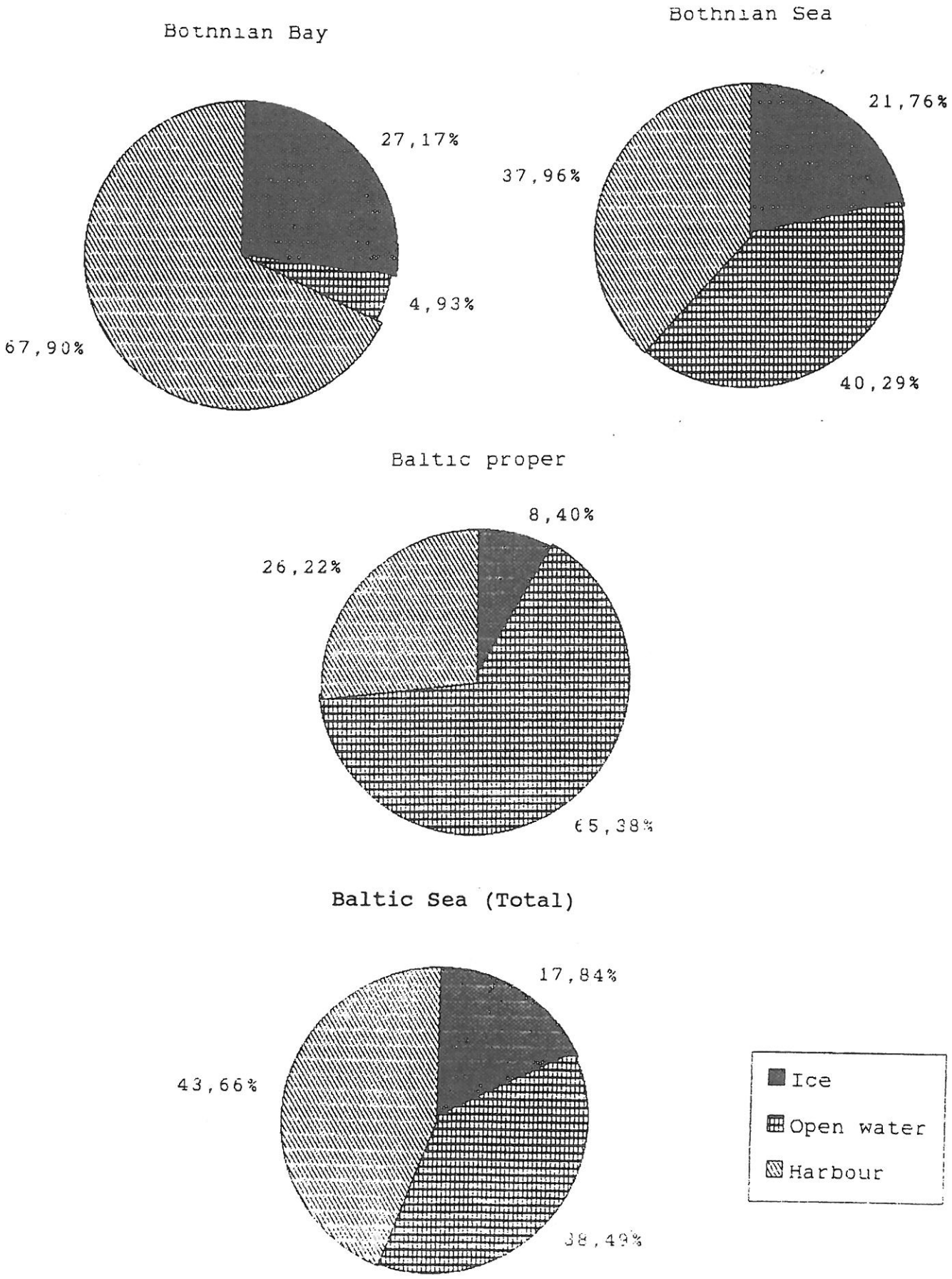


Fig. 11. The operation profile of M/S Kemira during the winters 1985 to 1988 in various sea areas.

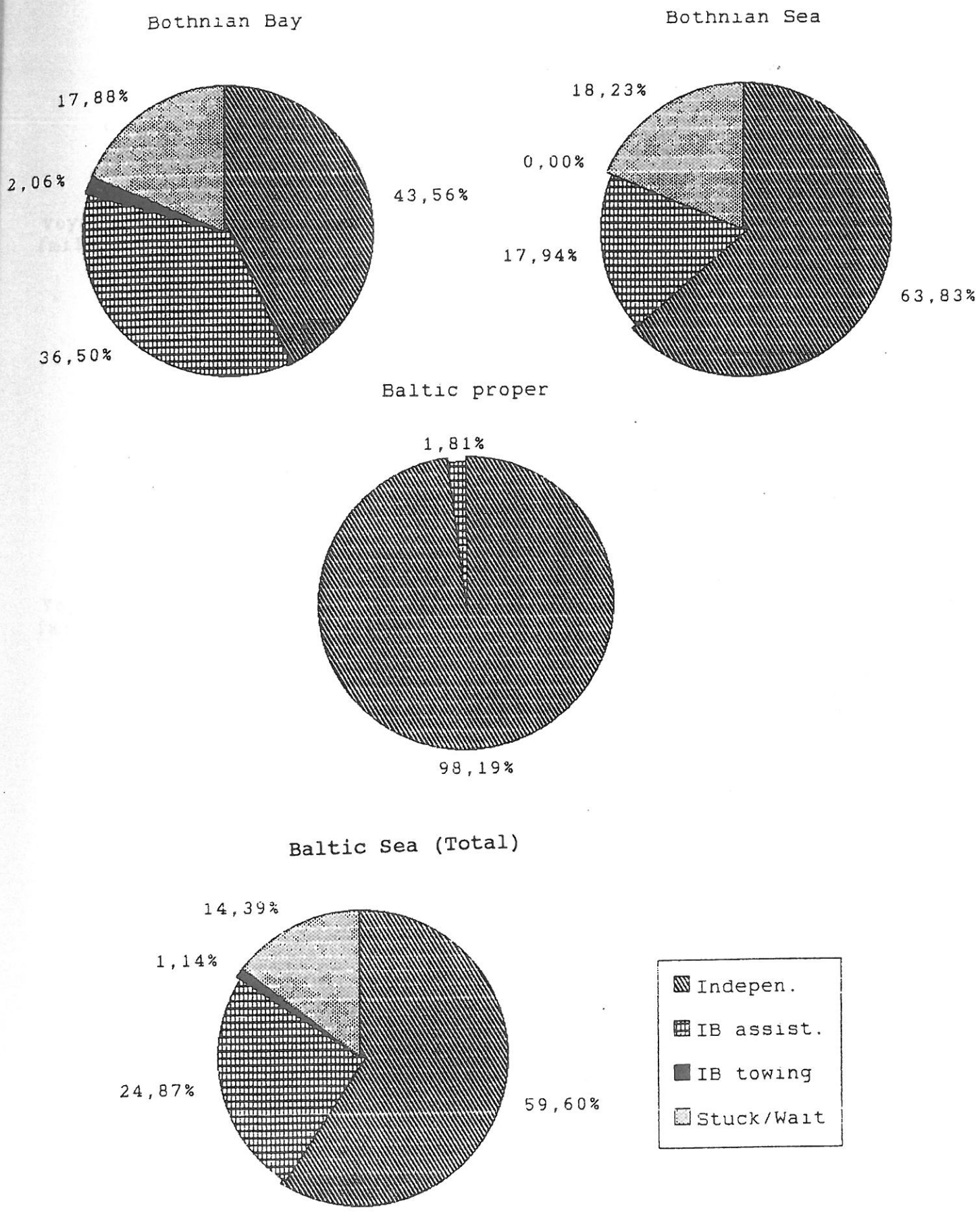


Fig. 12. The profile of ice navigation of M/S Kemira during the winters 1985 to 1988.

3.2.3 The ice conditions encountered

The ice conditions encountered by the ship are summarized so that the voyage travelled in various ice conditions independently or with icebreaker assistance are presented. The ice conditions are grouped in four categories:

- fast ice (index 39)
- new ice (index 30-33)
- pack ice (index 50-70)
- ridged ice (index 80-86)

The indices are specified in appendix 3. The category of pack ice includes basically a great variety of ice conditions, but the conditions with encountered ice loads have been mainly pack ice with large floes or consolidated pack ice. This category together with the new ice represents the part of sea ice, which has been fairly level. Figs 13 illustrate the total voyage in these ice conditions in various sea areas during the measurements. Appendix 6 shows the annual figures.

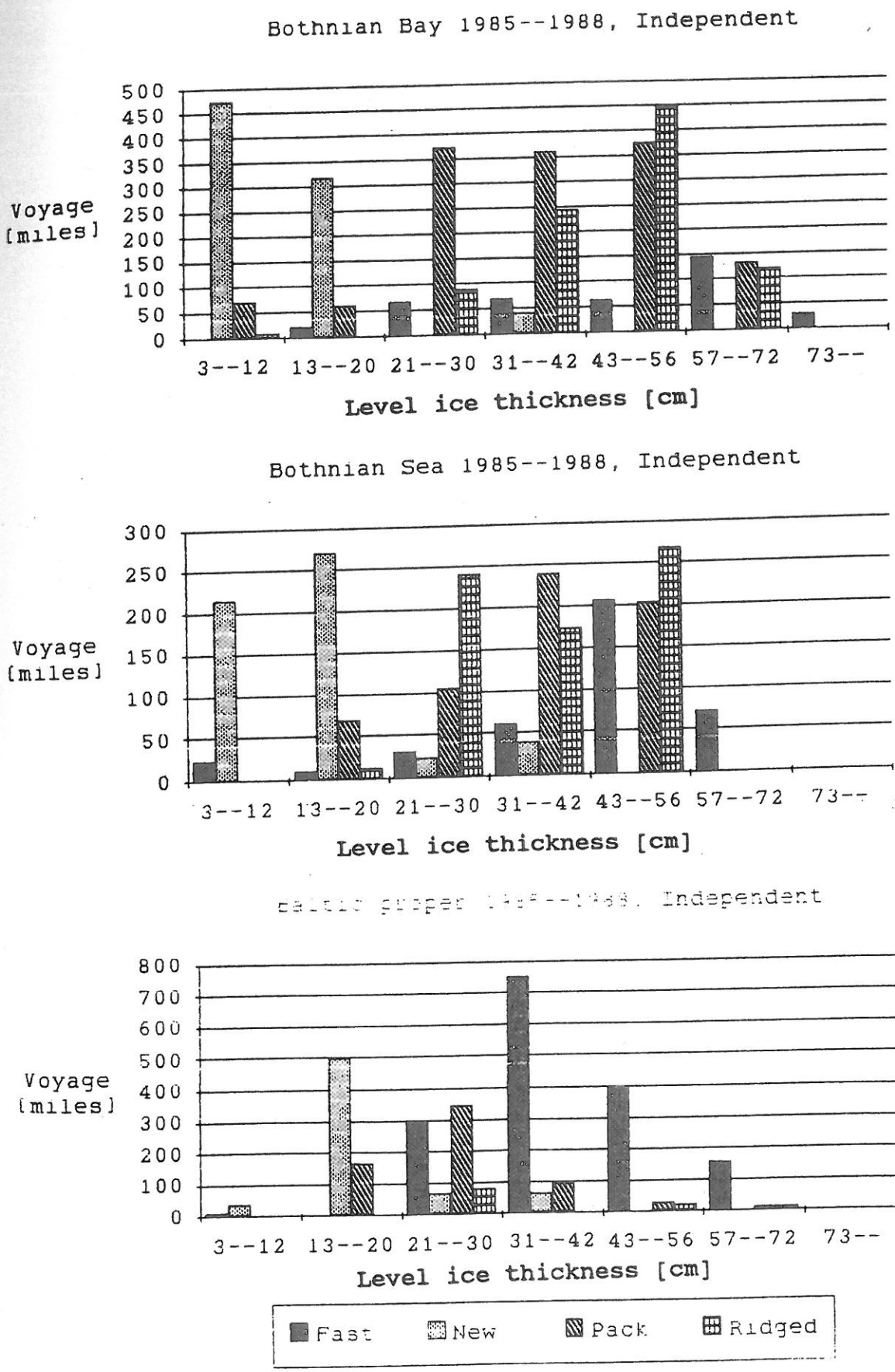


Fig. 13a. Voyage in various ice conditions and level ice thickness classes while navigating independently during the measurements.

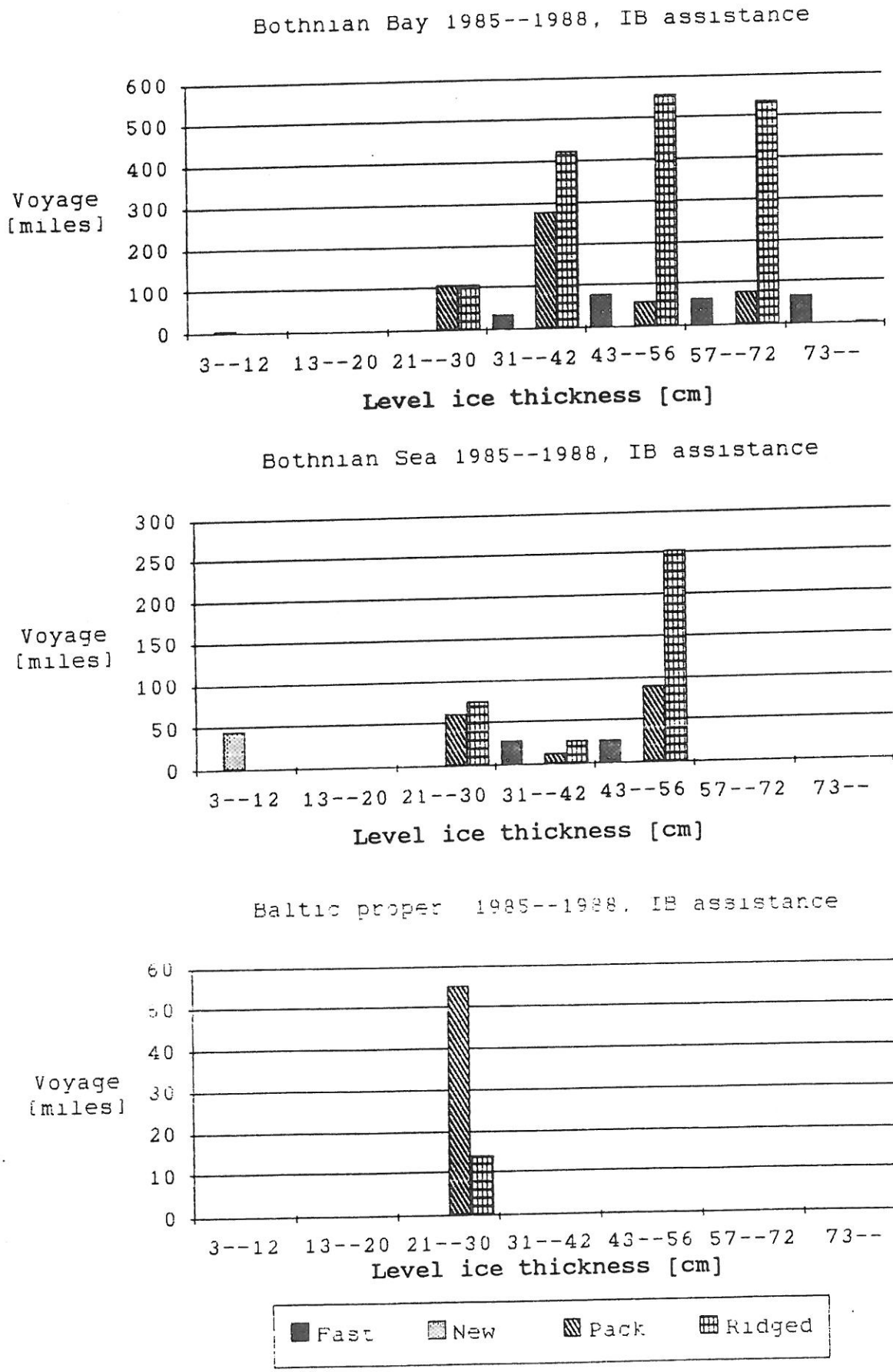


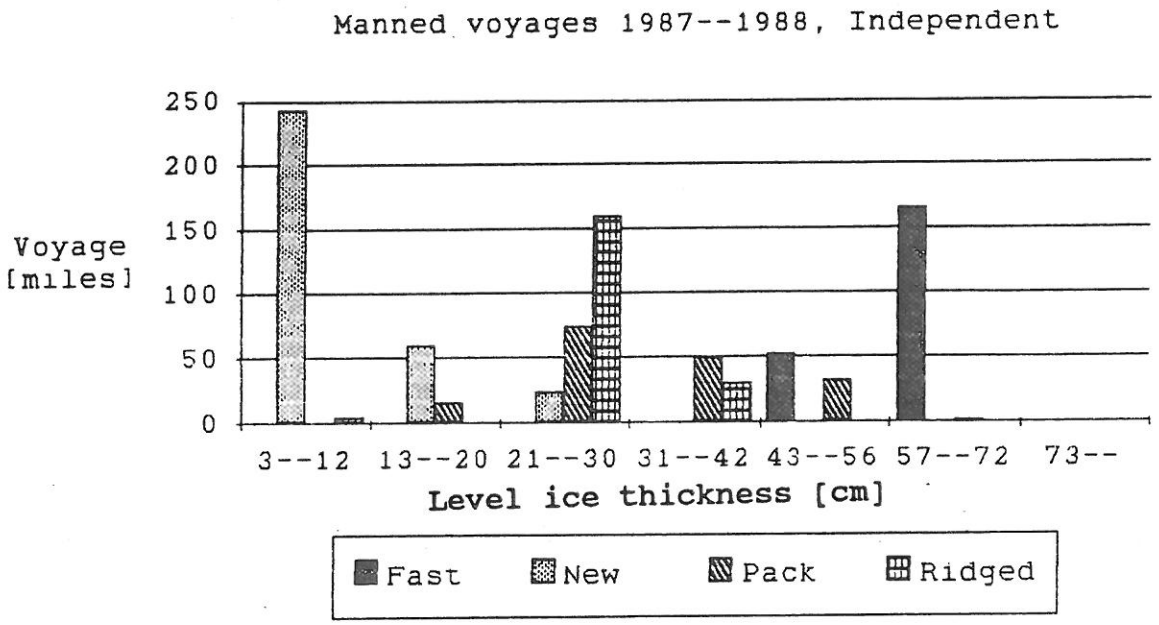
Fig. 13b. Voyage in various ice conditions and level ice thickness classes while navigating with icebreaker assistance during the measurements.

3.3 Manned voyages

Some manned voyages were conducted during the winters of 1987 and 1988 to study in more detail the ice-induced loads in various ice and operation conditions. During the manned voyages, the microprocessor was programmed to print the measured data at one hour intervals. For each hour the same data as specified in chapter 3.2.1 for 12-hour intervals was gathered and in addition air temperature and wind speed were observed. The ice conditions were studied with a video camera installed on board the ship. Also some recordings of typical time histories of the measured channels were conducted. Table 4 gives a summary of the manned voyages and appendix 7 shows the routes of the ship during the voyages together with the profile of ship operations and ice conditions encountered. The mean speed of the ship can be obtained on the basis of the voyage in ice during an hour given in appendix 7. Fig. 14a illustrates the voyage of the ship and Fig. 14b the mean speed of the ship in various ice conditions while navigating independently or with icebreaker assistance during the measured 1 hour periods.

Table 4 Summary of the manned voyages conducted

Voyage	Route	Draught			Navigation time		
		Bow	Mid	Aft	in ice Indep	IB	open water
			(m)			(hour)	
1987							
28-29.1	Kokkola-Uki	7.3	7.5	7.	12.5	10.8	2
10-11.2	Kokkola-Uki	7.4	7.5	7.	5	20	4
31.3-1.4	Turku-Ventsp	4.4	4.8	5.6	6.8	0.8	10
1-2.4	Ventsp-Uki	7.0	7.2	7.4	10		10
25-26.4	Uki-Kokkola	6.8	7.0	7.2	12.6	3.5	16.9
1988							
20-21.2	Uki-Oulu	6.8	7.0	7.2	13.1	3.5	13
24-25.2	Oulu-Uki	6.2	6.6	7.1	15.5	4.8	12.5
3-4.3	Uki-Kokkola	6.5	6.7	6.9	1.1	6.4	12
5-6.3	Kokkola-Uki	6.8	7.1	7.3	7.5		13



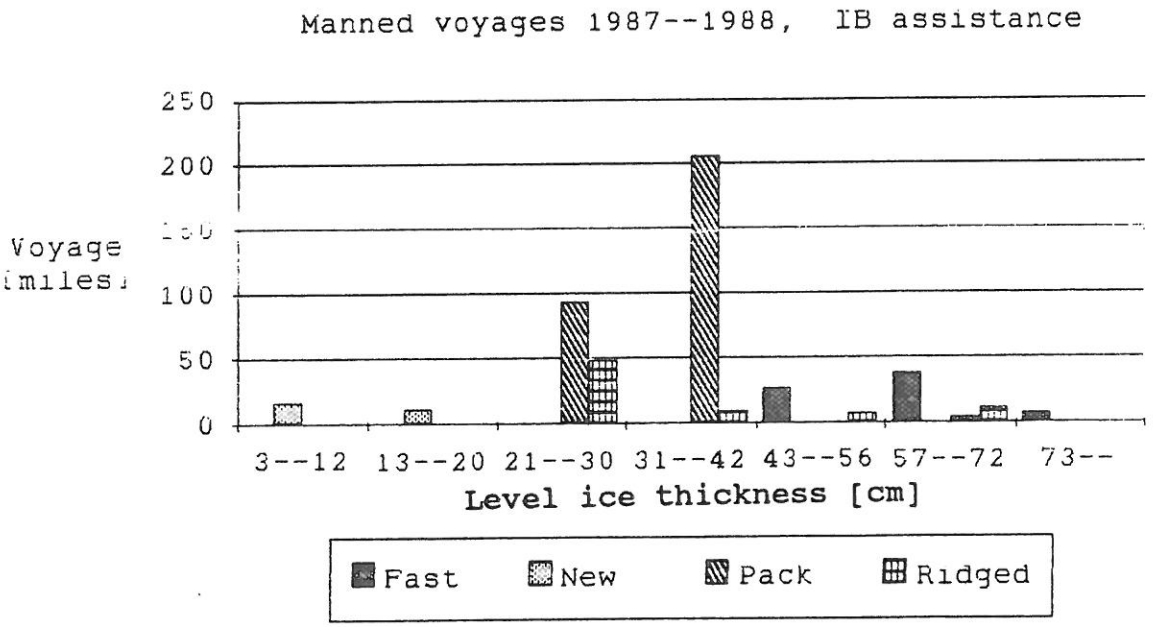
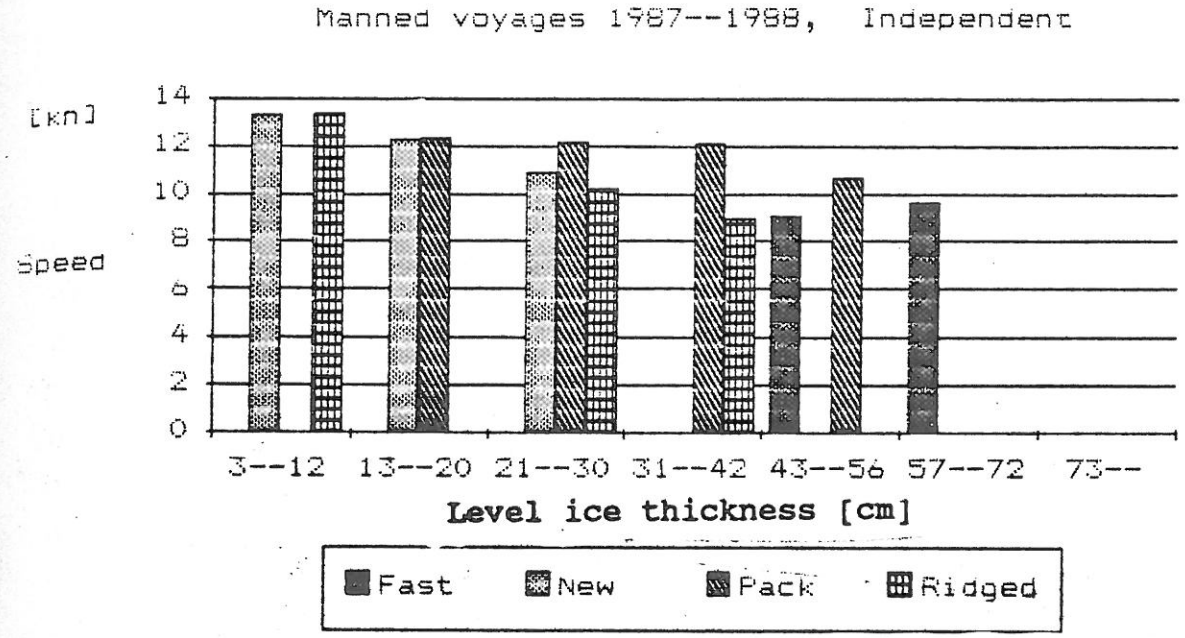


Fig. 14a. Voyage of M/S Kemira in various ice conditions and level ice thickness classes during the manned voyages while navigating independently or with IB assistance.



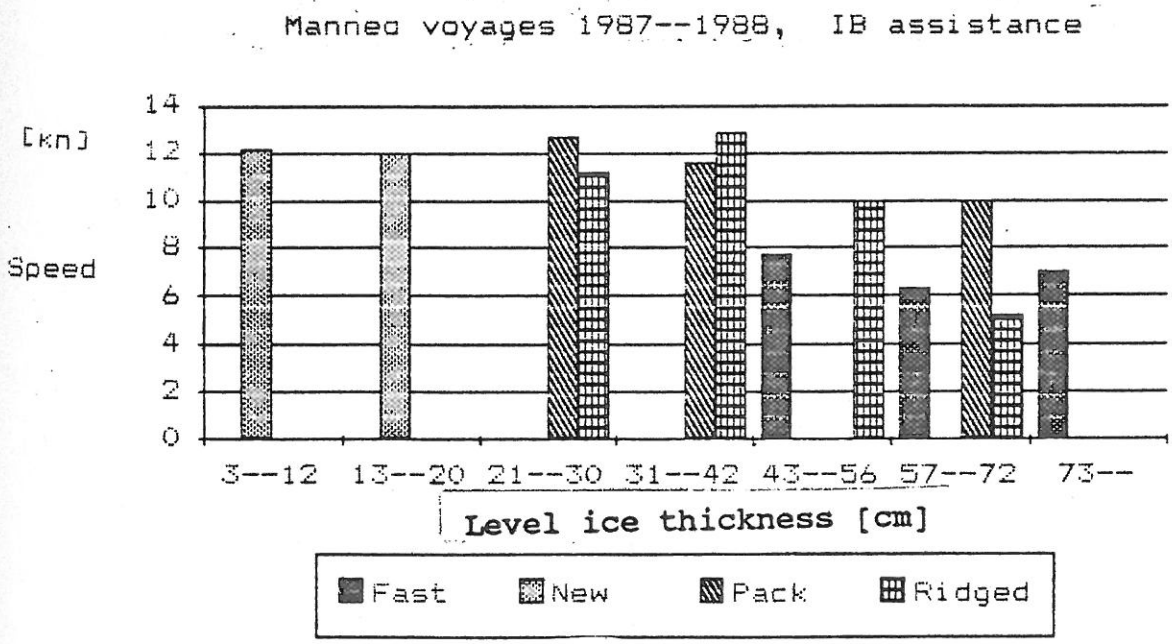


Fig. 14b. Mean speed of M/S Kemira in various ice conditions and level ice thickness classes during the manned voyages while navigating independently or with IB assistance.

4 RESULTS OF THE MEASUREMENTS

4.1 Manned voyages

Some examples of the recorded time histories are given first. The time histories were measured during the manned voyage on 26th of April 1987, see appendix 7/4 for the route of the ship and ice conditions encountered. For the bow channels, time histories in four ice conditions are given : Fig. 15a shows time histories in ridged ice, Fig. 15b in consolidated pack ice, Fig. 15c in channel behind an icebreaker and Fig. 15d in a thick ridge behind an icebreaker just before the ship got stuck near the Kokkola lighthouse. Fig. 15a gives also the measured time history of ship's speed and dynamic part of the stress on the deck plating at midship. Fig. 16 gives the highest time histories recorded for the midship channels, which occurred at the same time as the time histories given in Fig. 15d for the bow. Fig. 17 gives the highest time histories recorded for the aftship channels, which took place while navigating independently in consolidated pack ice. Finally Fig. 18 gives two examples of a time history of the stress on the plating at the aftship while the ship was stuck in ice in the thick ridge near the Kokkola lighthouse.

Appendix 8 summarizes the measured 1 hour maximum values for the measured channels during the manned voyages and gives graphically the maxima for the load channels FT 17, FT 18 and FT 19 at bow, midship and aftship respectively. The highest load on the bow (430 kN) and stress on the frame (250 MPa) occurred during the voyage on 25th to 26th of April 1987 (see appendix 8/4 and 7/4), when the ship was navigating independently in the ridged ice with ice concentration of 20 to 40 % and could therefore keep a fairly high speed (10-12 kn) among the ridged ice floes. Other high loads occurred on the 2nd of April (see appendix 8/3 and 7/3), when the ship came from the open sea to the fast ice and had to go through the ridged ice field in front of the fast ice zone. Also Fig. 15d shows an example of high load at the bow, the load occurring about 1.5 metres

below the actual waterline. The highest stress on the bow plating (290 MPa) occurred on 24th of February 1988, when the ship was navigating independently in fast ice channel (see appendix 8/6 and 7/6).

For the midship the highest load (323 kN) and stress on the plating (200 MPa) and frame (290 MPa) took place on 26th of April 1987 just before the ship got stuck behind an icebreaker in a thick ridge, see also Fig. 16 for the time history. In addition high load (275 kN) was encountered at the midship on 28th of January 1987 (see appendix 8/1 and 7/1), when the ship was navigating behind an icebreaker and got out from the channel to the solid ice in a sharp turn.

The level of ice-induced loads at the aftship was fairly low during the manned voyages. The highest value of 210 kN took place on 29th of January (see appendix 8/1 and 7/1), when the ship made a hook from the channel to the fast ice to pass a ship in front. The highest stress on the aft plating (250 MPa) occurred on 26th of April as shown in Fig. 18b.

Finally the measured maximum loads (FT17-FT19) are plotted as a function of the maximum ice thickness during the measuring period in various ice conditions and while navigating independently or with IB assistance, see Fig. 19. The ice conditions are grouped as defined in chapter 3.2.3. As can be seen, the maximum ice thickness has a clear effect on the loads in ridged and pack ice. The loads in the pack and ridged ice have the same order of magnitude. On the bow the highest loads took place while navigating independently, whereas on the mid- and aftship both independent navigation and icebreaker assistance caused high loads. The fairly limited amount of 1 hour data in ice thicknesses higher than 42 cm (see Fig. 14) has to be remembered when studying Figs 19.

Also some attempts were made to study the effect of ship's speed on the loads, but no considerable effect could be found due to the great scatter in the figures and due to the small variation in ship's speed during the manned voyages.

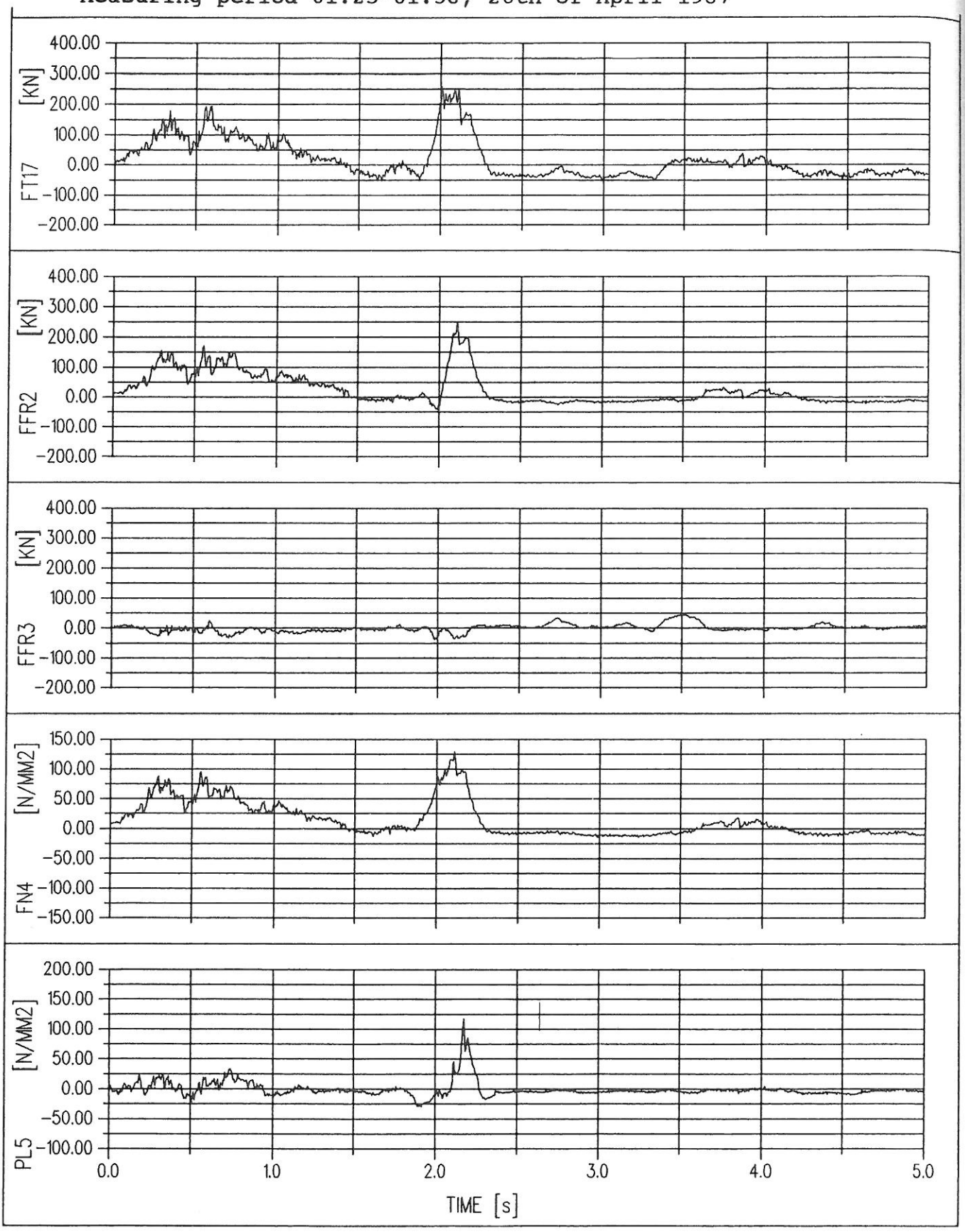


Fig. 15a. Time histories of the bow channels while navigating independently in ridged ice with ice thickness of about 40 cm. Ridge height about 1.0 m. Ice concentration 20 %.

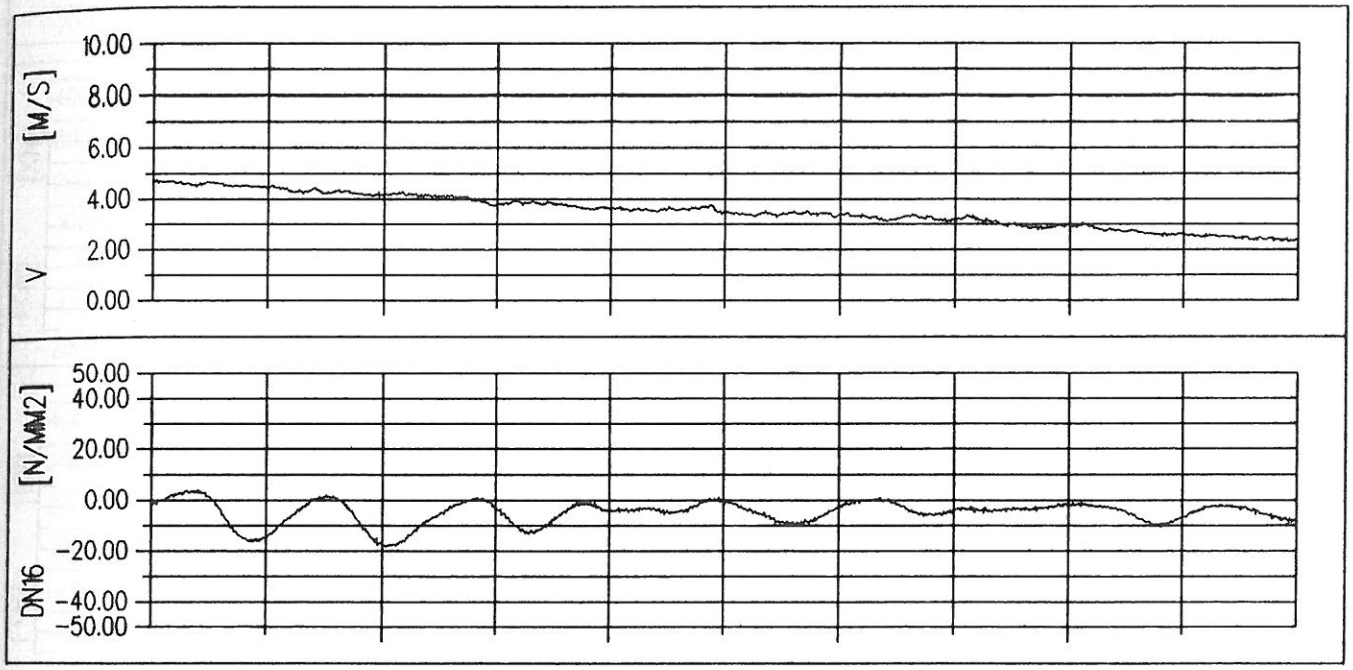


Fig. 15a (continues). Time histories for ship's speed and dynamic part of the stress on the deck plating.

Measuring period 08:21-08:33, 26th of April 1987

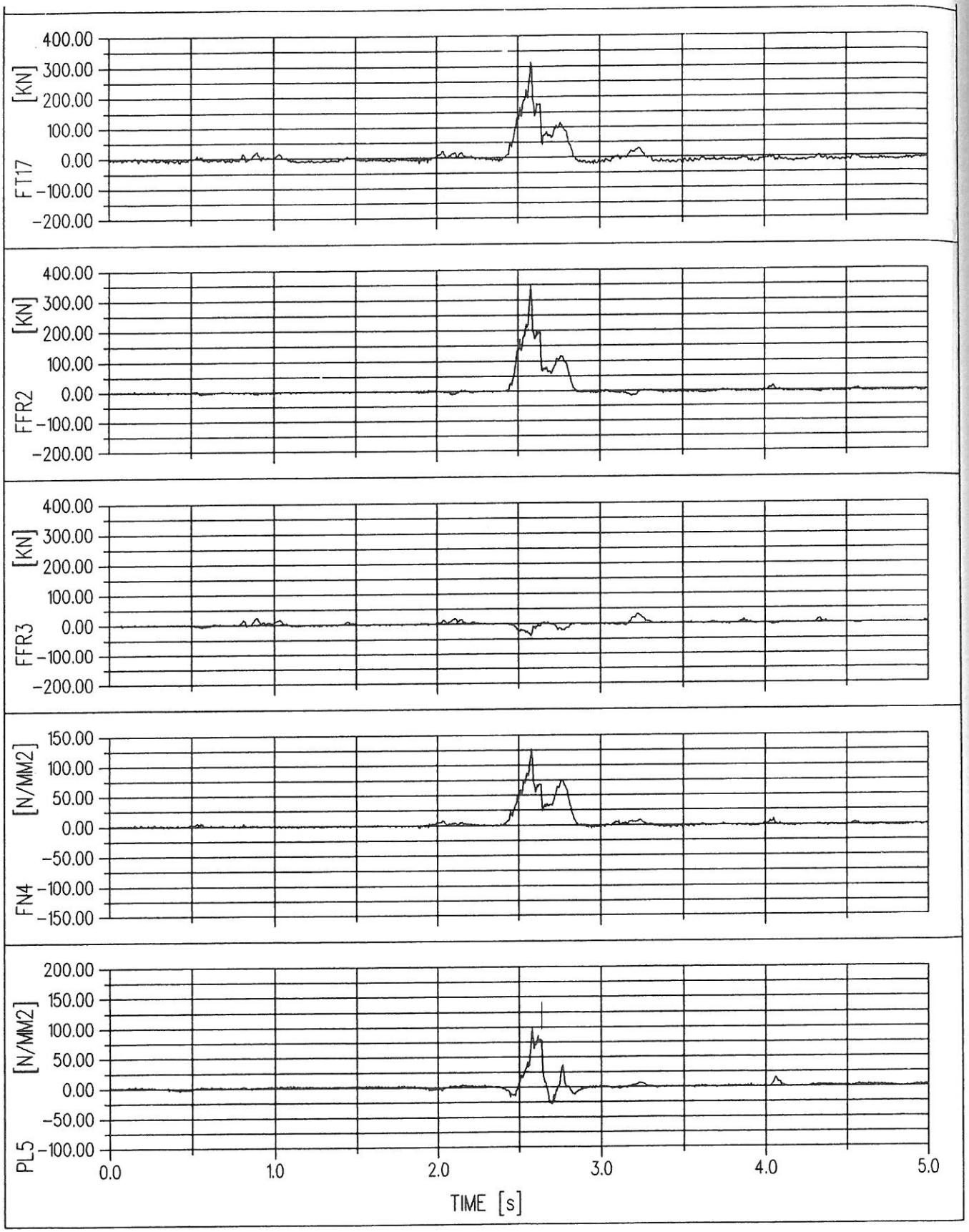


Fig. 15b. Time histories of the bow channels while navigating independently in consolidated pack ice with ice thickness of about 40 cm and ship's speed 11 kn.

Measuring period 12:16-13:00, 26th of April 1987

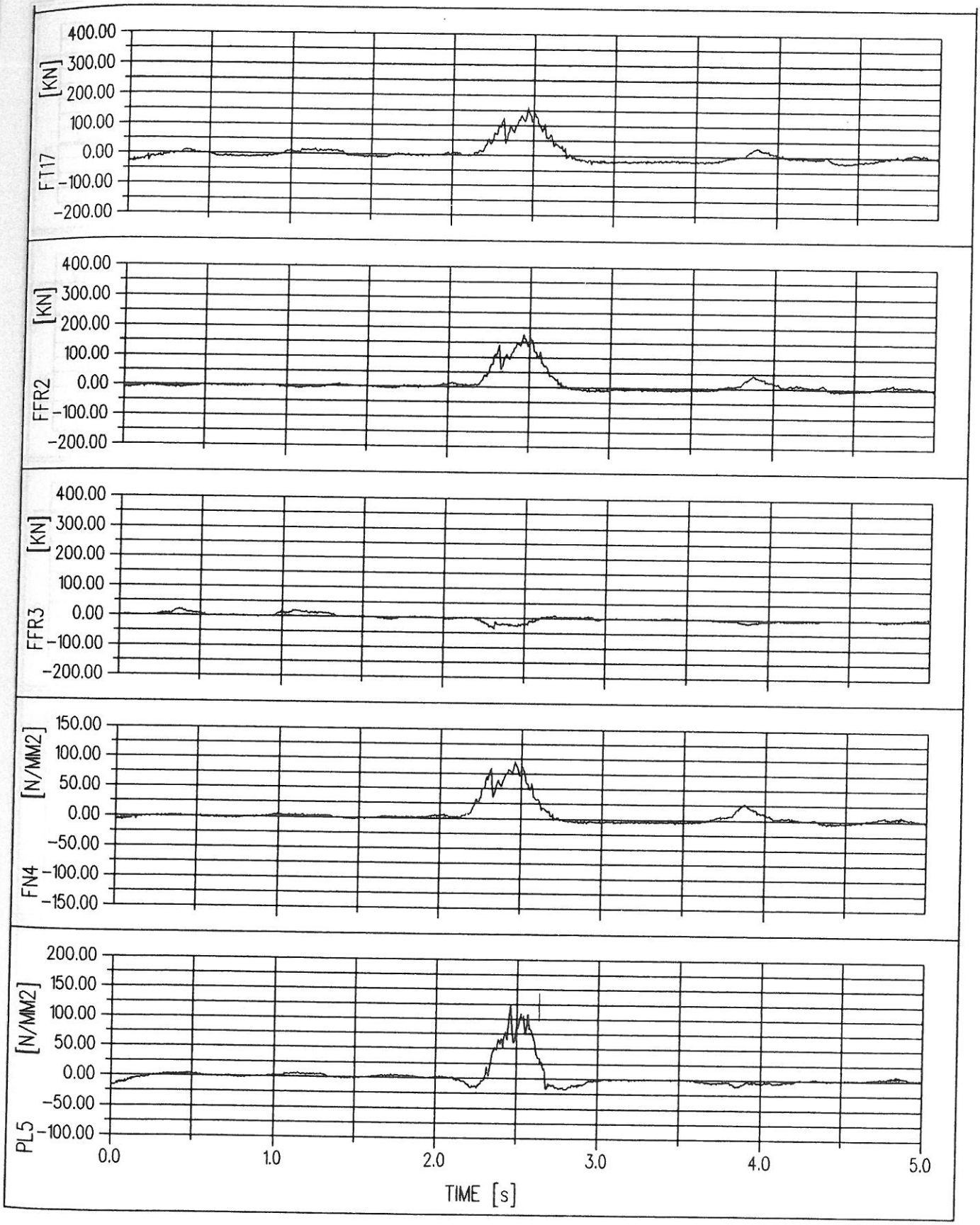


Fig. 15c. Time histories of the bow channels while navigating with IB assistance in ridged ice with ice thickness of about 70 cm and ship's speed 5 kn.

Measuring period 13:31-13:37, 26th of April 1987

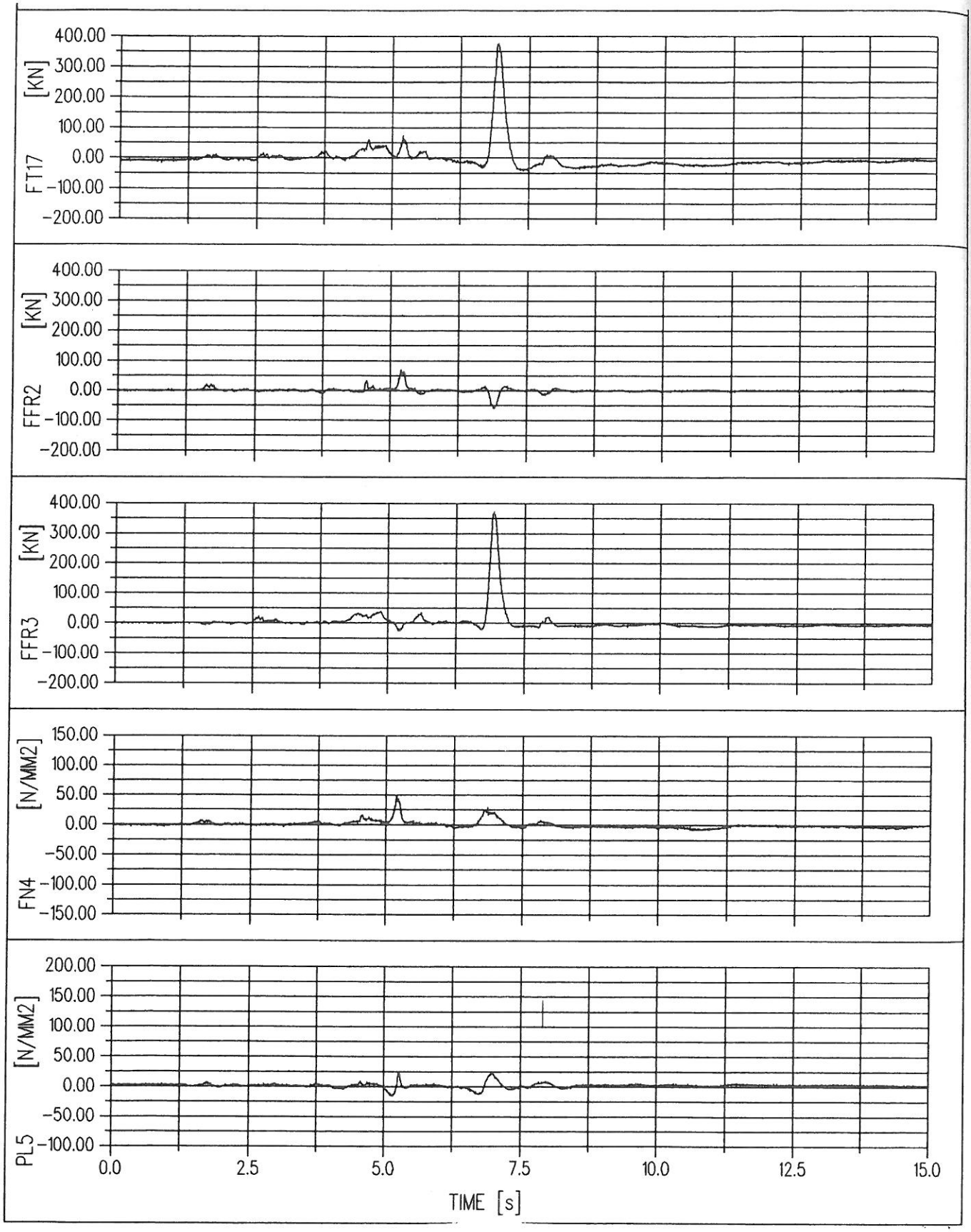


Fig. 15d. Time histories of the bow channels while navigating with IB assistance in ridged ice with ice thickness of about 70 cm and ship's speed 4 kn just before getting stuck in the ridge. Ridge height 1.5-2.0 m.

Measuring period 13:31-13:37, 26th of April 1987

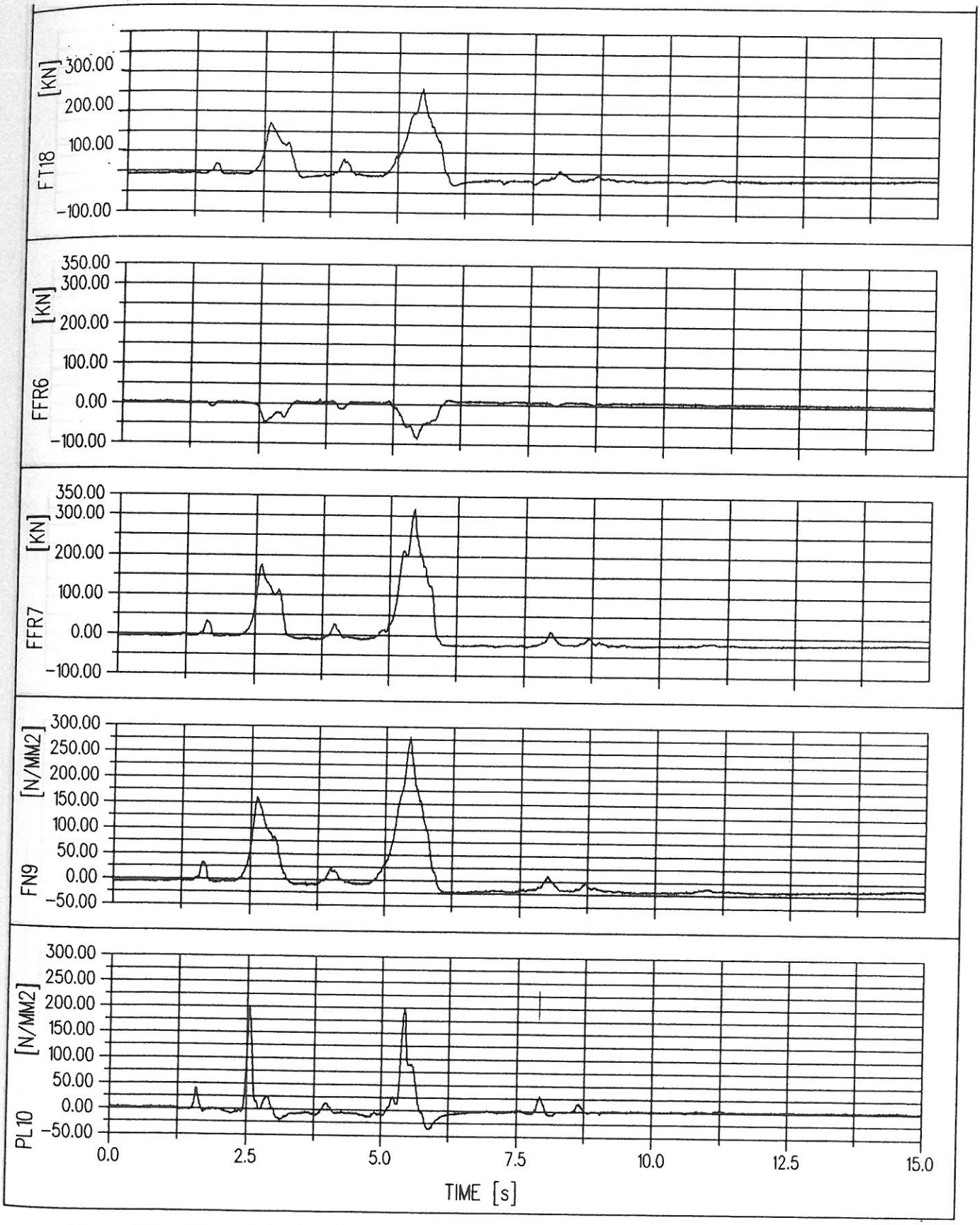


Fig. 16. Time histories of the midship channels while navigating with IB assistance in ridged ice with ice thickness of about 70 cm and ship's speed 4 kn just before getting stuck in the ridge. Ridge height 1.5 to 2.0 m.

Measuring period 08:21-08:33, 26th of April 1987

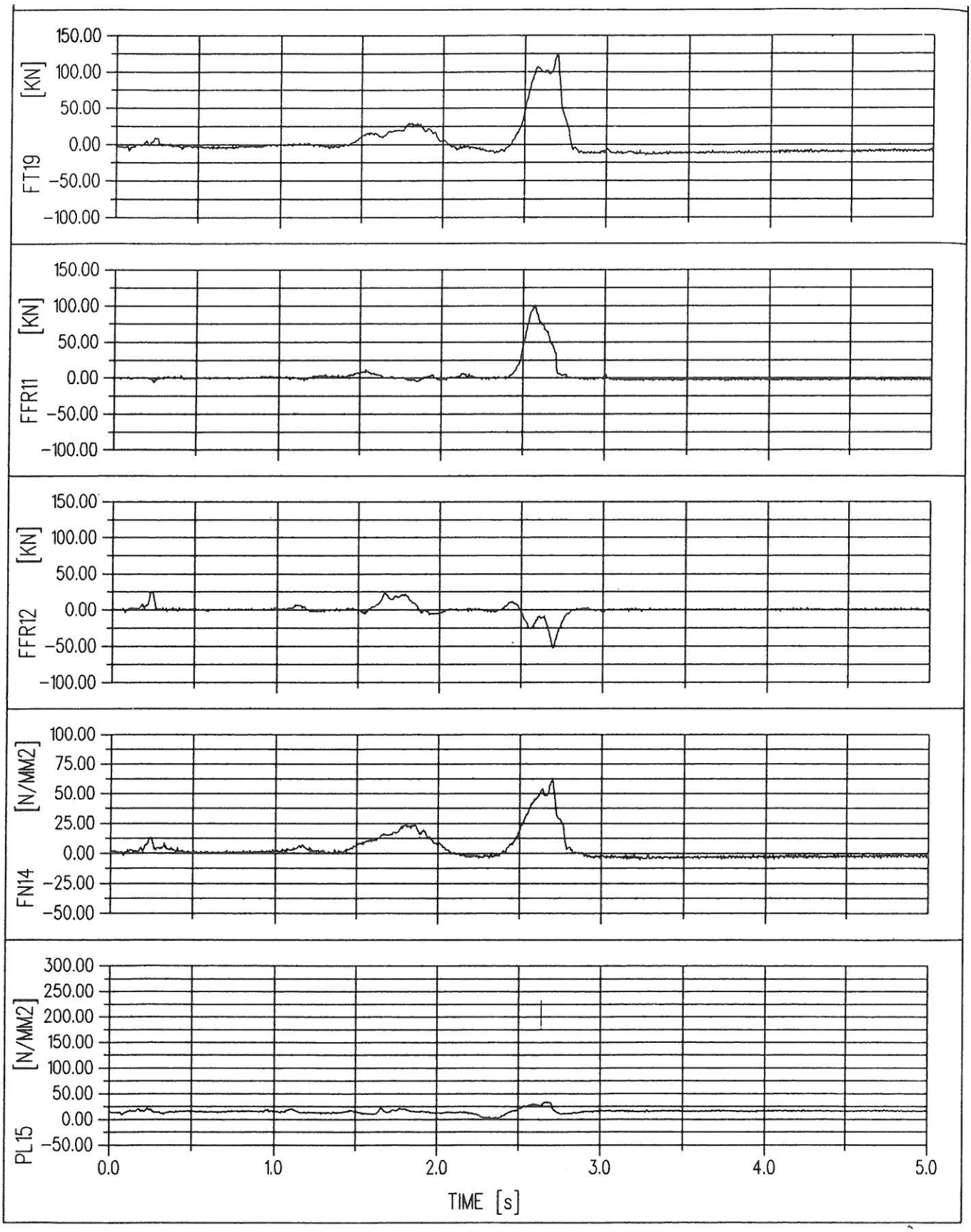


Fig. 17. Time histories of the aftship channels while navigating independently in consolidated pack ice with ice thickness of about 40 cm and ship's speed 8 kn.

Measuring period 13:31-13:37, 26th of April 1987

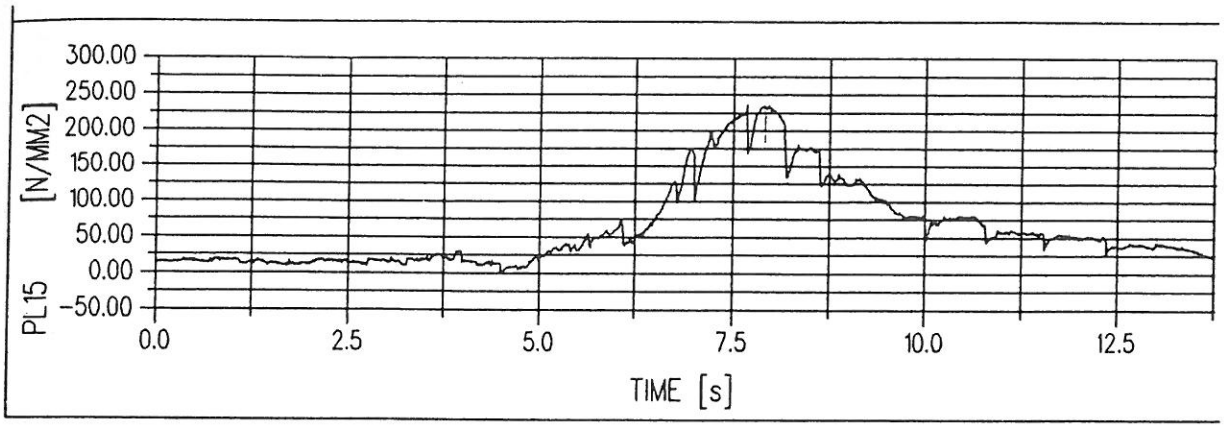


Fig. 18a. Time history of the stress on the aft plating just after the ship got stuck in ridge behind an icebreaker. Ice thickness about 70 cm, ridge height 1.5-2.0 m. The measured load on the frame was 125 kN.

Measuring period 13:43-13:56, 26th of April 1987

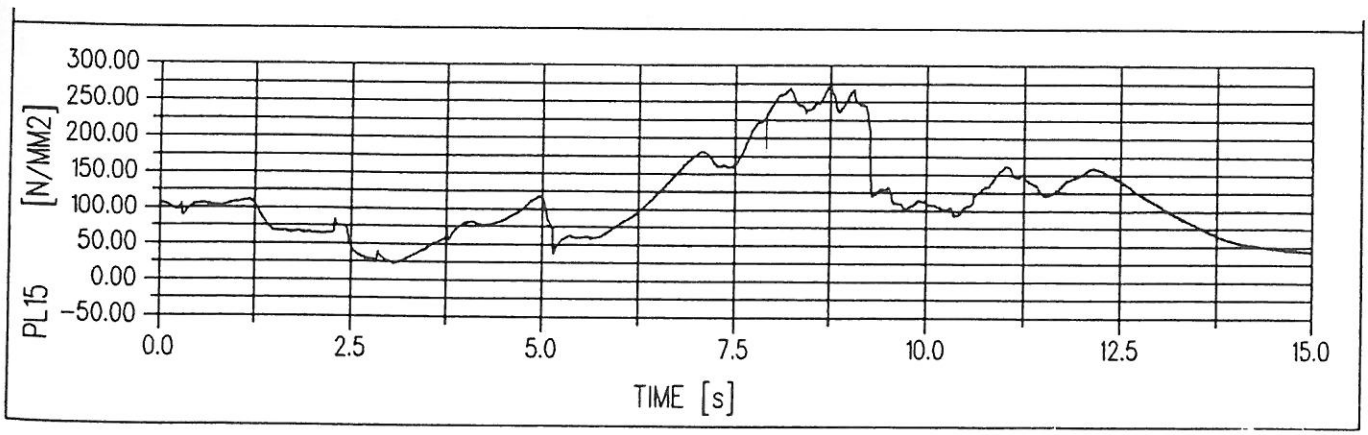


Fig. 18b. Time history of stress on the aft plating while the ship was stuck in ridged ice with ice thickness 70 cm and ridge height 1.5-2.0 m. The measured stress occured, when IB Kontio was operating near the ship to loose her. The measured load on the frame was 100 kN.

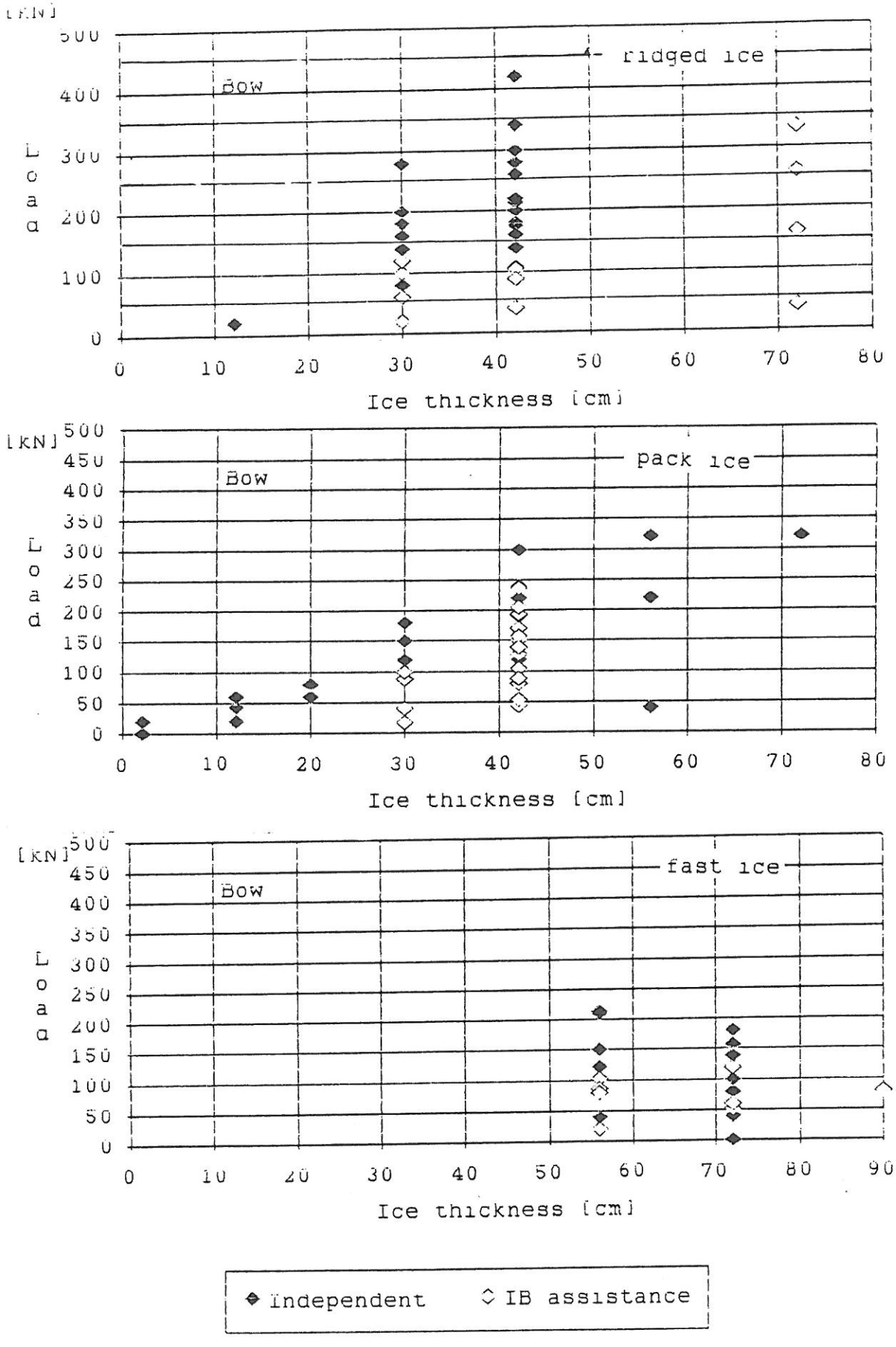


Fig. 19a. The measured 1 hour maximum loads at the bow (FT 17) as a function of the maximum ice thickness during the measuring period in various ice conditions.

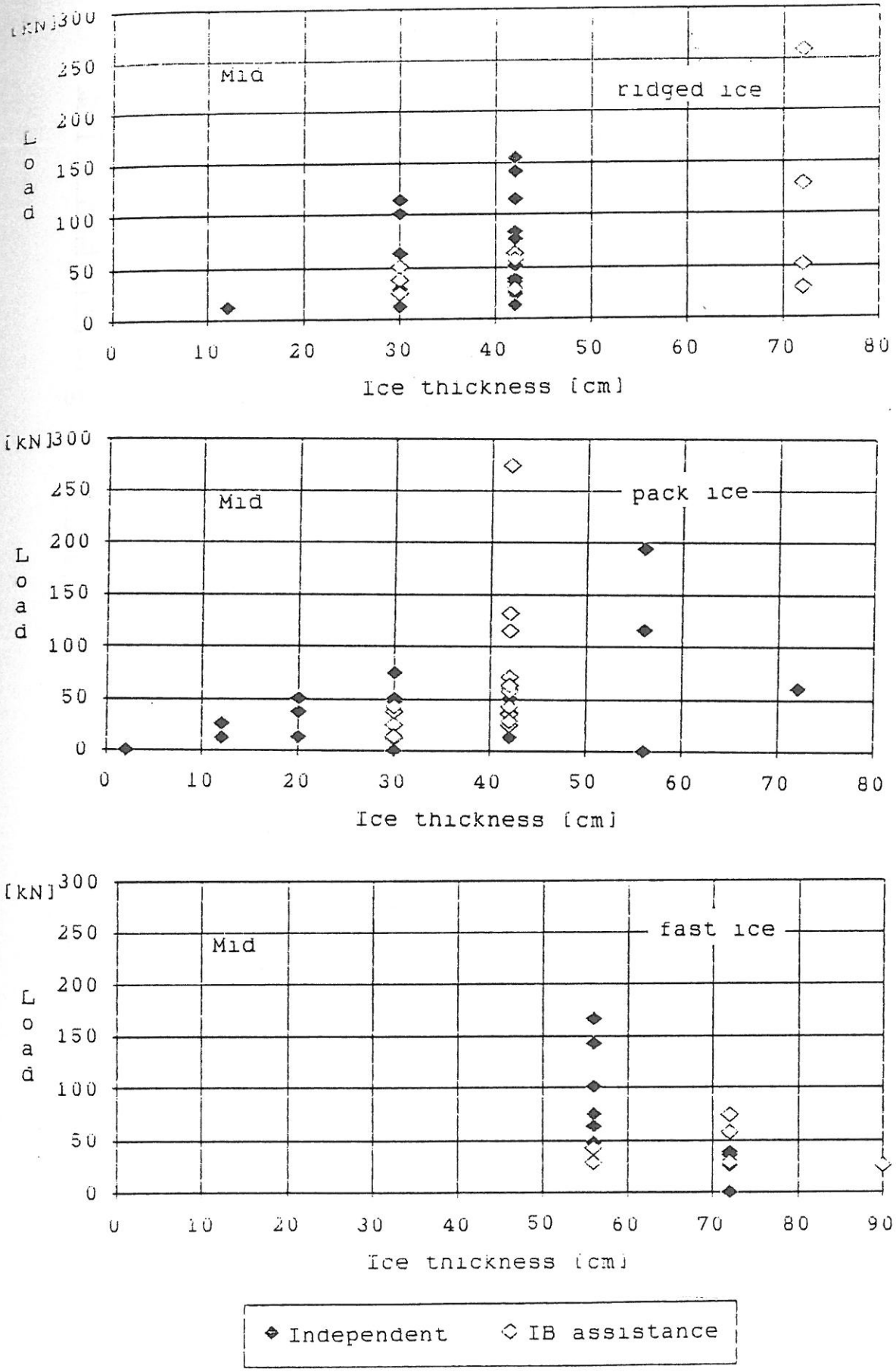
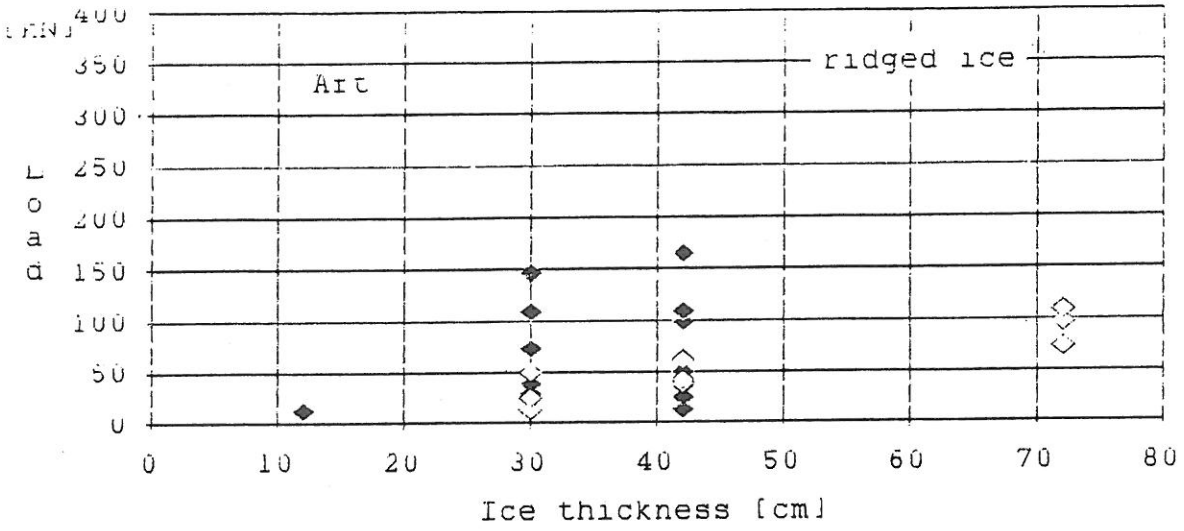
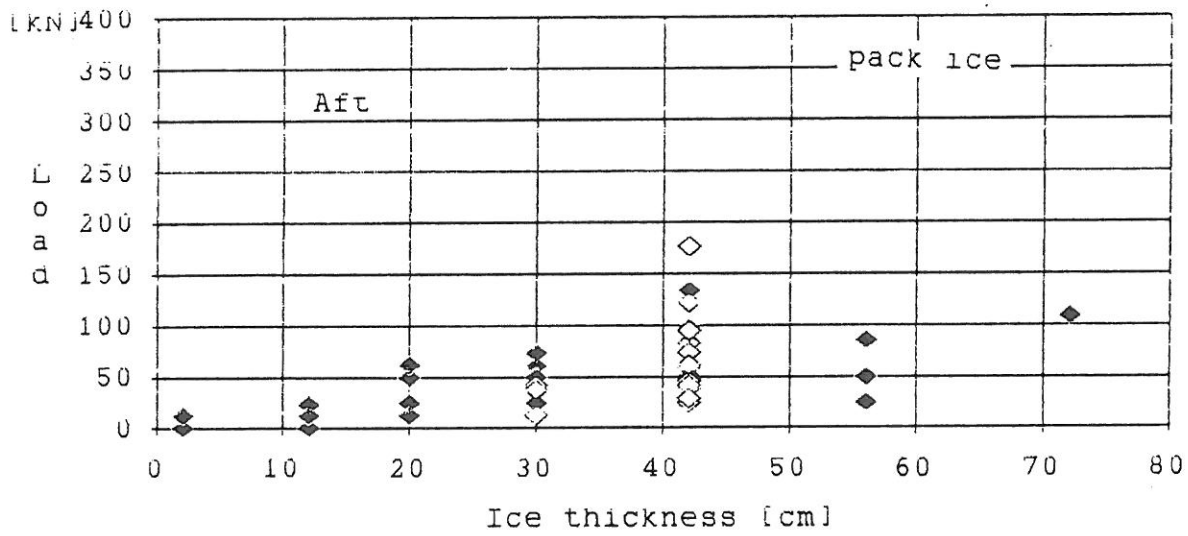
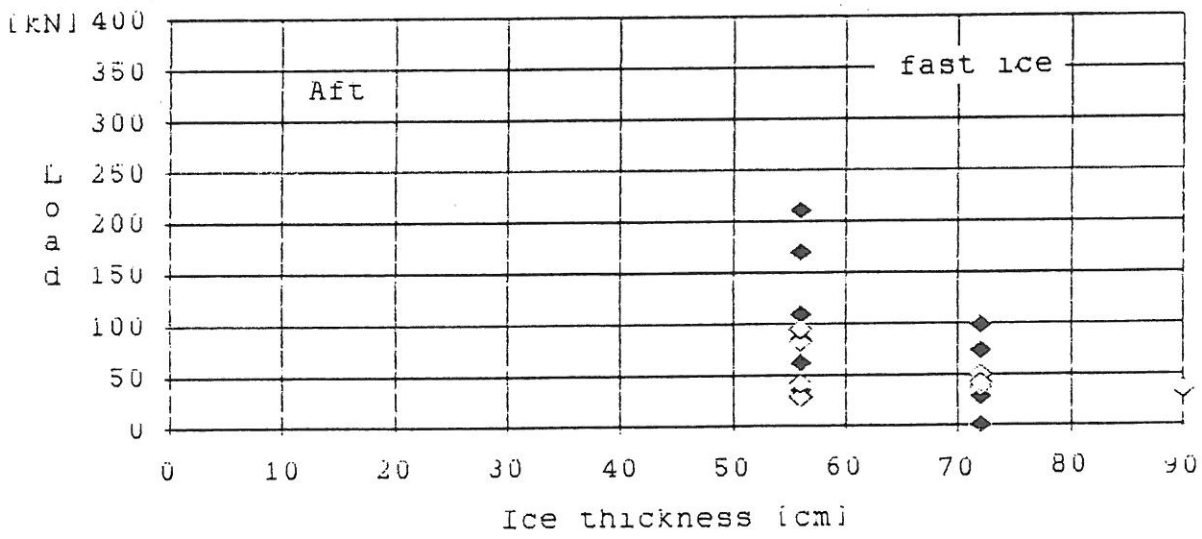


Fig. 19b. The measured 1 hour maximum loads at the midship (FT 18) as a function of the maximum ice thickness during the measuring period in various ice conditions.







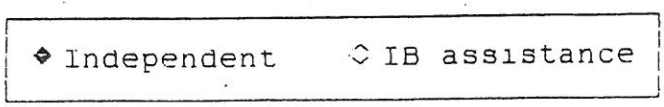


Fig. 19c. The measured 1 hour maximum loads at the aftship (FT 19) as a function of the maximum ice thickness during the measuring period in various ice conditions.

4.2 Automatic long-term measurements

The maximum values for the measured channels during the measured 12 hour periods form the basic data base. Appendix 9 gives all the measured 12-hour maxima. The random nature of the ice-induced loads can be clearly seen. The statistical analyses are not, however, included in this report and reference (Kujala, 1989) is referred to, where the statistical characteristics are discussed for evaluation of life-time extreme loads for the ship based on the measured results.

The maximum measured load value on the bow is 653 kN from 2nd of May 1985, when the ship was stuck in compressing ice near Kokkola lighthouse. The next biggest value is 643 kN from 10th of May 1985 near the lighthouse of Nordvalen, when the ship hit, according to the ship's logbook, some large thick ice floes. The maximum values of the winter 1987 (544 kN, 20th of April and 533 kN, 6th of February) both occurred near Kokkola lighthouse, when the ship was following an icebreaker in a heavily ridged ice. The maximum value from winter 1986 is 493 kN, which occurred in the Bothnian Sea on 24th of February, when the ship was ramming independently through ridged ice near the lighthouse Säppi.

The maximum measured value on the frame at midship is 323 kN and it occurred on 26th of April in 1987 during a manned voyage shortly before the ship got stuck in heavily ridged ice near Kokkola lighthouse behind an icebreaker, see Fig. 16 for the time history. The maximum value of winter 1985 occurred on 1st of May, when the ship was stuck in compressing ice also near the Kokkola lighthouse. In that situation also one strain gauge (FFR 8 lower, see Fig. 31) was damaged due to yielding of the frame. Also the other large values on the frame at midship have mostly occurred in compressed ice. There are, however, at least two exceptions; on 3rd of February in 1985 the load of value 246 kN most probably occurred during the two and a half hour towing of the ship through ice by an icebreaker and on the 28th of January 1987 the load of value 275 kN

occurred during the deviation of the ship from the channel to the level ice after a sharp turning of the icebreaker.

The measured load values on the aftship were mainly caused in situations similer to those at midship. The maximum value of 421 kN occurred also on 2nd of May 1985 during the strong compression near the Kokkola lighthouse. During the compression at the same place on 1st of May 1985 a value of 362 kN and on 3rd of April in 1985 a value of 327 kN were reached. The towing of the icebreaker on 3rd of February 1985 caused a load of 310 kN. The maximum value of winter 1987 is 362 kN and it occurred on 6th of February behind an icebreaker also near the Kokkola lighthouse.

Fig. 20 gives the distribution of the total obtained data of the maximum loads and stresses on various parts of the ship and appendix 10 shows the data obtained annually in various sea areas as defined in Fig. 9. As can be seen from Fig. 20 the mean actual yield stress of the normal strength steel used (nominal 235 MPa, mean 289 MPa, see reference Kujala 1989) has been exceeded 4 times on the bow plating, twice on the bow frame, once on the midship frame and once on the aft plating. The stress levels on the plating and frames have been about the same except on the bow plating, where the frequency of high stresses is higher than on the frame. The measured stresses are very sensitive to the location of the contact between ship and ice, therefore the draught distribution given in Fig. 10 has a great effect on the measured stresses on the plating and frames in various parts of the ship.

Fig. 21 summarizes the measured maximum loads as a function of the maximum ice thickness during the 12-hour measuring period in various ice conditions. The ice conditions are grouped as specified in chapter 3.2.3. The data is also grouped in three categories according to the type of ice navigation during the 12-hour period; independent navigation, icebreaker assistance or both of these types of navigation. The navigation in thick ridged ice with icebreaker assistance caused most of the extreme loads especially at mid- and aftship. At the bow independent navigation also caused high extreme load values. In most cases

the highest loads, while navigating independently, have occurred with maximum ice thicknesses in the region of 40-50 cm and thereafter with higher ice thicknesses the loads decrease. In fast ice, the loads encountered were considerably lower than in ridged or fast ice.

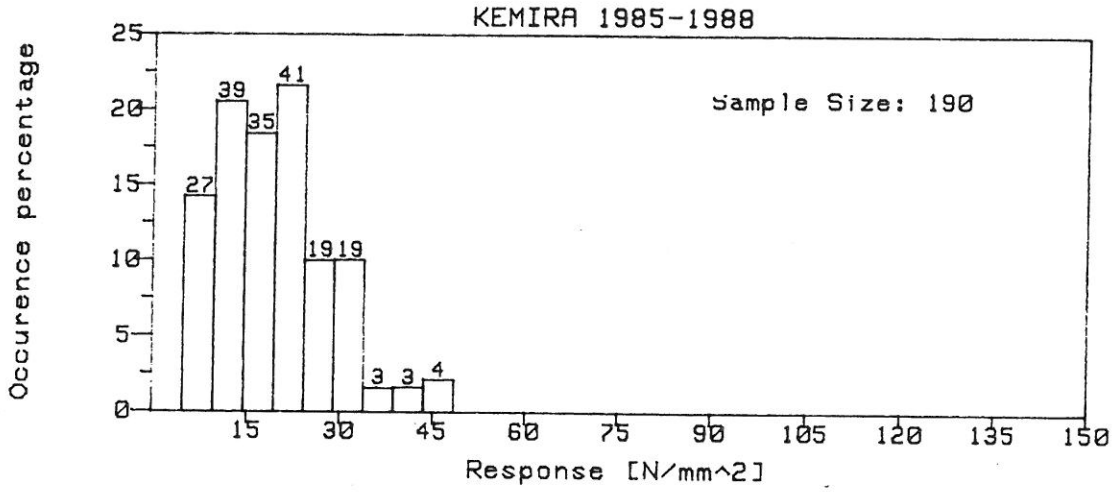


Fig. 20a . Sample of the total measured 12-hour maximum stress on the deck plating at midship (dynamic part,HB16).

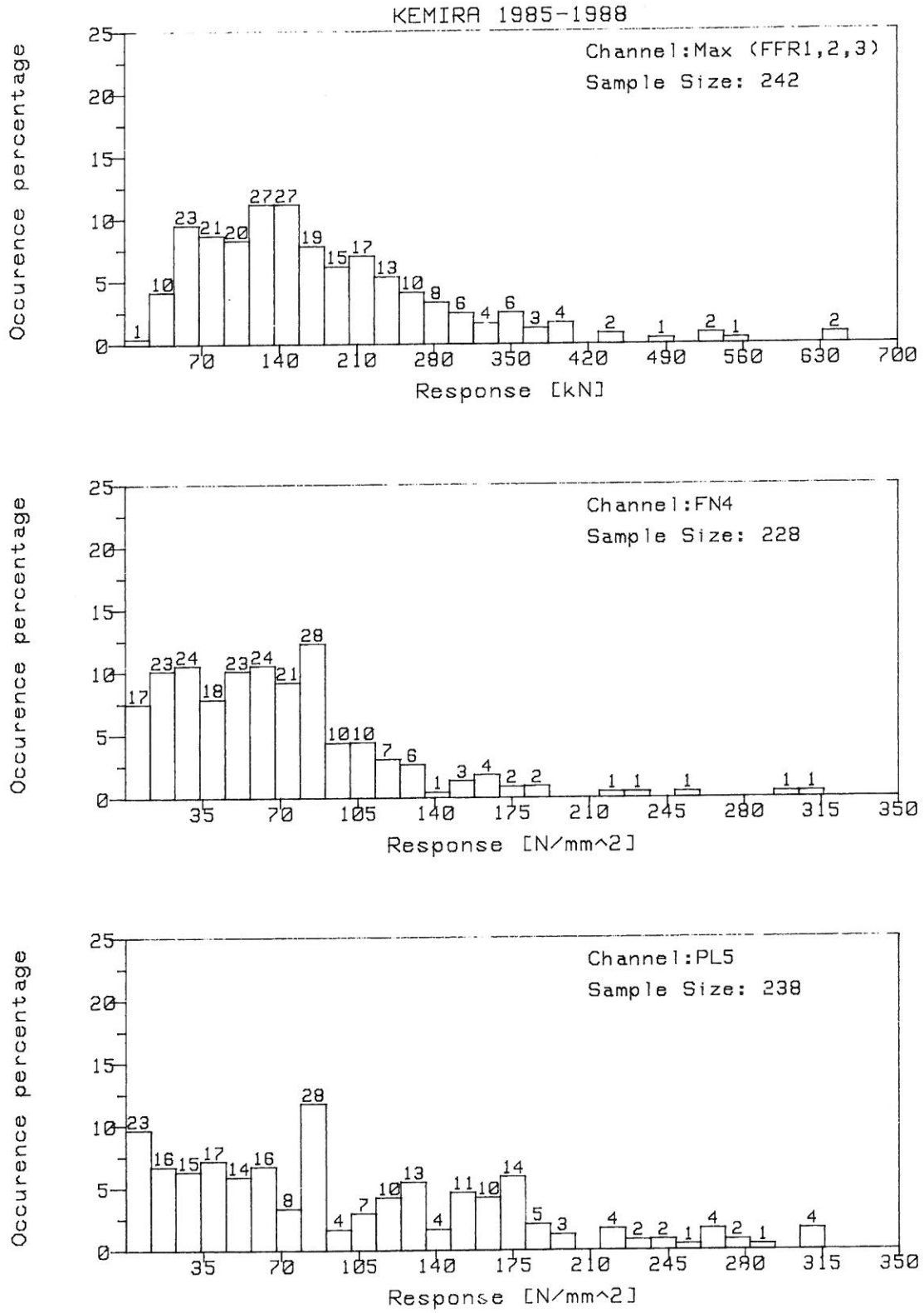


Fig. 20b . The sample of the total measured 12-hour maximum loads, stress on plating (PL5) and stress on frame (FN4) at the bow.

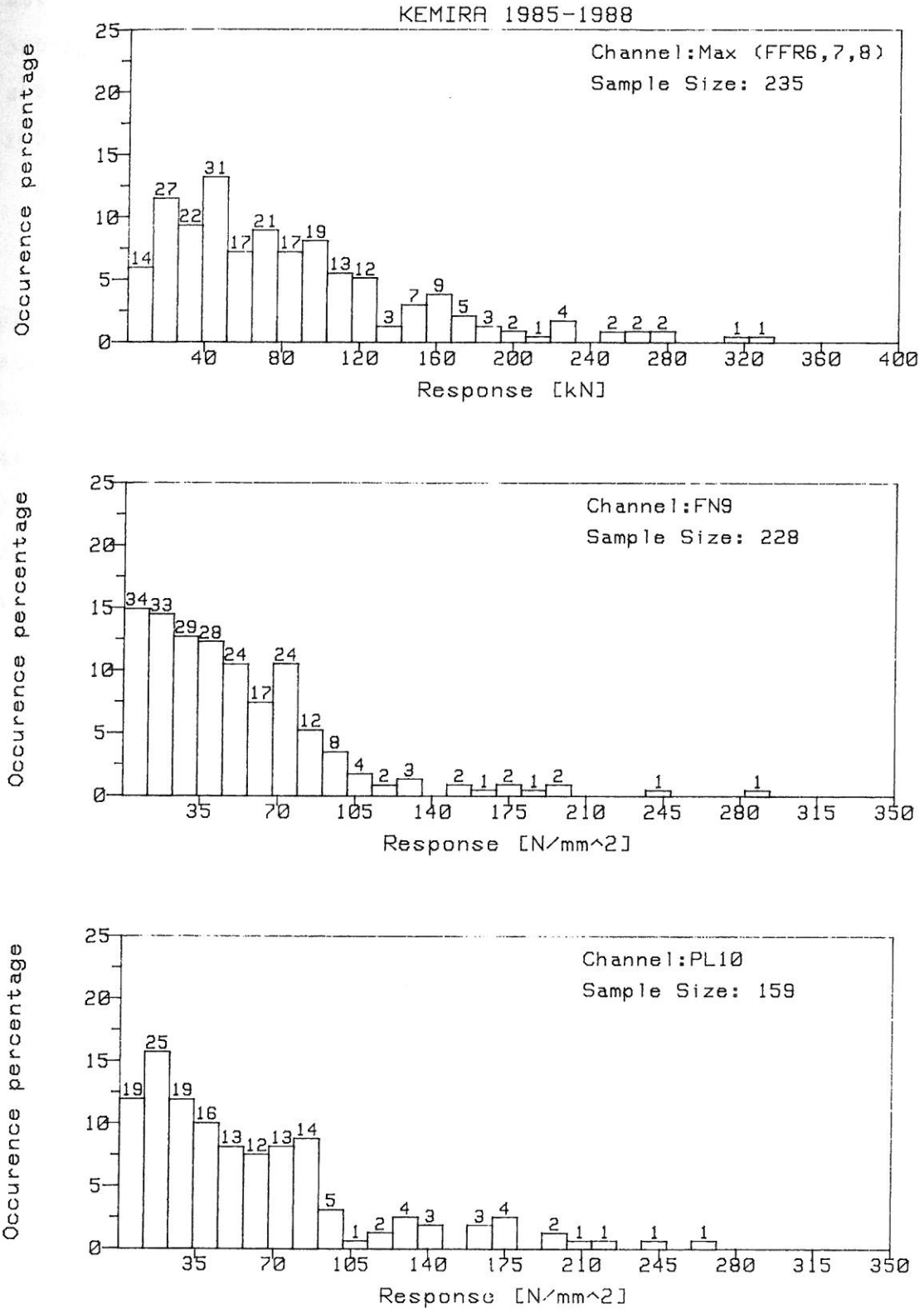


Fig. 20c . The sample of the total measured 12-hour maximum loads, stress on plating (PL10) and stress on frame (FN9) at the midship.

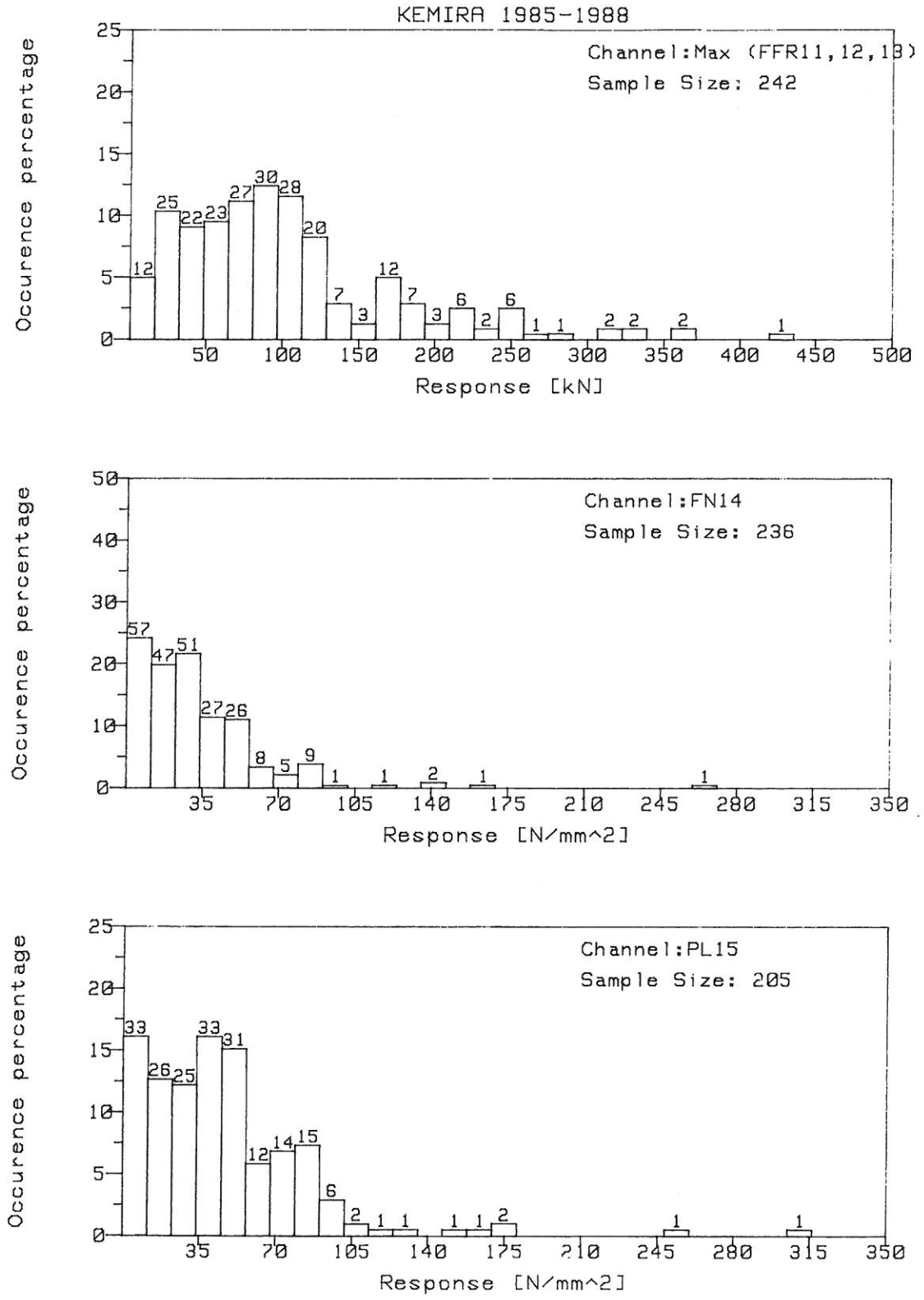
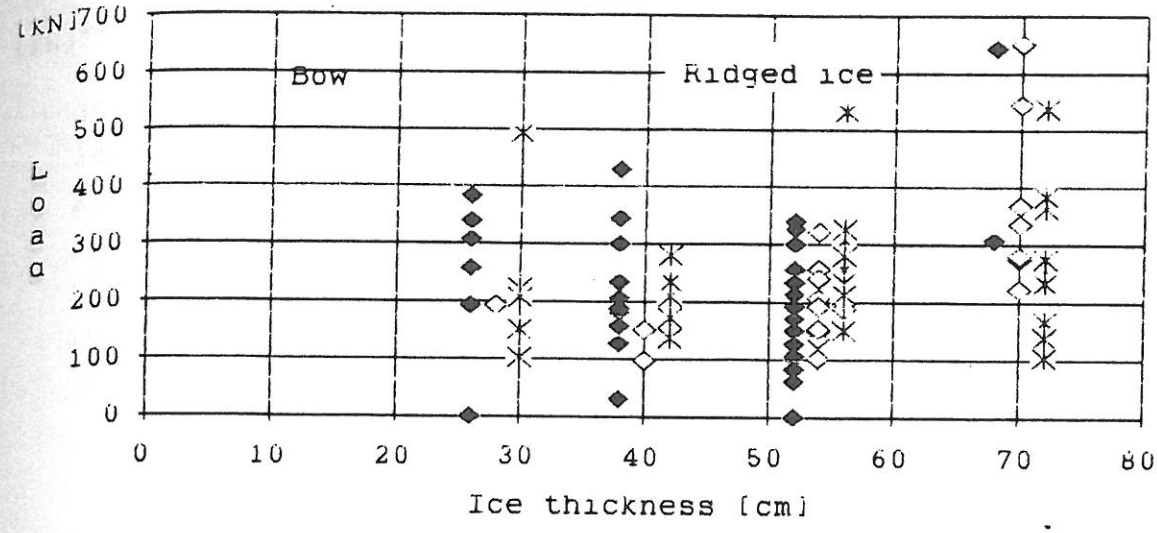
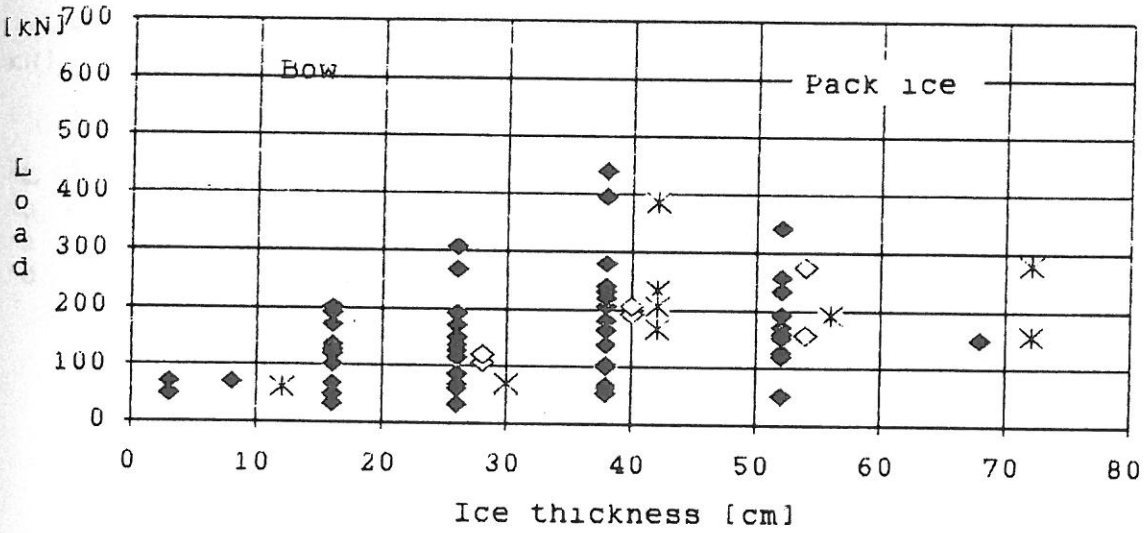
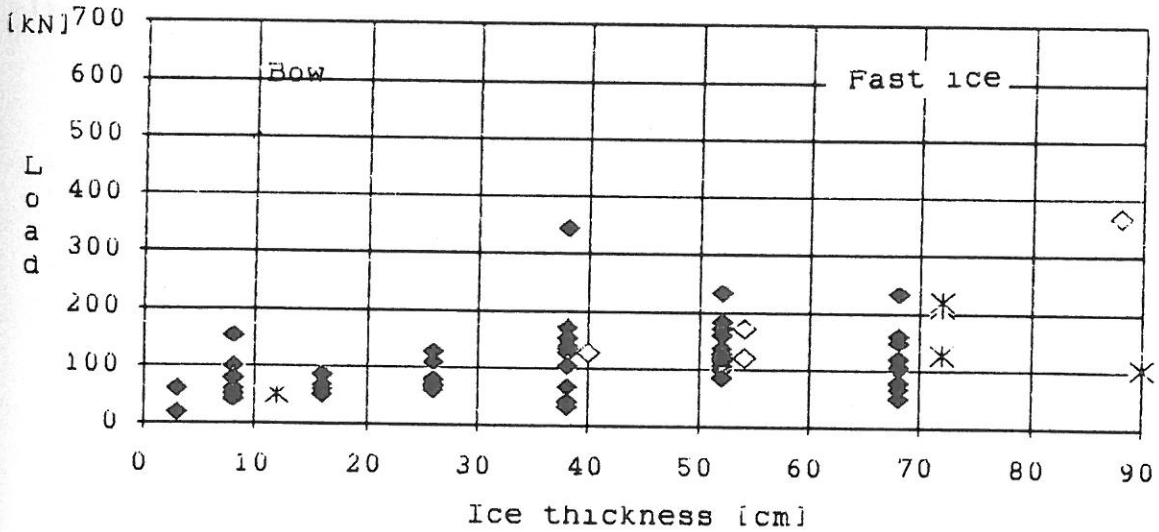


Fig. 20d. The sample of the total measured 12-hour maximum loads, stress on plating (PL15) and stress on frame (FN14) at the aftship.







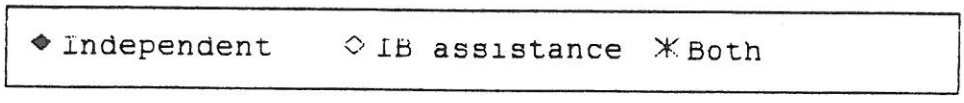


Fig. 21a. The measured 12-hour maximum loads at the bow as a function of the maximum ice thickness during the 12-hour period in various ice conditions.

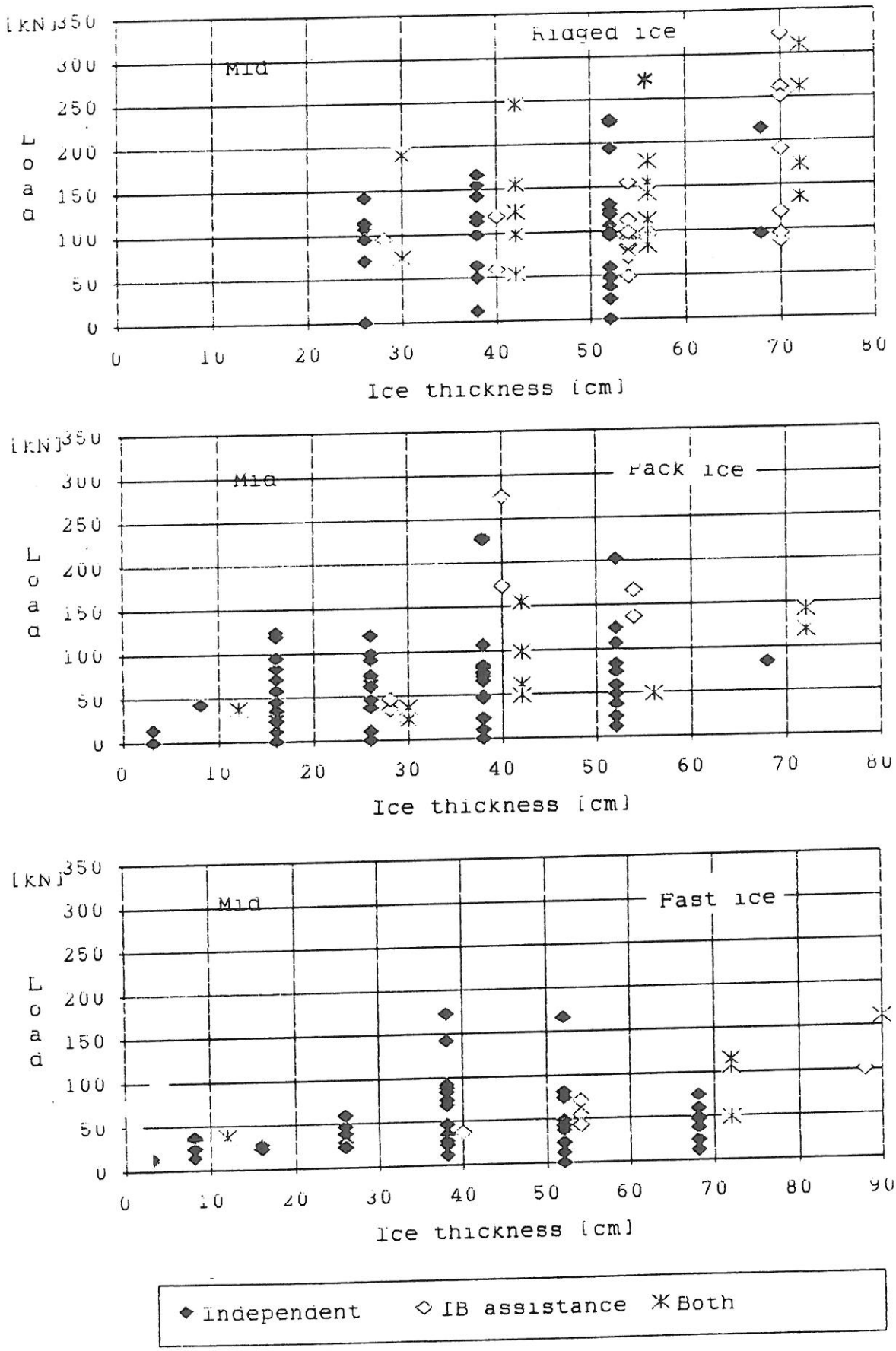


Fig. 21b. The measured 12-hour maximum loads at the midship as a function of the maximum ice thickness during the 12-hour period in various ice conditions.

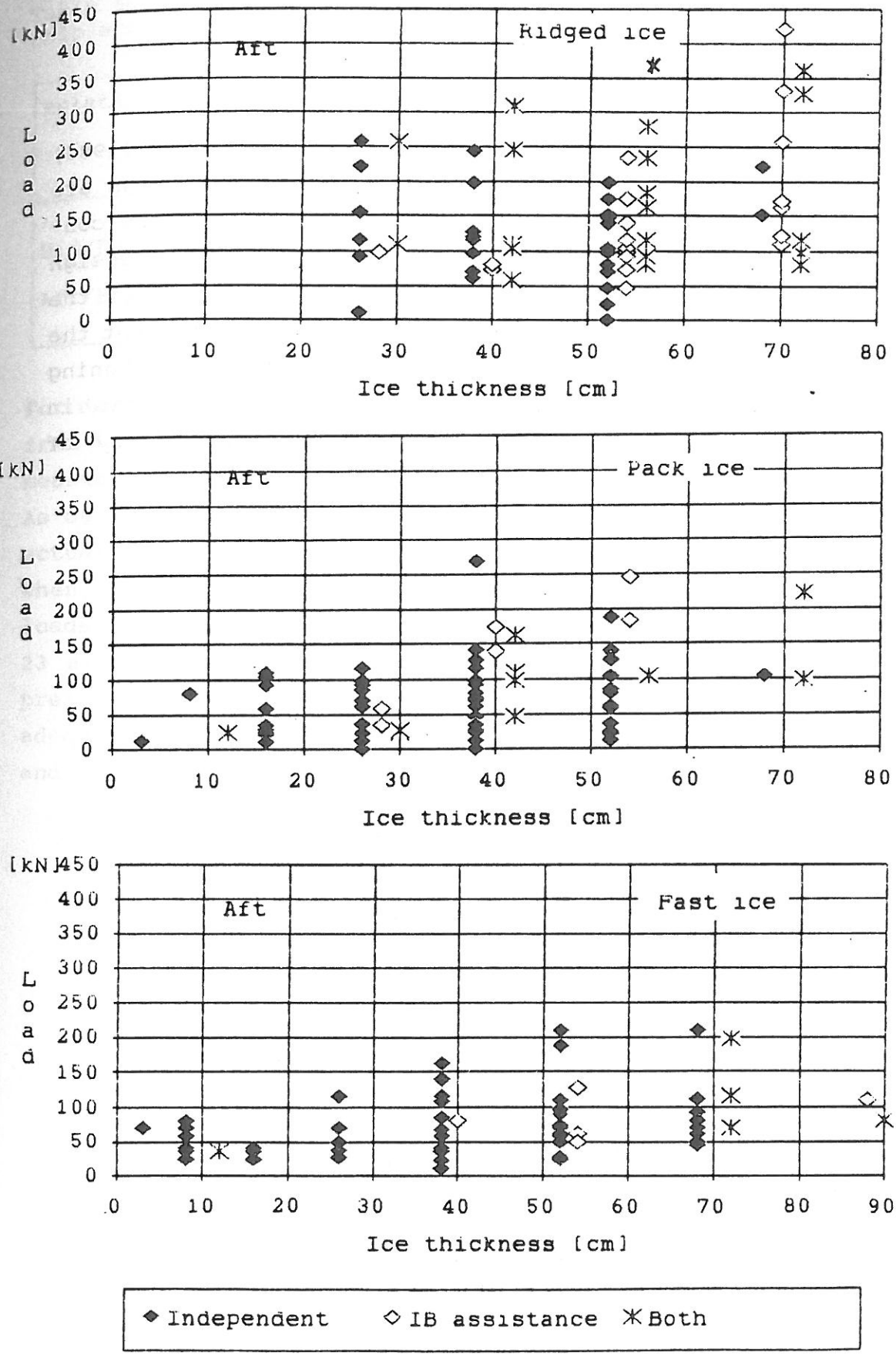


Fig. 21c. The measured 12-hour maximum loads at the aftship as a function of the maximum ice thickness during the 12-hour period in various ice conditions.

4.3 Comparison of the results with ice rules

The design ice loads according to the present ice rules (1985) together with measured winter maxima in various sea areas are given in Fig. 22. As can be seen, the measured loads are considerably higher than those given in the rules. The design loads are, however, related to the design formulations of the rules used and therefore this does not indicate as such that the design loads are too low. The level of ice-strengthening according to the measured results is discussed further in reference (Kujala, 1989), where the failure probability of the frames is evaluated.

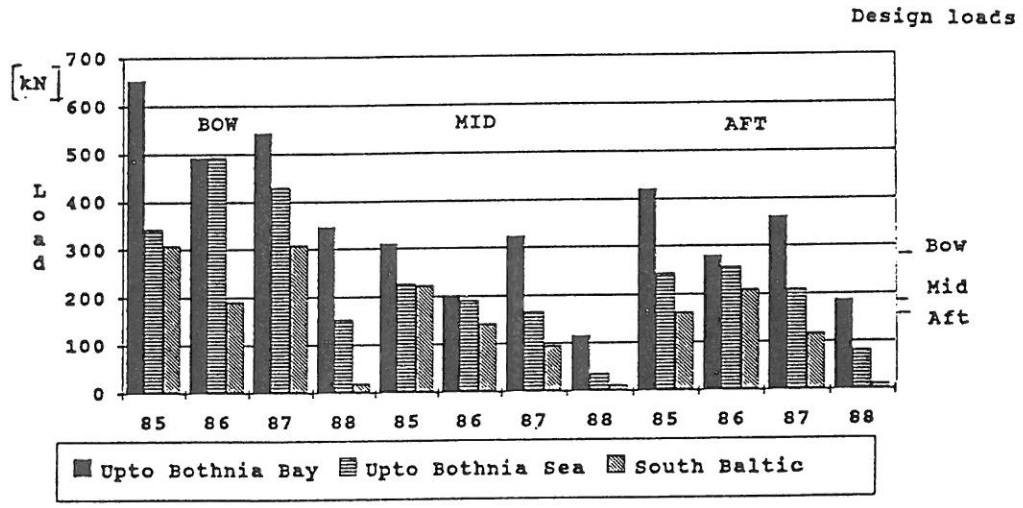


Fig. 22. The measured winter maximum load values in various sea areas and on various parts of the ship. Also the design loads for the frames of M/S Kemira according to the latest ice rules are given.

Another way to compare the rule approach and the results of the present study is to compare the relationship between loads on various parts of the ship given by the rules and measured maxima. Table 5 shows the results of the comparison. The measured values give somewhat lower relative values for the midship and considerably higher for the aftship than those given by the ice rules.

Table 5. Comparison of the relative loads on various parts of a ship according to ice rules and to the measured maxima.

Relation	Rule value		Measured maxima		
	1A Super	1A	Bothnian Bay	Bothnian Sea	Baltic proper
Mid/Bow	0.636	0.540	0.494	0.460	0.724
Aft/Bow	0.477	0.413	0.644	0.521	0.679

For design purposes, the ice loads as a function of the distance from the waterline are also important. Therefore in Fig. 23 the measured load values are plotted as a function of this distance. As can be seen, the ice can cause loads down to 4-5 m below the actual waterline. The maximum loads almost linearly decrease when the distance increases. Above the waterline remarkable ice loads can occur as high as about 1 m above the waterline. Fig. 23 also illustrates the extent of ice framing required in the present ice rules. The extent of the ice framing seems to be adequate above the waterline, but below the waterline at mid- and aftship some extensions should be considered.

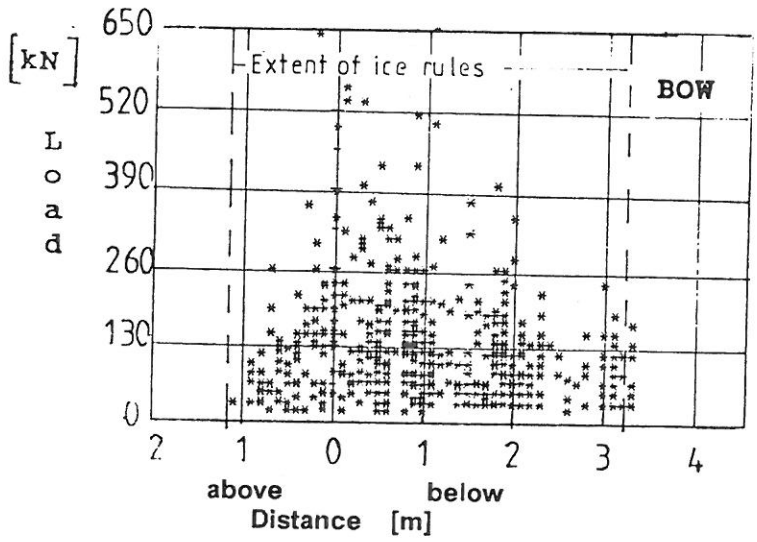


Fig. 23a. The measured 12-hour maximum load values as a function of the distance from waterline at bow.

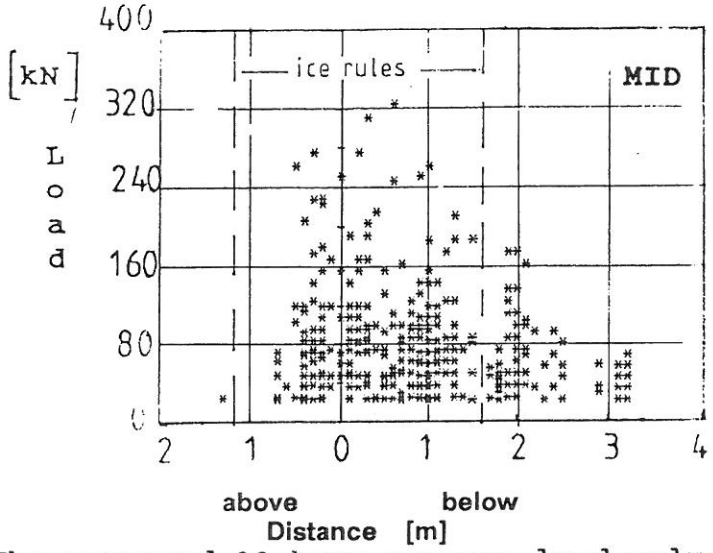


Fig. 23b. The measured 12-hour maximum load values as a function of the distance from waterline at midship.

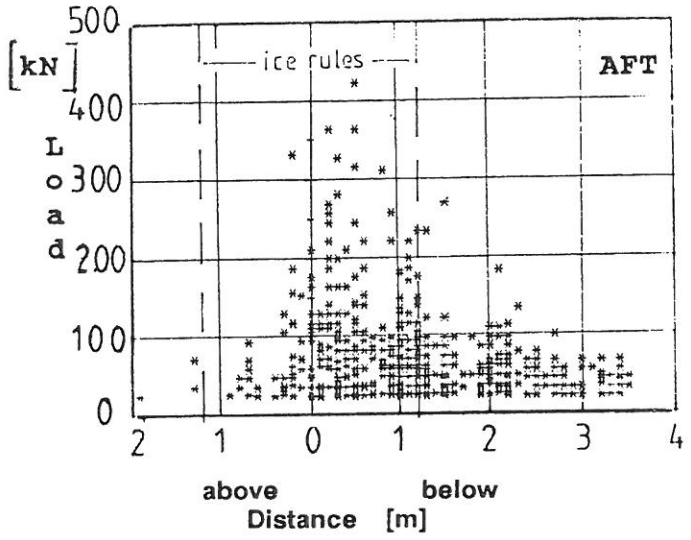


Fig. 23c. The measured 12-hour maximum load values as a function of the distance from waterline at aftship.

4.4 On the accuracy of the measured results

Finally the accuracy of the measured load values on the frames is discussed. The general level of the measured loads can be checked by comparing the measured loads (FFR2, FFR7, FFR12) with the measured bending stresses at midspan of the frame (FN4, FN9, FN14) as shown in Fig. 24. This figure also shows the calculated relationships between load and stresses on the frames using the FE-model of Fig. 4 with varying load heights and locations of the load. For the aftship frame, the comparison is based on the inside point force calibration, because during this calibration, the strain gauge FN 14 was found to be in the

wrong place. This gauge should be located above the web of the frame, but the gauge FN 14 was located at the edge of the flange giving 40-50 % lower values for the stresses than the FE-model gives above the web plating. Fig. 24 illustrates that the measured stresses and loads have good comparability.

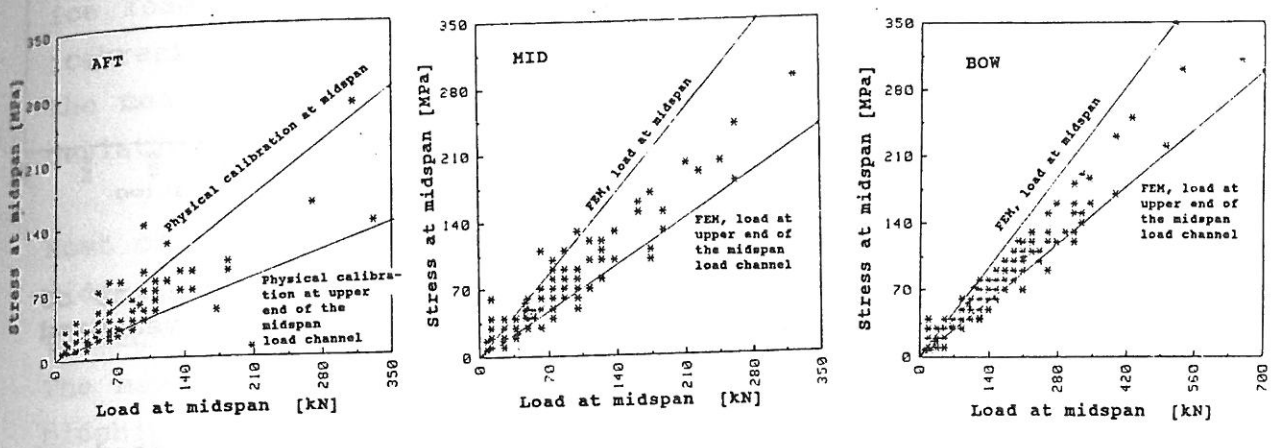


Fig. 24. Comparison of the measured loads at midspan channels (FFR2, FFR7, FFR12) with the measured stresses at the flange of the frames at midspan (FN4, FN9, FN14). Also the calculated relationship and relationship obtained with physical calibration between load and stress are given varying the location of the load within the load measuring area.

Another way of comparing the results is to plot the measured maximum values of the individual load channels (as FFR1,FFR2, FFR3) in the same picture with the measured total load (FT17) on the frame. This comparison can be made only for winters 1987 and 1988, because the total load channels were not connected to the system in the winters 1985 and 1986. Fig. 25 shows the results of this comparison. As can be seen, the results follow quite accurately the equality line even though some fluctuations exist. This is probably due to the local effects of the ice induced loads on the shear strain gauges, when the load is just above the gauge.

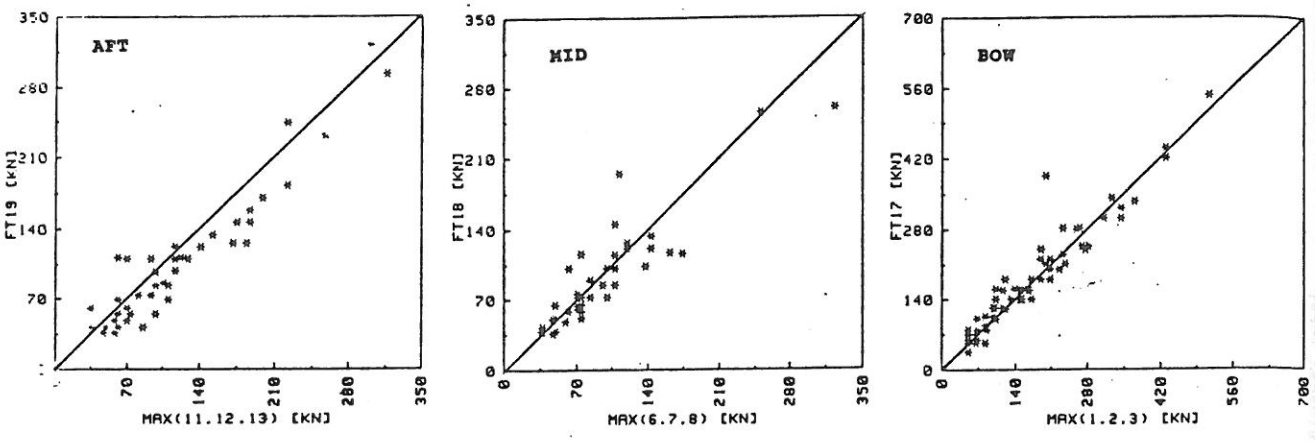


Fig. 25. Comparison of the measured loads on various parts of the instrumented frames (FFR-channels) with the total measured load on the frames (FT-channels).

The uncertainty of the measured load values is evaluated on the basis of Fig. 25. It is assumed that the measured load values of the total load channels can be considered accurate so that the difference of the measured individual channels from these values form the model error. Table 6 gives the obtained mean values and standard deviations for the error.

Table 6. Statistical characteristics of the error in the measured loads.

Location	Mean value	Standard deviation	c.o.v (%)
Bow	1.01	0.242	24.0
Mid	0.98	0.315	32.0
Aft	0.90	0.221	24.6

5 CONCLUSIONS

The automatic measuring system on board M/S Kemira has worked successfully for four winters. The ship was navigating in ice during about 18 % of the total measuring time and encountered ice loads during 211 days, of which 26 % was navigation with icebreaker assistance. The mean values for the model error of the measuring system vary in the range 0.90-1.01 and standard deviations from 0.22 to 0.32.

Most of the highest loads encountered have occurred in heavily ridged ice near the Kokkola lighthouse both during navigation through the ridge and while stuck in compressing ridged ice. The maximum value measured on the bow frame is 653 kN, on the midship frame 323 kN and on the aftship frame 421 kN. When these values are compared with the design load values according to the present Baltic ice rules the difference is greatest, in relative terms, at the aftship.

The mean actual yield stress of the normal strength steel used has been exceeded 4 times on the bow plating, twice on the bow frame, once on midship frame and once on the aft plating. The only damage to the strain gauges due the large permanent displacement took place at the lower part of the midship frame in compressing ice near the Kokkola lighthouse.

Ice-induced loads have a clear stochastic nature. New approaches are needed to evalute in statistical terms the occurrence probability of extreme loads in various ice conditions and operation situations so that a sound basis for design purposes can be found. It is hoped that the data given in this report will be useful for such purposes.

6 ACKNOWLEDGEMENTS

The financial support of the Finnish Board of Navigation has enabled the work carried out for this report, which is here gratefully acknowledged. The author expresses his special thanks to the crew of M/S Kemira as the measurements would not have been possible without close and fruitful co-operation with the crew. The analysis of the measurements started during the year 1986 when the author was working as an assistant at the Helsinki University of Technology. That opportunity is warmly appreciated.

7 REFERENCES

BASIS 1981. A data bank for Baltic sea ice and sea surface temperatures. Norrköping. Winter Navigation Research Board. Report No. 34. 23 p. + app 9 p.

Finnish-Swedish ice class rules 1985. Board of Navigation, Helsinki. 43 p.

Hoffmann, L. 1985. Impact forces and fricton coefficient on the forebody of the German polar research vessel "Polarstern". POAC 85, proceedings vol. 3, Narssarssuaq, September 7-14, 1985. Danish Hydraulic Institute. Denmark, pp. 1189-1202.

Korri, P. & Varsta, P. 1979. On the ice trial of a 14500 dwt tanker on the Gulf of Bothnia. NSTM-79, Helsinki, 1979. Society of Naval Architects in Finland (LARADI), Helsinki. 31 p.

Kujala, P. 1989. Probability based safety of ice-strengthened ship hull in the Baltic Sea. Licenciate thesis, Espoo 1989. Helsinki University of Technology. 109 p + app. 12.

Kujala, P. & Vuorio, J. 1986. Results and statistical analysis of ice load measurements onboard icebreaker Sisu in winters 1979 to 1985. Helsinki. Winter Navigation Research Board, Report No. 43. 52 p. + app. 73 p.

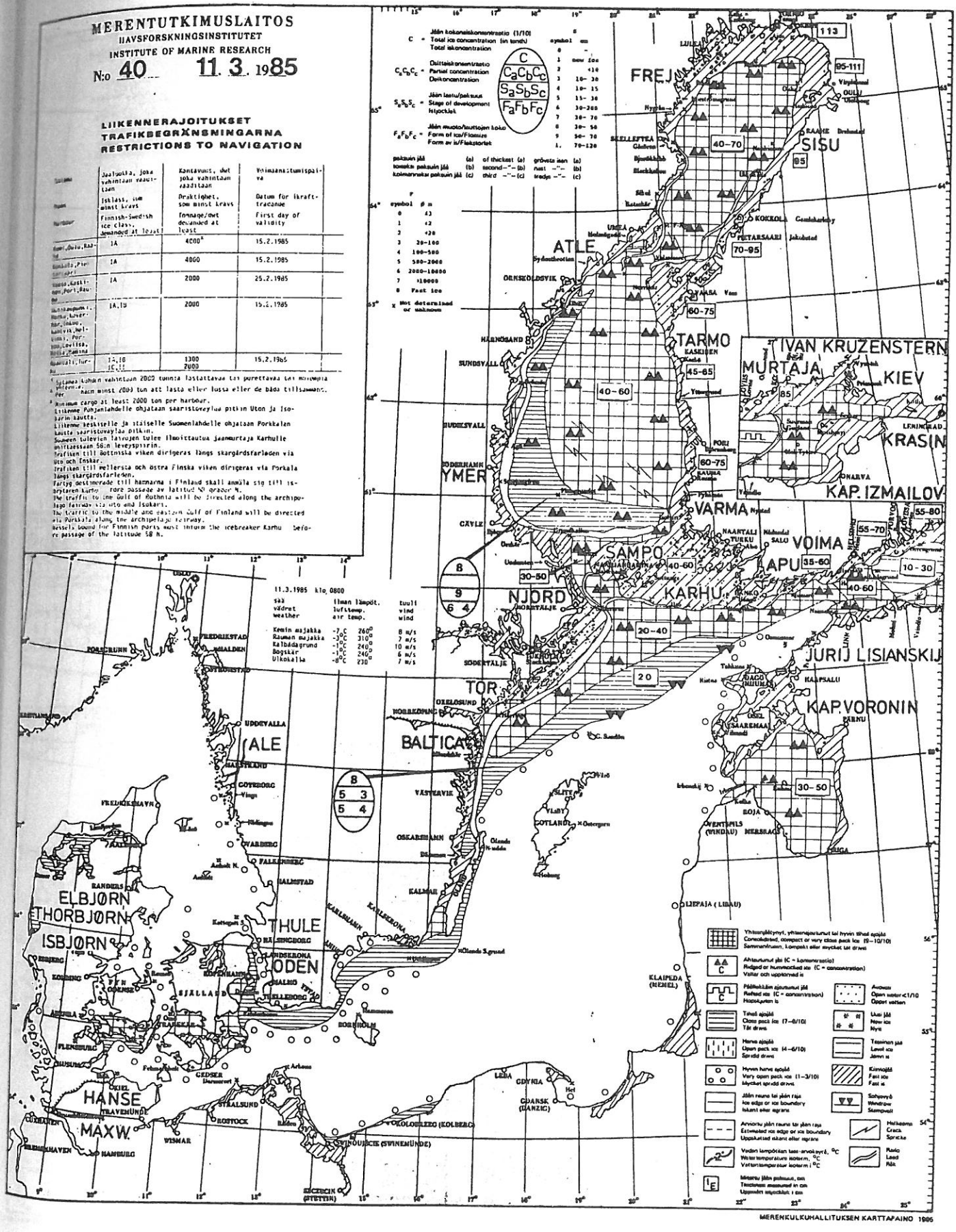
Leppäranta, M. & Seinä, A. 1985. Data of freezing, maximum annual ice thickness and breakup of ice on the Finnish coast during 1830-1984. Helsinki. Institute of Marine Research. (not published)

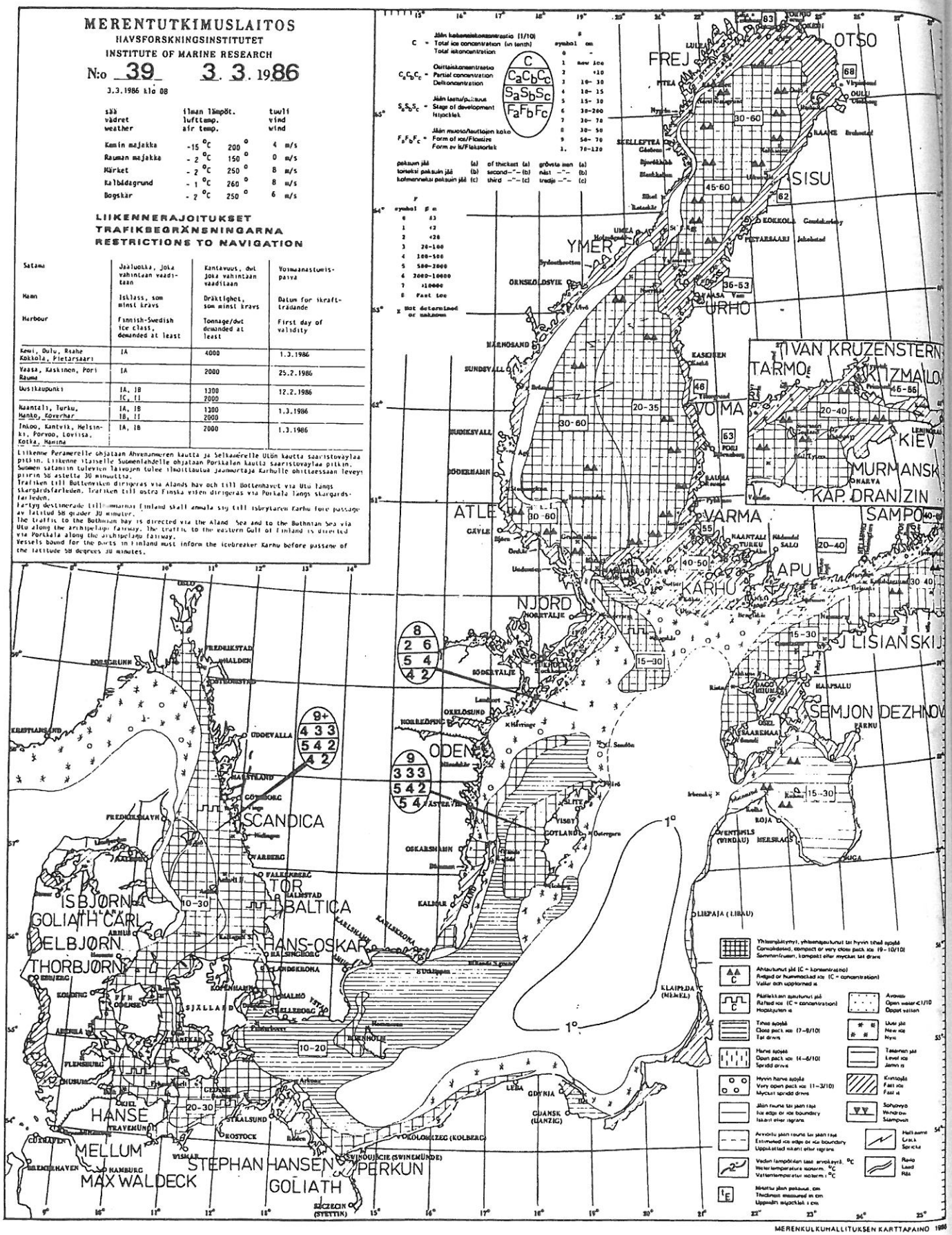
Riska, K. et al. 1983. Ice load and pressure measurements on board icebreaker Sisu. POAC 83, proceedings Vol. 2 Helsinki, April 5-9, 1983. Technical Research Centre of Finland. Espoo. VTT Symposium 28. Pp. 1055-1069.

Varsta, P. 1977. Measurement and analysis of ice-induced stres-

ses in the shell of an icebreaker. Helsinki. Winter Navigation Research Board, Report no. 21. 103 p.

Vuorio, J. et al. 1979. Long-term measurements of ice pressure and ice-induced stresses on the icebreaker Sisu in winter 1978. Helsinki. Winter Navigation Reasearch Board, Report no. 28. 50 p.


MERENTUTKIMUSLAITOS
HAVSFORSKNINGSINSTITUTET
INSTITUTE OF MARINE RESEARCH
N:o 40 11. 3. 1985
LIIKENNERAJOITUKSET
TRAFIKBEGRÄNSNINGARNA
RESTRICTIONS TO NAVIGATION
11.3.1985 klo 0800
FREJ
SISU
ATLE
TARMO
IVAN KRUZENSTERN
MURTAJA
KIEV
KRASIN
KAP. IZMAILOV
VARMA
SAMPO
VOIMA
APU
KARHU
NJORD
TOR
BALTICA
ALE
JURIJ LISIANSKIJ
KAP. VORONIN
ELBJØRN
THORBJØRN
ISBJØRN
THULE
ODEN
HANSE
MAXW.
MERENKULKUHALLITUKSEN KARTTAPAINO 1985


MERENTUTKIMUSLAITOS
HAVSFORSKNINGSINSTITUTET
INSTITUTE OF MARINE RESEARCH
No 39 3.3.1986
3.3.1986 klo 08
LIIKENNERAJOITUKSET
TRAFIKBEGRÄNSNINGARNA
RESTRICTIONS TO NAVIGATION
Kemi, Oulu, Raahe Kokkola, Pietarsaari
Vaasa, Kaskinen, Pori Rauma
Uusikaupunki
Naantali, Turku, Hanko, Koverhar
Inkoo, Kantvik, Helsinki, Porvoo, Loviisa, Kotka, Hamina
Liikenne Perämerelle ohjataan Ahvenanmeren kautta ja Selkämerelle Utön kautta saaristovaylaa pitkin. Liikenne itäiselle Suomenlahdelle ohjataan Porkkalan kautta saaristovaylaa pitkin. Suomen satamiin tulevien laivojen tulee ilmoittautua jäämurtaja Karhulle ohittaessaan leveys piirin 58 astetta 30 minuuttia.
Trafiken till Bottenviken dirigeras via Ålands hav och till Bottenhavet via Utö längs skärgårdsfarleden. Trafiken till östra Finska viken dirigeras via Porkala längs skärgårdsfarleden.
Fartyg destinerade till hamnar i Finland skall anmäla sig till isbrytaren Karhu före passage av latitud 58 grader 30 minuter.
The traffic to the Bothnian bay is directed via the Aland Sea and to the Bothnian Sea via Uto along the archipelago fairway. The traffic to the eastern Gulf of Finland is directed via Porkala along the archipelago fairway.
Vessels bound for the ports in Finland must inform the icebreaker Karhu before passing of the latitude 58 degrees 30 minutes.
OTSO
FREJ
SISU
YMER
URHO
TARMO
VOIMA
VARMA
SAMPO
KARHU
KAPU
NJORD
ODEN
SCANDICA
TOR
BALTICA
HANS-OSKAR
ISBJÖRN
GOLIATH
CARL
ELBJÖRN
THORBJÖRN
HANSE
MELLUM
MAX WALDECK
STEPHAN HANSEN
PERKUN
GOLIATH
IVAN KRUZENSTERN
KIEV
MURMANSK
KAP. DRANITZIN
J LISIANSKIJ
SEMJON DEZHNOV
MERENKULKUHALLITUKSEN KARTTAPAINO 1986

MERENTUTKIMUSLAITOS
HAVSFORSKNINGSINSTITUTET
INSTITUTE OF MARINE RESEARCH

N:o 40 12. 3. 1987

LIIKENNERAJOITUKSET
TRAFIKBEGRÄNSNINGARNA
RESTRICTIONS TO NAVIGATION

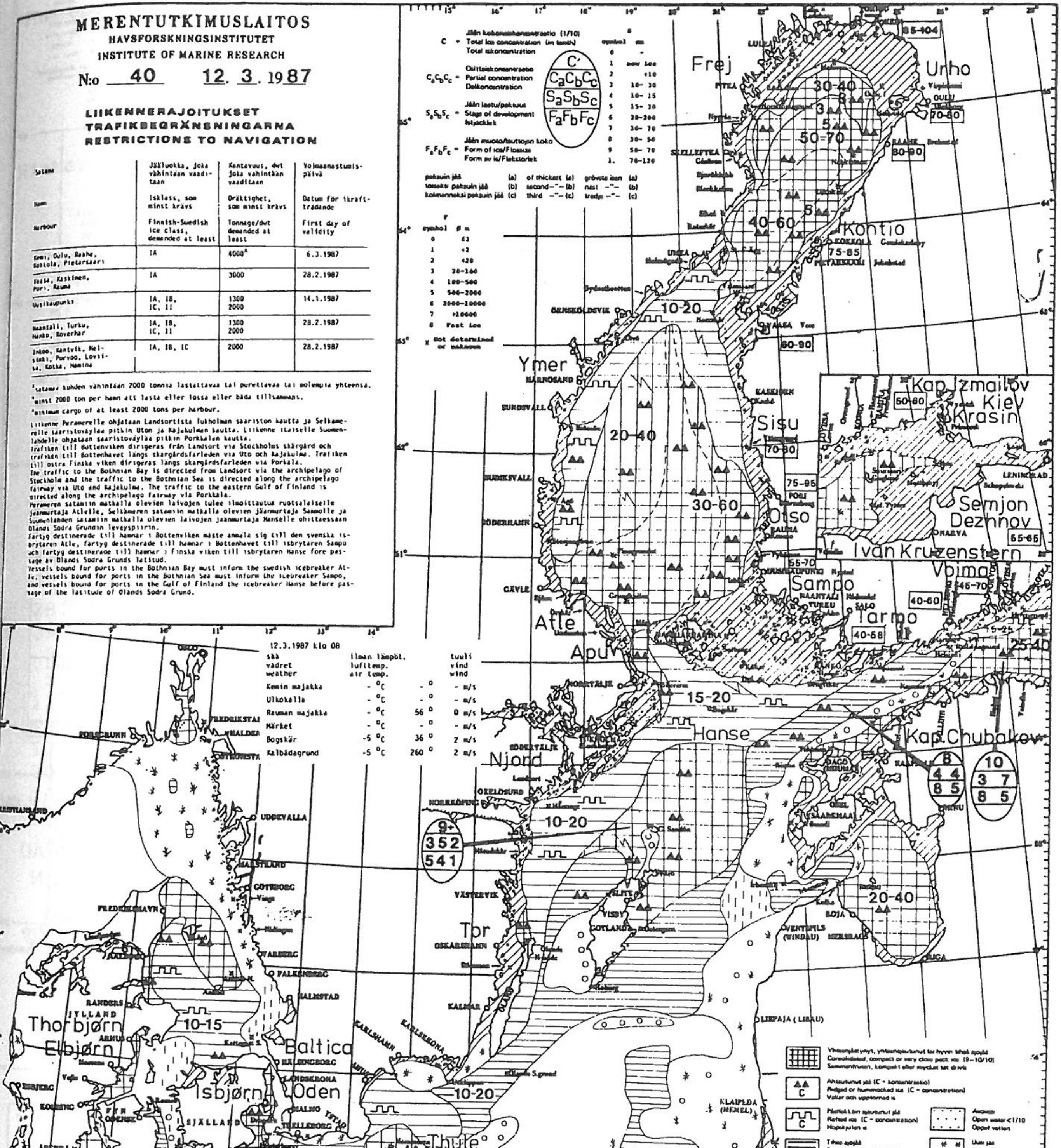
Satama Hamn Harbour	Jääluokka, joka vähintään vaaditaan Isklass, som minst krävs Finnish-Swedish ice class, demanded at least	Kantavuus, dwt joka vähintään vaaditaan Dräktighet, som minst krävs Tonnage/dwt demanded at least	Voimaanastumispäivä Datum för ikraftträdande First day of validity
Kemi, Oulu, Raahe, Kokkola, Pietarsaari	IA	4000*	6.3.1987
Vaasa, Kaskinen, Pori, Rauma	IA	3000	28.2.1987
Uusikaupunki	IA, IB, IC, II	1300 2000	14.1.1987
Naantali, Turku, Hanko, Koverhar	IA, IB, IC, II	1300 2000	28.2.1987
Inkoo, Kantvik, Helsinki, Porvoo, Loviisa, Kotka, Hamina	IA, IB, IC	2000	28.2.1987

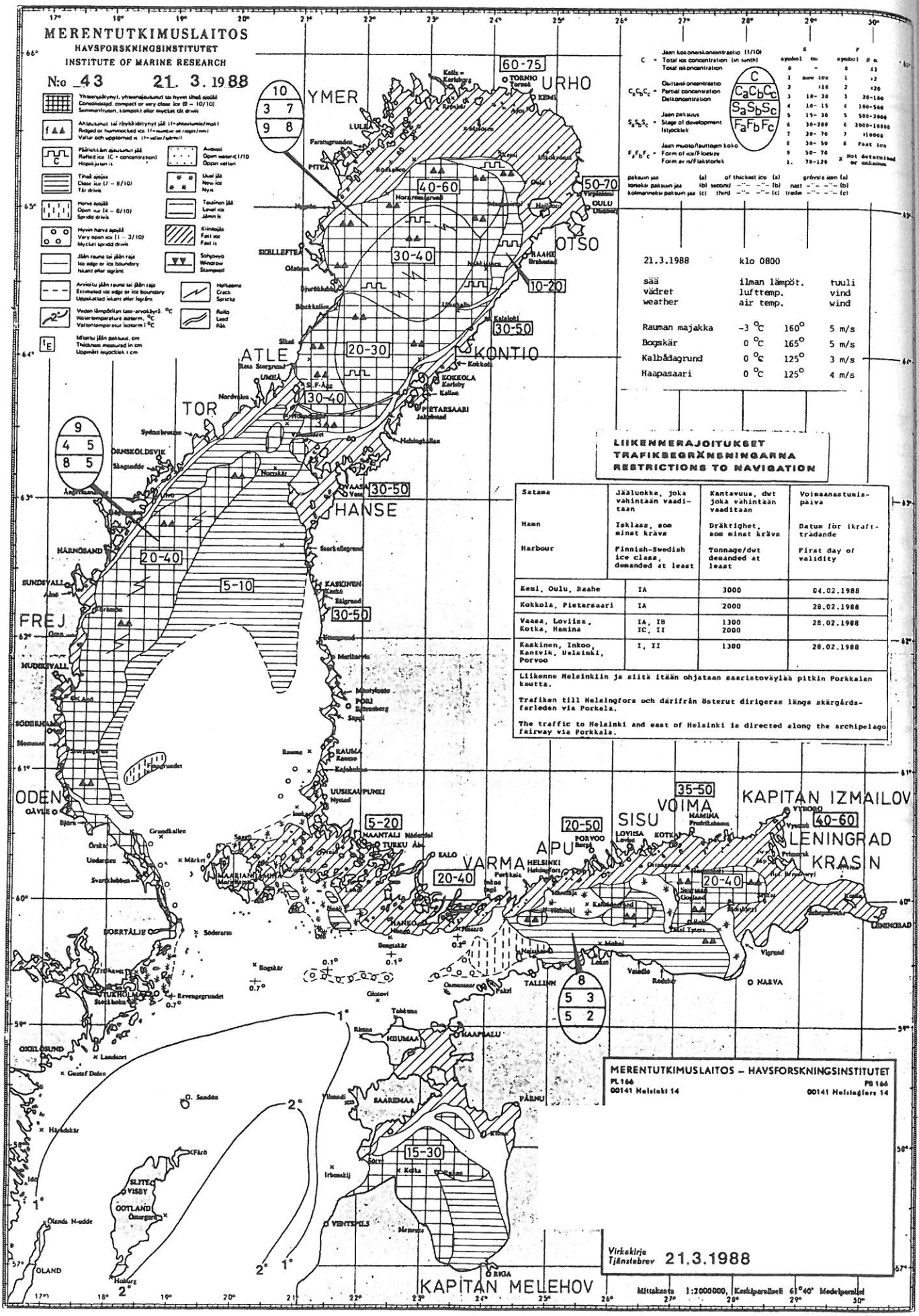
*satamaa kohden vähintään 2000 tonnia lastattavaa tai purettavaa tai molempia yhteensä.

*minst 2000 ton per hamn att lasta eller lossa eller båda tillsammans.

*minimum cargo of at least 2000 tons per harbour.

Liikenne Perämerelle ohjataan Landsortista Tukholman saariston kautta ja Selkämerelle saaristoväylää pitkin Uton ja Kajakulman kautta. Liikenne itäiselle Suomenlahdelle ohjataan saaristoväylää pitkin Porkkalan kautta.
Trafiken till Bottenviken dirigeras från Landsort via Stockholms skärgård och trafiken till Bottenhavet längs skargårdsfarleden via Uto och Kajakulma. Trafiken till ostra Finska viken dirigeras längs skargårdsfarleden via Porkala.
The traffic to the Bothnian Bay is directed from Landsort via the archipelago of Stockholm and the traffic to the Bothnian Sea is directed along the archipelago fairway via Uto and Kajakulma. The traffic to the eastern Gulf of Finland is directed along the archipelago fairway via Porkkala.
Perämeren satamiin matkalla olevien laivojen tulee ilmoittautua ruotsalaiselle jäänmurtaja Atlelle, Selkämeren satamiin matkalla olevien jäänmurtaja Sammolle ja Suomenlahden satamiin matkalla olevien laivojen jäänmurtaja Hanselle ohittaessaan Olands Sodra Grundin leveyspiirin.
Fartyg destinerade till hamnar i Bottenviken måste anmäla sig till den svenska isbrytaren Atle, fartyg destinerade till hamnar i Bottenhavet till isbrytaren Sampo och fartyg destinerade till hamnar i Finska viken till isbrytaren Hanse före passage av Olands Sodra Grunds latitud.
Vessels bound for ports in the Bothnian Bay must inform the swedish icebreaker Atle, vessels bound for ports in the Bothnian Sea must inform the icebreaker Sampo, and vessels bound for ports in the Gulf of Finland the icebreaker Hanse before passage of the latitude of Olands Sodra Grund.




MERENTUTKIMUSLAITOS
HAVSFORSKNINGSINSTITUTET
INSTITUTE OF MARINE RESEARCH
N:o 43 21. 3. 1988
YMER
URHO
OTSO
ATLE
KONTIO
TOR
HANSE
FREJ
ODEN
SISU
VOIMA
APU
VARMA
KAPITAN IZMAILOV
LENINGRAD
KRASIN
KAPITAN MELEHOV
60-75
50-70
40-60
30-40
30-50
20-30
20-40
10-20
5-10
5-20
35-50
20-50
15-30
21.3.1988 klo 0800
säävädret weather
ilman lämpöt. lufttemp. air temp.
tuuli vind wind
Rauman majakka −3 °C 160° 5 m/s
Bogskär 0 °C 165° 5 m/s
Kalbådagrund 0 °C 125° 3 m/s
Haapasaari 0 °C 125° 4 m/s
LIIKENNERAJOITUKSET
TRAFIKBEGRÄNSNINGARNA
RESTRICTIONS TO NAVIGATION
Satama / Hamn / Harbour
Jääluokka, joka vähintään vaaditaan
Isklass, som minst krävs
Finnish-Swedish ice class, demanded at least
Kantavuus, dwt joka vähintään vaaditaan
Dräktighet, som minst krävs
Tonnage/dwt demanded at least
Voimaanastumispäivä
Datum för ikraftträdande
First day of validity
Kemi, Oulu, Raahe IA 3000 04.02.1988
Kokkola, Pietarsaari IA 2000 28.02.1988
Vaasa, Loviisa, Kotka, Hamina IA, IB IC, II 1300 2000 28.02.1988
Kaskinen, Inkoo, Kantvik, Helsinki, Porvoo I, II 1300 28.02.1988
Liikenne Helsinkiin ja siitä itään ohjataan saaristoväylää pitkin Porkkalan kautta.
Trafiken till Helsingfors och därifrån österut dirigeras längs skärgårdsfarleden via Porkala.
The traffic to Helsinki and east of Helsinki is directed along the archipelago fairway via Porkkala.
MERENTUTKIMUSLAITOS – HAVSFORSKNINGSINSTITUTET
PL 166 00141 Helsinki 14
PB 166 00141 Helsingfors 14
Virkakirje Tjänstebrev 21.3.1988
Mittakaava 1:2000000, Keskiparalleeli 61°40' Medelparallel

Appendix 2/1

The operation schedule of M/S Kemira during the winters 1985-1988

Winter 1985

Departure			Arrival		
Date	Time	Port	Date	Time	Port
2. 2.	7.20 pm	Uusikaupunki	4. 2.	2.15 am	Kokkola
4. 2.	6.10 pm	Kokkola	6. 2.	7.15 pm	Storungs
7. 2.	5.45 pm	Storungs	9. 2.	2.15 pm	Kokkola
13. 2.	7.45 pm	Kokkola	15. 2.	4.00 am	Uusikaupunki
15. 2.	8.00 pm	Uusikaupunki	16. 2.	3.10 pm	Ventspils
17. 2.	10.20 am	Ventspils	18. 2.	9.00 am	Uusikaupunki
19. 2.	2.40 pm	Uusikaupunki	21. 2.	5.00 pm	Wismar
24. 2.	8.30 am	Wismar	28. 2.	7.20 am	Kokkola
5. 3.	6.30 pm	Kokkola	10. 3.	11.00 am	Immingham
13. 3.	9.05 pm	Immingham	15. 3.	10.05 pm	Teesside
16. 3.	8.20 pm	Teesside	20. 3.	6.30 pm	Uusikaupunki
20. 3.	10.20 pm	Uusikaupunki	22. 3.	11.30 am	Kokkola
26. 3.	10.00 am	Kokkola	27. 3.	5.20 pm	Uusikaupunki
28. 3.	2.15 pm	Uusikaupunki	29. 3.	10.00 am	Storungs
29. 3.	5.35 pm	Storungs	1. 4.	1.30 am	Kokkola
2. 4.	11.30 pm	Kokkola	4. 4.	9.00 pm	Uusikaupunki
5. 4.	5.05 am	Uusikaupunki	8. 4.	12.00 am	Wismar
11. 4.	2.00 pm	Wismar	13. 4.	10.55 am	Uusikaupunki
13. 4.	3.15 pm	Uusikaupunki	14. 4.	10.15 pm	Kokkola
17. 4.	10.20 pm	Kokkola	19. 4.	3.45 am	Uusikaupunki
20. 4.	0.10 am	Uusikaupunki	21. 4.	11.50 am	Storungs
22. 4.	4.40 pm	Storungs	25. 4.	9.40 am	Kokkola
27. 4.	0.40 pm	Kokkola	28. 4.	00.50 pm	Uusikaupunki
29. 4.	7.45 pm	Uusikaupunki	30. 4.	9.00 pm	Kokkola
1. 5.	10.50 am	Kokkola	2. 5.	6.40 pm	Uusikaupunki
3. 5.	4.40 am	Uusikaupunki	4. 5.	6.00 pm	Storungs
6. 5.	2.10 pm	Storungs	8. 5.	8.15 pm	Kokkola
10. 5.	6.50 am	Kokkola	13. 5.	6.50 am	Fredericia

Winter 1986

Departure			Arrival		
Date	Time	Port	Date	Time	Port
3. 1.	5.00 am	Uusikaupunki	4. 1.	6.50 am	Kokkola
6. 1.	0.05 pm	Kokkola	7. 1.	9.40 am	Uusikaupunki
8. 1.	5.50 am	Uusikaupunki	11. 1.	1.10 pm	Wismar
12. 1.	4.30 pm	Wismar	15. 1.	4.25 am	Kokkola
17. 1.	7.35 pm	Kokkola	18. 1.	9.45 pm	Uusikaupunki
19. 1.	3.20 pm	Uusikaupunki	21. 1.	0.40 am	Storungs
21. 1.	9.10 pm	Storungs	23. 1.	11.05 am	Kokkola
23. 1.	10.10 pm	Kokkola	27. 1.	1.05 pm	Wismar
29. 1.	8.15 am	Wismar	31. 1.	10.05 am	Uusikaupunki
31. 1.	2.25 pm	Uusikaupunki	1. 2.	1.10 pm	Kokkola
4. 2.	6.30 pm	Kokkola	6. 2.	4.05 am	Uusikaupunki
6. 2.	11.35 pm	Uusikaupunki	10. 2.	4.20 pm	Immingham
14. 2.	4.20 am	Immingham	15. 2.	4.45 pm	Hamburg
18. 2.	5.00 am	Hamburg	21. 2.	2.15 am	Uusikaupunki
21. 2.	9.15 pm	Uusikaupunki	22. 2.	4.10 pm	Ventspils
23. 2.	6.30 am	Ventspils	28. 2.	5.20 pm	Kokkola
2. 3.	5.30 am	Kokkola	4. 3.	9.00 am	Uusikaupunki
5. 3.	0.30 am	Uusikaupunki	7. 3.	1.40 pm	Wismar
8. 3.	7.40 am	Wismar	10. 3.	6.45 am	Uusikaupunki
10. 3.	6.20 pm	Uusikaupunki	13. 3.	8.30 am	Hamburg
13. 3.	10.45 pm	Hamburg	19. 3.	7.00 pm	Kokkola
22. 3.	5.25 am	Kokkola	27. 3.	3.30 pm	Uusikaupunki
28. 3.	3.05 pm	Uusikaupunki	29. 3.	8.30 am	Storungs
29. 3.	7.20 pm	Storungs	1. 4.	6.15 am	Kokkola
4. 4.	3.25 am	Kokkola	5. 4.	6.30 am	Uusikaupunki
6. 4.	2.15 am	Uusikaupunki	6. 4.	10.15 pm	Ventspils
7. 4.	8.05 am	Ventspils	8. 4.	0.40 pm	Uusikaupunki
8. 4.	6.30 pm	Uusikaupunki	9. 4.	8.40 pm	Kokkola
12. 4.	0.15 am	Kokkola	13. 4.	2.50 am	Uusikaupunki
13. 4.	1.50 pm	Uusikaupunki	14. 4.	7.40 am	Storungs
14. 4.	8.30 pm	Storungs	16. 4.	4.40 pm	Kokkola
18. 4.	2.05 pm	Kokkola	19. 4.	9.50 am	Uusikaupunki
19. 4.	8.45 pm	Uusikaupunki	20. 4.	4.30 pm	Ventspils
21. 4.	4.45 am	Ventspils	22. 4.	4.00 pm	Kokkola
24. 4.	8.20 pm	Kokkola	25. 4.	5.30 pm	Uusikaupunki
26. 4.	3.10 am	Uusikaupunki	26. 4.	9.15 pm	Kokkola
27. 4.	6.40 am	Kokkola	28. 4.	0.37 am	Uusikaupunki
28. 4.	6.00 am	Uusikaupunki	2. 5.	4.00 pm	Immingham

Winter 1987.

Departure			Arrival		
Date	Time	Port	Date	Time	Port
28. 1.	6.57 pm	Kokkola	29. 1.	7.30 pm	Uusikaupunki
31. 1.	1.55 am	Uusikaupunki	2. 2.	3.15 pm	Wismar
3. 2.	10.10 am	Wismar	6. 2.	0.10 pm	Kokkola
10. 2.	9.00 pm	Kokkola	11. 2.	10.25 pm	Uusikaupunki
13. 2.	10.00 am	Uusikaupunki	14. 2.	3.30 am	Storungs
14. 2.	9.00 pm	Storungs	16. 2.	1.30 pm	Kokkola
18. 2.	9.50 pm	Kokkola	21. 2.	11.15 pm	Fredericia
23. 2.	9.30 pm	Fredericia	24. 2.	8.00 am	Wismar
25. 2.	0.25 am	Wismar	4. 3.	0.05 am	Gävle
7. 3.	7.10 pm	Gävle	11. 3.	2.30 am	Uusikaupunki
12. 3.	8.30 pm	Uusikaupunki	13. 3.	7.45 am	Turku
31. 3.	4.00 pm	Turku	1. 4.	3.30 pm	Ventspils
2. 4.	2.30 am	Ventspils	2. 4.	10.00 pm	Uusikaupunki
3. 4.	4.10 am	Uusikaupunki	4. 4.	1.40 pm	Kokkola
7. 4.	11.15 pm	Kokkola	9. 4.	5.00 am	Uusikaupunki
9. 4.	4.10 pm	Uusikaupunki	12. 4.	7.35 am	Fredericia
13. 4.	8.30 pm	Fredericia	14. 4.	1.00 pm	Wismar
16. 4.	3.05 pm	Wismar	20. 4.	4.10 am	Kokkola
22. 4.	4.30 pm	Kokkola	24. 4.	12.00 am	Uusikaupunki
25. 4.	6.30 am	Uusikaupunki	26. 4.	3.30 pm	Kokkola
28. 4.	5.25 pm	Kokkola	30. 4.	1.30 am	Uusikaupunki
30. 4.	0.20 pm	Uusikaupunki	3. 5.		Wismar
6. 5.		Wismar	9. 5.	4.00 am	Kokkola
13. 5.	6.20 pm	Kokkola	14. 5.	8.20 pm	Uusikaupunki
15. 5.	5.50 pm	Uusikaupunki	16. 5.	1.00 pm	Kokkola
18. 5.	4.20 pm	Kokkola	19. 5.	2.45 pm	Uusikaupunki
20. 5.	3.05 am	Uusikaupunki	20. 5.	9.30 am	Mäntyluoto
20. 5.	9.15 pm	Mäntyluoto	21. 5.	11.05 pm	Storungs
22. 5.	2.40 pm	Storungs	24. 5.	1.10 am	Kokkola

Winter 1988

Departure			Arrival		
Date	Time	Port	Date	Time	Port
7. 1.	5.35 pm	Storungs	9. 1.	6.20 am	Kokkola
13. 1.	10.05 pm	Kokkola	14. 1.	7.45 pm	Uusikaupunki
15. 1.	5.25 am	Uusikaupunki	17. 1.	7.25 am	Fredericia
18. 1.	4.10 pm	Fredericia	21. 1.	2.25 pm	Wismar
22. 1.	1.45 pm	Wismar	24. 1.	1.20 pm	Uusikaupunki
24. 1.	8.05 pm	Uusikaupunki	25. 1.	3.20 pm	Kokkola
27. 1.	10.25 am	Kokkola	28. 1.	8.05 am	Uusikaupunki
28. 1.	5.40 pm	Uusikaupunki	29. 1.	6.45 pm	Kokkola
30. 1.	4.00 pm	Kokkola	31. 1.	2.25 pm	Uusikaupunki
31. 1.	7.20 pm	Uusikaupunki	3. 2.	10.45 pm	Fredericia
5. 2.	0.50 pm	Fredericia	5. 2.	12.00 pm	Rostock
6. 2.	3.45 pm	Rostock	8. 2.	9.05 am	Uusikaupunki
8. 2.	4.10 pm	Uusikaupunki	9. 2.	10.40 am	Kokkola
10. 2.	5.20 pm	Kokkola	11. 2.	0.30 pm	Uusikaupunki
11. 2.	9.45 pm	Uusikaupunki	13. 2.	9.25 pm	Fredericia
14. 2.	8.10 pm	Fredericia	15. 2.	5.25 pm	Wismar
17. 2.	3.45 pm	Wismar	19. 2.	2.20 pm	Uusikaupunki
19. 2.	8.45 pm	Uusikaupunki	21. 2.	4.15 am	Oulu
24. 2.	2.15 pm	Oulu	26. 2.	2.30 am	Uusikaupunki
26. 2.	5.40 pm	Uusikaupunki	28. 2.	5.05 pm	Fredericia
29. 2.	11.05 pm	Fredericia	2. 3.	8.30 am	Storungs
2. 3.	6.20 pm	Storungs	3. 3.	0.40 pm	Uusikaupunki
3. 3.	7.35 pm	Uusikaupunki	4. 3.	3.50 pm	Kokkola
5. 3.	9.05 pm	Kokkola	6. 3.	5.30 pm	Uusikaupunki
7. 3.	2.00 am	Uusikaupunki	9. 3.	0.40 am	Fredericia
10. 3.	0.15 am	Fredericia	10. 3.	0.40 pm	Wismar
11. 3.	11.50 am	Wismar	13. 3.	11.50 am	Uusikaupunki
14. 3.	0.40 pm	Uusikaupunki	15. 3.	0.30 pm	Kokkola
18. 3.	0.40 am	Kokkola	20. 3.	5.40 pm	Fredericia
22. 3.	2.05 pm	Fredericia	23. 3.	6.05 am	Wismar
24. 3.	10.50 am	Wismar	27. 3.	5.10 am	Kokkola
29. 3.	2.35 pm	Kokkola	30. 3.	9.05 am	Rauma
30. 3.	0.10 pm	Rauma	1. 4.	9.10 am	Wismar
2. 4.	4.15 am	Wismar	4. 4.	5.10 pm	Kokkola
7. 4.	0.20 pm	Kokkola	8. 4.	8.45 am	Uusikaupunki
8. 4.	5.40 pm	Uusikaupunki	11. 4.	6.05 pm	Storungs
12. 4.	1.20 am	Storungs	13. 4.	9.00 am	Kokkola
14. 4.	3.30 pm	Kokkola	15. 4.	9.55 am	Uusikaupunki
15. 4.	6.45 pm	Uusikaupunki	18. 4.	8.20 am	Fredericia
19. 4.	9.50 pm	Fredericia	25. 4.	9.15 pm	Ventspils
27. 4.	1.25 pm	Ventspils	28. 4.	6.25 pm	Uusikaupunki
29. 4.	0.20 pm	Uusikaupunki	30. 4.	9.40 am	Kokkola
3. 5.	4.50 pm	Kokkola	6. 5.	6.45 am	Fredericia

Ice code = ICDic

IC and ic give ice type and concentration. IC is the primary ice type.

I = 3 new ice, level ice, rafted ice, fast ice

IC = 30 new ice, level ice
= 31 rafted ice (<50% of grid cell)
= 32 " " (>50% of grid cell)
= 33 fragile spring ice (rotten ice)
= 34 -
= 35 -
= 36 -
= 37 -
= 38 -
= 39 fast ice

I = 4 belts of slush and shuga

IC = 40 loose slush and shuga
= 41 compact shuga, width 0 - 1/2 nautical miles
= 42 " " , " 1/2 - 1 "
= 43 " " , " 1 - 3 "
= 44 " " , " > 3 "
= 45 compact, frozen shuga, width 0 - 1/2 nautical miles
= 46 " , " " , " 1/2 - 1 "
= 47 " , " " , " 1 - 3 "
= 48 " , " " , " > 3 "
= 49 -

I = 5 pack ice, small and medium floes (< 500 m)

		ice concentration
IC = 50	pack ice, small and medium floes	< 1/10
= 51	" " , " "	1 - 2/10
= 52	" " , " "	2 - 3/10
= 53	" " , " "	3 - 4/10
= 54	" " , " "	4 - 5/10
= 55	" " , " "	5 - 6/10

= 56	"	" , "	" 6 - 7/10
= 57	"	" , "	" 7 - 8/10
= 58	"	" , "	" 8 - 9/10
= 59	"	" , "	" 9 -10/10

I = 6 pack ice, large floes (> 500 m)

		ice concentration
IC = 60	pack ice, large floes	< 1/10
= 61	" " , " "	1 - 2/10
= 62	" " , " "	2 - 3/10
= 63	" " , " "	3 - 4/10
= 64	" " , " "	4 - 5/10
= 65	" " , " "	5 - 6/10
= 66	" " , " "	6 - 7/10
= 67	" " , " "	7 - 8/10
= 68	" " , " "	8 - 9/10
= 69	" " , " "	9 -10/10

I = 7 consolidated pack ice

IC = 70 consolidated pack ice

= 71	-
= 72	-
= 73	-
= 74	-
= 75	-
= 76	-
= 77	-
= 78	-
= 79	-

I = 8 ridged ice

		ridge concentration
IC = 80	ridged ice, not consolidated	1 - 3/10
= 81	" " , " "	4 - 6/10
= 82	" " , " "	7 - 8/10
= 83	" " , " "	9 -10/10
= 84	ridged ice, consolidated	1 - 3/10
= 85	" " , "	4 - 6/10
= 86	" " , "	7 - 8/10

= 87 " " , " 9 -10/10
= 88 disintegrating ridges
= 89 ridged floes, growlers

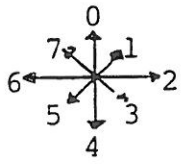
D - ice thickness (thickness = D^2)

D = 0 no information on thickness
= 1 thickness 1 - 2 cm
= 2 " 3 - 6 "
= 3 " 7 - 12 "
= 4 " 13 - 20 "
= 5 " 21 - 30 "
= 6 " 31 - 42 "
= 7 " 43 - 56 "
= 8 " 57 - 72 "
= 9 > 73 "

Leads and edges = 9RKic

First digit equals 9 indicates leads or ice edges.
R = direction
K = concentration of open water in the square

R
direction perpendicular to the dominant ice type from the ice towards the open water according to figure.



K
K = 0 < 1/10 open water
= 1 1 - 2/10 " "
= 2 2 - 3/10 " "
= 3 3 - 4/10 " "
= 4 4 - 5/10 " "
= 5 5 - 6/10 " "
= 6 6 - 7/10 " "
= 7 7 - 8/10 " "
= 8 8 - 9/10 " "
= 9 9 -10/10 " "

Year	Day	am/pm	Draught (m)			Disp.	Navigation time			Time	Voyage	Navigation	Enviromental conditions										Remarks
			Aft	Mid	Bow	(ton)	Indep.	Icebreaker assist	Icebreaker tow	in ice (hour)	in ice (miles)	Area	Ice thickness class	%	class	%	class	%	Ice type Index	%	index	%	index	%	
1985	2.2	am	7	6.6	6.3	8853	6			6	60	Baltic proper	5	100					39	100					
1985	2.2	pm	7.1	6.9	6.8	9270	5			2	15	Bothnian Sea	5	100					39	100					
1985	3.2	am	7.1	6.9	6.8	9270	12			2	20	Bothnian Sea	5	100					67	50	81	50			
1985	3.2	pm	7.1	6.9	6.8	9270	2	6	4	12	80	Bothnian Bay	6	100					85	100					
1985	4.2	am	7.1	6.9	6.8	9270		2		2	10	Bothnian Bay	7	100					39	100					
1985	4.2	pm	5.6	4.9	4.4	6448	6			6	40	Bothnian Bay	6	100					85	100					
1985	5.2	am	5.6	4.9	4.4	6448	12			12	80	Bothnian Bay	6	100					68	80	85	20			
1985	5.2	pm	5.6	4.9	4.4	6448	12			6	75	Bothnian Sea	6	20	5	20	4	20	68	60	30	40			
1985	8.2	am	8.3	8	7.7	11009	12			8	95	Baltic proper	5	100					39	100					
1985	8.2	pm	8.3	8	7.7	11009	12			12	120	Bothnian Sea	4	100					30	100					
1985	9.2	am	8.3	8	7.7	11009	3	9		12	115	Bothnian Bay	2	50	6	50			30	50	85	50			
1985	9.2	pm	8.3	8	7.7	11009		2		2	10	Bothnian Bay	6	100					85	50	39	50			
1985	13.2	pm	8.1	7.6	7.2	10460		4		4	40	Bothnian Bay	6	100					39	50	85	50			
1985	14.2	am	8.1	7.6	7.2	10460	3	9		12	90	Bothnian Bay	6	60	4	40			85	60	30	40			
1985	14.2	pm	8.1	7.6	7.2	10460	12			12	90	Bothnian Sea	4	100					30	100					
1985	15.2	am	8.1	7.6	7.2	10460		4		4	40	Bothnian Sea	5	30	6	70			85	30	39	70			
1985	15.2	pm	5.3	4.6	4	6040	4			4	40	Baltic proper	6	100					39	100					
1985	16.2	am	5.3	4.6	4	6040	12			9	90	Baltic proper	5	40	4	60			39	30	68	70			
1985	16.2	pm	5.3	4.6	4	6040	3			3	30	Baltic proper	4	100					68	100					
1985	17.2	am	7.8	7.4	7.1	10120	2			2	20	Baltic proper	4	100					30	100					
1985	17.2	pm	7.8	7.4	7.1	10120	12			12	120	Baltic proper	4	80	5	20			30	80	85	20			
1985	18.2	am	7.8	7.4	7.1	10120	9			9	90	Baltic proper	6	100					39	100					
1985	19.2	pm	6.7	5.6	4.7	7670	9			9	90	Baltic proper	6	100					39	100					
1985	20.2	am	6.7	5.6	4.7	7670	12			10	110	Baltic proper	4	100					30	100					
1985	21.2	am	6.7	5.6	4.7	7670	12			12	100	Baltic proper	4	60	5	40			30	100					
1985	21.2	pm	6.1	5.3	4.7	7070	2			2	20	Baltic proper	6	100					30	100					
1985	24.2	am	7.6	7.6	7.6	10250	3			3	30	Baltic proper	6	100					30	100					
1985	24.2	pm	7.6	7.6	7.6	10250	12			8	80	Baltic proper	5	20	4	80			30	100					
1985	25.2	pm	7.6	7.6	7.6	10250	12			3	30	Baltic proper	4	100					30	100					
1985	26.2	am	7.6	7.6	7.6	10250	12			12	100	Baltic proper	4	50	6	50			30	50	39	50			
1985	26.2	pm	7.6	7.6	7.6	10250	12			12	100	Bothnian Sea	6	100					86	100					
1985	27.2	am	7.6	7.6	7.6	10250	9	3		12	80	Bothnian Bay	6	100					32	50	85	50			2 hour wait
1985	27.2	pm	7.6	7.6	7.6	10250		12		12	40	Bothnian Bay	7	100					85	100					
1985	28.2	am	7.9	7.5	7.1	10230		7		7	40	Bothnian Bay	7	100					85	60	39	40			
1985	5.3	pm	8.3	8.2	8.1	11250	3	2		5	50	Bothnian Bay	7	100					85	100					
1985	6.3	am	8.3	8.2	8.1	11250	12			12	120	Bothnian Bay	7	20	2	80			85	20	30	80			
1985	6.3	pm	8.3	8.2	8.1	11250	12			12	130	Bothnian Sea	6	70	7	30			30	30	68	30	39	40	
1985	7.3	am	8.3	8.2	8.1	11250	12			3	35	Baltic proper	5	100					85	100					
1985	19.3	am	7.6	7.4	7.3	10100	12			1	15	Baltic proper	5	100					61	100					
1985	19.3	pm	7.6	7.4	7.3	10100	12			1	15	Baltic proper	5	100					61	100					
1985	20.3	am	7.6	7.4	7.3	10100	12			10	80	Baltic proper	5	80	7	20			68	80	39	20			

Year	Day	am/ pm	Draught (m)			Disp. (ton)	Navigation time		Time in ice (hour)	Voyage in ice (miles)	Navigation Area	Enviromental conditions										Remarks
												Ice thickness						Ice type				
			Aft	Mid	Bow		Indep.	Icebreaker assist tow.				class	%	class	%	class	%	Index	%	index	%	index	%	
1985	20.3	pm	7.2	6.9	6.7	9280	8		8	70	Baltic proper	7	100					39	100					
1985	21.3	am	8.4	8.2	8.1	11300	12		12	75	Bothnian Sea	7	100					86	80	39	20			
1985	21.3	pm	8.4	8.2	8.1	11300	12		12	100	Bothnian Bay	7	100					85	100					
1985	22.3	am	8.4	8.2	8.1	11300	5	2	7	70	Bothnian Bay	7	80	8	20			85	80	39	20			
1985	26.3	am	8.5	8.3	8.2	11470	2		2	15	Bothnian Bay	8	100					39	100					
1985	26.3	pm	8.5	8.3	8.2	11470	7.5	4.5	12	120	Bothnian Bay	7	100					85	100					
1985	27.3	am	8.5	8.3	8.2	11470	9	3	11	60	Bothnian Sea	7	100					85	100					3 hour wait
1985	27.3	pm	8.5	8.3	8.2	11470	5		3	60	Bothnian Sea	8	60	4	40			39	60	70	40			
1985	28.3	pm	6.6	6.1	5.8	8150	10		9	100	Baltic proper	6	50	7	30	8	20	39	70	85	20	68	10	
1985	29.3	am	6.6	6.1	5.8	8150	10		2	25	Baltic proper	6	100					68	100					
1985	30.3	am	8.5	8.3	8.2	11470	12		8	90	Baltic proper	6	50	7	50			39	70	68	20	85	10	
1985	30.3	pm	8.5	8.3	8.2	11470	2	10	5	60	Bothnian Sea	5	100					65	100					
1985	31.3	am	8.5	8.3	8.2	11470		12	6	60	Bothnian Sea	7	100					85	100					
1985	2.4	pm	7.6	7.3	7.1	9910	1		1	10	Bothnian Bay	8	100					39	100					
1985	3.4	day	7.6	7.3	7.1	9910	11	13	24	110	Bothnian Bay	8	60	7	40			85	100					4 hour wait
1985	4.4	day	7.6	7.3	7.1	9910	20	1	4	60	Bothnian Sea	7	50	5	50			70	50	68	50			
1985	5.4	day	5.3	4.7	4.3	6200	19		9	100	Baltic proper	6	70	5	30			39	70	68	30			
1985	12.4	day	6.9	6.6	6.3	8850	24		2	30	Baltic proper	5	100					68	100					
1985	13.4	day	6.9	6.6	6.3	8850	19		16	150	Bothnian Sea	6	30	7	70			39	50	85	50			
1985	14.4	day	8.5	8.3	8.2	11460	10	12	16	130	Bothnian Bay	7	60	8	40			68	60	85	40			
1985	18.4	day	8.5	8.2	7.9	11320	16	6	13	130	Bothnian Bay	8	60	7	40			85	60	68	40			
1985	19.4	am	8.5	8.2	7.9	11320		4	4	40	Bothnian Sea	7	100					39	50	68	30	85	20	
1985	20.4	am	6.6	6.1	5.7	8110	7		7	80	Baltic proper	7	50	6	50			39	100					
1985	23.4	day	8.5	8.3	8.1	11430	24		15	150	Bothnian Sea	7	80	6	20			39	40	68	60			
1985	24.4	day	8.5	8.3	8.1	11430	24		24	40	Bothnian Bay	7	100					69	100					18 hour wait
1985	25.4	am	8.4	8.2	8.1	11340	3	6.5	9.5	65	Bothnian Bay	8	100					85	80	39	20			1.5 hour wait
1985	27.4	pm	7.5	7.2	7.1	9790		11	4	45	Bothnian Bay	8	100					85	100					
1985	28.4	am	7.5	7.2	7.1	9790		13	6	70	Bothnian Sea	7	100					68	90	39	10			
1985	29.4	pm	6.1	5.8	5.6	7520	4		2	25	Bothnian Sea	7	100					68	50	39	50			
1985	30.4	day	6.1	5.8	5.6	7520	11	10	8	60	Bothnian Bay	8	100					68	40	85	50	39	10	
1985	1.5	pm	7.8	7.5	7.4	10270	5	8	13	60	Bothnian Bay	8	100					85	90	39	10			3 hour wait.
1985	2.5	day	7.8	7.5	7.4	10270	12.5	6	6	30	Bothnian Bay	8	60	6	40			85	20	68	40	53	40	
1985	7.5	day	7.9	7.7	7.5	10430	24		8	80	Bothnian Bay	8	80	7	20			85	80	67	20			
1985	8.5	am	7.9	7.7	7.5	10430	1		1	10	Bothnian Bay	8	100					39	100					
1985	10.5	day	7.9	7.5	7.1	10230	24		7	80	Bothnian Bay	8	70	7	30			85	70	67	30			
1985	11.5	am	7.9	7.5	7.1	10230	12		5	60	Bothnian Sea	7	100					68	100					
1986	1.1	am	7.7	7.4	7.1	10025	12		5	45	Bothnian Bay	4	100					30	100					
1986	1.1	pm	7.7	7.4	7.1	10025	7		0.5	5	Baltic proper	3	100					39	100					
1986	3.1	am	6.3	6	5.7	7905	7		0.5	5	Baltic proper	3	100					39	100					
1986	3.1	pm	6.3	6	5.7	7905	12		10	100	Bothnian Bay	4	100					30	100					
1986	4.1	am	6.3	6	5.7	7905	6	1	7	50	Bothnian Bay	4	60	5	40			30	60	85	40			3 hour wait.
1986	14.1	pm	7	6.8	6.6	9080	12		5	50	Bothnian Bay	6	80	5	20			85	80	70	20			
1986	15.1	am	7.4	7	6.7	9560	4		4	40	Bothnian Bay	6	100					85	80	39	20			
1986	17.1	pm	7.7	7.4	7.1	10110		1	1	10	Bothnian Bay	6	100					39	100					

Appendix 4/2

Year	Day	am/ pm	Draught (m)			Disp. (ton)	Navigation time			Time in ice (hour)	Voyage in ice (miles)	Navigation Area	Enviromental conditions										Remarks
			Aft	Mid	Bow		Indep.	Icebreaker assist	Icebreaker tow.				Ice thickness class	%	class	%	class	%	Ice type Index	%	index	%	index	
1986	18.1	am	7.7	7.4	7.1	10110	6	6		10	110	Bothnian Bay	6	50	2	50			85	50	30	50		
1986	18.1	pm	7.6	7.3	7.1	9970	10			7	80	Bothnian Sea	2	80	5	20			30	80	39	20		
1986	22.1	am	7.9	7.6	7.3	10350	12			5	60	Bothnian Sea	4	100					30	100				
1986	4.2	pm	7.6	7.3	7.1	9940	5			5	30	Bothnian Bay	7	100					85	60	39	40		
1986	5.2	am	7.6	7.3	7.1	9940	9	3		12	40	Bothnian Bay	7	100					85	100				7 hour wait.
1986	5.2	pm	7.6	7.3	7.1	9940	8	4		12	150	Bothnian Bay	3	80	7	20			30	80	85	20		
1986	6.2	am	7.5	7.2	7.1	9790	4			4	50	Bothnian Sea	3	70	6	30			30	70	39	30		
1986	7.2	am	8.4	8.3	8.3	11420	12			7	80	Baltic proper	6	40	5	20	4	40	39	60	30	40		
1986	20.2	pm	7.3	7	6.8	9450	12			7	70	Baltic proper	4	20	5	60	6	20	69	20	39	80		
1986	21.2	am	7.5	7.1	6.8	9640	2			2	20	Baltic proper	7	100					39	100				
1986	21.2	pm	7.5	7.4	7.3	10010	2.5			2.5	25	Baltic proper	7	100					39	100				
1986	22.2	am	7.5	7.4	7.3	10010	12			5	60	Baltic proper	4	20	5	60	6	20	69	20	39	80		
1986	23.2	pm	7.5	7.4	7.3	10010	12			6	50	Baltic proper	4	50	5	50			70	100				2 hour wait.
1986	24.2	am	7.5	7.4	7.3	10010	12			12	120	Baltic proper	5	20	6	60	7	20	39	100				
1986	24.2	pm	7.5	7.4	7.3	10010	9	3		5	25	Bothnian Sea	5	100					85	100				1 hour wait.
1986	25.2	am	7.5	7.4	7.3	10010	12			12	10	Bothnian Sea	5	100					85	100				10 hour drift
1986	25.2	pm	7.5	7.4	7.3	10010	12			12	0	Bothnian Sea	5	100					85	100				12 hour drift
1986	26.2	am	7.5	7.4	7.3	10010	12			5	30	Bothnian Sea	5	100					30	80	85	20		6 hour drift.
1986	3.3	am	7.8	7.8	7.8	10550	12			2	20	Bothnian Sea	7	100					69	100				
1986	3.3	pm	7.8	7.8	7.8	10550	12			2	20	Bothnian Sea	7	100					85	100				
1986	4.3	am	7.8	7.8	7.8	10550	9			6	60	Baltic proper	6	50	7	50			39	100				
1986	5.3	am	5.1	4.7	4.3	6040	12			7	70	Baltic proper	6	50	7	50			39	100				
1986	6.3	am	5.1	4.7	4.3	6040	12			1	10	Baltic proper	4	100					69	100				
1986	8.3	pm	7.3	7.1	6.9	9550	[illegible]			1	10	Baltic proper	5	100					30	100				
1986	9.3	am	7.3	7.1	6.9	9550	12			2	20	Baltic proper	5	100					69	100				
1986	10.3	am	7.3	7.1	6.9	9550	7			7	70	Baltic proper	6	50	8	50			39	100				
1986	15.3	pm	7.3	7.1	6.9	9540	12			1	10	Baltic proper	4	100					69	100				
1986	16.3	am	7.3	7.1	6.9	9540	12			1	10	Baltic proper	4	100					52	100				
1986	16.3	pm	7.3	7.1	6.9	9540	12			7	10	Bothnian Sea	7	100					85	100				
1986	17.3	am	7.3	7.1	6.9	9540	12			12	0	Bothnian Sea	7	100					85	100				12 hour wait
1986	17.3	pm	7.3	7.1	6.9	9540	12			12	25	Bothnian Sea	7	100					85	100				9 hour wait.
1986	18.3	am	7.3	7.1	6.9	9540	12			12	15	Bothnian Sea	7	100					85	100				10 hour stuck
1986	18.3	pm	7.3	7.1	6.9	9540	6	1	5	12	60	Bothnian Bay	7	100					85	100				6 hour stuck
1986	19.3	am	7.3	7.1	6.9	9540	11	1		12	20	Bothnian Bay	7	100					85	100				9 hour stuck
1986	19.3	pm	7.2	7	6.9	9460		7		4	40	Bothnian Bay	7	40	8	60			85	100				
1986	22.3	am	8.5	8.3	8.2	11470	6.5			3	25	Bothnian Bay	8	100					69	100				
1986	22.3	pm	8.5	8.3	8.2	11470	12			12	10	Bothnian Bay	7	100					85	100				11 hour drift
1986	23.3	am	8.5	8.3	8.2	11470	12			10	10	Bothnian Bay	7	100					85	100				8 hour drift.
1986	23.3	pm	8.5	8.3	8.2	11470	12			12	0	Bothnian Bay	7	100					85	100				12 hour drift
1986	24.3	am	8.5	8.3	8.2	11470	12			12	0	Bothnian Bay	7	100					85	100				12 hour drift
1986	24.3	pm	8.5	8.3	8.2	11470	3	8.5	0.5	12	20	Bothnian Bay	7	100					85	100				1 hour drift.
1986	25.3	am	8.5	8.3	8.2	11470	11	1		12	5	Bothnian Bay	7	100					85	100				10 hour stuck
1986	25.3	pm	8.5	8.3	8.2	11470	12			12	0	Bothnian Bay	7	100					85	100				12 hour stuck
1986	26.3	am	8.5	8.3	8.2	11470		11	1	12	20	Bothnian Bay	7	100					85	100				

Appendix 4/3

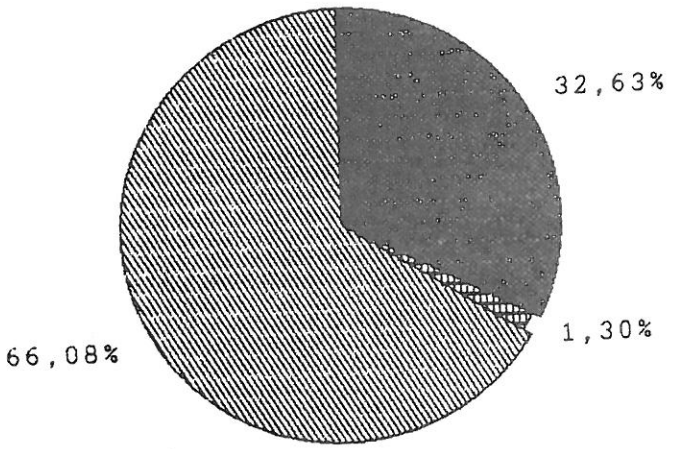
Year	Day	am/pm	Draught (m)			Disp.	Navigation time			Time	Voyage	Navigation	Enviromental conditions										Remarks
			Aft	Mid	Bow	(ton)	Indep.	Icebreaker assist	Icebreaker tow.	in ice (hour)	in ice (miles)	Area	Ice thickness class	%	class	%	class	%	Ice type Index	%	index	%	index	%	
1986	26.3	pm	8.5	8.3	8.2	11470	1	11		12	20	Bothnian Bay	7	100					85	100					1 hour wait.
1986	27.3	am	8.5	8.3	8.2	11470	8	4		4	20	Bothnian Sea	7	100					85	100					
1986	31.3	am	8.3	7.8	7.4	10760	3	4	5	12	85	Bothnian Bay	7	100					85	100					3 hour wait.
1986	31.3	pm	8.3	7.8	7.4	10760	6	2		2	20	Bothnian Bay	7	100					85	100					
1986	4.4	am	8.6	8.3	8.1	11480	4	3		3	30	Bothnian Bay	7	100					85	100					
1986	4.4	pm	8.6	8.3	8.1	11480	8	4		4	40	Bothnian Sea	7	100					85	100					
1986	5.4	am	8.5	8.3	8.1	11435	6			1.5	15	Baltic proper	6	100					39	100					
1986	7.4	pm	8.5	8.3	8.2	11470	12			1	10	Baltic proper	5	100					52	100					
1986	8.4	am	8.5	8.3	8.2	11470	12			1.5	15	Baltic proper	6	100					39	100					
1986	8.4	pm	8.5	8.3	8.2	11470	5			1.5	15	Baltic proper	6	100					39	100					
1986	9.4	am	8.5	8.3	8.2	11470	6	6		8	80	Bothnian Sea	7	100					85	100					
1986	9.4	pm	8.5	8.3	8.2	11470	6	3		3	35	Bothnian Bay	7	100					85	100					
1986	12.4	am	7.6	7.2	6.9	9860	9	2		6	70	Bothnian Bay	7	100					67	50	84	50			
1986	12.4	pm	7.6	7.2	6.9	9800	12			1	10	Bothnian Sea	7	100					67	100					
1986	13.4	am	7.6	7.2	6.9	9830	3			1.5	15	Baltic proper	6	100					39	100					
1986	16.4	am	7.9	7.5	7.2	10310	12			1	10	Bothnian Bay	7	100					67	100					
1986	16.4	pm	7.9	7.6	7.3	10420	1			1	5	Bothnian Bay	8	100					39	100					
1986	18.4	pm	7.7	7.3	7	10030	10			2	20	Bothnian Bay	7	100					68	50	52	50			
1986	22.4	am	7.5	7.1	6.7	9640	12			3	40	Bothnian Sea	6	100					53	50	66	50			
1986	22.4	pm	7.5	7	6.7	9600	4			2	20	Bothnian Bay	8	100					68	50	39	50			
1986	24.4	pm	7.9	7.6	7.3	10340	3			2	20	Bothnian Bay	8	50	7	50			39	50	67	50			
1986	25.4	am	7.9	7.6	7.3	10340	12			1	10	Bothnian Bay	7	100					67	100					
1986	27.4	am	7.3	7.2	7.1	9635	5			3	40	Bothnian Bay	7	100					67	100					
1986	27.4	pm	7.3	7.2	7.1	9635	12			1	10	Bothnian Bay	7	100					67	100					
1986	29.4	pm	7.2	7	6.9	9460	12			0.5	5	Baltic proper	5	100					62	100					
1987	4.1	am	6.4	6.2	6.1	8180	10			10	100	Bothnian Bay	7	20	5	80			39	20	69	80			
1987	28.1	pm	7.7	7.5	7.3	10190		5		5	40	Bothnian Bay	7	20	6	80			39	20	67	80			0.5 hour stu
1987	29.1	am	7.7	7.5	7.3	10190	6	6		12	140	Bothnian Bay	6	50	3	50			68	50	30	50			
1987	29.1	pm	7.7	7.5	7.3	10190	7			7	80	Bothnian Sea	3	80	7	20			30	80	39	20			
1987	3.2	am	7.5	7	6.6	9540	1.5	0.5		2	10	Baltic proper	5	100					69	100					1 hour wait.
1987	3.2	pm	7.5	7	6.6	9540	8	4		4	50	Baltic proper	5	100					69	100					
1987	5.2	am	7.6	7.1	6.8	9740	12			3	40	Baltic proper	5	100					52	100					
1987	5.2	pm	7.6	7.1	6.8	9740	12			12	140	Bothnian Bay	5	80	6	20			52	80	67	20			
1987	6.2	am	7.6	7.1	6.8	9740	9	3		12	80	Bothnian Bay	6	80	7	20			81	80	39	20			4 hour wait.
1987	10.2	pm	7.5	7.5	7.4	10080		3	0.5	3.5	10	Bothnian Bay	8	100					39	100					0.5 hour stuc
1987	11.2	am	7.5	7.5	7.4	10080		12		12	150	Bothnian Bay	6	80	5	20			69	100					
1987	11.2	pm	7.5	7.5	7.4	10080	5	5		7	90	Bothnian Sea	3	40	6	30	8	30	30	40	81	30	39	30	
1987	15.2	pm	7.8	7.5	7.2	10185	12			2	30	Bothnian Sea	4	100					69	100					
1987	16.2	am	7.8	7.5	7.2	10185	8	4		12	120	Bothnian Bay	4	40	5	20	6	40	69	60	85	40			
1987	16.2	pm	7.8	7.5	7.2	10185	1			1	10	Bothnian Bay	8	100					39	100					
1987	18.2	pm	6.5	6	5.5	7950		2		2	20	Bothnian Bay	9	100					39	100					
1987	19.2	am	6.5	6	5.5	7950	2	10		12	130	Bothnian Bay	5	50	6	50			85	60	70	40			
1987	19.2	pm	6.5	6	5.5	7950	12			4	50	Bothnian Sea	5	100					70	100					
1987	20.2	am	6.5	6	5.5	7950	12			4	50	Baltic proper	5	50	3	50			69	50	30	50			

Year	Day	am/pm	Draught (m) Aft	Mid	Bow	Disp. (ton)	Navigation time Indep.	Icebreaker assist	tow.	Time in ice (hour)	Voyage in ice (miles)	Navigation Area	Enviromental conditions: Ice thickness class	%	class	%	class	%	Ice type Index	%	index	%	index	%	Remarks
1987	20.2	pm	6.5	6	5.5	7950	12			1	13	Baltic proper	2	100					30	100					
1987	27.2	am	8.3	8.2	8.1	11190	11	1		6	70	Baltic proper	4	50	5	50			30	50	70	30	86	20	
1987	27.2	pm	8.3	8.2	8.1	11190	3			3	30	Baltic proper	5	100					70	100					
1987	31.3	pm	5.3	4.8	4.4	6250	7			7	70	Baltic proper	3	100					39	100					
1987	2.4	pm	7.4	7.2	7	9720	10			9	100	Baltic proper	5	20	8	80			85	20	39	80			
1987	3.4	am	8.4	8.4	8.3	11470	8			2	15	Bothnian Sea	8	50	7	50			39	50	86	50			
1987	3.4	pm	8.4	8.4	8.3	11470	12			12	115	Bothnian Sea	5	50	6	50			84	80	69	20			
1987	4.4	am	8.4	8.4	8.3	11470	9	3		12	115	Bothnian Bay	6	20	7	40	8	40	69	100					
1987	4.4	pm	8.4	8.4	8.3	11470	1.5		0.5	2	20	Bothnian Bay	9	100					39	100					
1987	8.4	am	8.5	8.4	8.4	11530	9	3		11	100	Bothnian Bay	8	40	6	40	5	20	84	20	69	80			
1987	8.4	pm	8.5	8.4	8.4	11530	6	6		8	65	Bothnian Sea	4	20	5	20	7	60	83	50	85	50			
1987	9.4	am	8.5	8.4	8.4	11530	5.5			2	20	Baltic proper	8	100					39	100					
1987	9.4	pm	6.7	6.4	6.3	8530	8			2	20	Baltic proper	8	100					39	100					
1987	10.4	am	6.7	6.4	6.3	8530	12			3	40	Baltic proper	7	20	6	80			68	100					
1987	18.4	am	8.2	8.2	8.2	11200	12			2	25	Baltic proper	6	100					65	100					
1987	18.4	pm	8.2	8.2	8.2	11200	12			1	15	Bothnian Sea	6	100					69	100					
1987	19.4	am	8.2	8.2	8.2	11200	12			2	25	Bothnian Sea	7	100					69	100					
1987	19.4	pm	8.2	8.2	8.2	11200	5	7		11	110	Bothnian Bay	6	30	7	30	8	40	85	60	69	40			
1987	20.4	am	8.2	8.2	8.2	11200		4		4	40	Bothnian Bay	8	50	9	50			86	50	39	50			
1987	22.4	pm	8.4	8.3	8.2	11420	1	6		6	50	Bothnian Bay	7	40	8	40	9	20	69	60	86	20	39	20	0.5 hour wait
1987	23.4	am	8.4	8.3	8.2	11420	9	3		12	60	Bothnian Bay	5	80	4	20			61	50	66	50			6 hour wait.
1987	23.4	pm	8.4	8.3	8.2	11420	9	3		6	70	Bothnian Sea	5	100					81	100					
1987	24.4	am	8.4	8.3	8.2	11420	12			5	50	Bothnian Sea	5	30	6	30	7	40	81	60	39	40			
1987	25.4	am	7.2	7	6.8	9360	5			2	25	Baltic proper	7	100					39	100					
1987	25.4	pm	7.2	7	6.8	9360	12			10	120	Bothnian Sea	5	80	6	20			81	50	80	50			
1987	26.4	am	7.2	7	6.8	9360	12			10	110	Bothnian Bay	5	40	7	60			62	20	69	40	81	40	
1987	26.4	pm	7.3	6.9	6.6	9420		3.5		3.5	28	Bothnian Bay	8	50	9	50			85	60	39	40			0.5 hour stu
1987	28.4	pm	8.5	8.3	8.2	11490	5	2		5	50	Bothnian Bay	8	70	9	30			69	40	85	30	39	30	
1987	29.4	am	8.5	8.3	8.2	11490	12			3	40	Bothnian Bay	6	100					67	100					
1987	29.4	pm	8.5	8.3	8.2	11490	12			3	40	Bothnian Sea	6	100					67	100					
1987	30.4	pm	7.6	7.3	7.1	9970	12			2	25	Baltic proper	6	100					67	50	33	50			
1987	8.5	pm	8.3	8.1	7.9	11070	11	1		3	40	Bothnian Sea	6	100					67	100					
1987	9.5	am	8.3	8.1	7.9	11070		4		4	40	Bothnian Bay	8	100					84	60	39	40			
1987	13.5	pm	8.4	8.4	8.3	11480	4	2		6	50	Bothnian Bay	6	40	8	60			67	40	84	40	39	20	1 hour stuck
1987	14.5	am	8.4	8.4	8.3	11480	12			3	30	Bothnian Bay	6	100					84	20	67	80			
1987	14.5	pm	8.4	8.4	8.3	11480	8			1	10	Bothnian Sea	6	100					65	100					
1987	16.5	am	5.3	4.8	4.4	6250	12			2	25	Bothnian Bay	6	100					81	50	69	50			
1987	18.5	pm	8.5	8.3	8.2	11500	8			2	25	Bothnian Bay	6	100					69	100					
1987	23.5	pm	7.7	7.5	7.3	10190	12			1	15	Bothnian Bay	6	100					65	100					
1988	8.1	pm	7.7	7.6	7.5	10330	12			1	15	Bothnian Bay	2	100					30	100					
1988	9.1	am	7.7	7.6	7.5	10330	6			1	10	Bothnian Bay	4	100					39	100					
1988	13.1	pm	7.7	7.4	7.3	10100	2			1	10	Bothnian Bay	4	100					39	100					
1988	14.1	pm	7.7	7.4	7.3	10100	5			0.2	2	Bothnian Sea	2	100					39	100					
1988	24.1	pm	7.4	7.2	6.7	9490	4			0.2	2	Bothnian Sea	2	100					39	100					

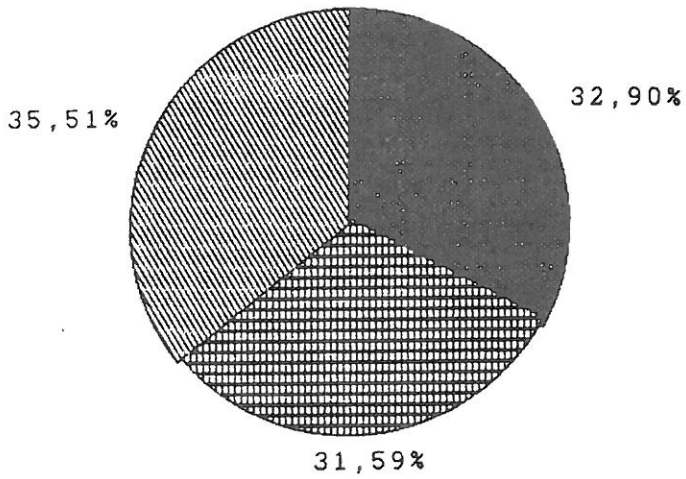
Year	Day	am/pm	Draught (m)			Disp. (ton)	Navigation time			Time in ice (hour)	Voyage in ice (miles)	Navigation Area	Enviromental conditions										Remarks
			Aft	Mid	Bow		Indep.	Icebreaker assist	Icebreaker tow.				Ice thickness class	%	class	%	class	%	Ice type Index	%	index	%	index	%	
1988	25.1	pm	7.4	7.0	6.7	9490	3			1	10	Bothnian Bay	5	100					39	100					
1988	27.1	am	8.0	7.9	7.8	10800	2			1	10	Bothnian Bay	5	100					39	100					
1988	28.1	am	8.0	7.9	7.8	10800	8			0.2	2	Bothnian Sea	3	100					39	100					
1988	28.1	pm	4.9	4.5	4.2	5800	6			0.2	2	Bothnian Sea	3	100					39	100					
1988	30.1	pm	8.4	8.3	8.3	11470	8			1	10	Bothnian Bay	5	100					39	100					
1988	8.2	am	7.4	7.0	6.7	9490	9			0.2	2	Bothnian Sea	3	100					39	100					
1988	8.2	pm	6.0	5.9	5.7	7580	8			0.2	2	Bothnian Sea	3	100					39	100					
1988	10.2	pm	8.1	7.7	7.4	10680	[illegible]			1	10	Bothnian Bay	6	100					39	100					
1988	11.2	pm	5.4	4.7	4.1	6140	2			0.2	2	Bothnian Sea	3	100					39	100					
1988	19.2	pm	7.2	7.0	6.8	9400	3			0.2	2	Bothnian Sea	3	100					39	100					
1988	20.2	pm	7.2	7.0	6.8	9400	12			12	140	Bothnian Bay	3	25	4	50	6	25	30	75	59	15	70	10	1 hour stuck
1988	21.2	am	7.2	7.0	6.8	9400	1	3		4	30	Bothnian Bay	8	100					85	20	39	80			0.5 hour stu
1988	24.2	pm	7.1	6.6	6.2	8920	9.5	0.5		10	50	Bothnian Bay	8	85	5	15			39	85	79	15			4 hour stuck
1988	25.2	am	7.1	6.6	6.2	8920	9	3		12	123	Bothnian Bay	5	70	4	30			84	70	30	30			
1988	25.2	pm	7.1	6.6	6.2	8920	11	1		4	30	Bothnian Sea	3	100					30	100					
1988	26.2	am	7.[illegible]	6.6	6.2	8920	2.5			1	10	Bothnian Sea	3	100					39	100					
1988	3.3	pm	6.9	6.7	6.5	8930	4			0.5	5	Bothnian Sea	4	100					39	100					
1988	4.3	am	6.9	6.7	6.5	8930	8.5	3.5		4	45	Bothnian Bay	3	30	5	60	6	10	30	30	69	70			
1988	4.3	pm	6.9	6.7	6.5	8930		4		4	40	Bothnian Bay	5	50	7	50			68	50	39	50			
1988	5.3	pm	7.3	7.1	6.8	9530	3			3	35	Bothnian Bay	7	30	2	50	3	20	39	30	30	50	80	20	
1988	6.3	am	7.3	7.1	6.8	9530	12			6	75	Bothnian Bay	5	80	6	20			59	50	84	50			
1988	6.3	pm	7.3	7.1	6.8	9530	5			0.5	5	Bothnian Sea	4	100					39	100					
1988	26.3	pm	8.2	8.1	7.9	11040	12			4	50	Bothnian Bay	3	100					59	100					
1988	27.3	am	8.2	8.1	7.9	11040	5			4	40	Bothnian Bay	3	50	7	50			59	50	39	50			
1988	13.4	am	7.2	6.7	6.3	9090	9			3	35	Bothnian Bay	5	30	6	70			59	30	39	70			
1988	14.4	pm	7.0	6.9	6.9	9210	8			3	35	Bothnian Bay	5	30	6	70			59	30	39	70			
1988	30.4	am	7.7	7.3	7.0	10000	10			4	40	Bothnian Bay	6	50	5	50			59	50	39	50			
1988	3.5	pm	7.2	7.1	7.1	9530	7			5	50	Bothnian Bay	6	70	5	30			80	70	39	30			

Operation profile of M/S Kemira during the winter 1985

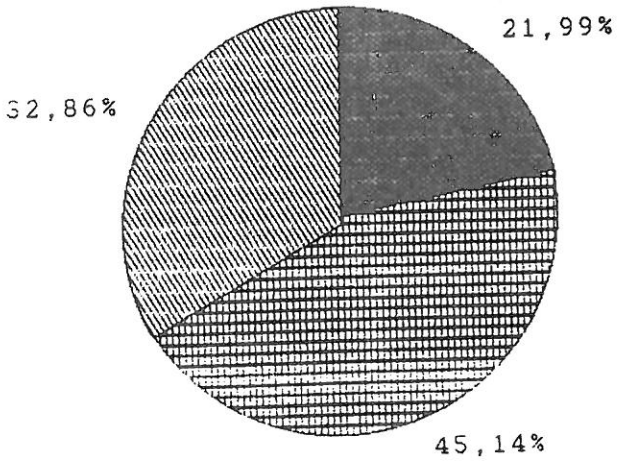
Bothnian Bay



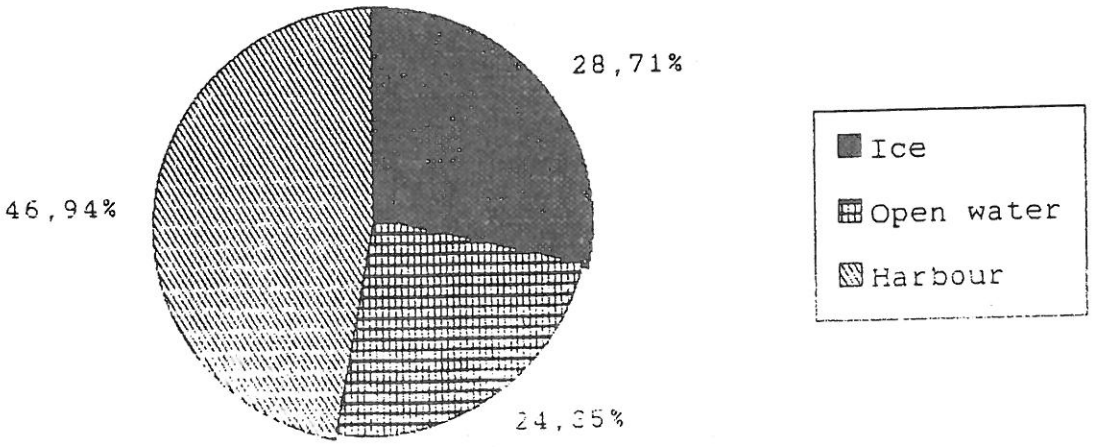
Bothnian Sea



Baltic proper

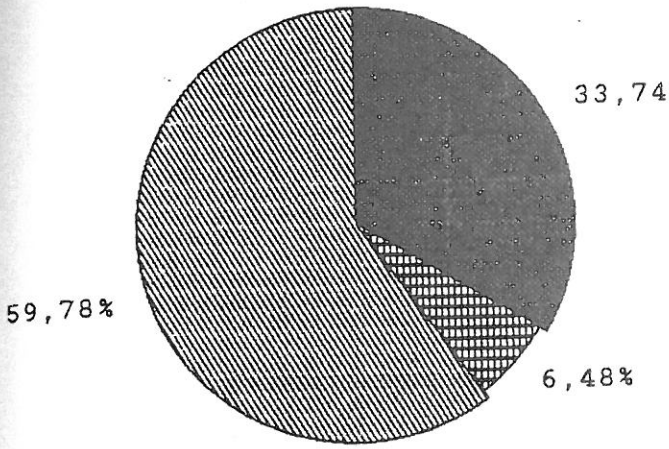


Baltic Sea

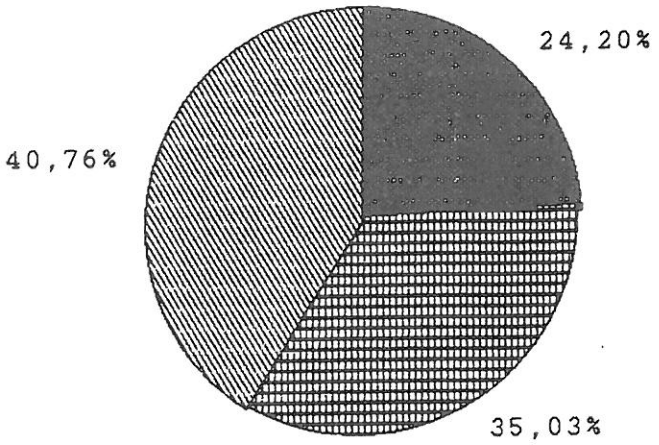


Operation profile of M/S Kemira during the winter 1986

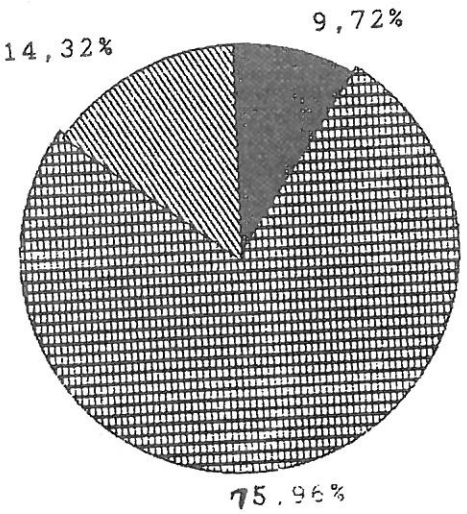
Bothnian Bay



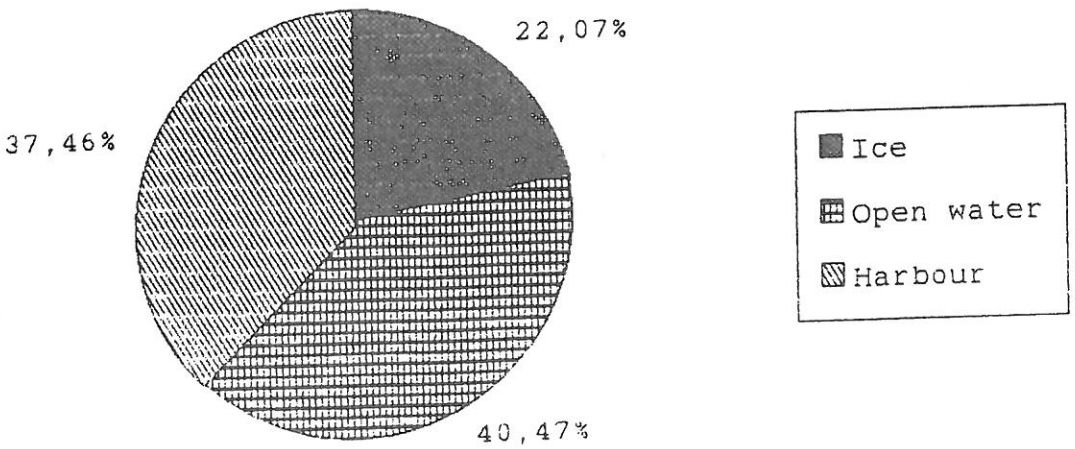
Bothnian Sea



Baltic proper

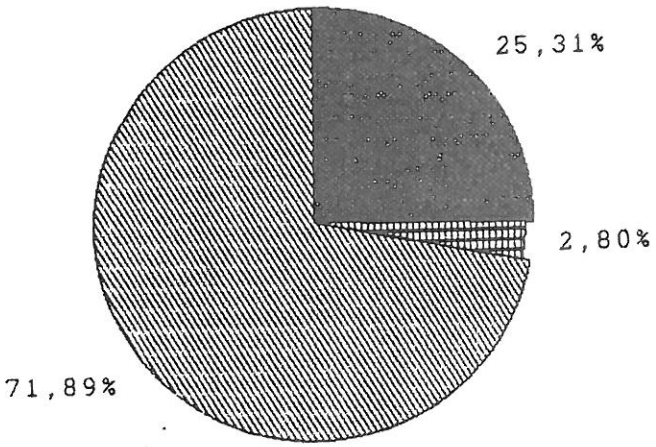


Baltic Sea

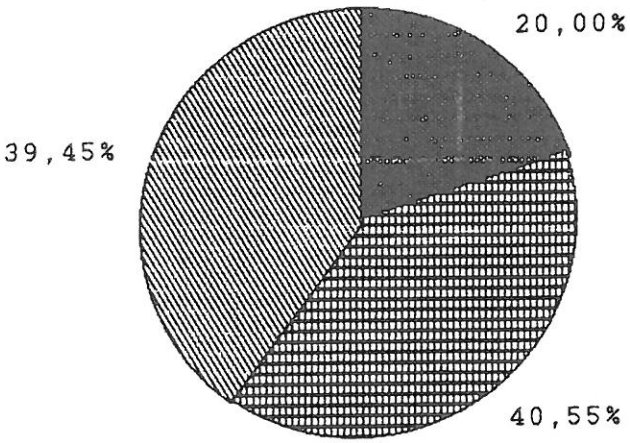


Operation profile of M/S Kemira during the winter 1987

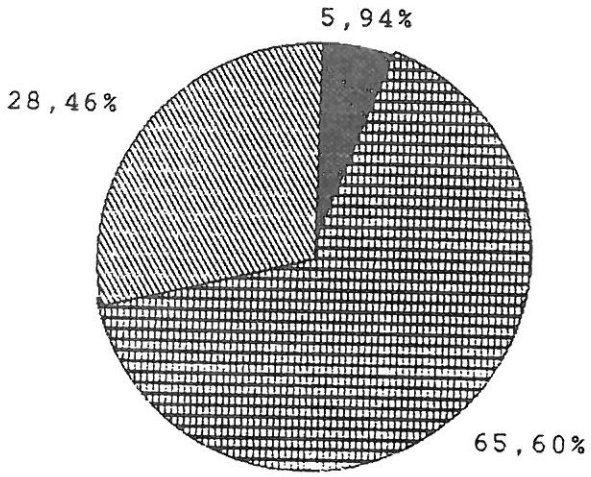
Bothnian Bay



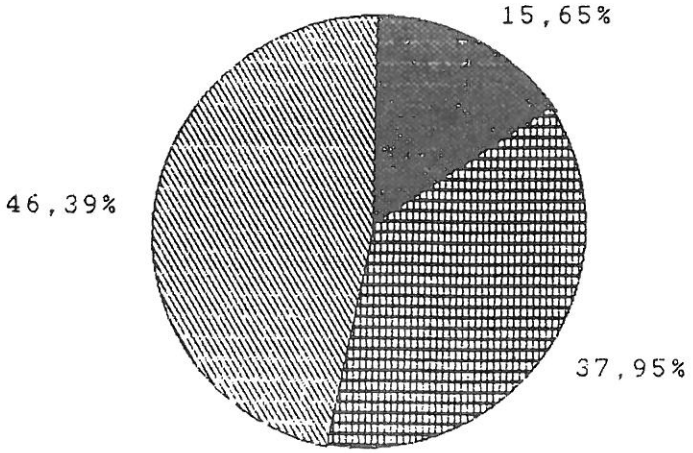
Bothnian Sea

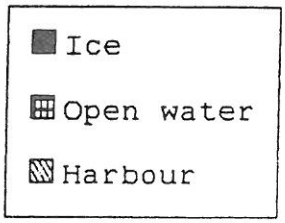


Baltic proper

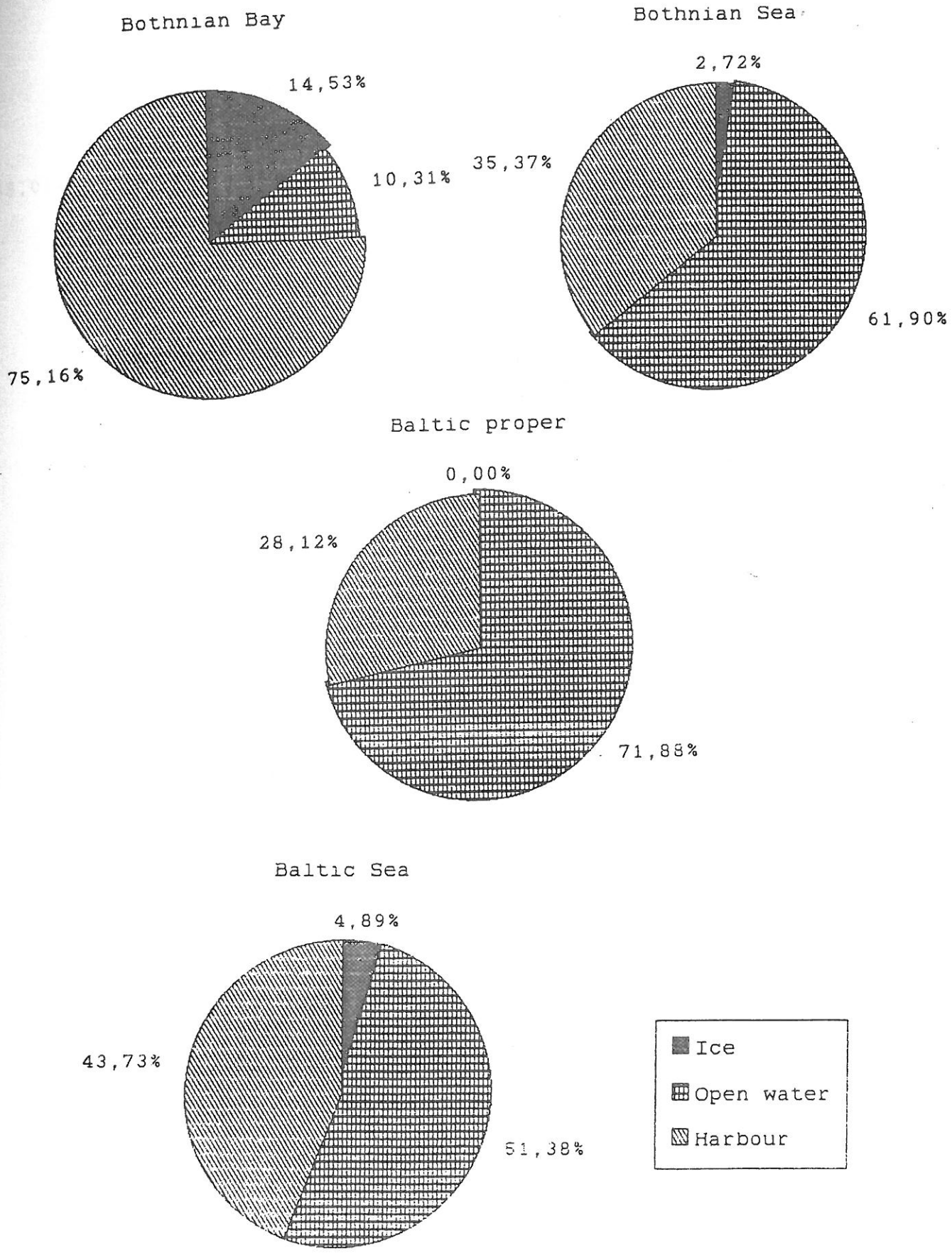


Baltic Sea



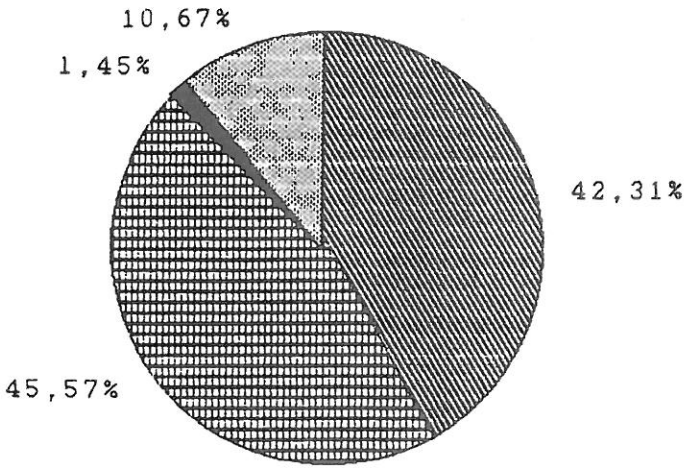


Operation profile of M/S Kemira during the winter 1988

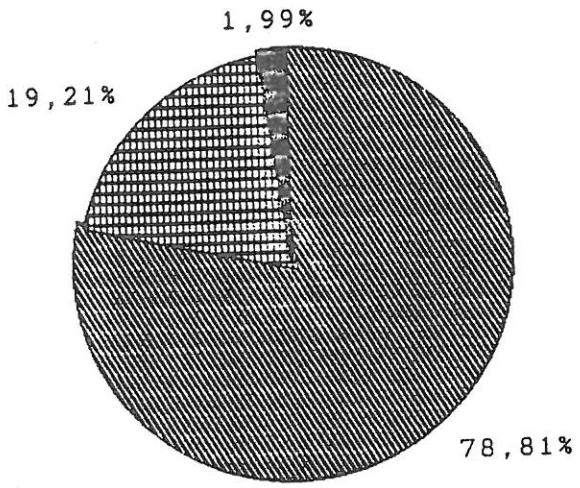


Profile of ice navigation of M/S Kemira during the winter 1985

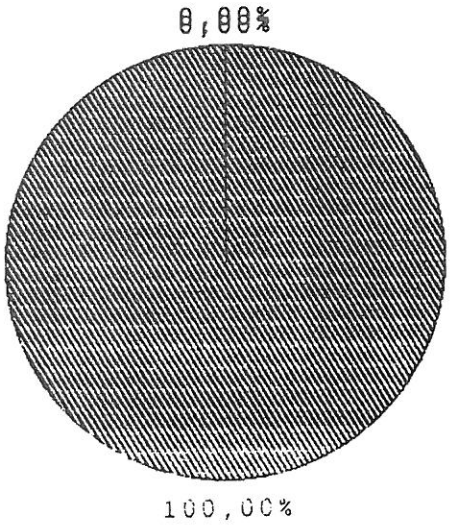
Bothnian Bay, 1985



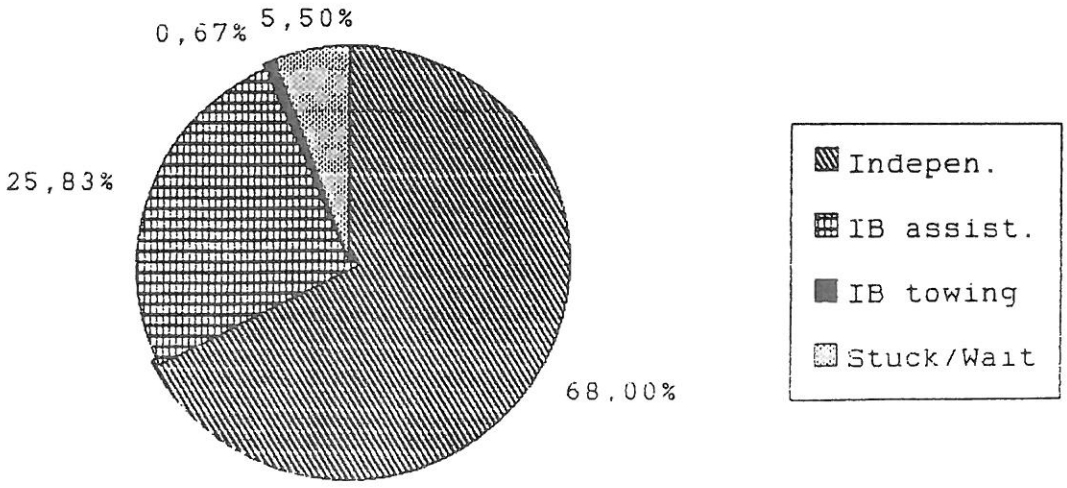
Bothnian Sea, 1985



Baltic proper, 1985

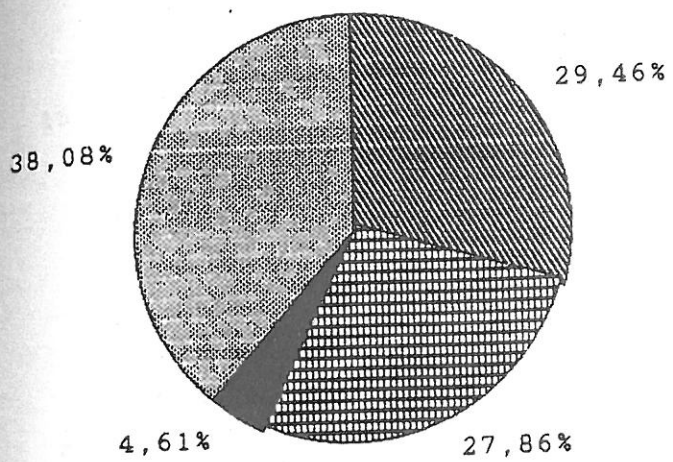


Baltic Sea, 1985

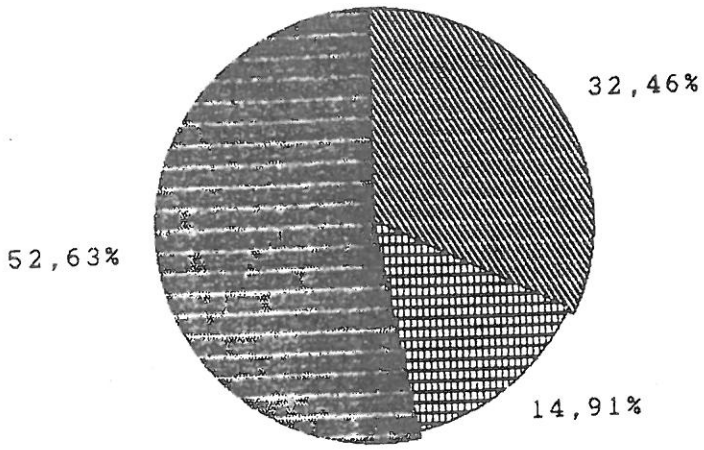


Profile of ice navigation of M/S Kemira during the winter 1986

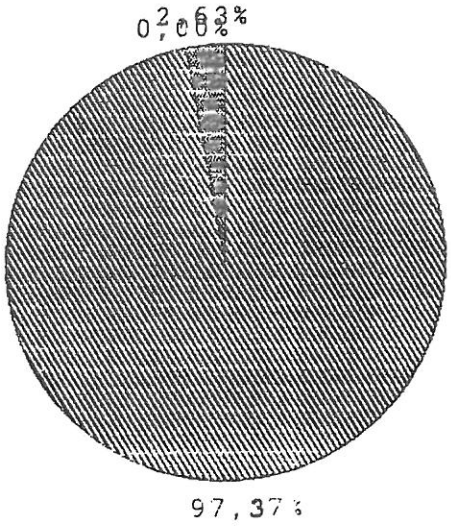
Bothnian Bay, 1986



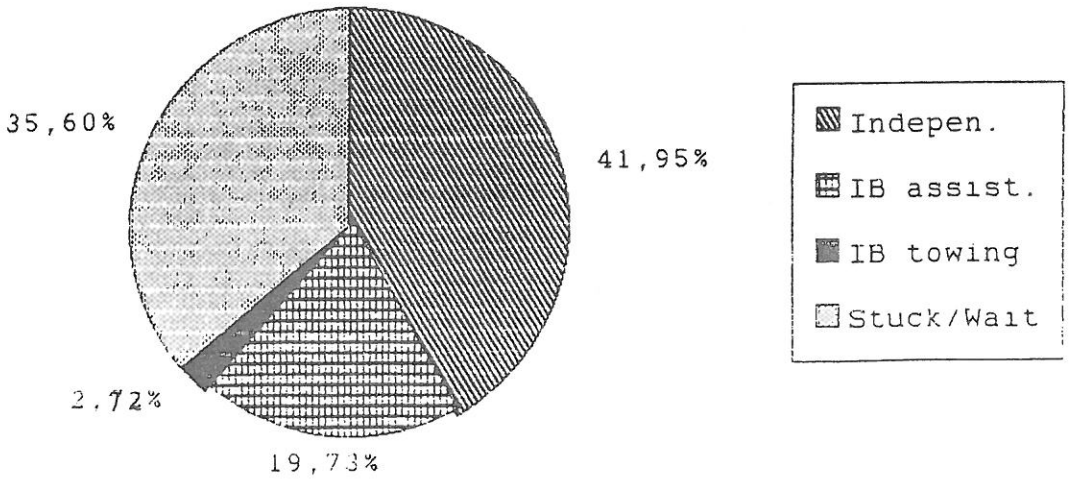
Bothnian Sea, 1986



Baltic proper, 1986

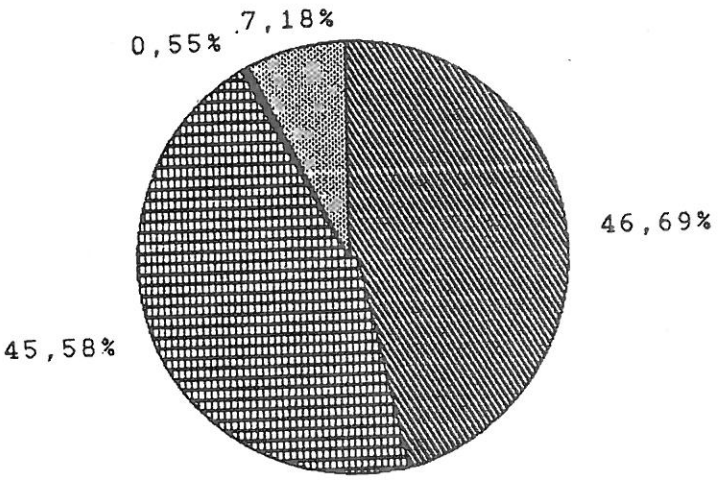


Baltic Sea, 1986

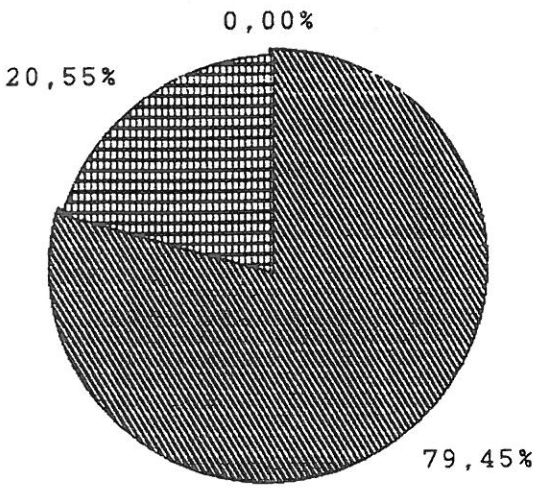


Profile of ice navigation of M/S Kemira during the winter 1987

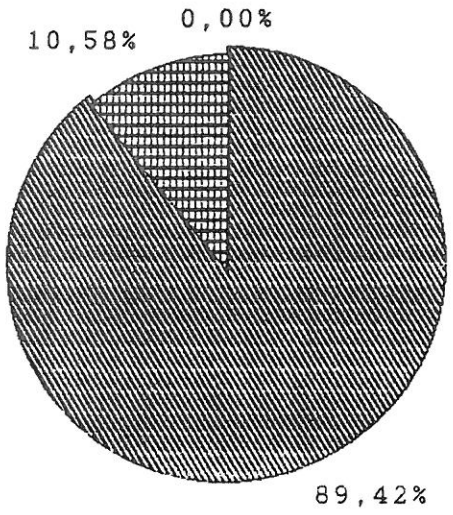
Bothnian Bay, 1987



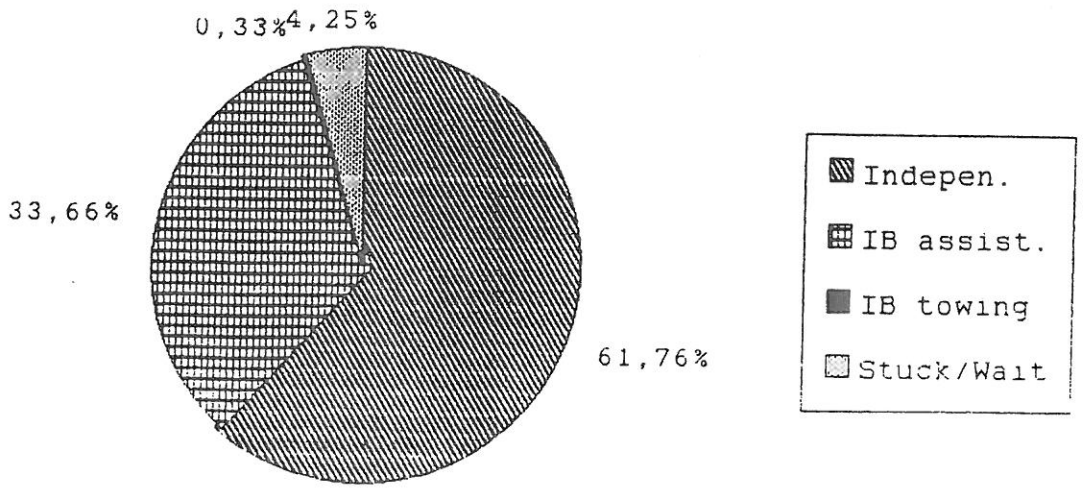
Bothnian Sea, 1987



Baltic proper, 1987

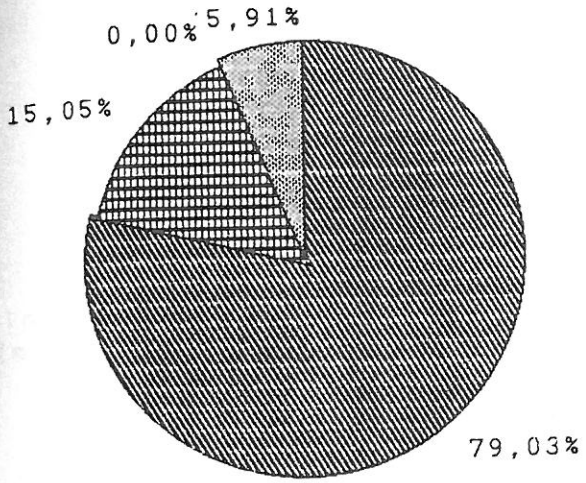


Baltic Sea, 1987

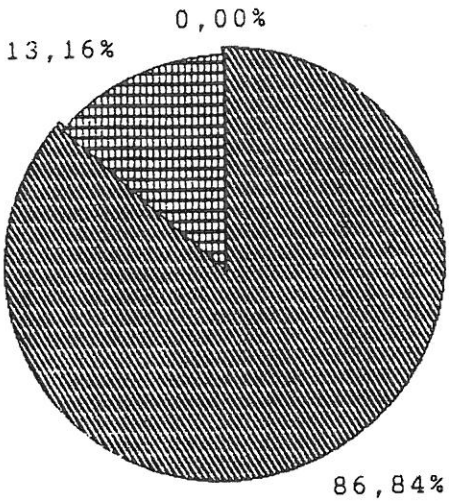


Profile of ice navigation of M/S Kemira during the winter 1988

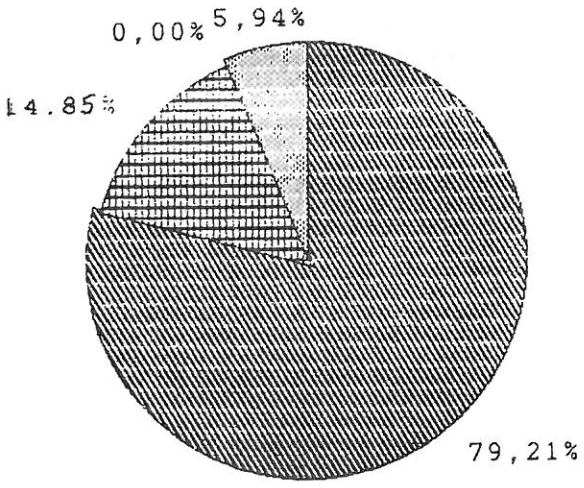
Bothnian Bay, 1988

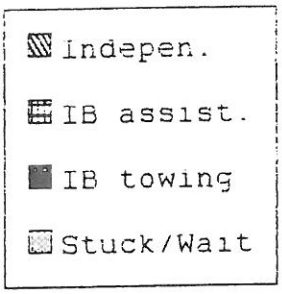


Bothnian Sea, 1988



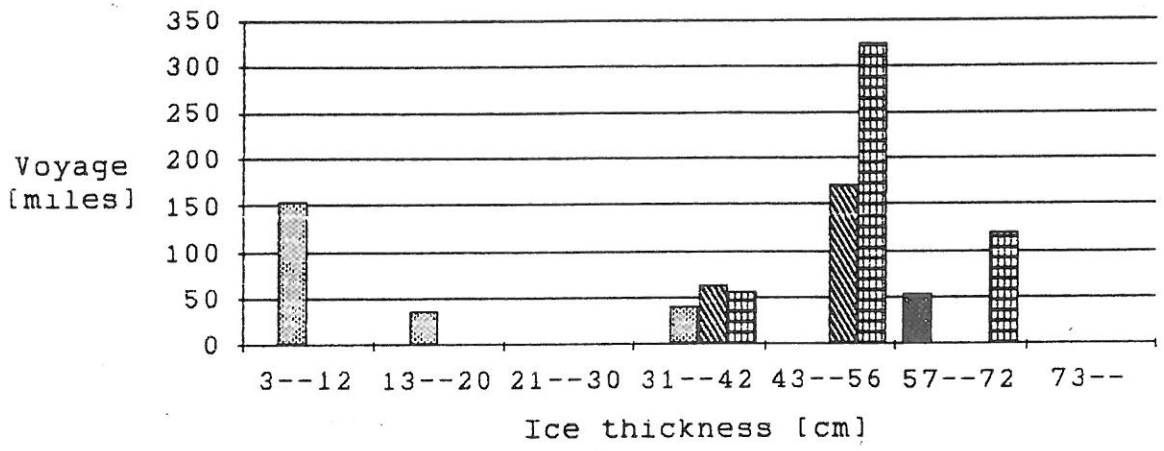
Baltic Sea, 1988



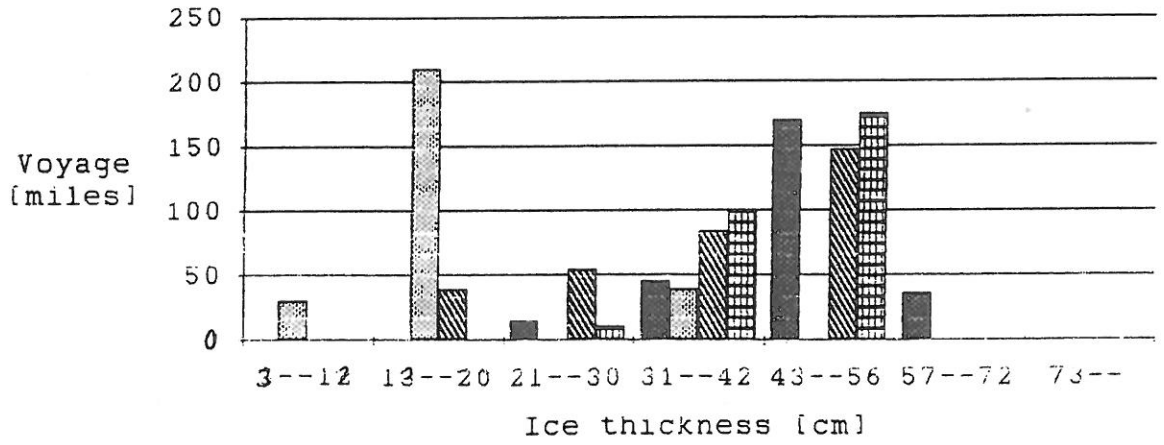


Voyage in various ice conditions while navigating independently during the winter 1985

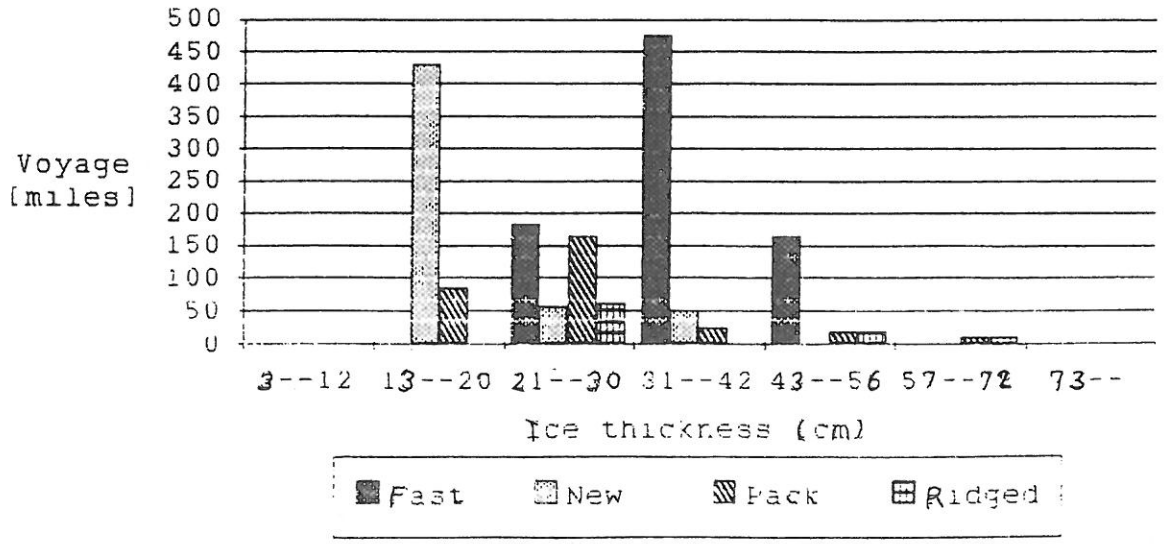
Bothnian Bay 1985, Independent



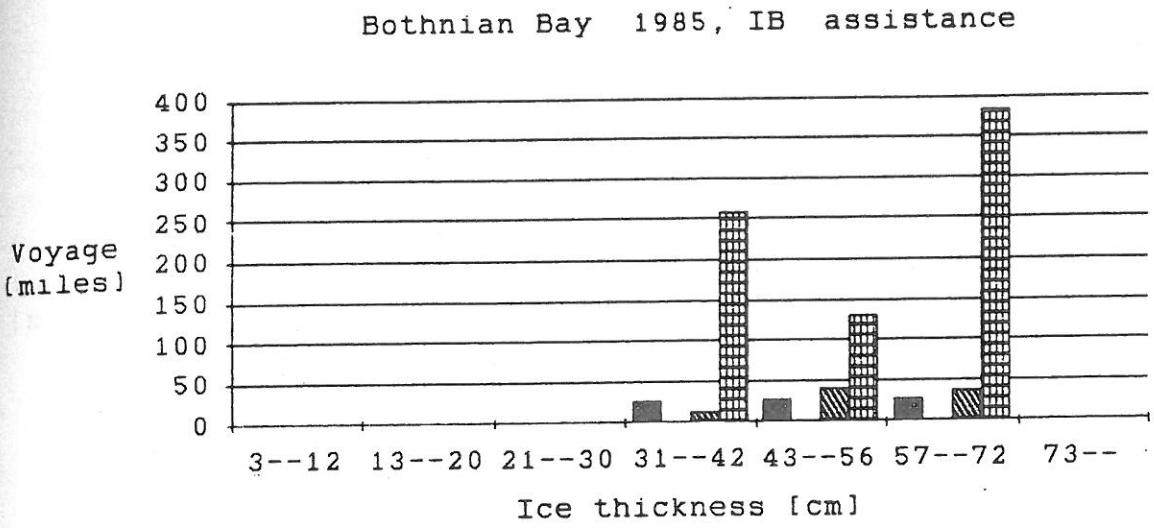
Bothnian Sea 1985, Independent

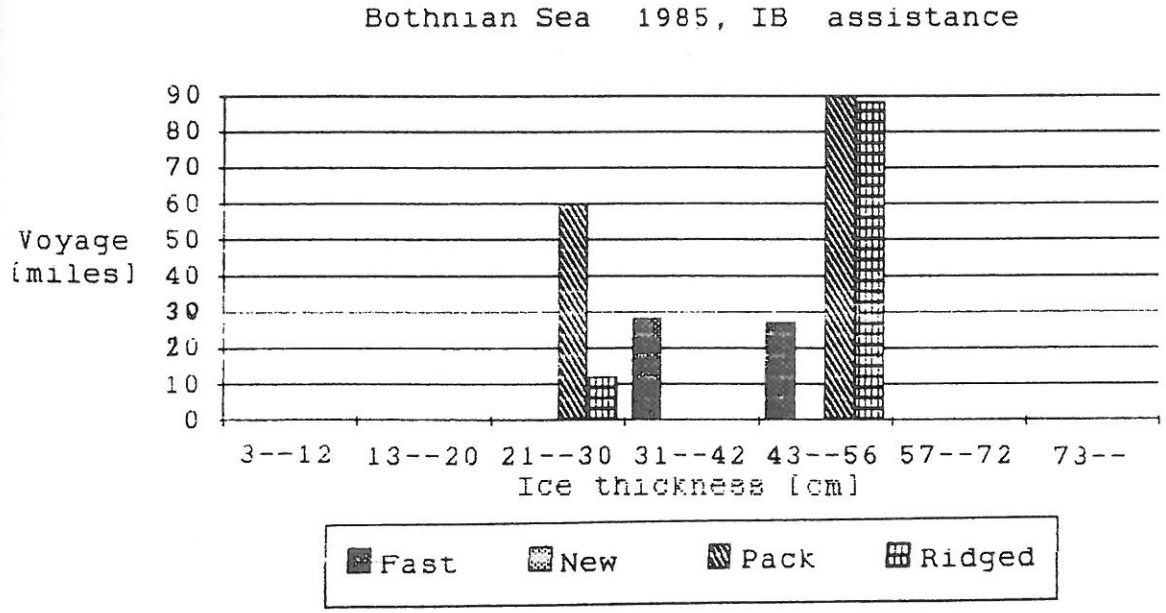


Baltic proper 1985, Independent



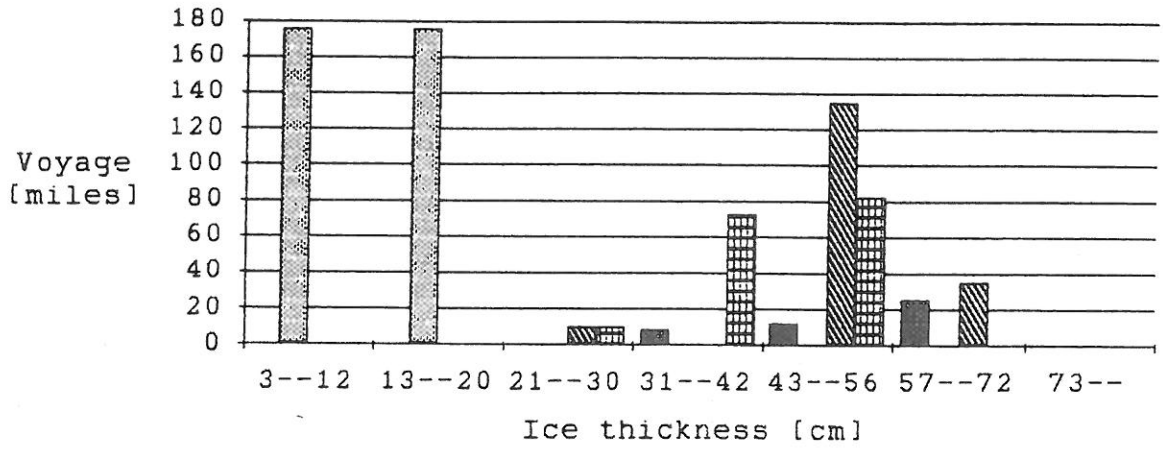
Voyage in various ice conditions with IB assistance during the winter 1985



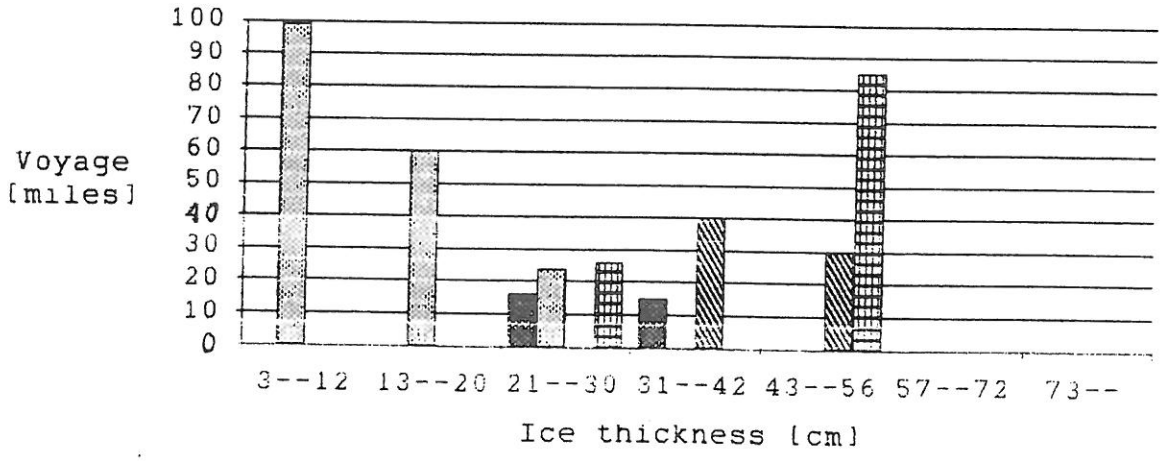


Voyage in various ice conditions while navigating independently during the winter 1986

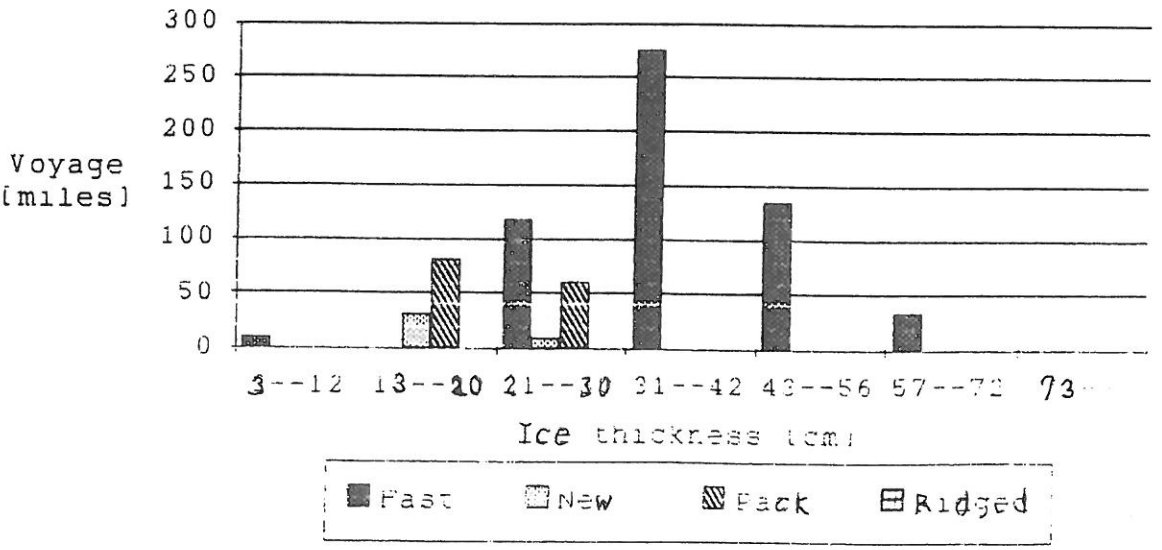
Bothnian Bay 1986, Independent



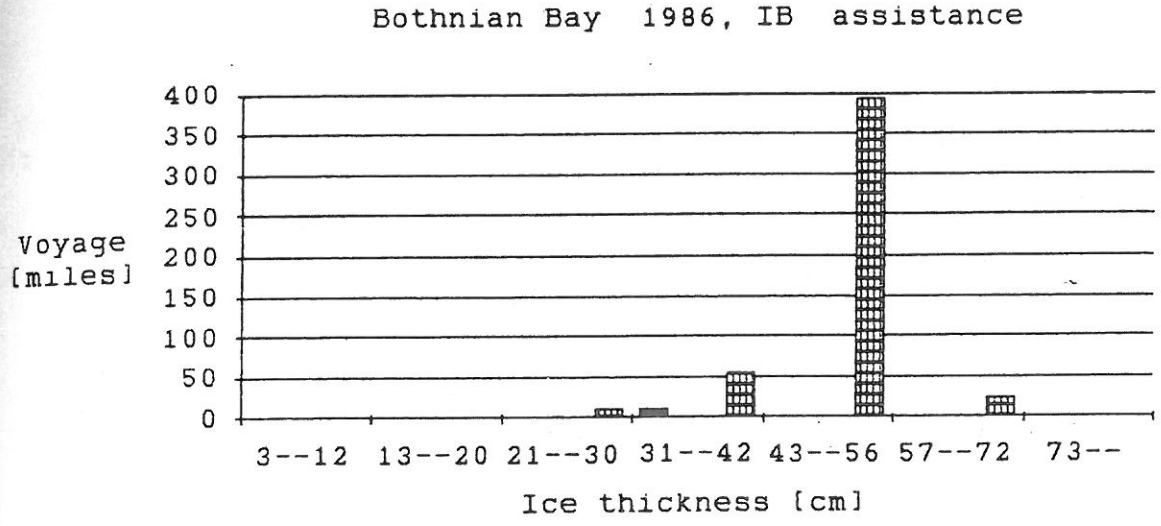
Bothnian Sea 1986, Independent

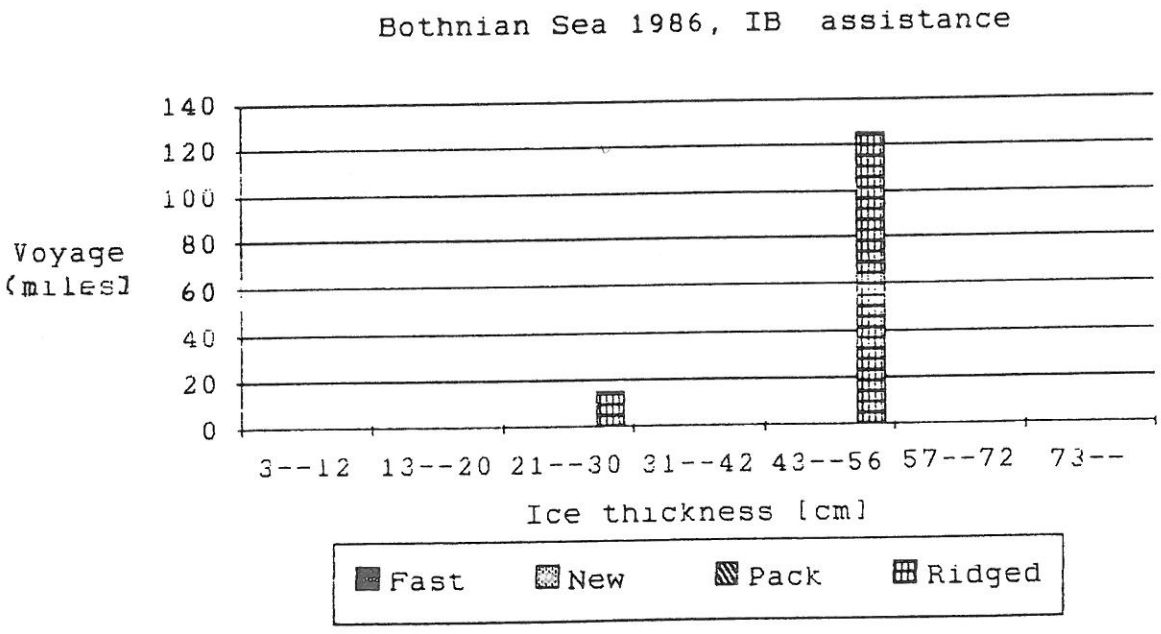


Baltic proper 1986, Independent



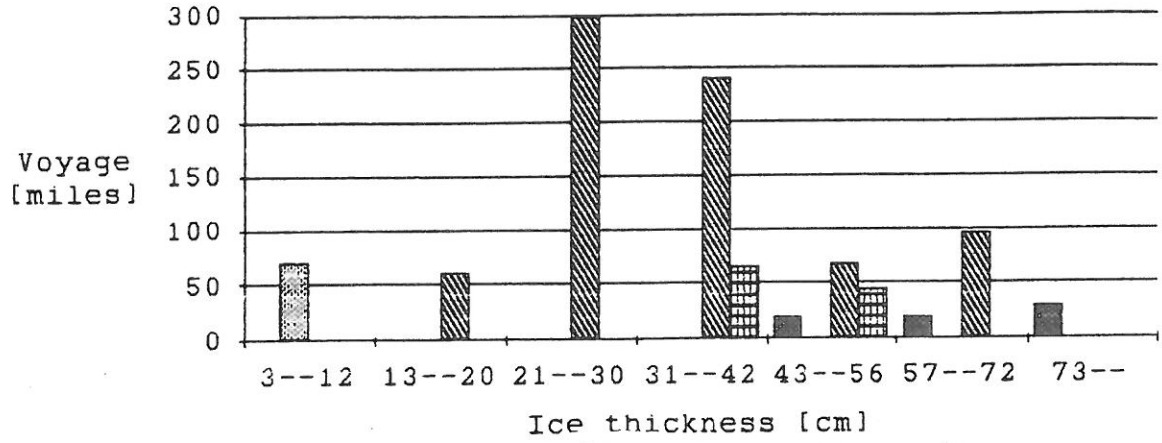
Voyage in various ice conditions with IB assistance during the winter 1986



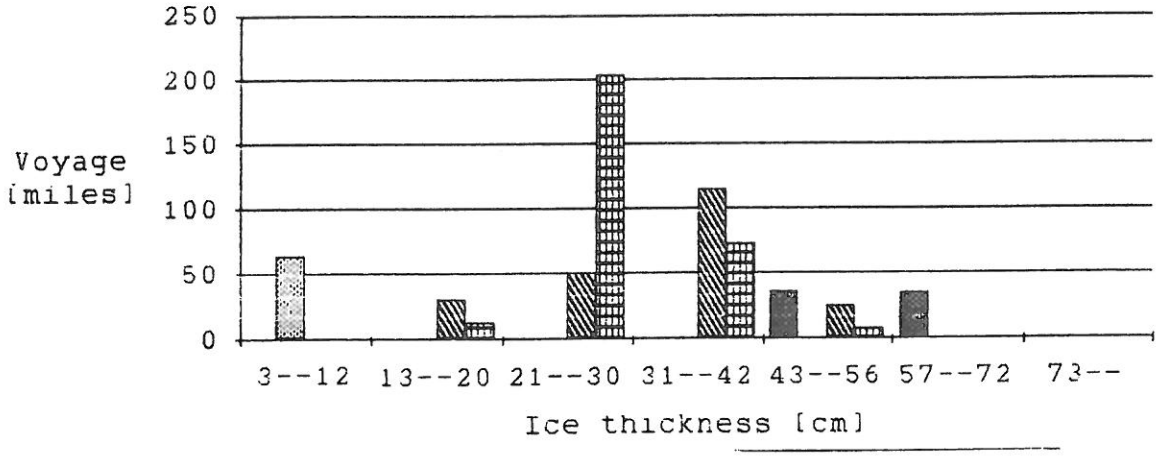


Voyage in various ice conditions while navigating independently during the winter 1987

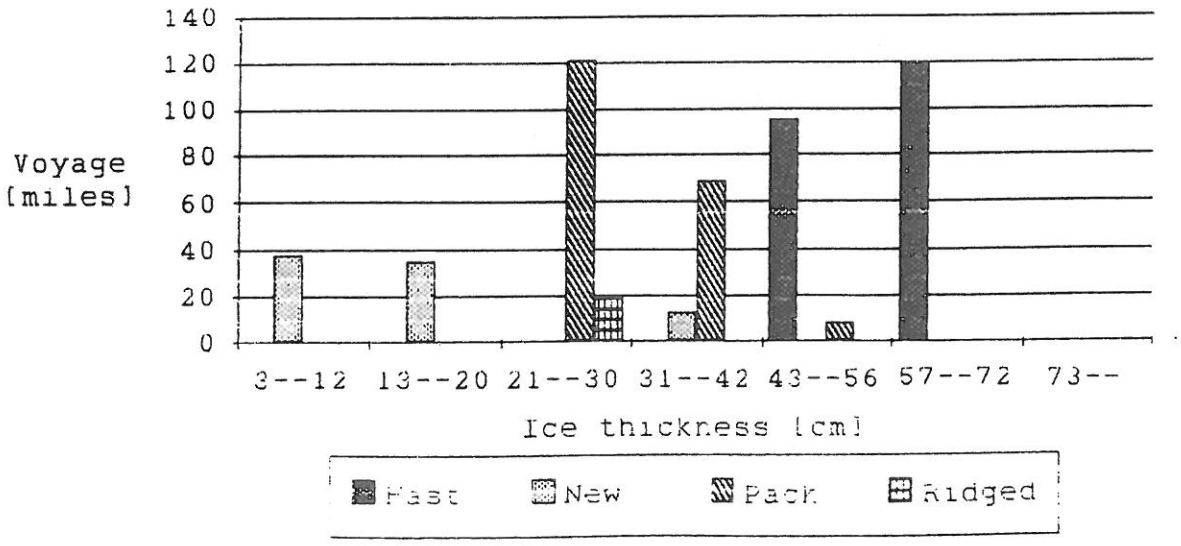
Bothnian Bay 1987, Independent



Bothnian Sea 1987, Independent

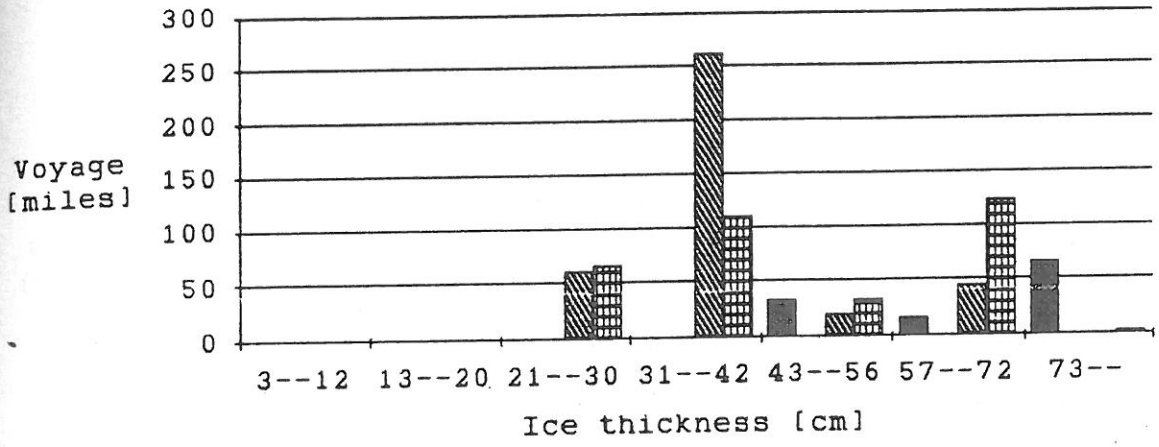


Baltic proper 1987, Independent

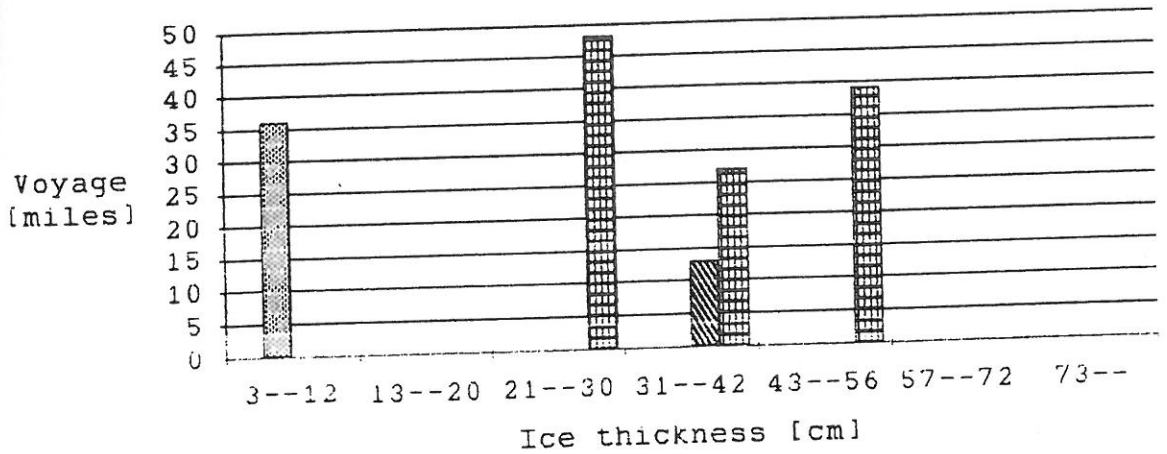


Voyage in various ice conditions with IB assistance during the winter 1987

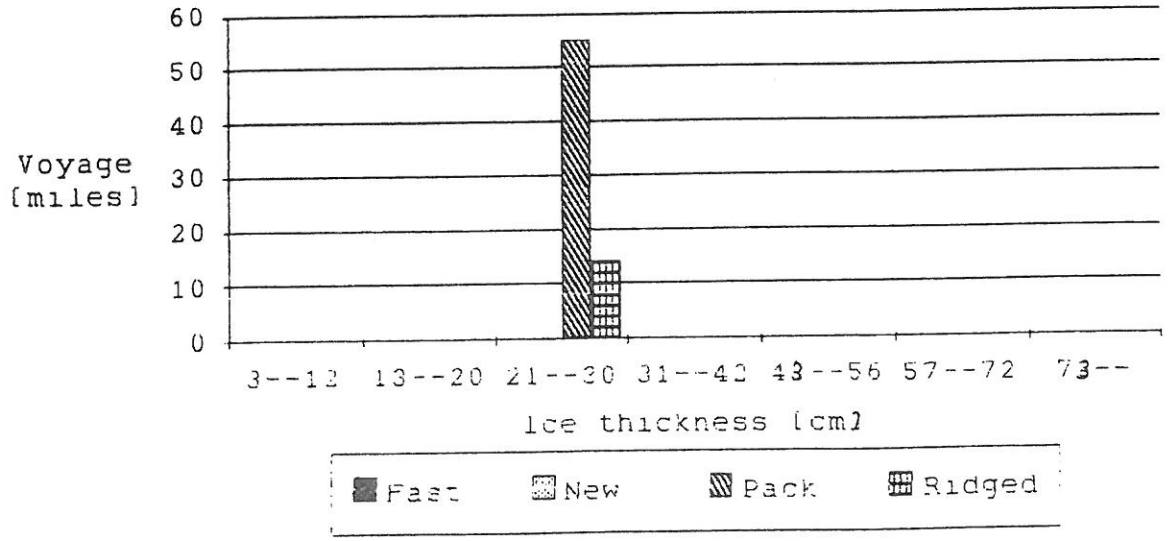
Bothnian Bay 1987, IB assistance



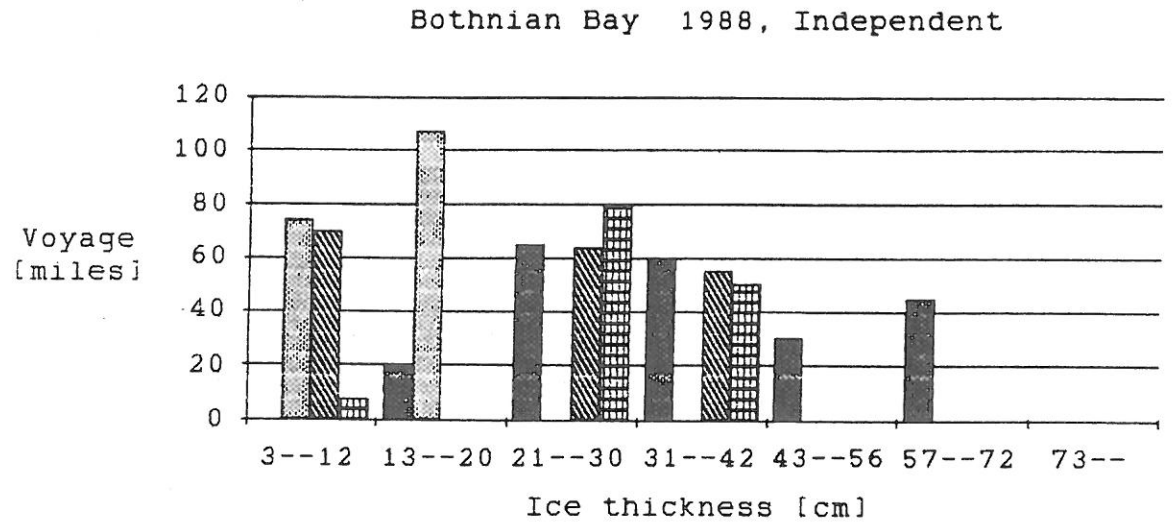
Bothnian Sea 1987, IB assistance

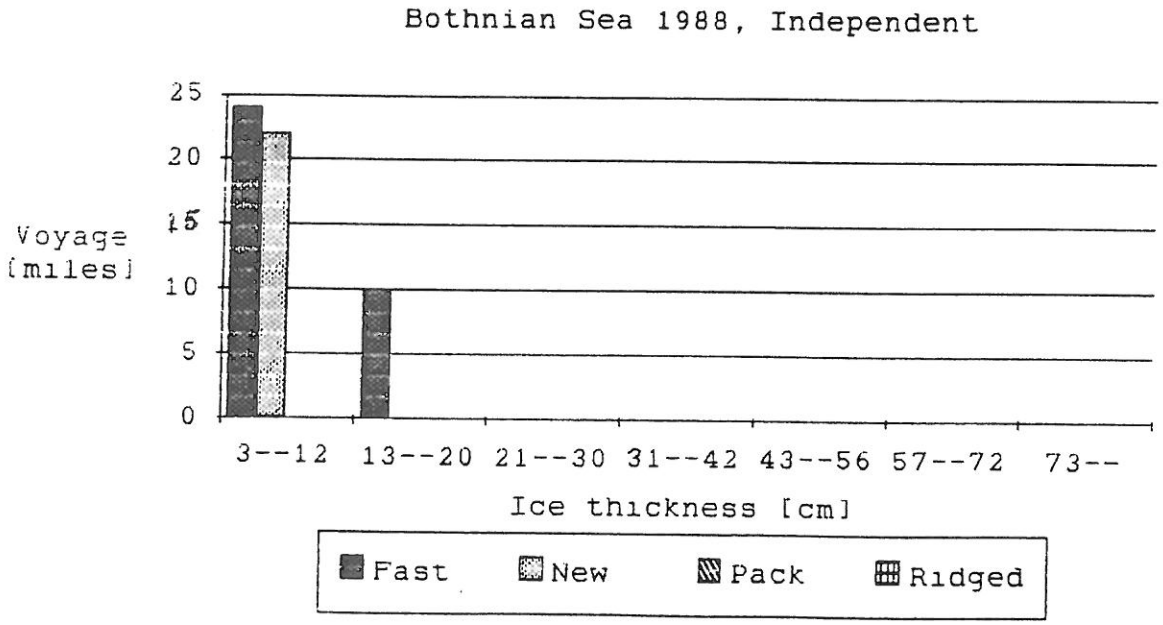


Baltic proper 1987, IB assistance

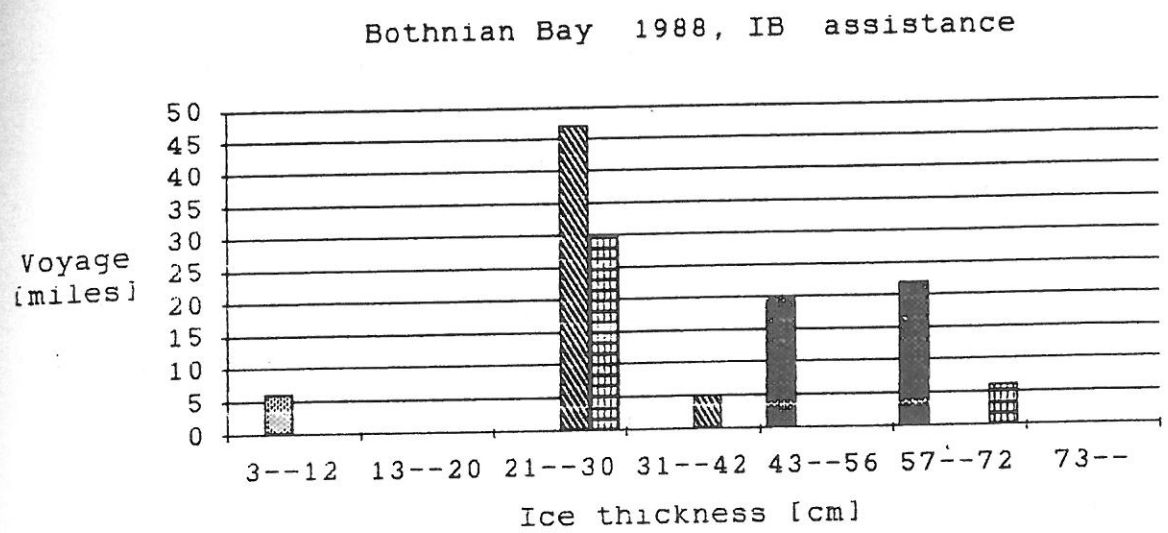


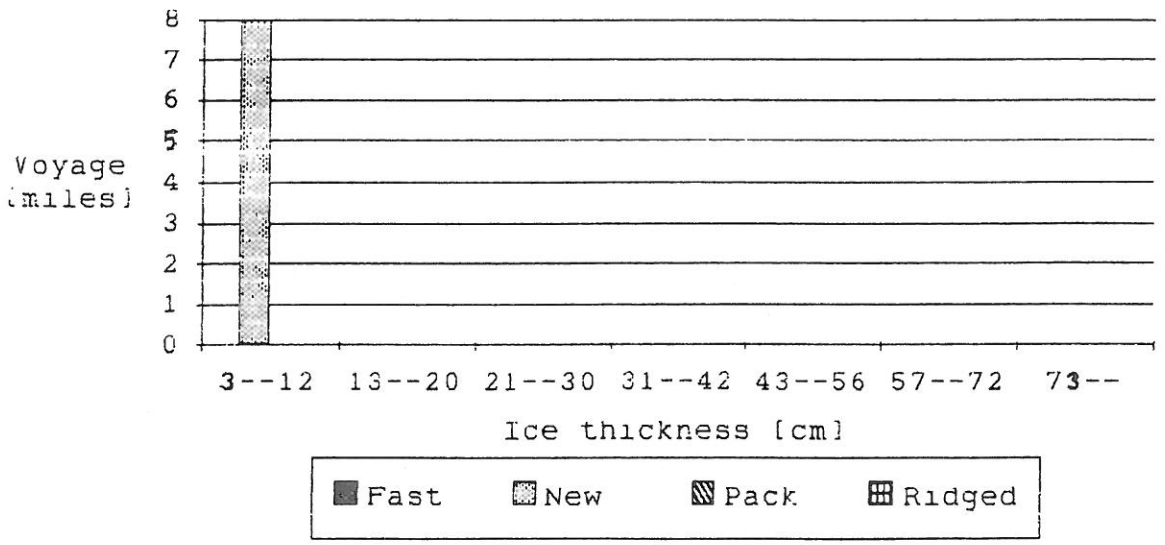
Voyage in various ice conditions while navigating independently during the winter 1988





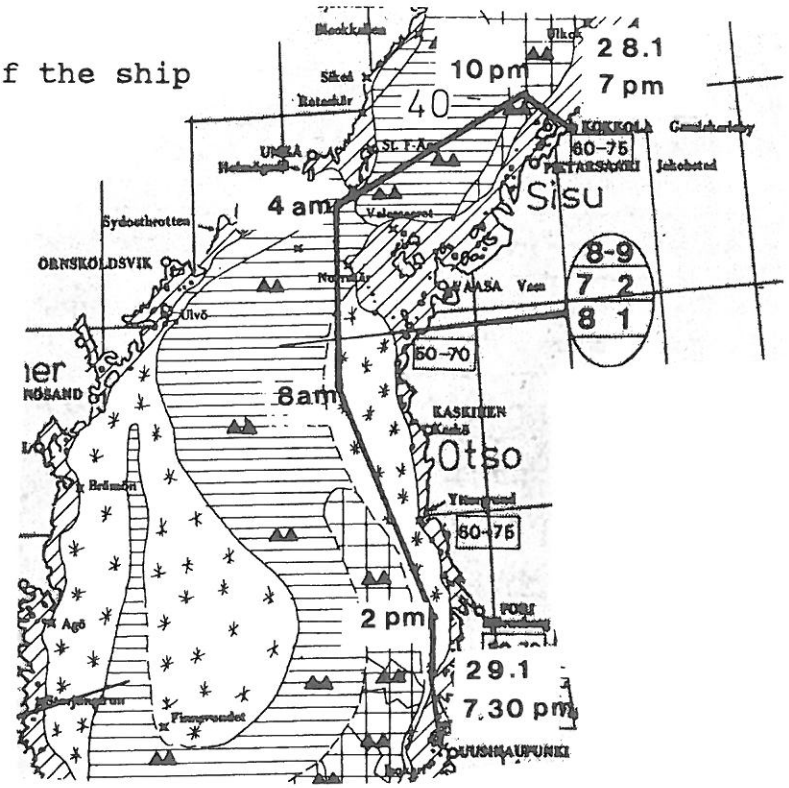
Voyage in various ice conditions with IB assistance during the winter 1988





Voyage 28th to 29th of January 1987

Route of the ship



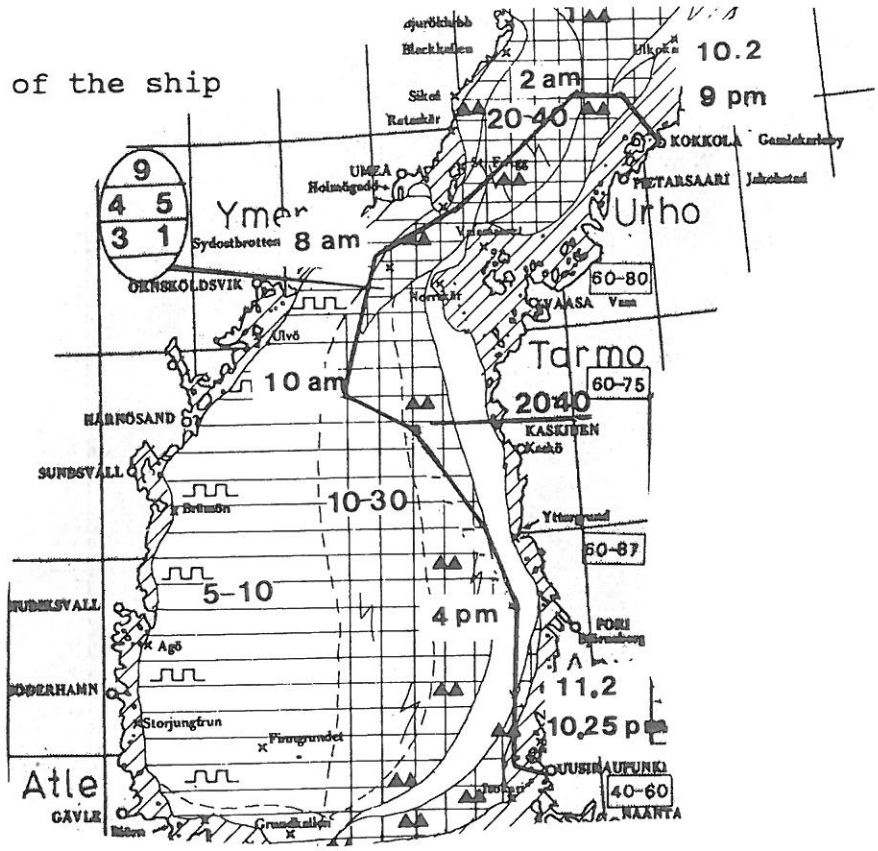
Summary of encountered ice conditions

Voyage 28--29.1.1987 Draught: Bow= 7.3 , Mid=7.5 , Aft=7.7

Day	Start	Navigation time Indep.	Icebreaker assist	Icebreaker tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	%	class	%	Ice type Index	%	index	%	Air T (C)	Wind (m/s)	Remarks
28.1	7pm		1		1	5,5	7	100			39	100			-15		Urho assisting
	8pm		1		1	5,5	7	100			39	100			-15		0.5h stuck
	9pm		1		1	10	6	100			67	100			-15		
	10pm		1		1	10	6	100			67	100			-18		out from ch. in sharp turn
	11pm		1		1	11	6	100			67	100			-18		
29.1	0am		1		1	10	6	100			68	100			-19		out from ch. to pass a shi
	1am		1		1	11	6	100			68	100			-18		Otso assisting
	2am		1		0,75	7	6	100			68	100			-18		
	3am		1		1	11	6	100			68	100			-18		
	4am		1		1	13	6	100			68	100			-18		
	5am	0,25	0,75		1	11	6	100			65	100			-18		
	6am	1			0,5	7	3	100			30	100			-13		
	7am	1			0,5	7	3	100			30	100			-13		
	8am	1			1	14	3	100			30	100			-13		
	9am	1			1	12	3	90	6	10	30	90	80	10	-13		
	10am	1			1	12	3	90	6	10	30	90	80	10	-11		
	11am	1			1	13	3	100			30	100			-9		
	0pm	1			1	13	3	100			30	100			-8		
	1pm	1			1	13	3	90	6	10	30	90	80	10	-8		
	2pm	1			1	13	3	90	6	10	30	90	80	10	-9		
	3pm	1			1	11	3	50	5	50	30	50	70	50	-12		
	4pm	1			1	11	7	100			39	100			-14		
	5pm	1			1	10	7	100			39	100			-14		out of ch. to fast ice
	6pm	0,25			0,25	1	7	100			39	100			-14		from fast back to ch.

Voyage 10th to 11th of February 1987

Route of the ship



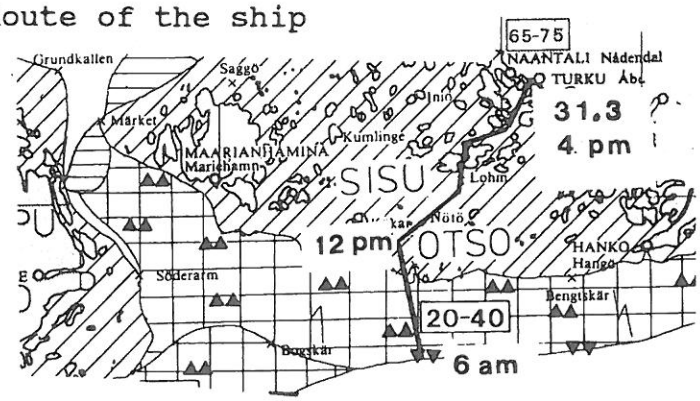
Summary of encountered ice conditions

Voyage 10.--11.2. 1987 Draught: Bow= 7.4, Mid=7.5 , Aft=7.6

Day	Start	Navigation time Indep.	Navigation time Icebreaker assist	Navigation time Icebreaker tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	Ice thickness %	Ice thickness class	Ice thickness %	Ice type Index	Ice type %	Ice type index	Ice type %	Air T (C)	Wind (m/s)	Remarks
10.2	9pm		1		1	6	8	100			39	100			-15		Urho assisting
	10pm		1		1	4	8	100			39	100			-16		0,5 h stuck
	11pm		0,5	0,5	1	4	8	100			39	100			-15		
11.2	0am		1		1	12,5	6	100			69	100			-14		
	1am		1		1	12,8	6	100			69	100			-12		
	2am		1		1	12	6	100			69	100			-12		
	3am		1		1	12,2	6	100			69	100			-12		
	4am		1		1	12,8	6	100			69	100			-15		
	5am		1		1	12,5	6	100			69	100			-14		
	6am		1		1	12,7	6	100			69	100			-14		
	7am		1		1	12,5	6	100			69	100			-12		
	8am		1		1	12,8	6	100			69	100			-10		
	9am		1		1	12,5	5	100			69	100			-8		
	10am		1		1	12,6	5	100			69	100			-8		
	11am		1		1	13,2	5	100			69	100			-8		
	0pm		1		0	0									-8		open water
	1pm		1		0	0									-8		"
	2pm		1		0	0									-7		"
	3pm		1		1	12,1	3	90	6	10	30	90	80	10	-7		
	4pm		1		1	10	4	50	6	50	30	50	80	50	-6		
	5pm	1			0,5	6,5	2	100			30	100			-6		
	6pm	1			0,5	6,5	2	100			30	100			-5		
	7pm	1			1	11	2	50	7	50	30	50	39	50	-5		
	8pm	1			1	8	7	100			39	100			-5		out of ch. to pass a ship
	9pm	1			1	8	7	100			39	100			-5		out of ch. in sharp turnin

Voyage 31th of March to 1st of April 1987

Route of the ship



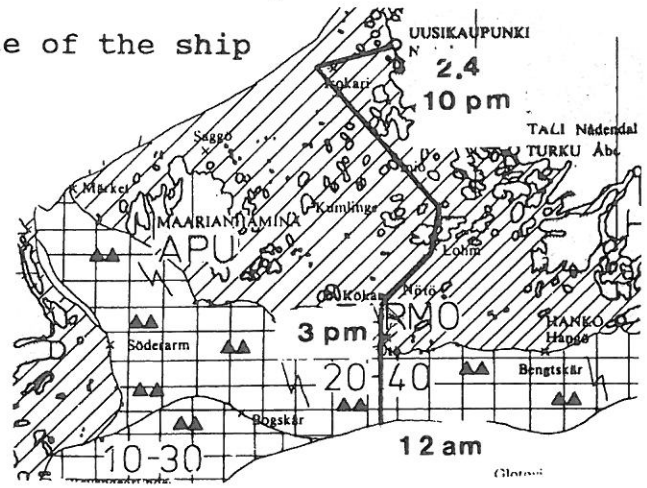
Summary of encountered ice conditions

Voyage 31.3.--1.4.1987 Draught: Bow= 5.6 , Mid=4.8 , Aft=4.4

Day	Start	Navigation time Indep.	Icebreaker assist	tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	%	class	%	Ice type Index	%	index	%	Air T (C)	Wind (m/s)	Remarks
31.3	6pm	1			1	11	8	100			39	100			1		
	7pm	1			1	13	8	100			39	100			0		
	8pm	1			1	7,5	8	100			39	100			-2		
	9pm	1			1	10	8	100			39	100			-2		
	10pm	1			1	13	8	100			39	100			-1		
	11pm	0,75			0,75	2	8	100			39	100			-1		
1.4	0am	0			0	0											wait for IB
	1am	0			0	0											"
	2am	0			0	0											"
	3am	0			0	0											"
	4am		0,75		0,75	6,5	5	100			59	100			-1	6SWS	
	5am	1			1	8	5	100			59	100			-1		

Voyage 1st to 2nd of April 1987

Route of the ship



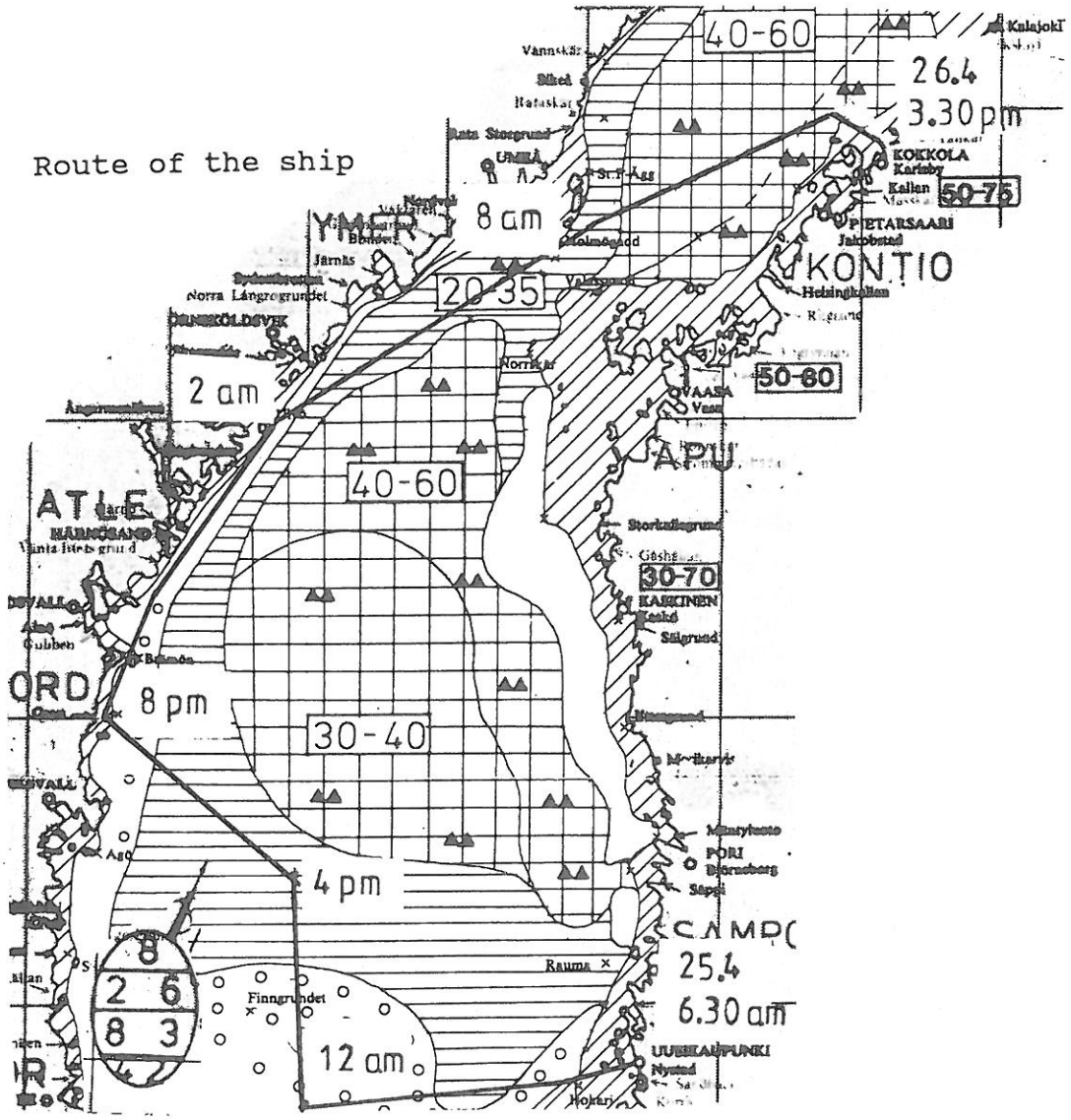
Summary of encountered ice conditions

Voyage 1-2.4.1987 Draught: Bow= 7.0 , Mid=7.2 , Aft=7.4

Day	Start	Navigation time Indep.	Icebreaker assist	tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	%	class	%	Ice type Index	%	index	%	Air T (C)	Wind (m/s)	Remarks
2.4	0pm	1			0,5	5	5	80	6	20	81	100			1		
	1pm	1			1	9	5	80	6	20	80	100			1		
	2pm	1			1	5,5	5	50	8	50	81	50	39	50	2		
	3pm	1			1	13	8	100			39	100			2		
	4pm	1			1	12	8	100			39	100			2		
	5pm	1			1	11	8	100			39	100			2		
	6pm	1			1	13	8	100			39	100			3		
	7pm	1			1	11	8	100			39	100			3		
	8pm	1			1	12	8	100			39	100			3		
	9pm	1			1	10	8	100			39	100			3		

Voyage 25th to 26th of April 1987

Route of the ship



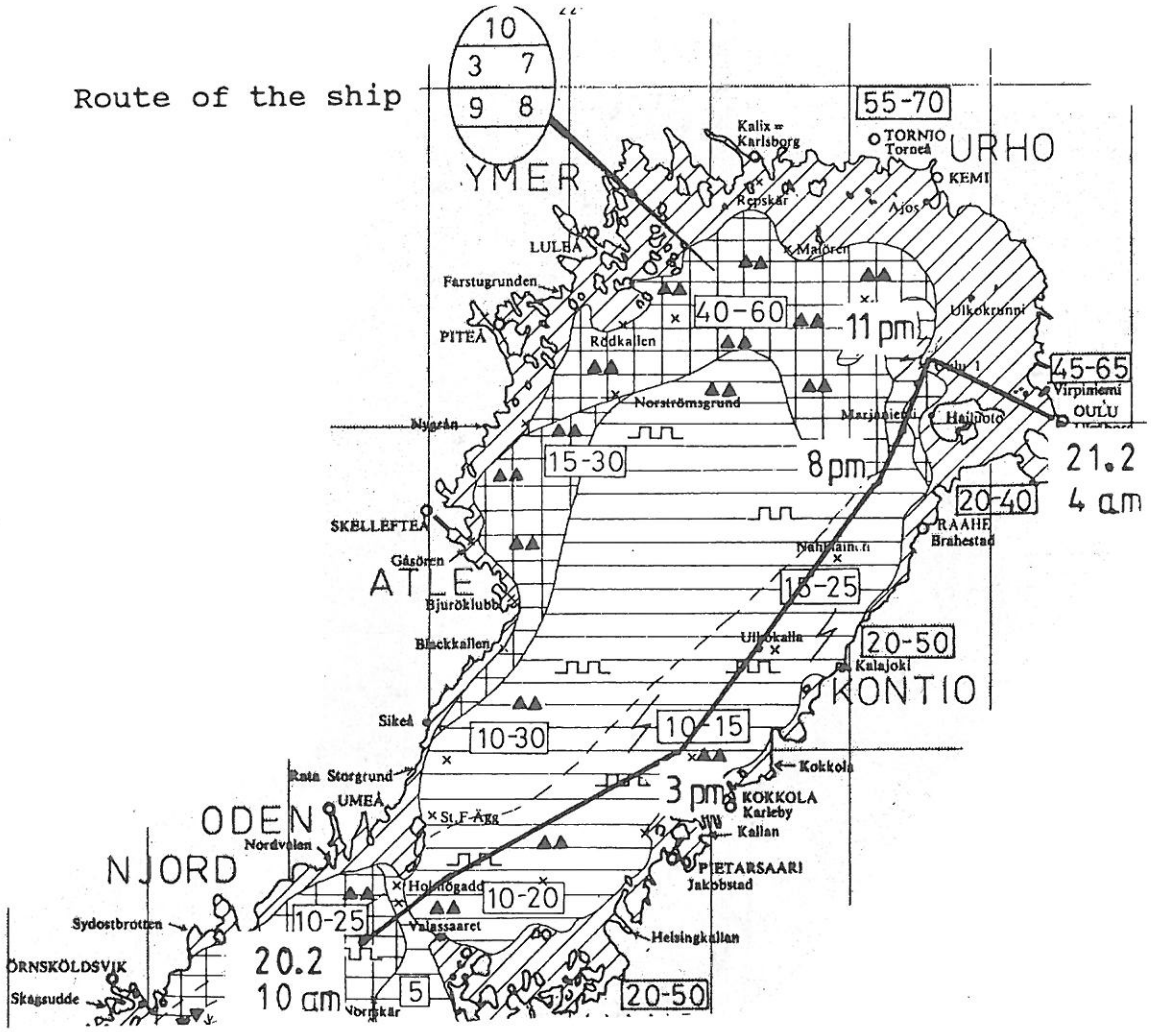
Summary of encountered ice conditions

Voyage 25.--26.4. 1987 Draught: Bow= 6.8 , Mid=7.0 , Aft=7.2

Day	Start	Navigation time Indep.	Navigation time Icebreaker assist	Navigation time Icebreaker tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	%	class	%	Ice type Index	%	index	%	Air T (C)	Wind (m/s)	Remarks
25.4	2pm	1			0,4	5	5	75	6	25	80	100			3	3N	
	3pm	1			0,4	5	5	75	6	25	81	100			4	4N	
	4pm	1			0,5	6	5	75	6	25	80	100			4	5N	
	5pm	1			0,4	5	5	75	6	25	80	100			3	5N	
	6pm	1			0,4	5	5	75	6	25	80	100			2	10NE	
	7pm	1			0,2	2,5	5	75	6	25	80	100			2	10NE	
	8pm	1			0,4	4	5	75	6	25	80	100			2	10NE	
	9pm	1			1	11	5	80	6	20	59	100			2	10NE	
	10pm	1			0,2	2	5	75	6	25	80	100			2	10NE	
	11pm	1			0,2	3	6	100			80	100			2	10NE	
26.4	0am	1			0	0									1	2NE	open water
	1am	1			0,5	6	5	75	6	25	80	100			1	2NE	
	2am	1			1	12	5	100			52	100			0	2NE	
	3am	1			0,3	3	5	100			80	100			0	2NE	
	4am	1			0,3	3	5	60	6	40	80	100			0	4NE	
	5am	1			0,4	5	5	70	6	30	80	100			1	4NE	
	6am	1			1	12	6	100			70	25	58	75	0	4NE	
	7am	1			1	12	6	100			59	100			0	4NE	
	8am	1			1	10	6	100			70	100			0	4NE	old channel,some level ice
	9am	1			1	10,5	7	100			70	100			0	4NE	"
	10am	1			1	11,5	7	100			70	100			2	4NE	"
	11am	1			1	10	7	90	8	10	70	100			2	4NE	"
	12am		1		1	10	7	70	8	30	80	100			1	3NE	Kontia assists
	1pm		1		1	6	8	100			81	100			2	3NE	0.5 h stuck
	2pm		1		1	6	8	50	9	50	81	50	39	50	2	3NE	
	3pm		0,5		0,5	4	9	100			39	100			2	3NE	

Voyage 20th to 21st of February 1988

Route of the ship



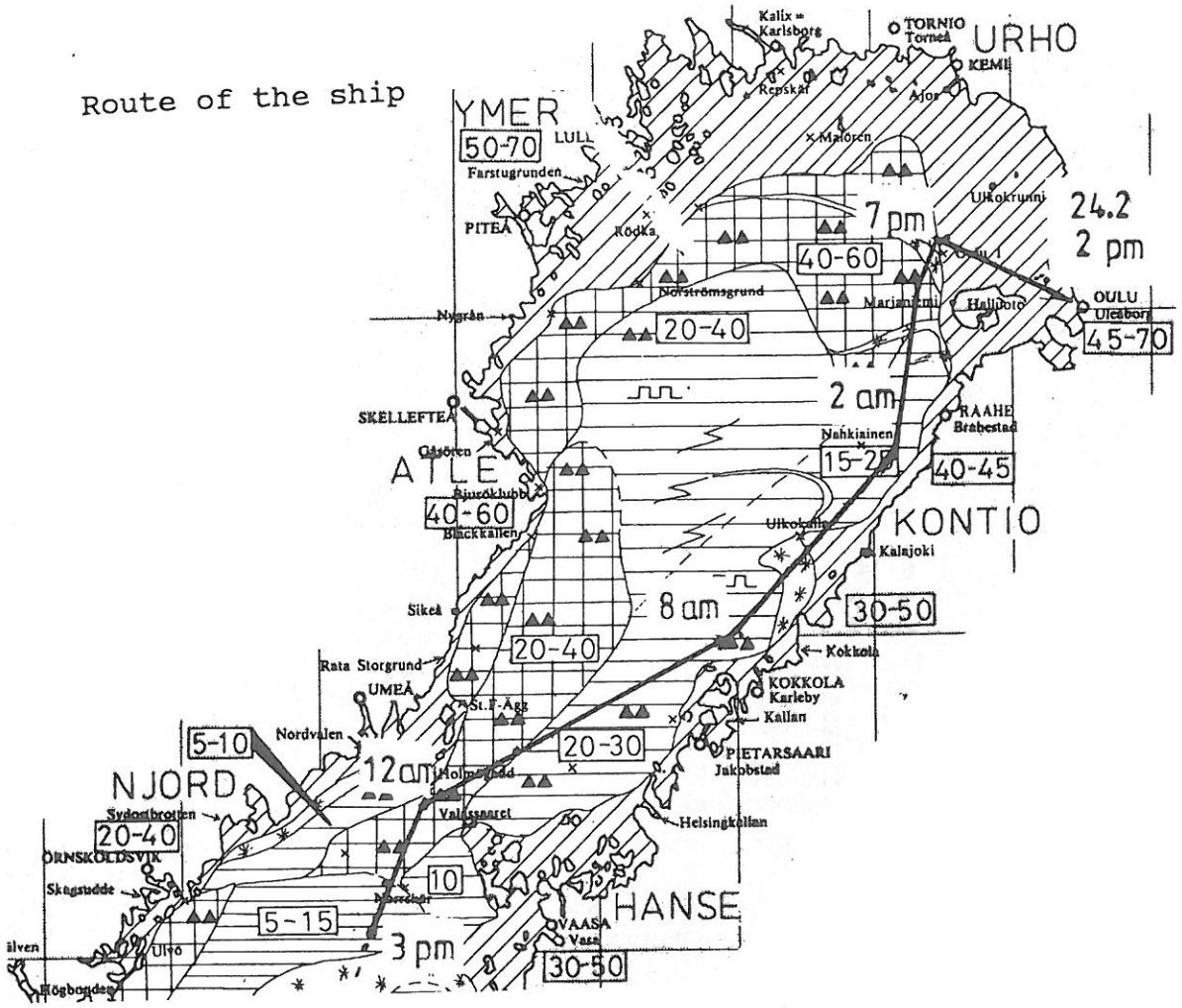
Summary of encountered ice conditions

Voyage 20.--21.2.1988 Draught: Bow= 6.8 , Mid=7.0 , Aft=7.2

Day	Start	Navigation time Indep.	Navigation time Icebreaker assist	Navigation time Icebreaker tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	%	class	%	class	%	Index	%	Ice type index	%	Air T (C)	Wind (m/s)	Remarks
20.2	10am	1			1	13,5	3	100					30	100			-12	5NE	channel
	11am	1			1	13	2	15	3	70	4	15	30	100			-12	5NE	"
	12am	1			1	13	2	15	3	70	4	15	30	100			-12	5NE	"
	1pm	1			1	13	3	60	4	40			30	100			-13	0	"
	2pm	1			1	13	3	60	4	40			30	100			-13	0	"
	3pm	1			1	13	3	30	4	70			30	100			-13	0	"
	4pm	1			1	12	3	15	4	70	5	15	30	100			-13	0	"
	5pm	1			1	11,5	3	15	4	70	5	15	30	100			-15	0	"
	6pm	1			1	11,5	4	50	5	50			30	100			-15	0	"
	7pm	1			1	11,5	4	60	5	40			30	100			-15	0	", some level ice
	8pm	1			1	9,5	4	60	5	40			30	100			-18	0	"
	9pm	1			1	12	4	70	5	20	6	10	59	70	30	30	-18	0	"
	10pm	1			1	10	5	50	6	50			59	50	70	50	-19	0	search for fast ice ch.
	11pm	0,1			0,1	1	7	100					59	100			-19	0	0.9h stuck
21.2	0am		0,5		0,5	4	8	100					85	100			-19	0	Urho assists, 0.5 h stuck
	1am		1		1	8	8	100					39	100			-19	0	
	2am		1		1	8	8	100					39	100			-19	0	
	3am		1		1	8	8	100					39	100			-19	0	

Voyage 24th to 25th of February 1988

Route of the ship



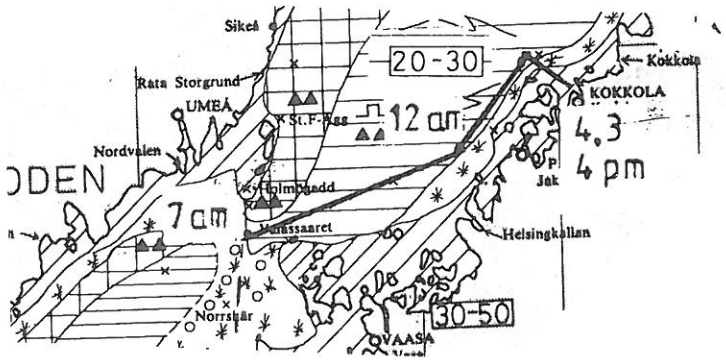
Summary of encountered ice conditions

Voyage 24.--26.2. 1988 Draught: Bow= 6.2, Mid=6.6 , Aft=7.1

Day	Start	Navigation time Indep.	Navigation time Icebreaker assist	Navigation time Icebreaker tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	Ice thickness %	Ice thickness class	Ice thickness %	Ice type Index	Ice type %	Ice type index	Ice type %	Air T (C)	Wind (m/s)	Remarks
							8	100			39	100			-19	0	
24.2	3pm	1			1	10	8	100			39	100			-19	0	
	4pm	1			1	5,5	8	100			39	100			-19	0	
	5pm	1			1	5,4	8	100			39	100			-19	0	
	6pm	1			1	7,3	8	100			39	100			-19	0	
	7pm	0,75			0,75	8	5	50	6	50	30	50	84	50	-18	0	.25h stuck
	8pm	0			0	0									-17	0	1h stuck
	9pm	0			0	0									-20	0	1h stuck
	10pm	0			0	0									-18	0	1h stuck
	11pm	0	0,5		0,5	3	6	100			84	100			-17	0	0.5 h stuck, Urho assists
25.2	0am	1			1	12	5	100			84	100			-15	0	
	1am	1			1	9	5	100			84	100			-15	0	
	2am	1			1	13	5	100			84	100			-15	0	
	3am	1			1	13	5	100			84	100			-15	0	
	4am	1			1	10,5	5	100			84	100			-14	0	
	5am	1			1	10,5	5	100			84	100			-14	0	
	6am	1			1	9,5	5	100			84	100			-14	0	
	7am	1			1	11	5	100			84	100			-14	0	
	8am	0,7	0,3		1	11	5	100			84	100			-13	0	Kontio assists
	9am		1		1	10,5	5	100			84	100			-13	0	
	10am		1		1	12	5	100			84	100			-13	0	
	11am		1		1	11	5	100			84	100			-12	0	
	12am		1		1	11	5	100			84	100			-8	0	
	1pm	1			1	10	3	85	5	15	30	85	84	15	-7	0	
	2pm	1			1	14	3	100			30	100			-7	0	

Voyage 3th to 4th of March 1988

Route of the ship



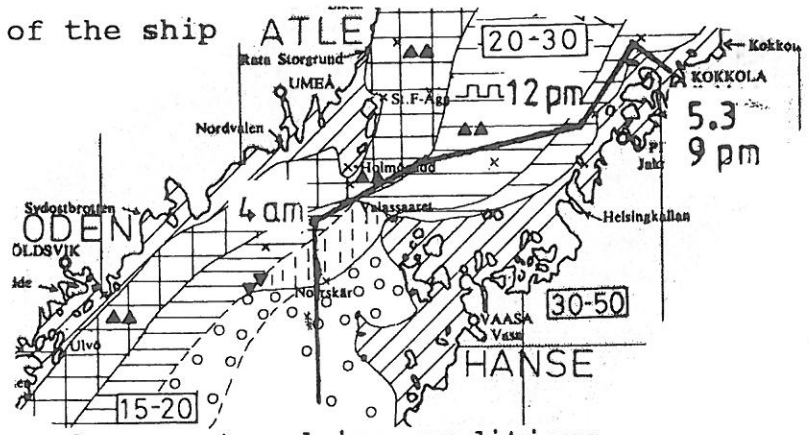
Summary of encountered ice conditions

Voyage 3.--4.3. 1988 Draught: Bow= 6.5 , Mid=6.7 , Aft=6.9

Day	Start	Navigation time Indep.	Icebreaker assist	Icebreaker tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	%	class	%	Ice type Index	%	index	%	Air T (C)	Wind (m/s)	Remarks
4.3	8am	0,5	0,5		1	9,5	2	80	5	20	30	80	69	20	-2	3S	Otso assists
	9am		1		1	12	3	50	5	50	30	50	69	50	-4	4S	
	10am	0,1	0,9		1	11	5	90	6	10	69	100			-4	4S	out of ch. to pass a ship
	11am	0,5	0,5		1	10,5	5	90	6	10	67	100			-3	8SE	"
	12am		1		1	12,5	5	90	6	10	68	100			-2	7SE	
	1pm		1		1	13	5	50	4	50	68	50	30	50	-1	7S	
	2pm		1		0,5	6	7	100			39	100			0	7S	
	3pm		1		1	10	7	100			39	100			0	7S	

Voyage 5th to 6th of March 1988

Route of the ship



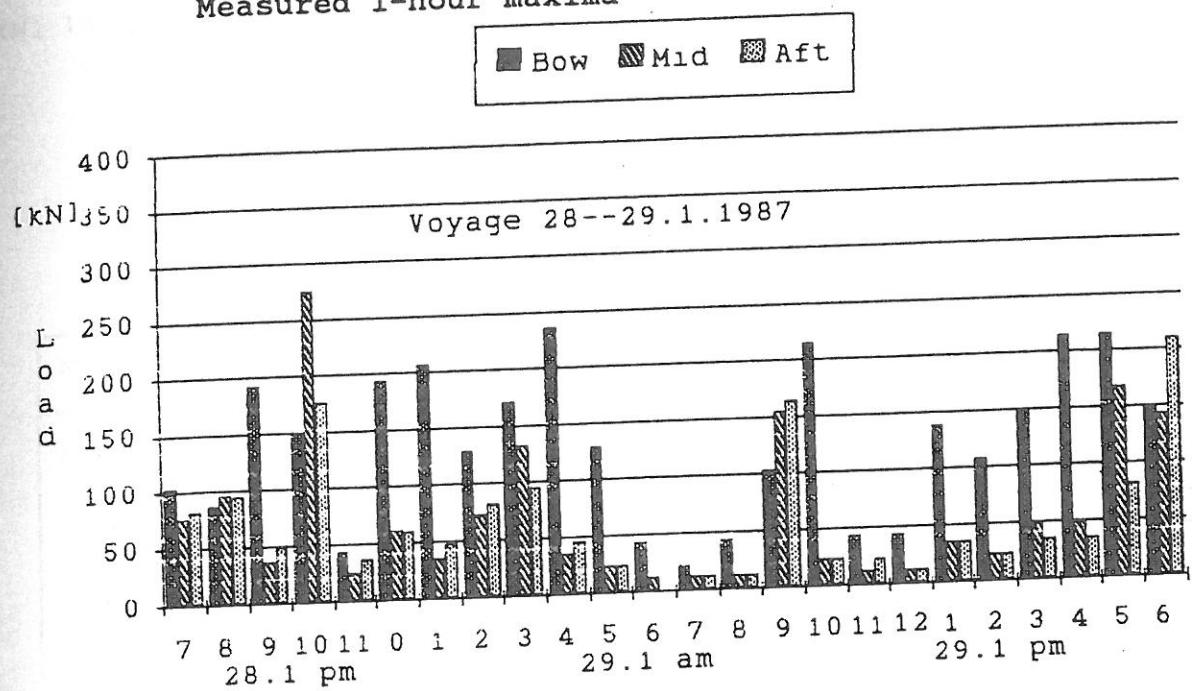
Summary of encountered ice conditions

Voyage 5.--6.3. 1988 Draught: Bow= 6.8 , Mid=7.1 , Aft=7.3

Day	Start	Navigation time Indep.	Icebreaker assist	Icebreaker tow.	Time in ice (hour)	Voyage in ice (miles)	Environmental conditions: Ice thickness class	%	class	%	Ice type Index	%	index	%	index	%	Air T (C)	Wind (m/s)	Remarks
5.3	9pm	1			1	9	7	100			39	100					-2	3SE	
	10pm	1			1	11	2	100			30	100					-2	3SE	
	11pm	1			1	13	2	70	3	30	30	70	80	30			-2	3SE	
6.3	0am	1			1	13	4	60	5	40	59	60	70	20	84	20	-1	4SE	
	1am	1			0,75	9	5	80	6	20	59	60	84	20			-1	4SE	
	2am	1			1	10	5	100			69	50	84	50			-1	5SE	
	3am	1			0,75	8,5	5	30	6	70	59	30	69	40	80	30	-1	5SE	
	4am	1			1	12	5	100			59	100					-1	5SE	

Voyage 28th to 29th of January 1987

Measured 1-hour maxima

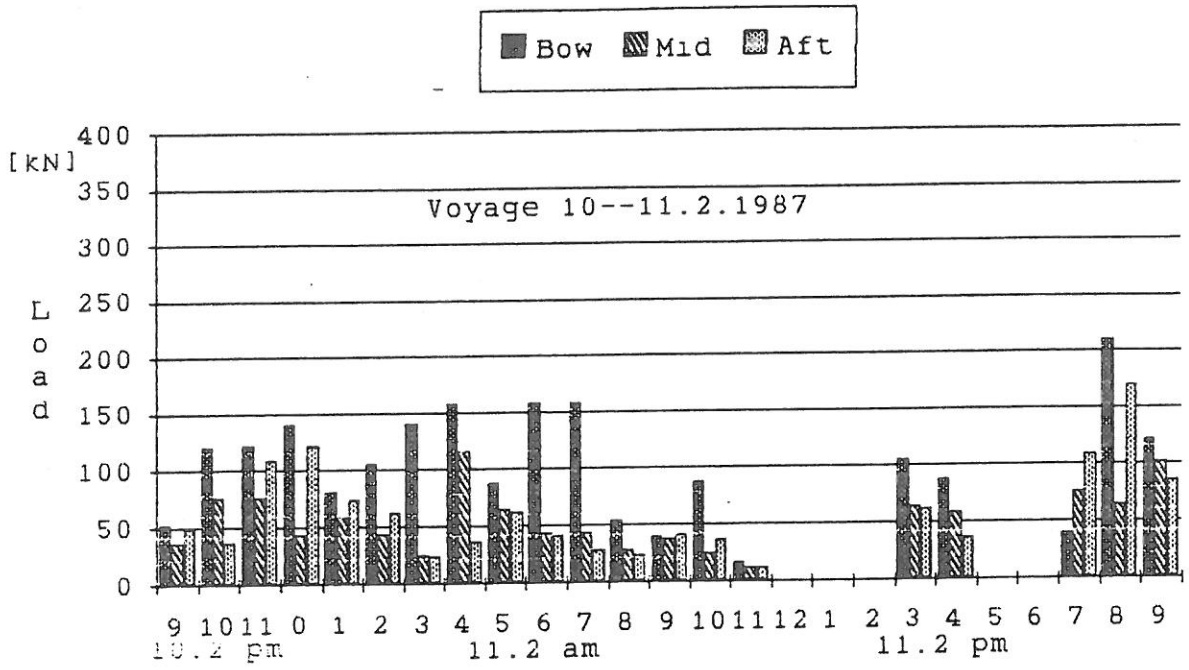


Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14	PL15 [N/mm^2]	HB16
28.1	7 pm	64	103	33	30	90	59	74		70	50	81	36		20	30	5
	8 pm	64	86	50	40	90	95	62		40	60	93	49		30	30	5
	9 pm	192	86	67	50	80	23	37		30	30	35	49		20	30	5
	10 pm	150	86	16	50	60	275	24		50	30	175	85		50	40	10
	11 pm	42	34	16	20	50	23	24		30	20	35	36		20	20	5
29.1	12 pm	192	86	16	30	40	59	24		20	30	58	36		20	10	5
	1 am	85	208	16	70	130	35	24		30	40	46	36		20	40	5
	2 am	128	86	83	40	60	71	62		50	60	81	49		20	50	5
	3 am	171	51	33	30	60	131	24		40	20	93	36		10	30	5
	4 am	235	68	33	40	50	35	24		20	30	35	36		20	10	5
	5 am	128	17	0	10	10	23	12		10	10	23	12		10	10	10
	6 am	42	0	0	10	10	11	0		10	10	0	0		0	0	5
	7 am	21	0	0	10	10	11	0		0	0	11	12		10	0	5
	8 am	42	34	0	10	20	11	0		10	10	11	12		0	10	10
	9 am	85	103	50	40	50	155	74		60	70	163	12		50	20	20
	10 am	214	120	50	50	70	23	12		20	20	23	12		10	10	15
	11 am	42	17	0	10	20	11	0		0	0	23	0		10	0	10
	12 am	42	17	0	10	10	11	0		0	0	11	0		0	0	5
	1 pm	85	137	16	70	50	35	12		20	10	35	12		10	10	15
	2 pm	107	68	0	30	30	23	12		10	10	23	0		10	0	10
	3 pm	150	34	33	30	30	47	24		20	10	35	24		10	10	20
	4 pm	214	51	33	30	90	47	24		20	20	35	24		20	30	20
	5 pm	214	120	33	40	80	167	37		40	40	81	49		20	30	20
	6 pm	150	51	16	30	60	143	24		30	40	210	85		30	50	10

Voyage 10th to 11th of February 1987

Measured 1-hour maxima (FT17-FT19)

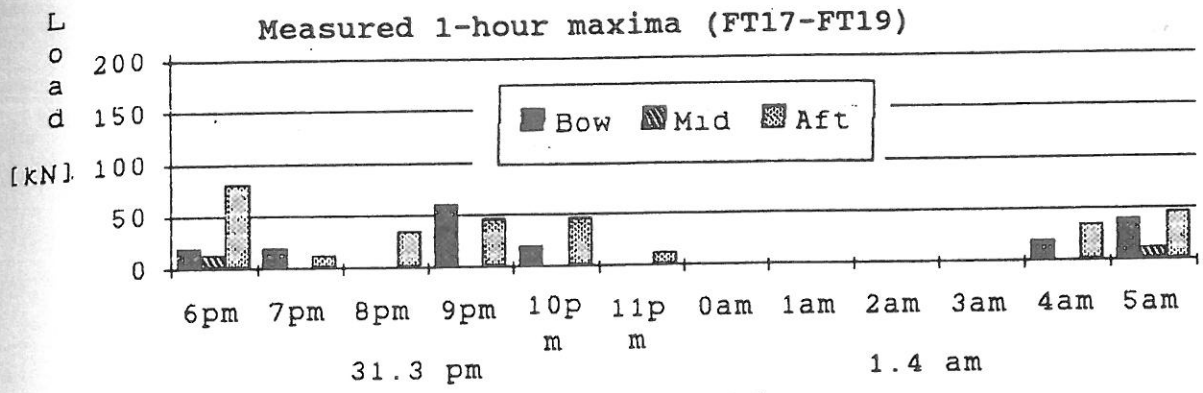


Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14	PL15 [N/mm^2]	HB18	FT17 [kN]	FT18 [kN]	FT19 [kN]
10.2	9 pm	0	51	0	30	50	0	37		30	20	0	49		20	0	5	20	0	0
	10 pm	0	120	0	50	60	0	74		50	70	0	36		10	0	5	0	0	0
	11 pm	82	86	100	40	80	71	62		50	140	128	73		30	40	5	122	76	109
11.2	12 pm	99	208	50	90	130	35	49		50	30	140	49		30	20	5	140	43	122
	1 am	49	68	33	40	120	35	37		30	30	81	49		20	30	5	80	57	73
	2 am	99	103	33	40	50	23	49		30	30	70	49		20	0	5	120	43	61
	3 am	132	51	33	30	40	23	37		30	20	35	24		10	0	5	140	28	24
	4 am	148	103	151	50	70	35	174		110	50	35	36		20	30	10	158	115	41
	5 am	82	68	33	40	80	71	37		50	30	70	36		20	0	10	87	63	61
	6 am	148	68	33	30	60	23	37		30	50	23	24		10	0	5	158	43	41
	7 am	148	51	16	30	40	23	49		30	30	23	24		10	0	5	158	43	27
	8 am	49	34	16	20	20	23	24		20	20	35	24		10	0	10	52	28	24
	9 am	16	34	16	30	30	35	24		20	30	46	49		20	20	5	40	38	41
	10 am	33	34	16	20	30	23	24		10	20	35	12		20	0	5	100	28	36
	11 am	16	0	0	0	10	11	12		10	10	11	0		0	0	5	17	14	12
	12 am	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	1 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	5	0	0	0
	2 pm	0	0	0	10	0	11	0		0	0	11	0		0	0	5	20	0	12
	3 pm	82	86	50	30	150	59	24		30	20	70	36		20	10	5	120	63	61
	4 pm	82	68	50	30	60	35	49		50	40	46	36		10	20	10	87	57	36
	5 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	5	0	0	0
	6 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	7 pm	16	51	16	20	30	71	49		30	40	105	85		40	40	10	40	76	109
	8 pm	198	103	50	50	90	71	62		50	50	198	61		40	40	15	210	63	170
	9 pm	132	68	33	30	80	107	62		50	40	105	61		30	80	10	122	101	85

Voyage 31th of March to 1st of April 1987

Measured 1-hour maxima (FT17-FT19)

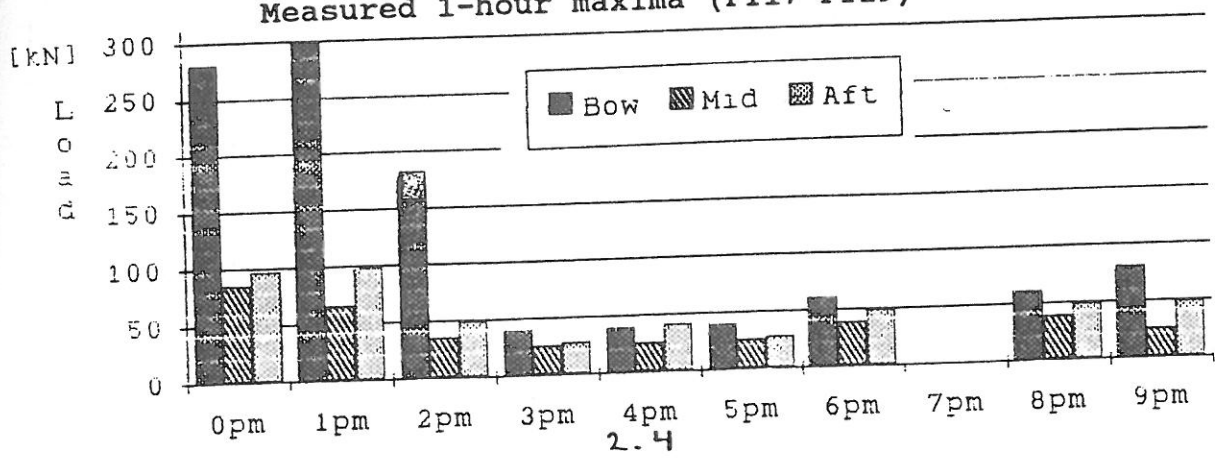


Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14	PL15 [N/mm^2]	HB18	FT17 [kN]	FT18 [kN]	FT19 [kN]
31.3	6 pm	0	0	[83]	0	0	0	12		10	10	0	12		10	0	15	17	12	[97]
	7 pm	0	0	16	0	0	0	0		0	10	0	0		10	0	5	17	0	13
	8 pm	0	0	0	0	10	0	0		0	10	0	12		10	0	5	0	0	41
	9 pm	0	0	50	0	0	0	0		10	10	0	12		[20]	10	15	[52]	0	55
	10 pm	0	0	33	0	0	0	0		0	10	0	12		10	0	10	17	0	55
	11 pm	0	0	0	0	0	0	0		0	0	0	0		10	0	0	0	0	13
1.4	12 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	1 am	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	2 am	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	3 am	"	"	"	"	"	"	"		"	"	"	"		"	"	"	"	"	"
	4 am	0	0	16	0	0	0	0		0	0	0	12		10	0	5	17	0	41
	5 am	0	0	33	0	0	11	0		10	10	0	12		10	0	15	35	12	55

Voyage 1st to 2nd of April 1987

Measured 1-hour maxima (FT17-FT19)

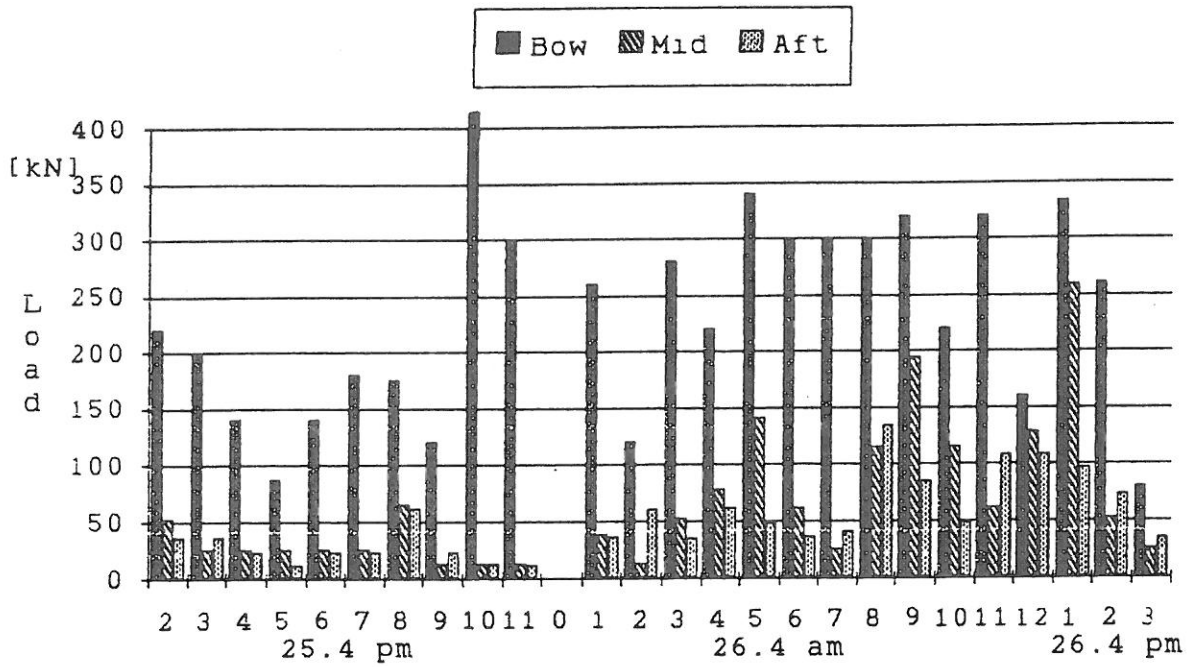


Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14	PL15 [N/mm^2]	HB18	FT17 [kN]	FT18 [kN]	FT19 [kN]
2.4	0 pm	[165]	206	[134]	120	[220]	[95]	[82]		40	40	105	36		20	30	20	280	[84]	[85]
	1 pm	99	[309]	100	[130]	130	59	62		[50]	[50]	[117]	24		30	30	20	[300]	64	[97]
	2 pm	49	86	33	50	40	35	24		20	20	58	49		20	30	5	180	36	48
	3 pm	16	34	33	30	20	23	24		20	30	35	36		10	20	10	40	25	27
	4 pm	0	51	16	20	110	11	24		20	30	35	36		20	30	5	40	25	41
	5 pm	16	51	16	20	40	11	24		20	20	35	24		10	10	5	40	25	24
	6 pm	33	68	50	20	40	35	37		40	30	70	[61]		30	[40]	5	60	38	48
	7 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	8 pm	16	68	33	30	110	23	37		30	30	58	36		20	20	5	60	38	48
	9 pm	16	86	16	50	50	23	37		40	20	48	36		20	30	5	80	25	48

Voyage 25th to 26th of April 1987

Measured 1-hour maxima (FT17-FT19)

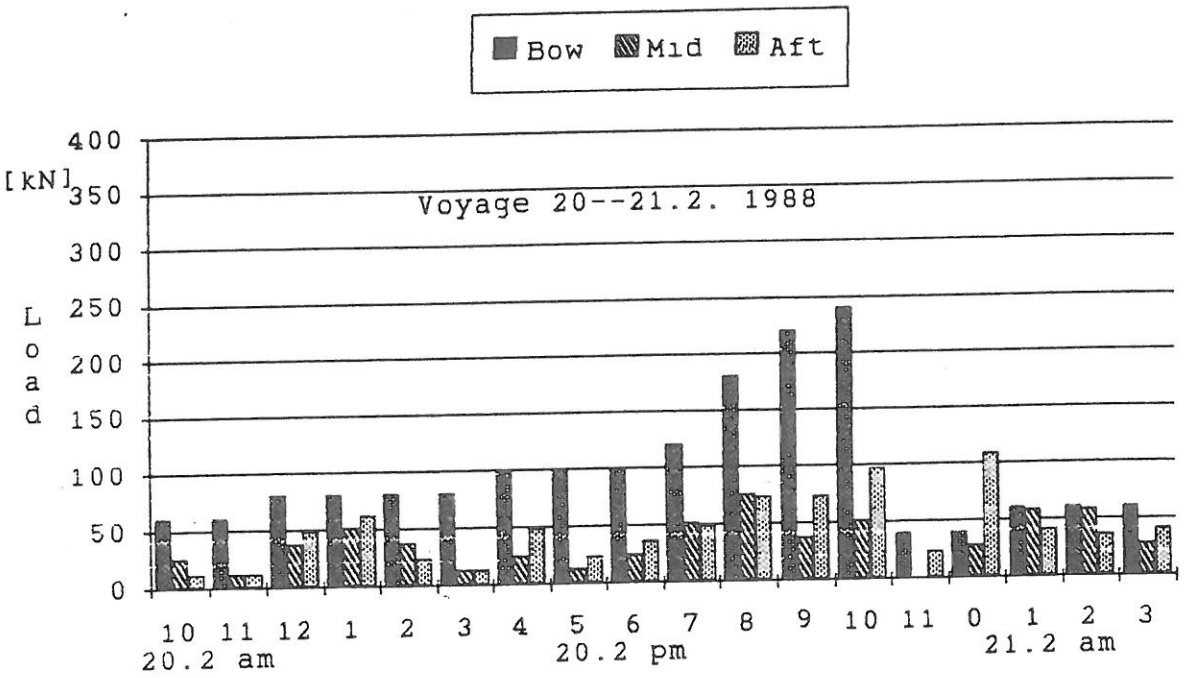


Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14	PL15 [N/mm^2]	HB16	FT17 [kN]	FT18 [kN]	FT19 [kN]
25.4	2 pm	16	189	134	90	170	47	49		40	60	35	12		10	0	15	220	51	36
	3 pm	33	172	50	90	100	11	37		20	10	35	24		10	0	10	200	25	36
	4 pm	16	172	117	80	90	23	24		20	10	35	24		10	0	15	140	25	24
	5 pm	16	120	151	70	110	11	37		30	20	11	24		10	0	20	140	25	13
	6 pm	16	154	117	80	40	23	24		30	10	35	24		10	0	20	140	25	24
	7 pm	16	206	83	90	160	11	12		10	10	23	24		10	0	15	180	25	27
	8 pm	0	137	184	60	100	11	37		50	30	70	24		20	0	15	175	64	61
	9 pm	16	137	67	60	100	11	24		20	10	35	12		10	0	10	120	12	24
	10 pm	16	430	67	250	260	11	0		0	10	0	12		0	0	15	420	12	13
	11 pm	16	137	117	90	90	11	12		0	10	11	24		10	0	10	300	12	13
26.4	12 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	5	0	0	0
	1 am	16	275	83	140	230	35	49		40	20	35	24		10	0	25	260	38	36
	2 am	0	103	100	50	90	0	12		10	10	70	12		20	0	20	120	12	61
	3 am	49	258	100	130	190	47	62		60	100	35	24		20	50	20	280	51	36
	4 am	33	223	117	130	200	35	62		60	100	70	73		50	20	20	220	77	69
	5 am	66	326	67	150	150	23	49		90	50	58	36		20	20	30	340	142	48
	6 am	33	258	67	140	170	35	12		30	20	46	24		10	0	25	300	60	36
	7 am	33	275	67	110	220	11	37		20	70	23	49		30	0	20	300	25	41
	8 am	33	326	83	150	190	71	74		50	40	152	85		60	70	15	300	116	134
	9 am	49	326	83	150	210	35	74		100	60	70	73		30	50	20	320	194	97
	10 am	16	240	117	90	220	71	112		120	20	46	49		30	0	10	220	118	55
	11 am	33	326	167	190	200	47	37		40	70	128	73		30	40	10	320	80	109
	12 am	16	172	100	90	150	107	149		100	100	93	85		60	70	15	160	129	109
	1 pm	66	292	989	130	190	119	923		290	200	128	171		60	250	10	333	259	97
	2 pm	33	137	100	70	100	11	74		80	80	81	85		50	80	15	260	51	83
	3 pm	0	86	50	50	110	11	24		20	40	35	12		10	0	5	80	25	38

Voyage 20th to 21st of February 1988

Measured 1-hour maxima (FT17-FT19)

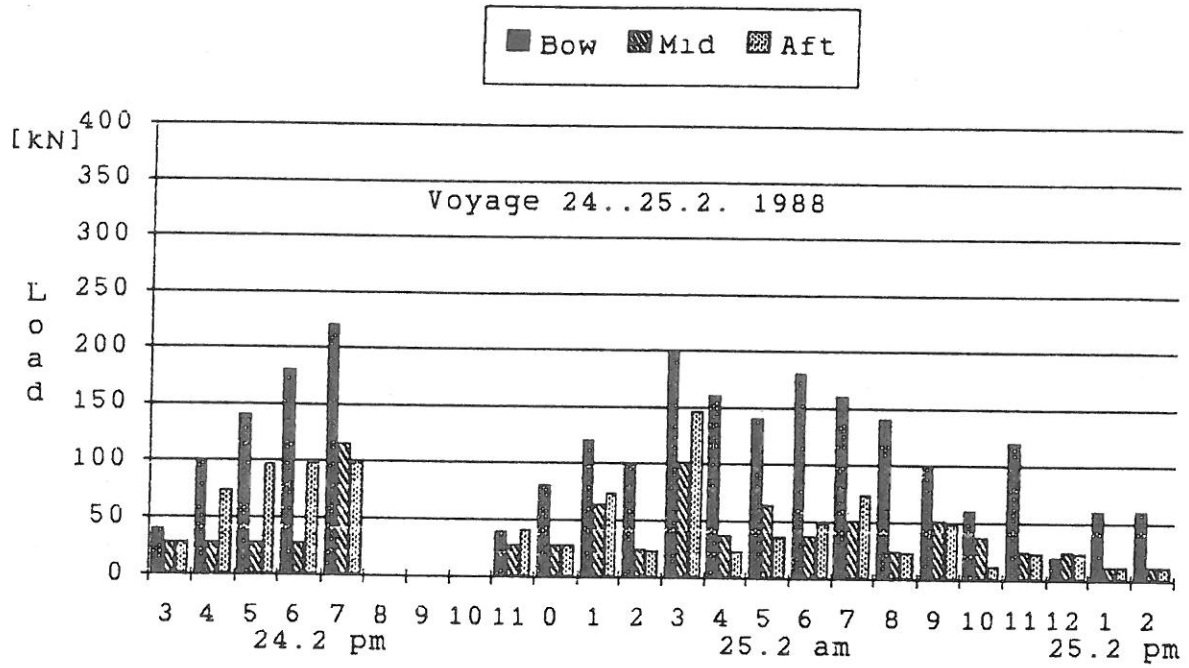


Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14 [N/mm^2]	PL15	HB16	FT17 [kN]	FT18 [kN]	FT19 [kN]
20.2	10 am	16	51	0	20	40	23	12		10	10	11	12		0	0	5	60	25	13
	11 am	16	51	0	20	30	11	12		10	10	11	12		0	0	5	60	14	13
	12 am	49	51	16	20	50	35	12		10	20	46	12		10	0	5	80	38	48
	1 pm	33	51	0	20	30	47	12		10	10	70	12		10	0	5	80	50	61
	2 pm	33	68	16	30	60	35	12		10	20	23	12		10	0	10	80	38	24
	3 pm	16	68	16	30	90	23	12		10	10	11	12		10	0	10	80	12	13
	4 pm	16	68	16	30	80	23	24		20	20	58	12		30	0	10	100	28	48
	5 pm	33	86	33	30	70	23	12		10	10	35	24		10	0	10	100	12	24
	6 pm	33	86	16	40	140	23	24		10	30	35	24		10	0	10	100	28	36
	7 pm	49	86	16	30	90	47	24		20	20	35	24		20	0	10	120	50	48
	8 pm	66	86	16	30	50	[71]	12		30	30	70	36		20	0	10	180	[76]	73
	9 pm	49	[189]	33	[90]	160	35	12		10	10	93	36		30	0	15	220	38	73
	10 pm	[82]	154	[50]	70	[170]	59	49		50	40	81	[98]		[60]	40	10	[240]	50	97
	11 pm	16	34	16	20	50	0	0		0	0	11	12		10	0	0	40	0	27
21.2	12 pm	16	51	33	20	80	23	24		20	30	[93]	49		50	40	5	40	28	[109]
	1 am	49	68	50	20	60	23	[62]		[50]	[50]	46	61		30	[50]	5	60	57	41
	2 am	33	51	50	20	60	23	62		30	40	35	36		20	0	0	60	57	41
	3 am	33	68	33	30	70	23	24		20	40	35	36		20	0	5	80	28	41

Voyage 24th to 25th of February 1988

Measured 1-hour maxima (FT17-FT19)

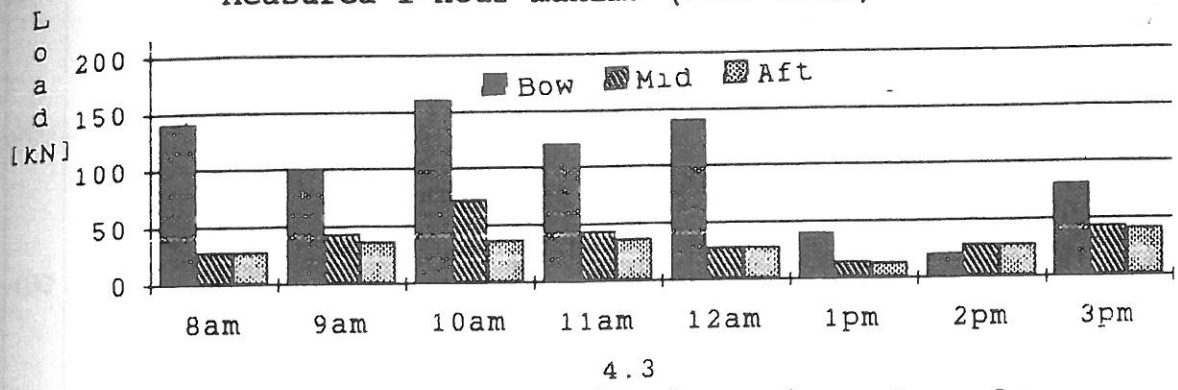


Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14	PL15 [N/mm^2]	HB16	FT17 [kN]	FT18 [kN]	FT19 [kN]
24.2	3 pm	0	51	33	20	110	11	37		20	10	23	36		20	0	5	40	28	27
	4 pm	16	120	50	60	130	23	37		30	40	81	61		30	40	5	100	28	73
	5 pm	16	154	50	70	170	11	49		30	30	81	110		50	90	5	140	28	97
	6 pm	16	189	67	100	290	23	37		30	30	117	98		50	100	5	180	28	97
	7 pm	33	206	33	110	150	47	74		40	30	93	36		50	0	10	220	115	97
	8 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	9 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	10 pm	0	0	0	0	0	0	0		0	0	0	0		0	0	0	0	0	0
	11 pm	0	34	33	10	30	11	37		40	70	23	49		20	0	5	40	28	41
25.2	12 pm	0	103	50	40	190	23	12		10	10	23	24		10	50	5	80	25	27
	1 am	0	103	100	50	90	71	37		30	20	81	24		20	0	5	120	63	73
	2 am	16	137	50	70	110	35	24		20	30	35	24		10	0	10	100	25	36
	3 am	66	206	50	120	240	47	99		70	40	187	61		50	50	20	200	101	146
	4 am	16	154	33	70	160	47	24		30	30	35	36		10	0	20	160	38	27
	5 am	16	154	33	70	160	59	37		40	40	35	12		20	0	20	140	63	36
	6 am	16	189	16	110	150	35	24		30	40	58	24		20	0	20	180	38	48
	7 am	49	189	50	90	210	47	37		40	70	81	24		20	0	15	160	50	73
	8 am	0	154	33	80	160	23	24		20	20	35	12		10	0	15	140	28	24
	9 am	0	103	16	60	170	35	37		30	20	35	36		20	0	5	100	57	55
	10 am	0	68	16	30	90	0	12		20	10	11	12		10	0	5	60	43	13
	11 am	33	120	50	60	210	35	37		30	50	11	49		20	30	5	120	28	27
	12 am	0	34	16	10	40	23	37		20	20	23	12		10	0	5	20	28	24
	1 pm	0	51	33	20	30	0	0		0	10	0	12		10	0	5	60	14	13
	2 pm	0	51	16	20	40	0	12		10	10	11	0		0	0	15	60	14	12

Voyage 3th to 4th of March 1988

Measured 1-hour maxima (FT17-FT19)



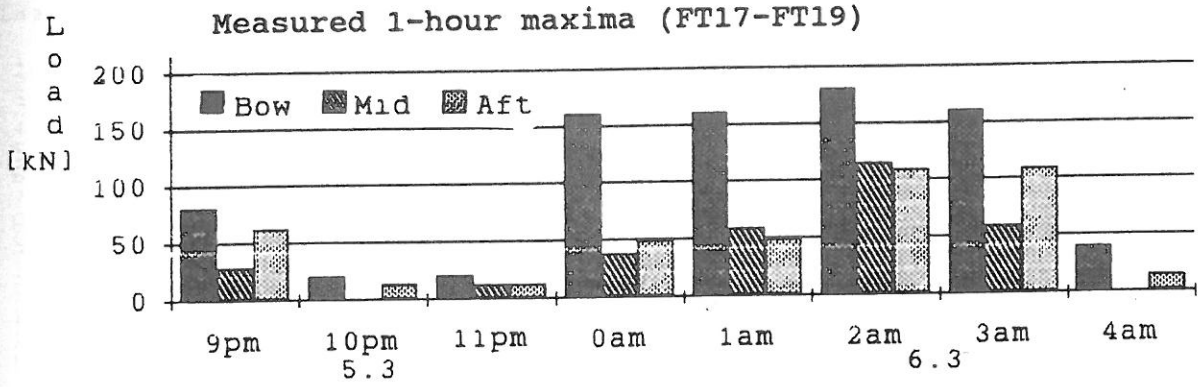
4.3

Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14 [N/mm^2]	PL15	HB16	FT17 [kN]	FT18 [kN]	FT19 [kN]
4.3	8 am	16	172	50	90	180	11	12		20	20	11	24		30	20	10	140	28	27
	9 am	33	120	67	60	150	35	37		30	30	35	24		10	0	5	100	43	36
	10 am	33	109	67	100	260	23	99		90	60	35	36		20	0	10	160	72	41
	11 am	16	120	50	60	140	11	37		30	30	46	24		10	20	20	120	43	36
	12 am	16	172	33	90	130	11	37		40	30	11	24		10	20	5	140	28	27
	1 pm	0	34	16	20	40	11	12		10	0	0	12		10	0	5	40	14	13
	2 pm	0	34	18	10	30	11	37		40	20	11	24		10	30	5	20	28	27
	3 pm	0	88	18	20	30	11	24		20	90	48	48		20	30	5	80	43	41

Voyage 5th to 6th of March 1988

Measured 1-hour maxima (FT17-FT19)

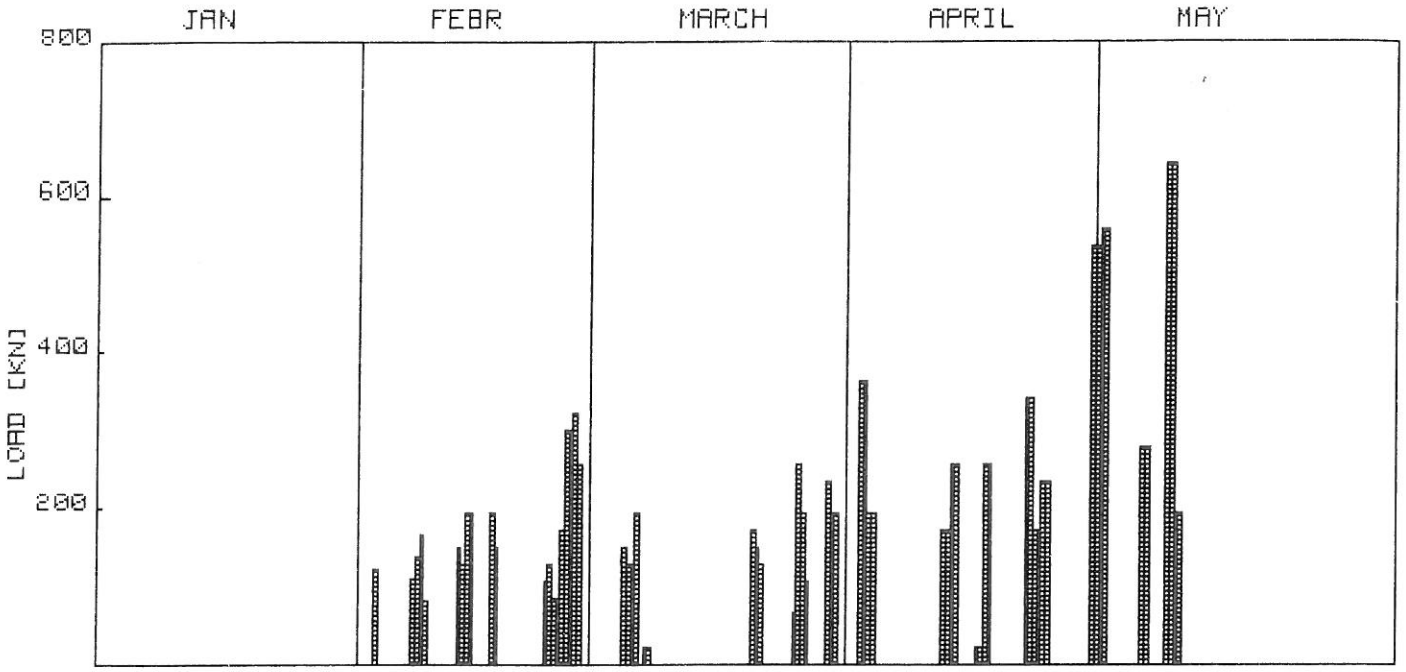


5.3 6.3

Measured 1-hour maxima in various channels

DAY	TIME	FFR1 [kN]	FFR2 [kN]	FFR3 [kN]	FN4 [N/mm^2]	PL5	FFR6 [kN]	FFR7 [kN]	FFR8 [kN]	FN9 [N/mm^2]	PL10	FFR11 [kN]	FFR12 [kN]	FFR13 [kN]	FN14 [N/mm^2]	PL15	HB16	FT17 [kN]	FT18 [kN]	FT19 [kN]
5.3	9 pm	16	88	33	50	80	23	37		30	30	58	61		30	40	5	80	28	69
	10 pm	0	34	16	20	40	11	0		0	10	11	12		10	0	5	20	0	13
	11 pm	0	17	0	10	20	11	0		0	10	11	12		10	40	5	20	12	13
6.3	12 pm	16	120	67	70	150	47	24		10	20	58	36		20	20	15	160	38	48
	1 am	33	172	67	100	130	35	62		50	20	46	36		20	30	15	160	57	48
	2 am	82	154	67	60	110	107	87		70	40	128	49		40	30	20	180	114	108
	3 am	33	137	67	70	130	47	62		40	50	93	85		40	40	20	160	57	109
	4 am	0	34	33	10	20	0	12		0	10	11	24		10	0	5	40	0	13

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

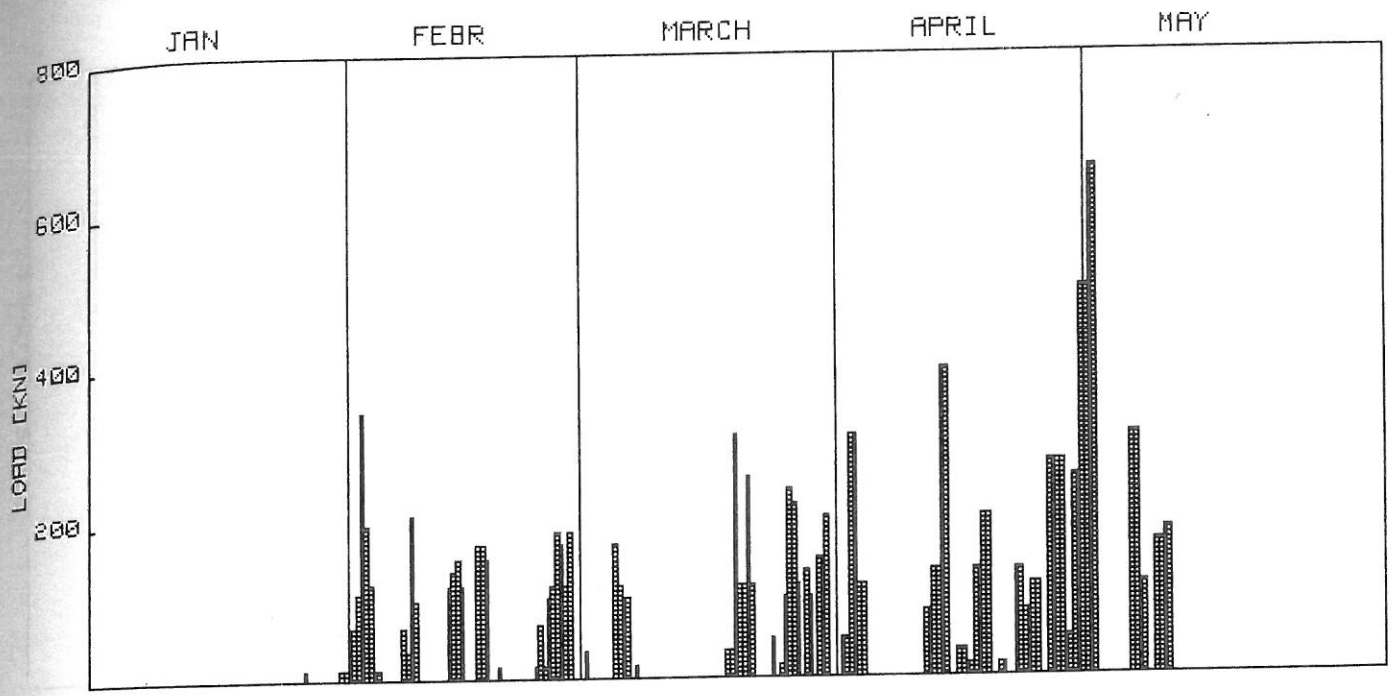


FFR1

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	0	<0	0	0	0	0	536	536
2	*	*	<0	<0	<0	<0	<0	<0	557	557
3	*	*	<0	123	0	0	364	364	<0	<0
4	*	*	<0	<0	0	0	192	192	<0	<0
5	*	*	<0	<0	0	150	<0	<0	0	0
6	*	*	<0	0	128	128	0	0	0	0
7	*	*	0	0	192	0	0	0	278	278
8	*	*	110	137	21	21	0	0	<0	<0
9	*	*	165	82	0	0	0	0	0	0
10	*	*	0	0	0	0	0	0	643	643
11	*	*	0	0	0	0	0	0	192	192
12	*	*	0	0	0	0	<0	<0	0	0
13	*	*	0	150	0	0	171	171	<0	<0
14	*	*	128	192	0	0	257	257	*	*
15	*	*	192	<0	0	0	0	0	*	*
16	*	*	<0	0	0	0	<0	<0	*	*
17	*	*	<0	192	0	0	21	21	*	*
18	*	*	150	0	0	0	257	257	*	*
19	*	*	0	<0	<0	0	<0	<0	*	*
20	*	*	<0	0	<0	<0	<0	<0	*	*
21	*	*	<0	<0	171	150	0	0	*	*
22	*	*	0	0	128	0	0	0	*	*
23	*	*	0	0	0	<0	343	343	*	*
24	*	*	107	128	0	<0	171	171	*	*
25	0	<0	85	<0	0	0	235	235	*	*
26	<0	0	171	300	64	257	0	0	*	*
27	<0	0	235	321	192	107	<0	<0	*	*
28	0	0	257	0	0	<0	<0	<0	*	*
29	0	0			<0	0	<0	<0	*	*
30	0	0			235	107	<0	<0	*	*
31	0	0			192	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

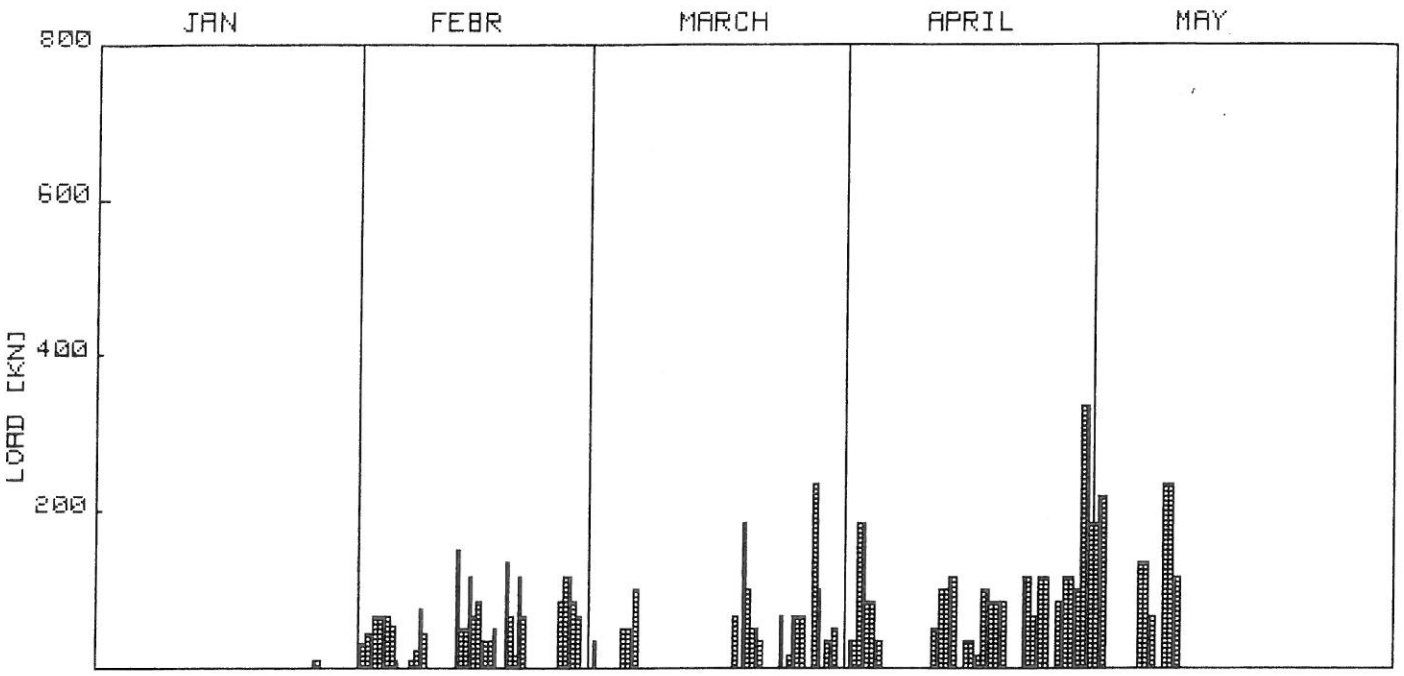


FFR2

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	11	22	0	0	0	0	498	498
2	*	*	66	110	34	0	51	51	653	653
3	*	*	341	198	0	0	309	309	0	0
4	*	*	121	11	0	0	120	120	0	0
5	*	*	11	0	0	172	<0	<0	0	0
6	*	*	0	0	120	86	0	0	0	0
7	*	*	0	<0	103	0	0	0	309	309
8	*	*	66	33	17	0	0	0	120	120
9	*	*	209	99	0	0	0	0	0	0
10	*	*	0	0	0	0	0	0	172	172
11	*	*	0	0	0	0	0	0	189	189
12	*	*	0	0	0	0	86	86	0	0
13	*	*	0	120	0	0	137	137	0	0
14	*	*	137	154	0	0	395	395		
15	*	*	120	0	0	0	0	0	*	*
16	*	*	0	0	0	0	34	34	*	*
17	*	*	172	172	0	0	17	17	*	*
18	*	*	154	0	0	0	137	137	*	*
19	*	*	0	17	34	34	206	206	*	*
20	*	*	0	0	309	120	<0	<0	*	*
21	*	*	<0	0	120	258	17	17	*	*
22	*	*	0	0	120	0	0	0	*	*
23	*	*	0	0	0	0	137	137	*	*
24	*	*	17	68	0	51	86	86	*	*
25	0	0	17	103	0	17	120	120	*	*
26	0	0	120	189	103	240	0	0	*	*
27	11	0	172	120	223	120	275	275	*	*
28	0	0	189	0	0	137	275	275	*	*
29	0	0			103	0	51	51	*	*
30	0	0			154	51	258	258	*	*
31	0	11			206	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

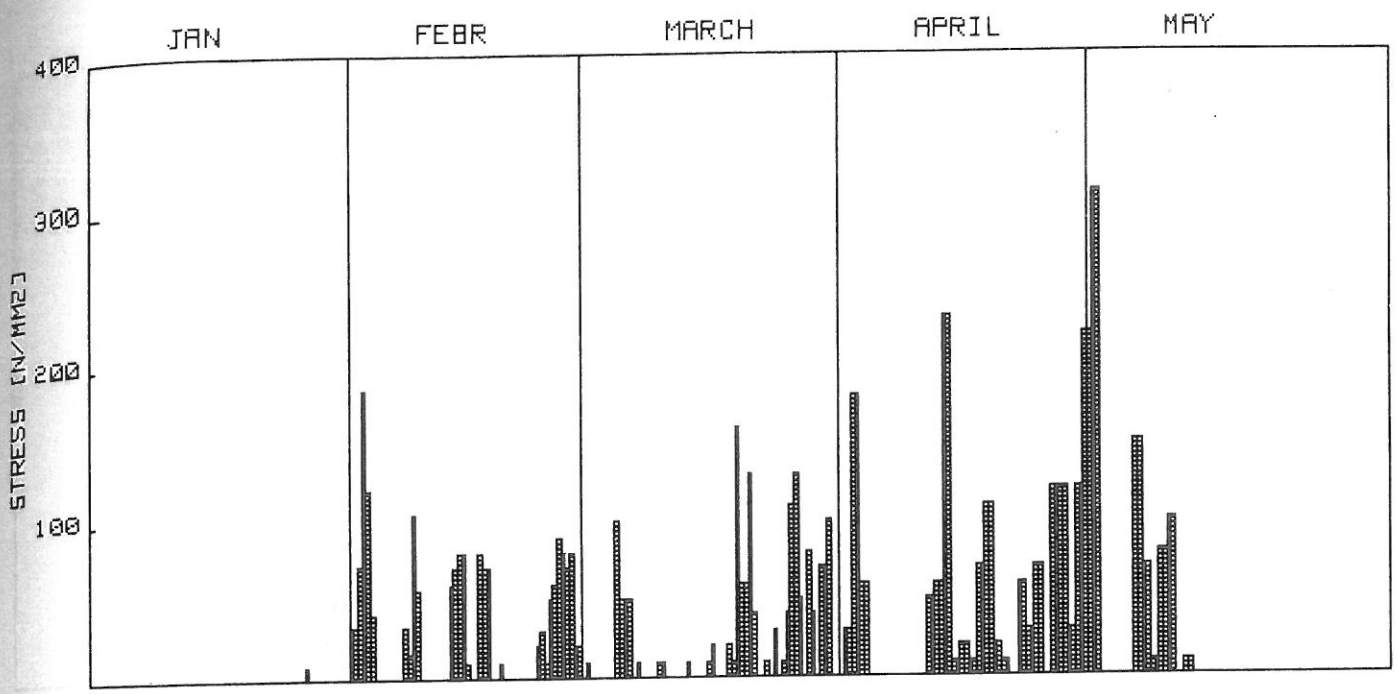


FFR3

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	<0	32	0	0	0	0	184	184
2	*	*	32	43	33	0	33	33	218	218
3	*	*	<0	64	0	0	184	184	0	0
4	*	*	64	32	0	0	83	83	0	0
5	*	*	64	53	0	50	33	33	0	0
6	*	*	10	0	50	33	0	0	0	0
7	*	*	0	<0	100	0	0	0	134	134
8	*	*	10	21	0	0	0	0	67	67
9	*	*	75	43	0	0	0	0	0	0
10	*	*	0	0	0	0	0	0	234	234
11	*	*	0	0	0	0	<0	<0	117	117
12	*	*	0	0	0	0	50	50	0	0
13	*	*	0	151	0	0	100	100	0	0
14	*	*	50	50	0	0	117	117	*	*
15	*	*	117	67	0	0	0	0	*	*
16	*	*	83	33	0	0	33	33	*	*
17	*	*	33	33	0	0	16	16	*	*
18	*	*	50	0	0	0	100	100	*	*
19	*	*	0	134	67	<0	83	83	*	*
20	*	*	67	16	184	100	83	83	*	*
21	*	*	117	67	50	50	0	0	*	*
22	*	*	0	0	33	0	0	0	*	*
23	*	*	0	0	0	0	117	117	*	*
24	*	*	<0	<0	0	67	67	67	*	*
25	0	0	0	<0	0	16	117	117	*	*
26	0	0	83	117	67	67	0	0	*	*
27	10	10	117	83	67	<0	83	83	*	*
28	0	0	67	0	0	234	117	117	*	*
29	0	0			100	0	100	100	*	*
30	0	0			33	33	335	335	*	*
31	0	<0			50	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

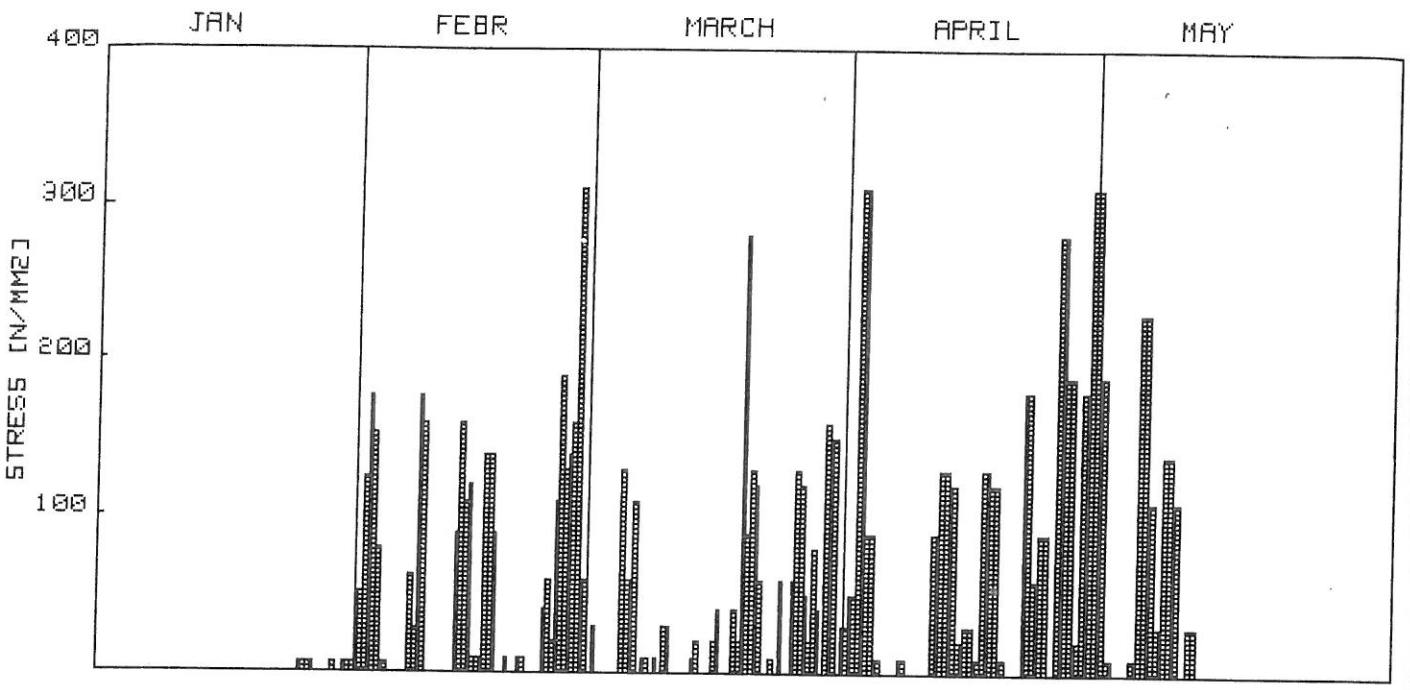


FN4

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	<0	8	20	0	0	0	220	220
2	*	*	32	72	10	0	30	30	310	310
3	*	*	185	121	0	0	180	180	<0	<0
4	*	*	40	<0	0	0	60	60	0	0
5	*	*	<0	<0	0	100	<0	<0	0	0
6	*	*	<0	0	50	40	<0	<0	0	0
7	*	*	0	<0	50	0	0	0	150	150
8	*	*	32	16	10	0	0	0	70	70
9	*	*	105	56	0	0	0	0	10	10
10	*	*	0	0	0	10	0	0	80	80
11	*	*	0	0	10	0	0	0	100	100
12	*	*	0	0	0	0	50	50	0	0
13	*	*	0	60	0	0	60	60	10	10
14	*	*	70	80	10	0	230	230	*	*
15	*	*	80	10	0	0	10	10	*	*
16	*	*	<0	0	0	10	20	20	*	*
17	*	*	80	70	20	0	10	10	*	*
18	*	*	70	0	0	0	70	70	*	*
19	*	*	0	10	20	10	110	110	*	*
20	*	*	<0	0	160	60	20	20	*	*
21	*	*	<0	<0	60	130	10	10	*	*
22	*	*	0	0	40	0	0	0	*	*
23	*	*	0	0	0	10	60	60	*	*
24	*	*	20	30	0	30	30	30	*	*
25	0	<0	10	50	0	10	70	70	*	*
26	<0	<0	60	90	40	110	0	0	*	*
27	8	<0	80	70	130	50	120	120	*	*
28	0	0	80	10	0	80	120	120	*	*
29	0	0			40	0	30	30	*	*
30	0	0			70	20	120	120	*	*
31	0	<0			100	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

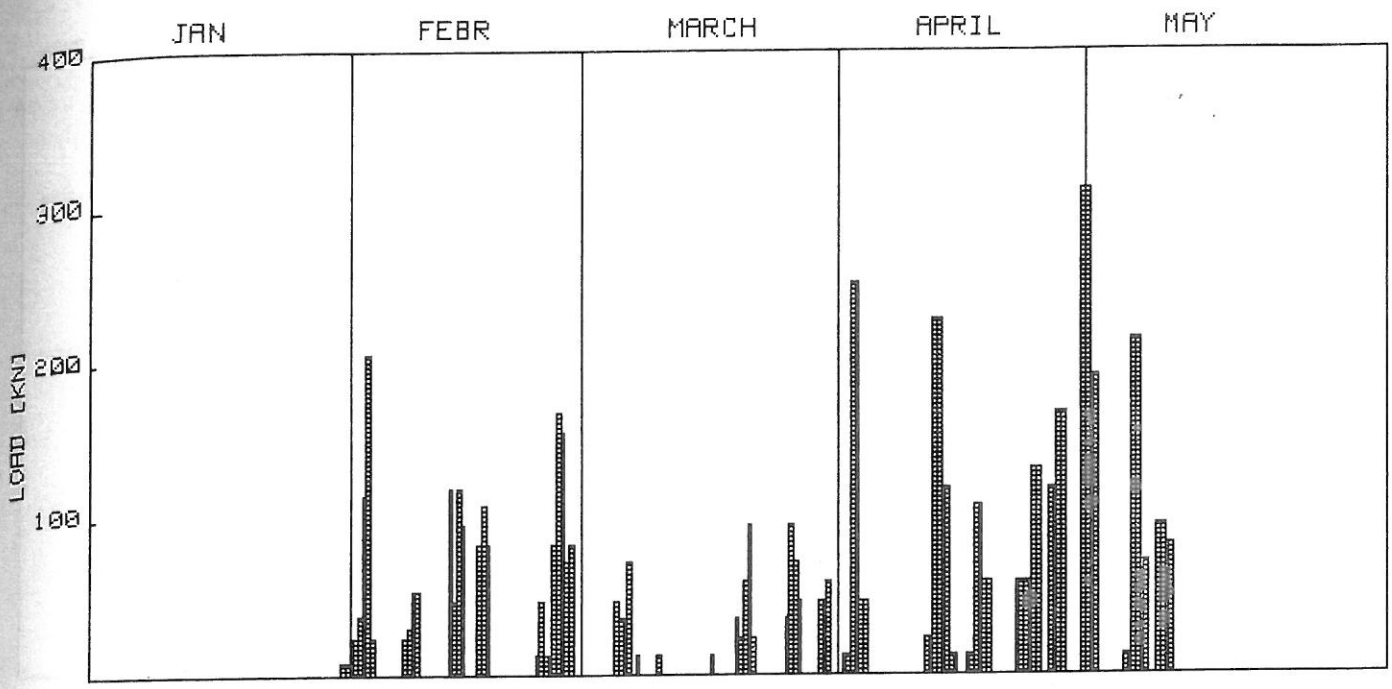


PL5

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	5	5	60	0	30	30	310	310
2	*	*	51	125	30	0	50	50	190	190
3	*	*	176	153	0	0	310	310	10	10
4	*	*	79	5	0	0	90	90	0	0
5	*	*	5	0	0	130	10	10	0	0
6	*	*	0	0	60	60	0	0	10	10
7	*	*	0	0	110	0	0	0	230	230
8	*	*	62	28	10	10	10	10	110	110
9	*	*	176	159	0	10	0	0	30	30
10	*	*	0	0	0	30	0	0	140	140
11	*	*	0	0	30	0	0	0	110	110
12	*	*	0	0	0	0	90	90	0	0
13	*	*	0	90	0	0	130	130	30	30
14	*	*	160	110	10	20	120	120	*	*
15	*	*	120	10	0	0	20	20	*	*
16	*	*	10	10	0	20	30	30	*	*
17	*	*	140	140	40	0	10	10	*	*
18	*	*	90	0	0	0	130	130	*	*
19	*	*	0	10	40	20	120	120	*	*
20	*	*	0	0	280	90	10	10	*	*
21	*	*	10	10	130	120	0	0	*	*
22	*	*	0	0	60	0	0	0	*	*
23	*	*	0	0	0	10	180	180	*	*
24	*	*	40	60	0	60	60	60	*	*
25	0	5	20	110	0	0	90	90	*	*
26	5	5	190	130	60	130	0	0	*	*
27	5	0	140	160	120	50	280	280	*	*
28	0	0	310	20	20	80	190	190	*	*
29	0	5			40	0	20	20	*	*
30	0	0			160	30	180	180	*	*
31	5	5			150	0				

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

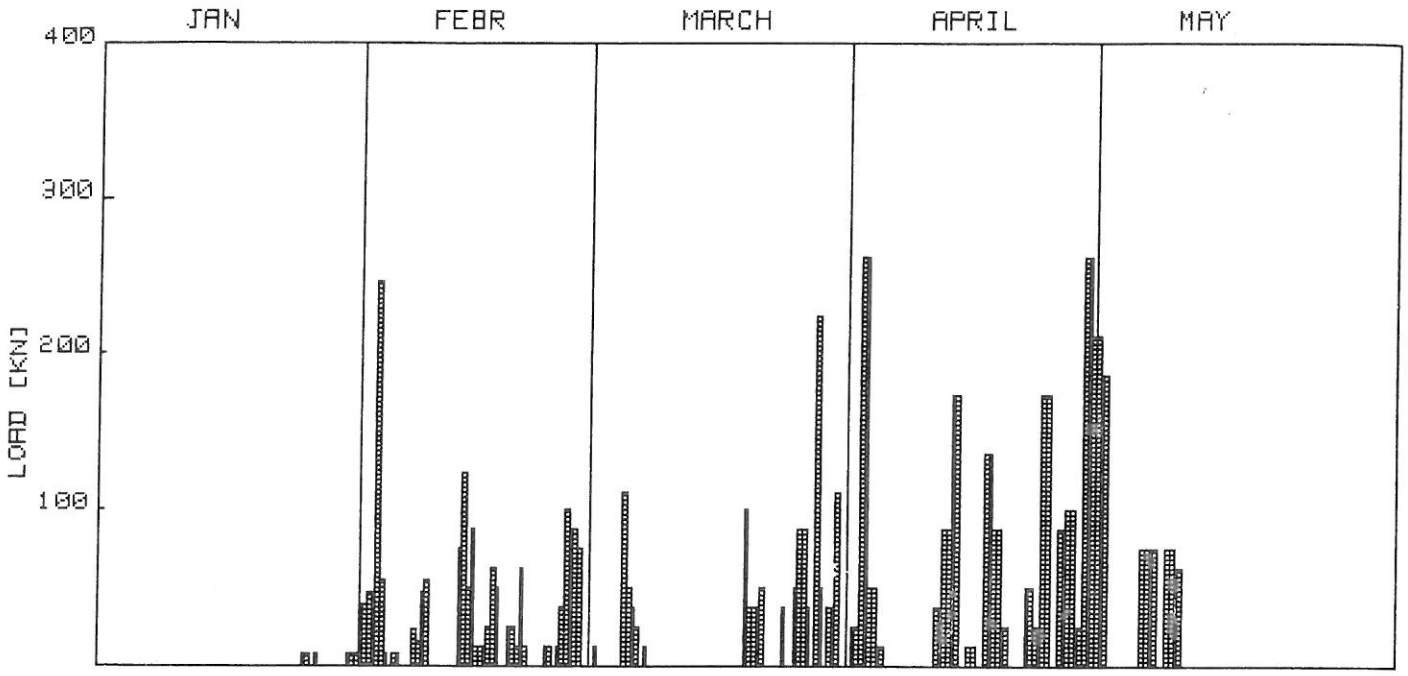


FFR6

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	7	0	0	0	0	0	310	310
2	*	*	22	38	0	0	11	11	191	191
3	*	*	114	205	0	0	251	251	0	0
4	*	*	22	<0	0	0	47	47	0	0
5	*	*	<0	<0	0	47	<0	<0	0	0
6	*	*	<0	0	35	35	0	0	11	11
7	*	*	0	0	71	0	0	0	215	215
8	*	*	22	30	11	0	0	0	71	71
9	*	*	53	53	0	0	0	0	0	0
10	*	*	0	0	0	11	0	0	95	95
11	*	*	0	0	0	0	0	0	83	83
12	*	*	0	0	0	0	23	23	0	0
13	*	*	0	119	0	0	227	227	0	0
14	*	*	47	119	0	0	119	119	*	*
15	*	*	95	<0	0	0	11	11	*	*
16	*	*	<0	<0	0	0	0	0	*	*
17	*	*	83	107	11	0	11	11	*	*
18	*	*	83	0	0	0	107	107	*	*
19	*	*	0	<0	0	0	59	59	*	*
20	*	*	<0	0	35	23	0	0	*	*
21	*	*	<0	<0	59	95	0	0	*	*
22	*	*	0	0	23	0	0	0	*	*
23	*	*	0	0	0	0	59	59	*	*
24	*	*	11	47	0	<0	59	59	*	*
25	0	<0	11	11	0	0	131	131	*	*
26	<0	0	83	167	35	95	0	0	*	*
27	0	0	155	71	71	47	119	119	*	*
28	0	0	83	0	0	<0	167	167	*	*
29	0	0			<0	0	<0	<0	*	*
30	0	0			47	35	<0	<0	*	*
31	0	7			59	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

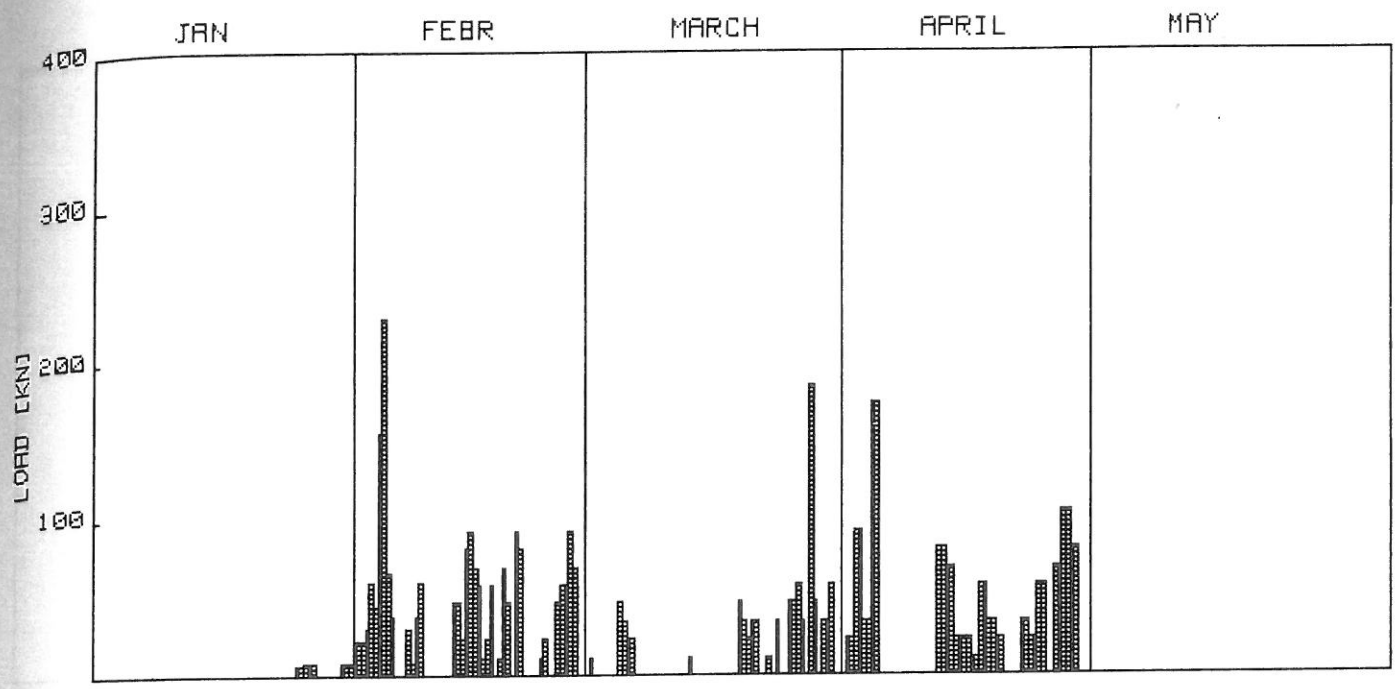


FFR?

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	7	7	0	0	0	0	211	211
2	*	*	38	47	12	0	24	24	186	186
3	*	*	47	246	0	0	261	261	0	0
4	*	*	55	7	0	0	49	49	0	0
5	*	*	<0	7	0	112	12	12	0	0
6	*	*	7	0	49	37	0	0	0	0
7	*	*	0	<0	24	0	0	0	74	74
8	*	*	23	15	12	0	0	0	74	74
9	*	*	47	55	0	0	<0	<0	<0	<0
10	*	*	0	0	0	0	0	0	74	74
11	*	*	0	0	0	0	<0	<0	62	62
12	*	*	0	0	0	0	37	37	<0	<0
13	*	*	0	74	0	0	87	87	<0	<0
14	*	*	124	49	0	0	174	174	*	*
15	*	*	87	12	0	0	0	0	*	*
16	*	*	12	0	0	<0	12	12	*	*
17	*	*	24	62	<0	<0	0	0	*	*
18	*	*	49	0	0	<0	137	137	*	*
19	*	*	0	24	<0	<0	87	87	*	*
20	*	*	24	12	99	37	24	24	*	*
21	*	*	62	12	37	37	0	0	*	*
22	*	*	0	0	49	0	0	0	*	*
23	*	*	0	0	0	0	49	49	*	*
24	*	*	12	12	0	37	24	24	*	*
25	0	7	0	12	0	0	174	174	*	*
26	7	0	37	99	49	87	<0	<0	*	*
27	7	0	62	87	87	37	87	87	*	*
28	0	0	74	0	<0	224	99	99	*	*
29	0	0			49	<0	24	24	*	*
30	0	0			37	24	261	261	*	*
31	7	7			112	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

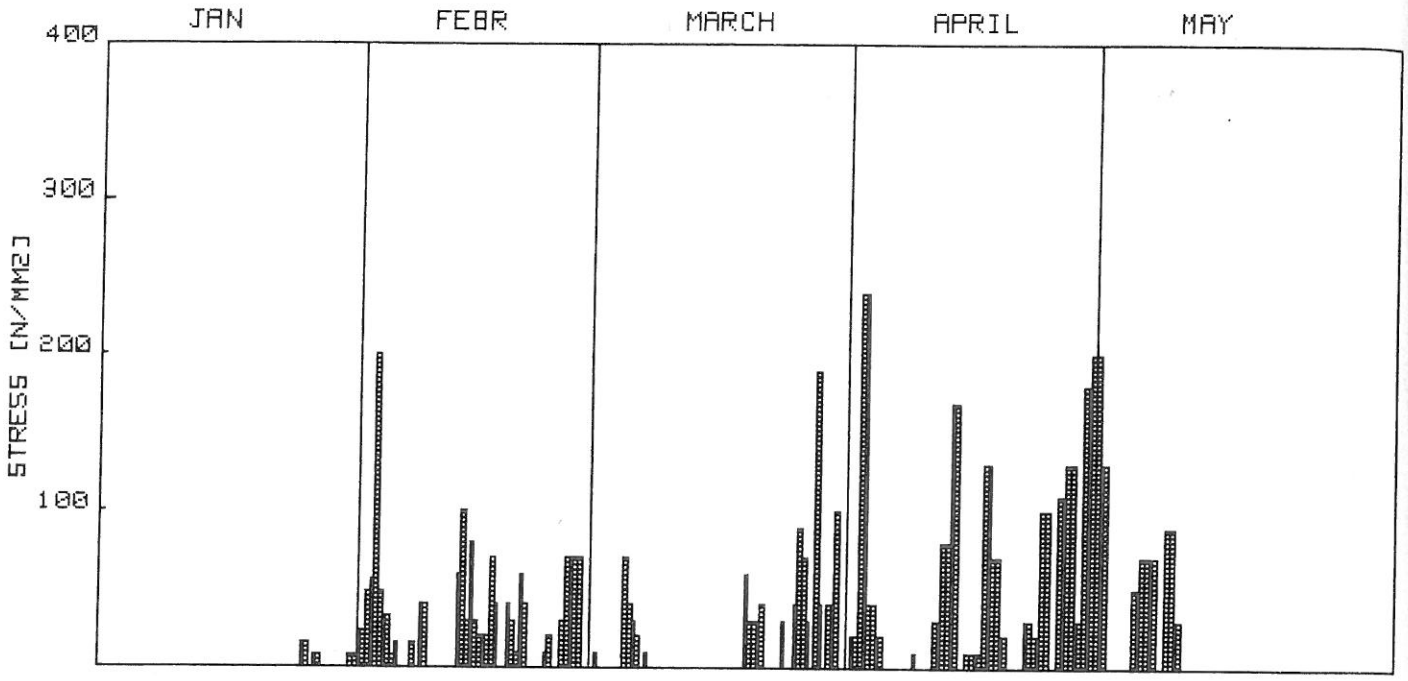


FEBR

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	7	7	0	0	0	0	0	0
2	*	*	22	22	11	0	23	23	0	0
3	*	*	29	59	0	0	92	92	0	0
4	*	*	44	155	0	0	34	34	0	0
5	*	*	229	66	0	46	174	174	0	0
6	*	*	37	0	34	23	0	0	0	0
7	*	*	0	<0	23	0	0	0	0	0
8	*	*	29	7	0	0	0	0	0	0
9	*	*	37	59	0	0	<0	<0	0	0
10	*	*	0	0	0	0	0	0	0	0
11	*	*	0	0	0	0	<0	<0	0	0
12	*	*	0	0	0	0	<0	<0	0	0
13	*	*	0	46	0	0	81	81	0	0
14	*	*	46	23	11	0	69	69	*	*
15	*	*	81	92	0	0	23	23	*	*
16	*	*	69	58	0	<0	23	23	*	*
17	*	*	11	23	<0	<0	11	11	*	*
18	*	*	58	0	0	0	58	58	*	*
19	*	*	11	69	<0	<0	34	34	*	*
20	*	*	46	0	46	34	23	23	*	*
21	*	*	92	81	23	34	0	0	*	*
22	*	*	0	0	34	0	0	0	*	*
23	*	*	0	0	0	11	34	34	*	*
24	*	*	11	23	0	34	23	23	*	*
25	0	7	0	0	0	0	58	58	*	*
26	7	7	46	58	46	46	0	0	*	*
27	7	0	34	92	58	34	69	69	*	*
28	0	0	69	0	<0	185	104	104	*	*
29	0	0			46	<0	81	81	*	*
30	0	0			34	11	0	0	*	*
31	7	7			58	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

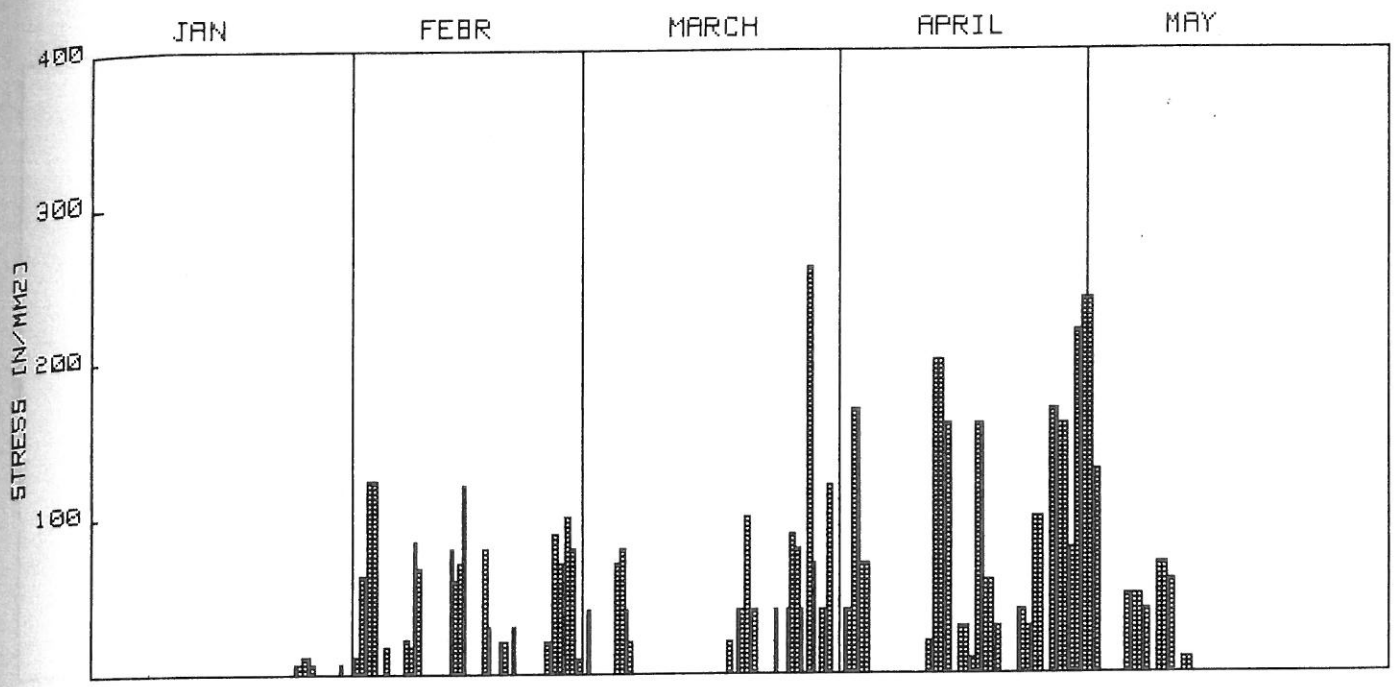


FN9

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	8	8	0	0	0	0	200	200
2	*	*	24	48	10	0	20	20	130	130
3	*	*	56	201	0	0	240	240	0	0
4	*	*	48	8	0	0	40	40	0	0
5	*	*	32	8	0	70	20	20	0	0
6	*	*	16	0	40	30	0	0	50	50
7	*	*	0	<0	20	0	0	0	70	70
8	*	*	16	<0	10	0	0	0	70	70
9	*	*	40	40	0	<0	<0	10	<0	<0
10	*	*	0	0	0	0	0	0	90	90
11	*	*	0	0	0	0	<0	<0	30	30
12	*	*	0	0	0	0	30	30	<0	<0
13	*	*	0	60	0	0	80	80	<0	<0
14	*	*	100	30	0	0	170	170	*	*
15	*	*	80	30	0	0	0	0	*	*
16	*	*	20	10	0	<0	10	10	*	*
17	*	*	20	70	<0	<0	10	10	*	*
18	*	*	40	0	0	<0	130	130	*	*
19	*	*	0	40	<0	<0	70	70	*	*
20	*	*	30	10	60	30	20	20	*	*
21	*	*	60	40	30	20	0	0	*	*
22	*	*	0	0	40	0	0	0	*	*
23	*	*	0	0	0	<0	30	30	*	*
24	*	*	10	20	0	30	20	20	*	*
25	0	16	<0	<0	0	0	100	100	*	*
26	16	0	30	70	40	90	<0	<0	*	*
27	8	8	50	70	70	30	110	110	*	*
28	0	0	70	0	<0	190	130	130	*	*
29	0	0			40	<0	30	30	*	*
30	0	0			40	20	180	180	*	*
31	0	8			100	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

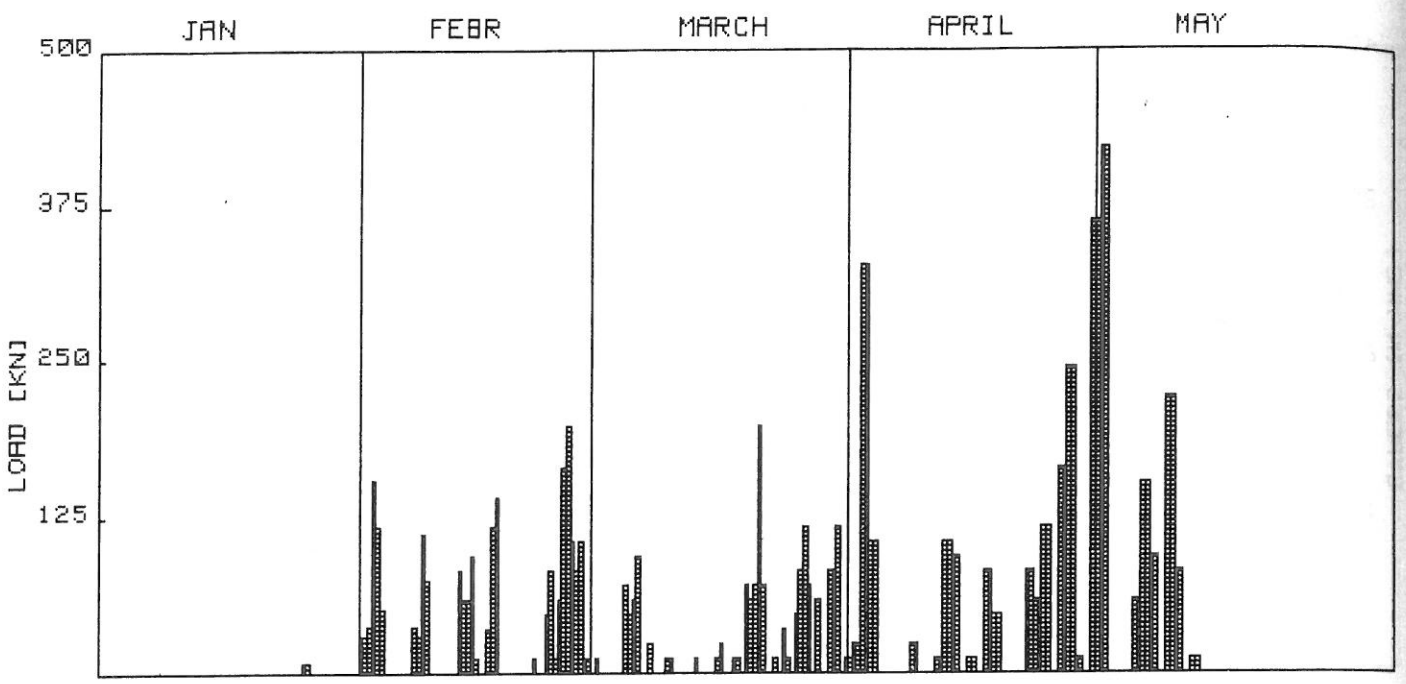


PL10

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	<0	11	10	0	0	0	240	240
2	*	*	11	62	40	0	40	40	130	130
3	*	*	50	124	0	0	170	170	<0	<0
4	*	*	124	<0	0	0	70	70	0	0
5	*	*	<0	16	0	70	<0	<0	0	0
6	*	*	<0	<0	80	40	<0	<0	50	50
7	*	*	0	<0	20	0	0	0	50	50
8	*	*	22	16	<0	0	0	0	40	40
9	*	*	84	67	0	0	0	0	0	0
10	*	*	0	0	0	0	0	0	70	70
11	*	*	0	0	0	0	0	0	60	60
12	*	*	0	0	0	0	20	20	<0	<0
13	*	*	0	80	0	0	200	200	10	10
14	*	*	60	70	0	<0	160	160	*	*
15	*	*	120	<0	<0	<0	0	0	*	*
16	*	*	<0	<0	0	<0	30	30	*	*
17	*	*	<0	80	<0	<0	10	10	*	*
18	*	*	30	0	<0	0	160	160	*	*
19	*	*	0	20	20	<0	60	60	*	*
20	*	*	20	0	40	40	30	30	*	*
21	*	*	30	<0	100	40	0	0	*	*
22	*	*	0	0	40	0	0	0	*	*
23	*	*	0	0	0	0	40	40	*	*
24	*	*	<0	<0	0	40	30	30	*	*
25	0	5	20	<0	0	0	100	100	*	*
26	5	11	90	70	40	90	<0	<0	*	*
27	11	5	50	100	80	40	170	170	*	*
28	0	0	80	0	0	260	160	160	*	*
29	0	<0			70	<0	80	80	*	*
30	0	0			40	30	220	220	*	*
31	5	<0			120	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

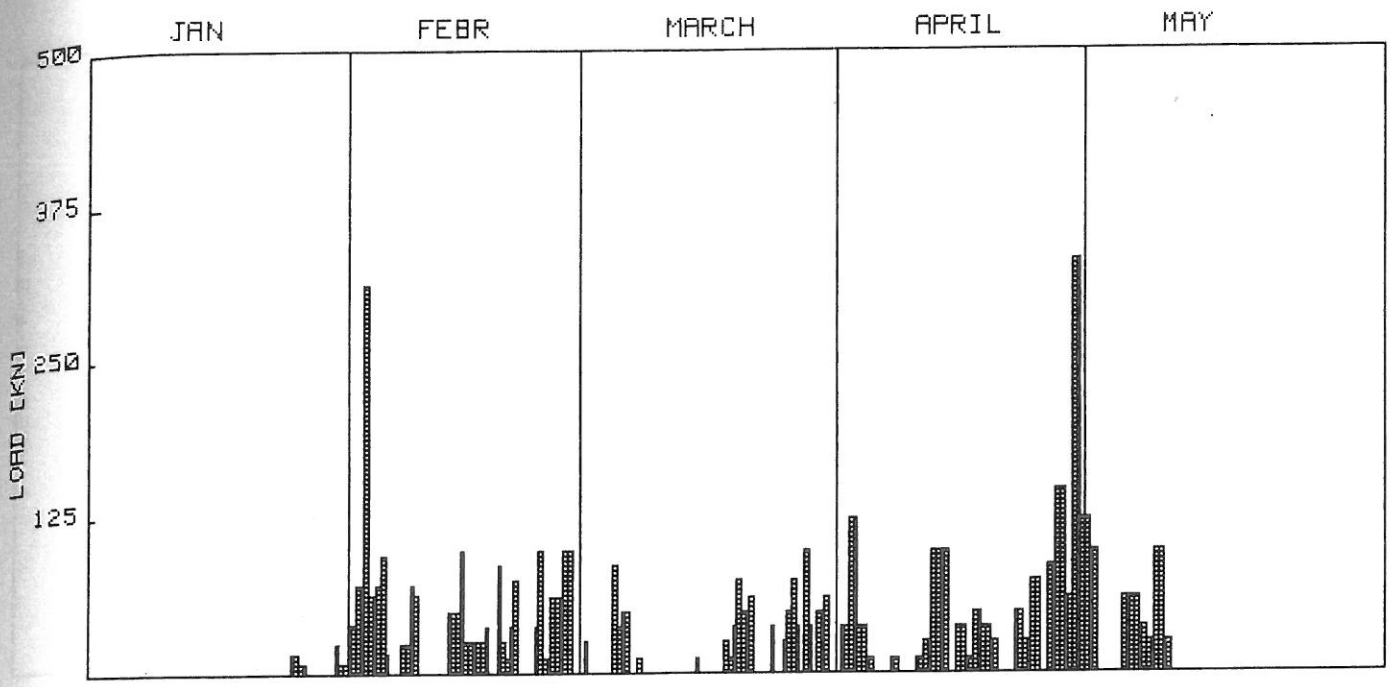


FFR11

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	0	0	11	0	11	11	362	362
2	*	*	29	37	11	0	23	23	421	421
3	*	*	155	118	0	0	327	327	<0	<0
4	*	*	51	<0	0	0	105	105	0	0
5	*	*	<0	<0	0	70	0	0	0	0
6	*	*	0	0	46	58	0	0	58	58
7	*	*	0	<0	93	0	0	0	152	152
8	*	*	37	29	0	23	0	0	93	93
9	*	*	111	74	0	0	23	23	<0	<0
10	*	*	0	0	0	11	0	0	222	222
11	*	*	0	0	11	0	0	0	81	81
12	*	*	0	0	0	0	11	11	0	0
13	*	*	<0	81	0	0	105	105	11	11
14	*	*	58	58	11	0	93	93	*	*
15	*	*	93	11	0	0	<0	<0	*	*
16	*	*	0	0	0	11	11	11	*	*
17	*	*	35	117	23	0	0	0	*	*
18	*	*	140	0	0	11	81	81	*	*
19	*	*	0	<0	11	0	46	46	*	*
20	*	*	0	0	70	58	<0	<0	*	*
21	*	*	<0	<0	70	198	0	0	*	*
22	*	*	0	11	70	0	0	0	*	*
23	*	*	0	0	0	11	81	81	*	*
24	*	*	46	81	0	35	58	58	*	*
25	0	7	11	58	11	0	117	117	*	*
26	7	0	163	198	46	81	0	0	*	*
27	<0	0	105	81	117	70	163	163	*	*
28	0	0	105	11	0	58	245	245	*	*
29	0	0			<0	0	11	11	*	*
30	0	0			81	35	<0	<0	*	*
31	<0	0			117	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

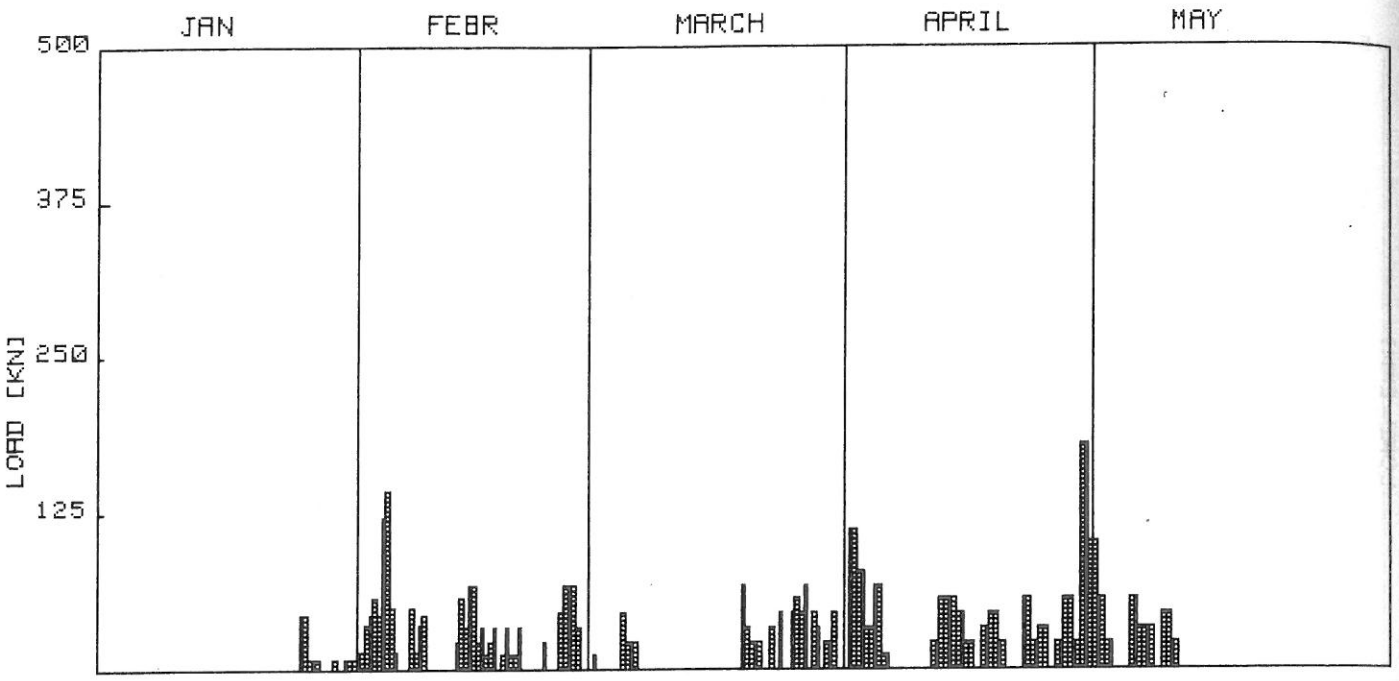


FFR12

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	7	15	0	0	0	0	122	122
2	*	*	38	69	24	0	36	36	98	98
3	*	*	<0	310	0	0	122	122	<0	<0
4	*	*	62	46	0	0	36	36	0	0
5	*	*	69	93	0	85	12	12	0	0
6	*	*	15	0	36	49	0	0	61	61
7	*	*	0	<0	49	0	0	0	61	61
8	*	*	23	23	0	12	12	12	36	36
9	*	*	69	62	0	0	0	0	24	24
10	*	*	0	0	0	0	0	0	98	98
11	*	*	0	0	0	0	12	12	24	24
12	*	*	0	0	0	0	24	24	<0	<0
13	*	*	0	49	0	0	98	98	<0	<0
14	*	*	49	49	0	0	98	98	*	*
15	*	*	98	24	0	12	<0	<0	*	*
16	*	*	24	0	0	<0	36	36	*	*
17	*	*	24	24	<0	0	12	12	*	*
18	*	*	36	0	0	0	49	49	*	*
19	*	*	0	85	24	12	36	36	*	*
20	*	*	24	12	36	73	24	24	*	*
21	*	*	36	73	49	49	0	0	*	*
22	*	*	0	0	61	0	0	0	*	*
23	*	*	0	0	0	<0	49	49	*	*
24	*	*	36	98	0	36	24	24	*	*
25	0	15	12	0	0	0	73	73	*	*
26	15	7	61	61	24	49	0	0	*	*
27	7	0	61	98	73	36	85	85	*	*
28	0	0	98	0	0	98	147	147	*	*
29	0	0			36	<0	61	61	*	*
30	0	0			49	24	331	331	*	*
31	23	7			61	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

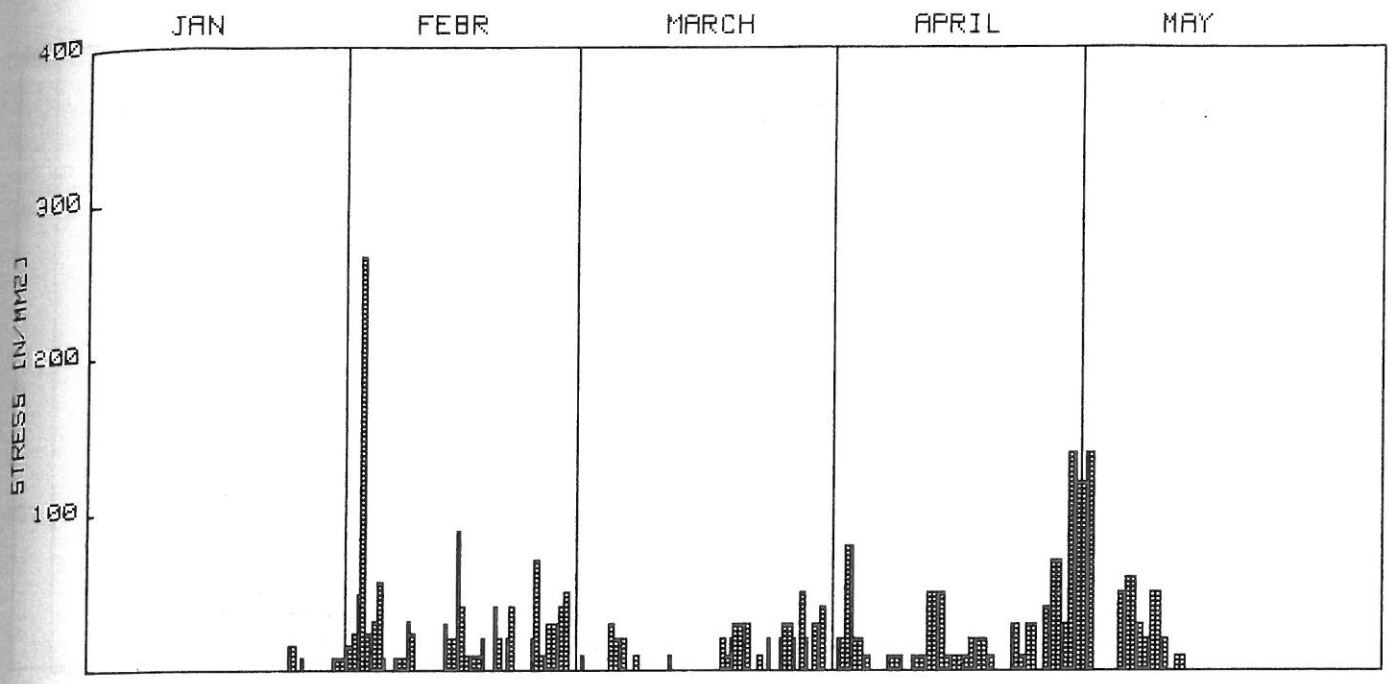


FFR13

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	7	7	0	0	0	0	101	101
2	*	*	14	35	11	0	112	112	56	56
3	*	*	42	57	0	0	78	78	22	22
4	*	*	42	121	0	0	33	33	0	0
5	*	*	142	49	0	45	67	67	0	0
6	*	*	14	0	22	22	11	11	56	56
7	*	*	0	<0	22	0	0	0	33	33
8	*	*	49	14	0	0	<0	<0	33	33
9	*	*	35	42	0	0	0	0	<0	<0
10	*	*	0	0	0	0	0	0	45	45
11	*	*	0	0	0	0	<0	<0	22	22
12	*	*	0	0	0	0	22	22	<0	<0
13	*	*	0	22	0	0	56	56	<0	<0
14	*	*	56	33	0	0	56	56	*	*
15	*	*	67	67	0	<0	45	45	*	*
16	*	*	22	33	0	0	22	22	*	*
17	*	*	11	22	0	0	0	0	*	*
18	*	*	33	0	0	0	33	33	*	*
19	*	*	11	33	<0	<0	45	45	*	*
20	*	*	11	11	67	33	22	22	*	*
21	*	*	33	<0	22	22	0	0	*	*
22	*	*	0	0	22	0	0	0	*	*
23	*	*	0	0	0	33	56	56	*	*
24	*	*	22	<0	0	45	22	22	*	*
25	0	42	0	0	0	0	33	33	*	*
26	42	7	45	67	45	56	0	0	*	*
27	7	7	67	67	45	67	22	22	*	*
28	0	0	33	0	0	45	56	56	*	*
29	0	7			33	0	22	22	*	*
30	0	0			22	11	180	180	*	*
31	7	7			45	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

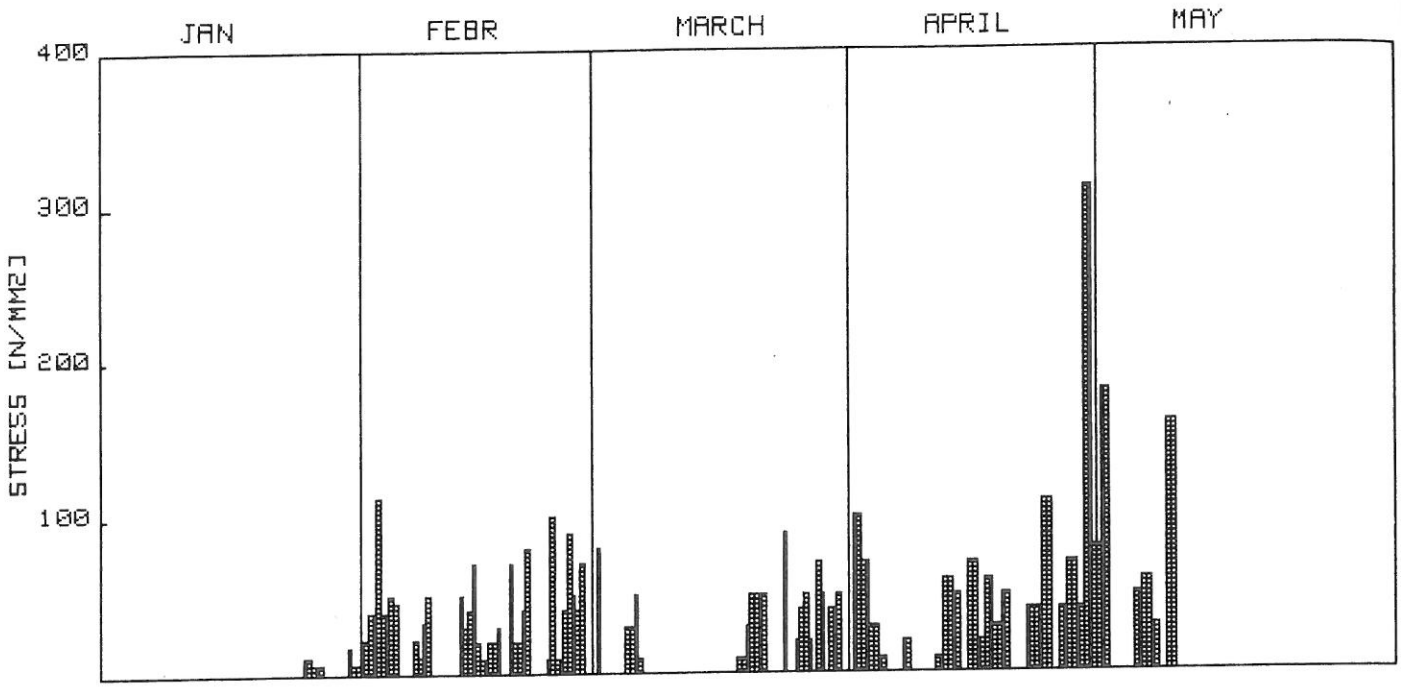


FN14

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	*	*	8	8	0	0	0	0	120	120
2	*	*	16	24	10	0	20	20	140	140
3	*	*	48	264	0	0	80	80	<0	<0
4	*	*	24	24	0	0	20	20	0	0
5	*	*	32	56	0	30	10	10	0	0
6	*	*	8	0	20	20	0	0	50	50
7	*	*	0	8	20	0	0	0	60	60
8	*	*	8	8	0	10	10	10	30	30
9	*	*	32	24	0	0	10	10	20	20
10	*	*	0	0	0	0	0	0	50	50
11	*	*	0	0	0	0	10	10	20	20
12	*	*	0	0	0	10	10	10	<0	<0
13	*	*	<0	30	0	0	50	50	10	10
14	*	*	20	20	0	0	50	50	*	*
15	*	*	90	40	<0	<0	10	10	*	*
16	*	*	10	10	0	<0	10	10	*	*
17	*	*	10	10	<0	<0	10	10	*	*
18	*	*	20	0	0	<0	20	20	*	*
19	*	*	0	40	20	10	20	20	*	*
20	*	*	20	0	20	30	10	10	*	*
21	*	*	20	40	30	30	0	0	*	*
22	*	*	0	0	30	0	0	0	*	*
23	*	*	0	0	0	10	30	30	*	*
24	*	*	20	70	0	20	10	10	*	*
25	0	16	10	10	0	0	30	30	*	*
26	16	<0	30	30	20	30	0	0	*	*
27	8	<0	30	40	30	20	40	40	*	*
28	0	0	50	0	0	50	70	70	*	*
29	0	0			20	<0	30	30	*	*
30	0	0			30	10	140	140	*	*
31	8	8			40	0			*	*

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

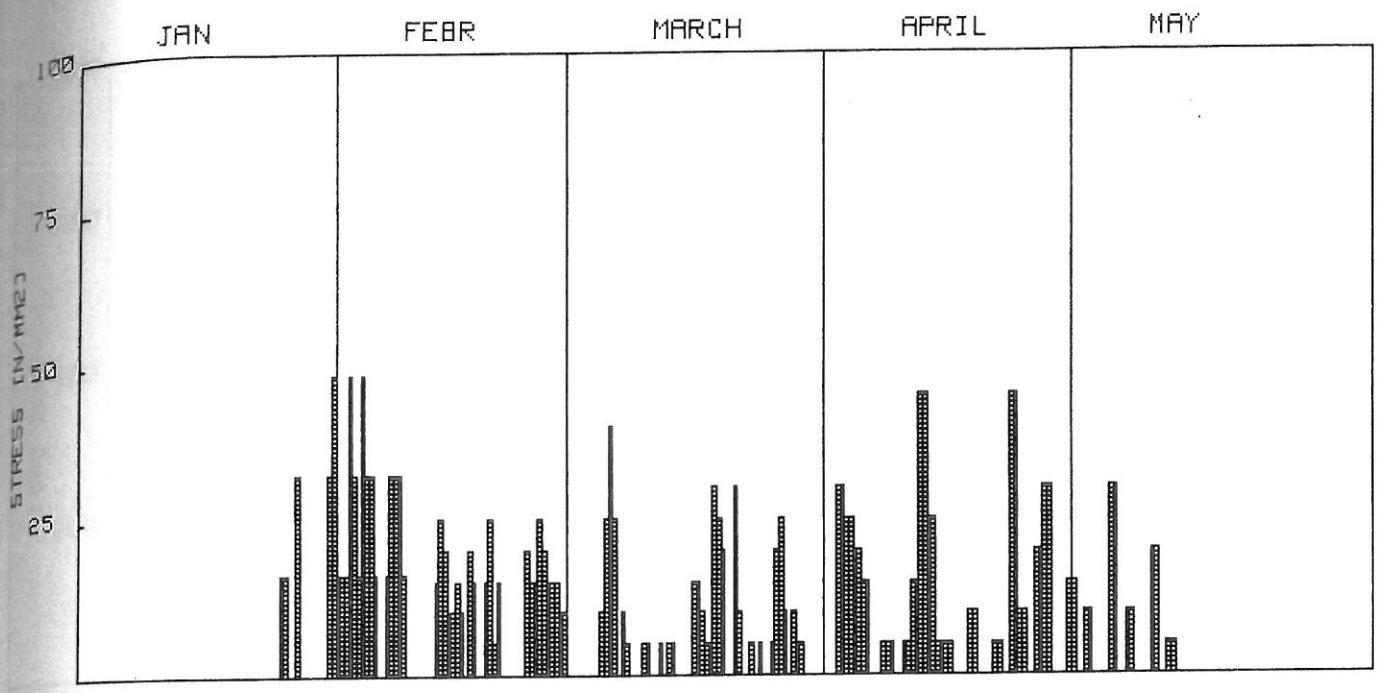


PL15

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	*	*	5	11	0	0	0	0	80	80
2	*	*	22	39	80	0	100	100	180	180
3	*	*	39	112	0	0	70	70	0	0
4	*	*	38	22	0	0	30	30	0	0
5	*	*	50	44	0	30	10	10	0	0
6	*	*	<0	0	30	50	<0	<0	50	50
7	*	*	0	0	10	0	0	0	60	60
8	*	*	22	11	0	0	20	20	30	30
9	*	*	33	50	0	0	0	0	0	0
10	*	*	0	0	0	0	0	0	160	160
11	*	*	0	0	0	0	10	10	<0	<0
12	*	*	0	0	0	0	60	60	0	0
13	*	*	0	50	<0	0	50	50	0	0
14	*	*	30	40	0	0	0	0	*	*
15	*	*	70	20	0	0	70	70	*	*
16	*	*	10	0	0	0	20	20	*	*
17	*	*	200	20	<0	0	60	60	*	*
18	*	*	30	0	0	0	30	30	*	*
19	*	*	0	70	10	10	50	50	*	*
20	*	*	20	20	30	50	0	0	*	*
21	*	*	40	80	50	30	0	0	*	*
22	*	*	0	0	50	0	40	40	*	*
23	*	*	0	0	0	0	40	40	*	*
24	*	*	10	100	0	90	110	110	*	*
25	0	11	10	10	0	0	0	0	*	*
26	11	5	40	90	20	40	40	40	*	*
27	5	5	50	40	50	20	70	70	*	*
28	0	0	70	0	0	70	40	40	*	*
29	0	0			50	0	310	310	*	*
30	0	0			40	30				
31	16	5			50	0				

* NOT MEASURED

KEMIRA 1985 MEASURED 12-HOUR MAXIMA

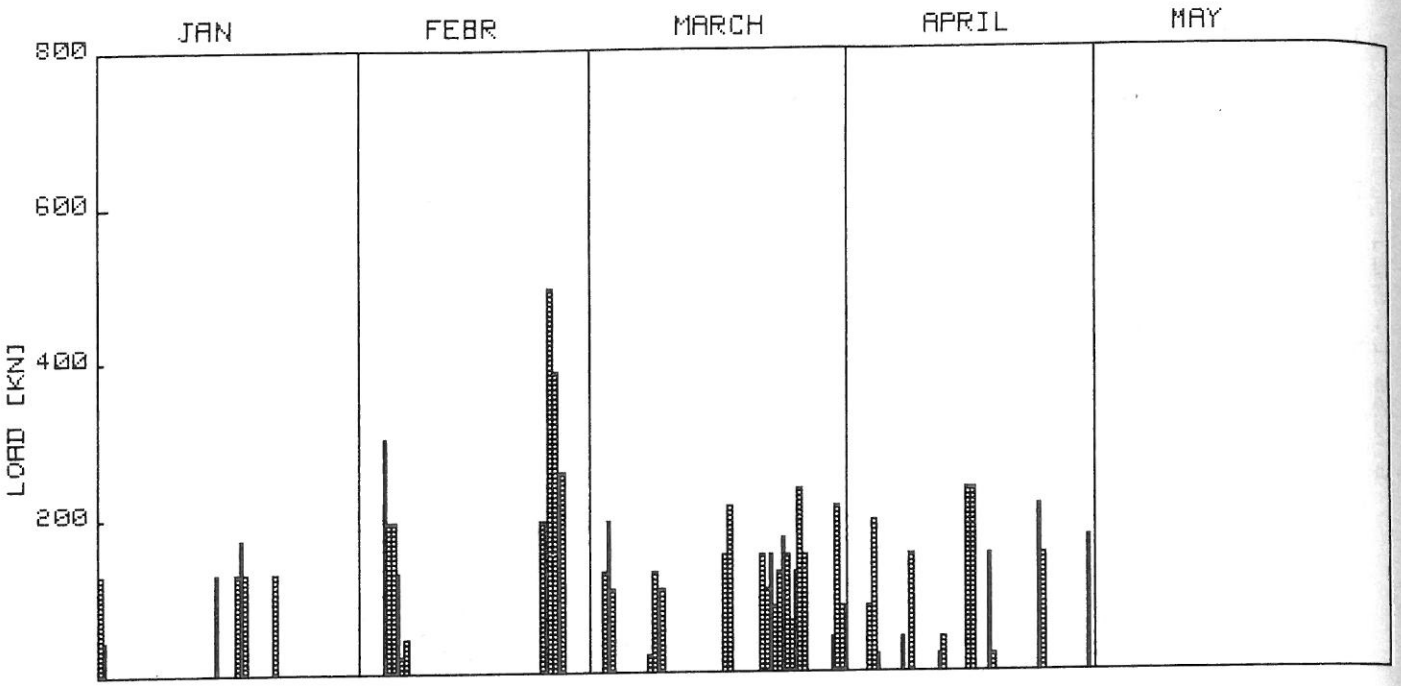


HB16 (DYNAMIC)

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	*	*	48	16	10	0	0	0	15	15
2	*	*	16	16	0	0	<0	<0	<0	<0
3	*	*	48	32	0	0	30	30	10	10
4	*	*	16	48	0	0	25	25	0	0
5	*	*	32	32	0	10	20	20	0	0
6	*	*	16	<0	25	40	15	15	30	30
7	*	*	0	16	25	0	<0	<0	<0	<0
8	*	*	32	32	10	5	<0	5	10	10
9	*	*	32	16	<0	<0	5	5	0	0
10	*	*	0	0	<0	5	0	0	<0	<0
11	*	*	0	0	5	0	5	5	20	20
12	*	*	0	0	<0	5	15	15	<0	<0
13	*	*	0	15	0	5	45	45	5	5
14	*	*	25	20	5	<0	25	25	*	*
15	*	*	0	10	<0	<0	5	5	*	*
16	*	*	15	10	0	15	5	5	*	*
17	*	*	<0	20	15	10	<0	<0	*	*
18	*	*	15	0	5	5	<0	<0	*	*
19	*	*	0	15	30	25	10	10	*	*
20	*	*	25	5	20	<0	<0	<0	*	*
21	*	*	15	<0	<0	30	0	0	*	*
22	*	*	0	0	10	0	5	5	*	*
23	*	*	0	0	0	5	<0	<0	*	*
24	*	*	<0	20	0	5	45	45	*	*
25	0	16	15	15	0	0	10	10	*	*
26	16	<0	25	20	5	20	0	0	*	*
27	<0	32	<0	15	25	10	20	20	*	*
28	0	0	15	5	0	10	30	30	*	*
29	0	0			<0	5	<0	<0	*	*
30	0	0			<0	<0	<0	<0	*	*
31	0	32			<0	0			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

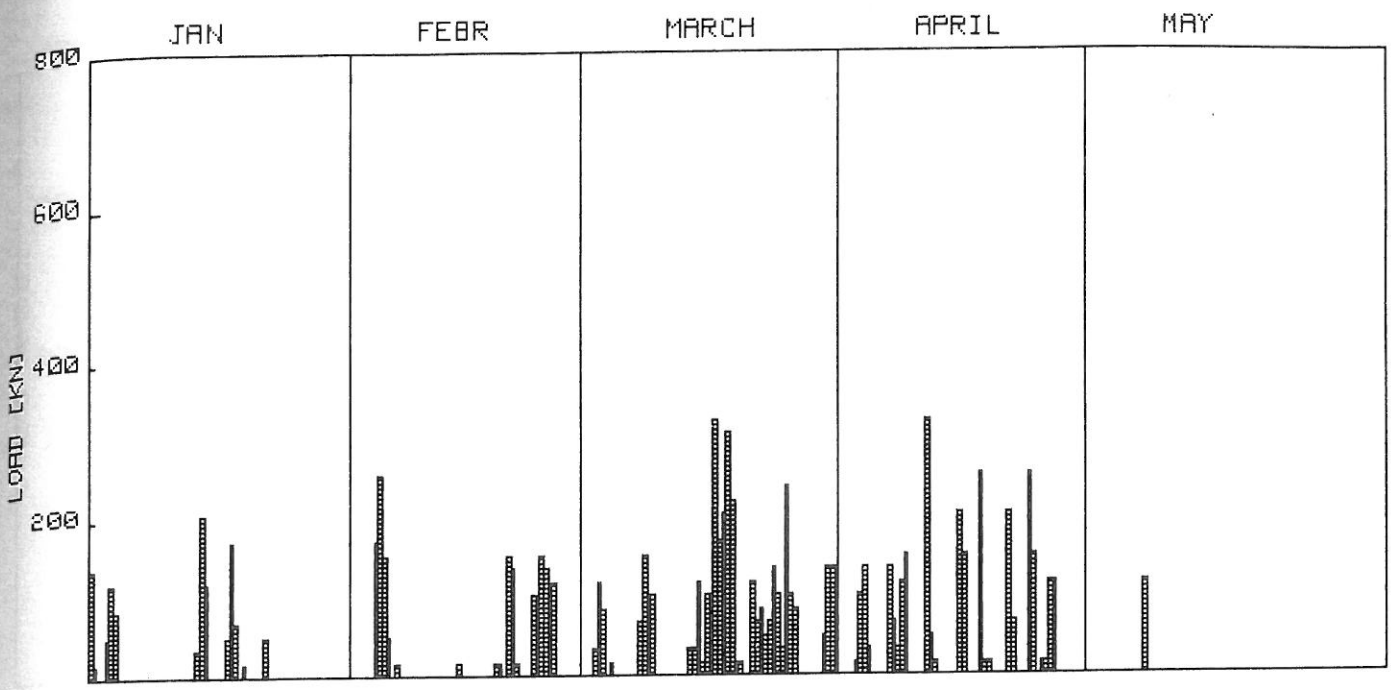


FFR1

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	128	42	*	*	*	*	21	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	<0	<0	0	0	128	192	0	0	0	0
4	<0	0	0	300	107	0	85	192	0	0
5	*	*	192	192	<0	<0	21	0	0	0
6	*	*	128	21	<0	0	0	0	0	0
7	*	*	42	0	0	0	0	<0	0	0
8	0	0	0	0	0	21	42	<0	0	<0
9	0	0	0	0	128	0	150	<0	*	*
10	0	0	0	0	107	0	0	0	*	*
11	0	0	0	0	0	0	<0	21	*	*
12	0	0	0	0	0	0	42	0	*	*
13	0	0	0	0	0	<0	0	0	*	*
14	<0	<0	0	0	0	<0	0	0	*	*
15	128	0	<0	0	0	<0	235	235	*	*
16	0	0	0	0	0	150	0	0	*	*
17	0	128	0	0	<214	<0	0	150	*	*
18	171	128	0	0	<0	<0	21	0	*	*
19	0	<0	0	0	0	0	0	0	*	*
20	0	0	0	<0	0	0	0	0	*	*
21	0	0	<0	<0	150	107	<0	<0	*	*
22	128	0	<0	0	150	85	0	0	*	*
23	*	*	0	192	128	171	0	214	*	*
24	*	*	171	493	150	64	150	0	*	*
25	*	*	385	0	128	235	<0	0	*	*
26	*	*	257	*	150	0	<0	<0	*	*
27	*	*	**	**	0	0	<0	0	*	*
28	*	*	*	*	0	0	0	0	*	*
29	*	*			0	42	<0	171	*	*
30	*	*			214	85				
31	*	*								

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

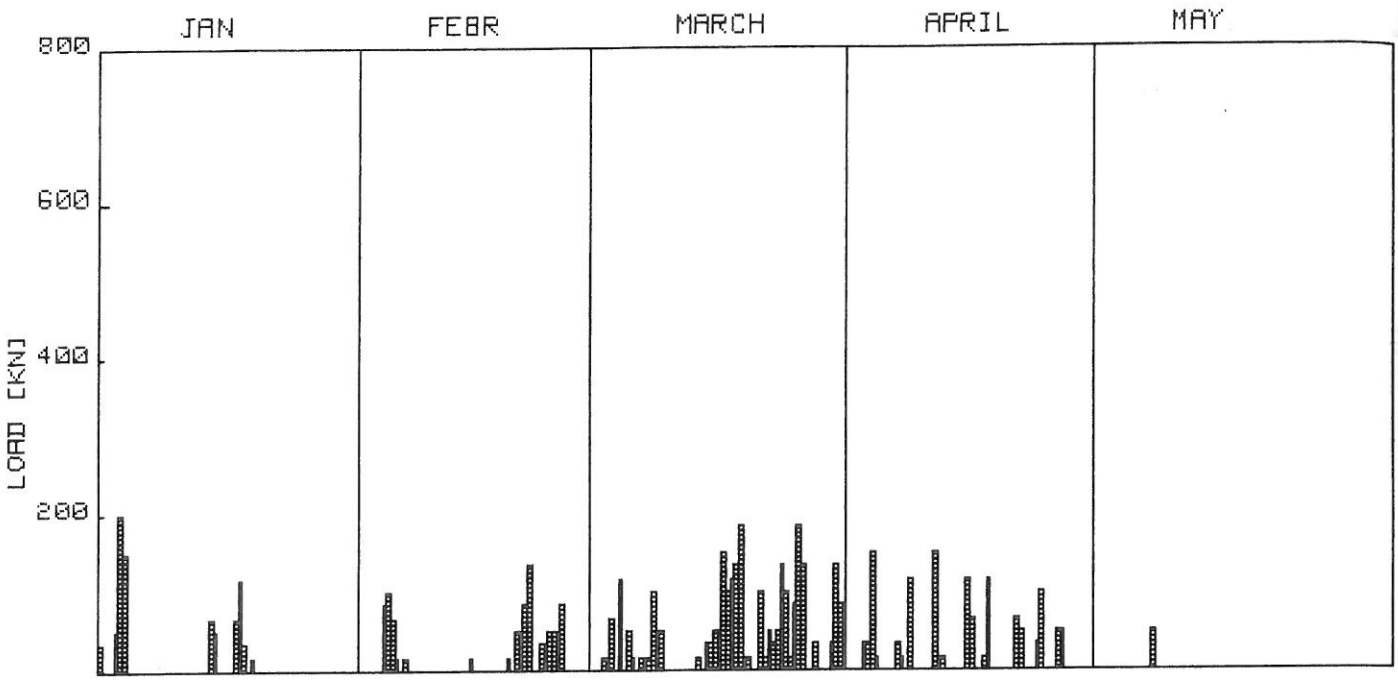


FFR2

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	137	17	*	*	*	*	17	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	51	120	0	0	34	120	0	17	0	0
4	86	0	0	172	86	0	103	137	0	0
5	*	*	258	154	17	0	34	0	0	0
6	*	*	51	0	0	0	<0	0	0	0
7	*	*	17	0	0	0	0	137	0	0
8	0	0	0	0	0	68	68	34	0	120
9	0	0	0	0	154	0	120	154	*	*
10	0	0	0	0	103	0	0	0	*	*
11	0	0	0	0	0	0	0	0	*	*
12	0	0	0	0	0	0	326	51	*	*
13	0	0	0	0	0	0	17	0	*	*
14	34	206	0	17	0	34	0	0	*	*
15	120	0	<0	0	34	120	0	0	*	*
16	0	0	0	0	17	103	206	154	*	*
17	0	51	0	0	0	326	0	0	*	*
18	172	68	0	0	172	206	0	258	*	*
19	0	17	17	17	309	223	17	17	*	*
20	0	0	0	154	0	17	0	0	*	*
21	0	0	137	17	0	0	0	0	*	*
22	51	0	<0	0	120	68	206	68	*	*
23	*	*	0	103	86	51	0	0	*	*
24	*	*	103	154	68	137	0	258	*	*
25	*	*	137	0	103	34	154	0	*	*
26	*	*	120	*	240	103	17	17	*	*
27	*	*	*	*	86	0	120	120	*	*
28	*	*	*	*	0	0	0	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			0	51	0	0	*	*
31	*	*			137	137				

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

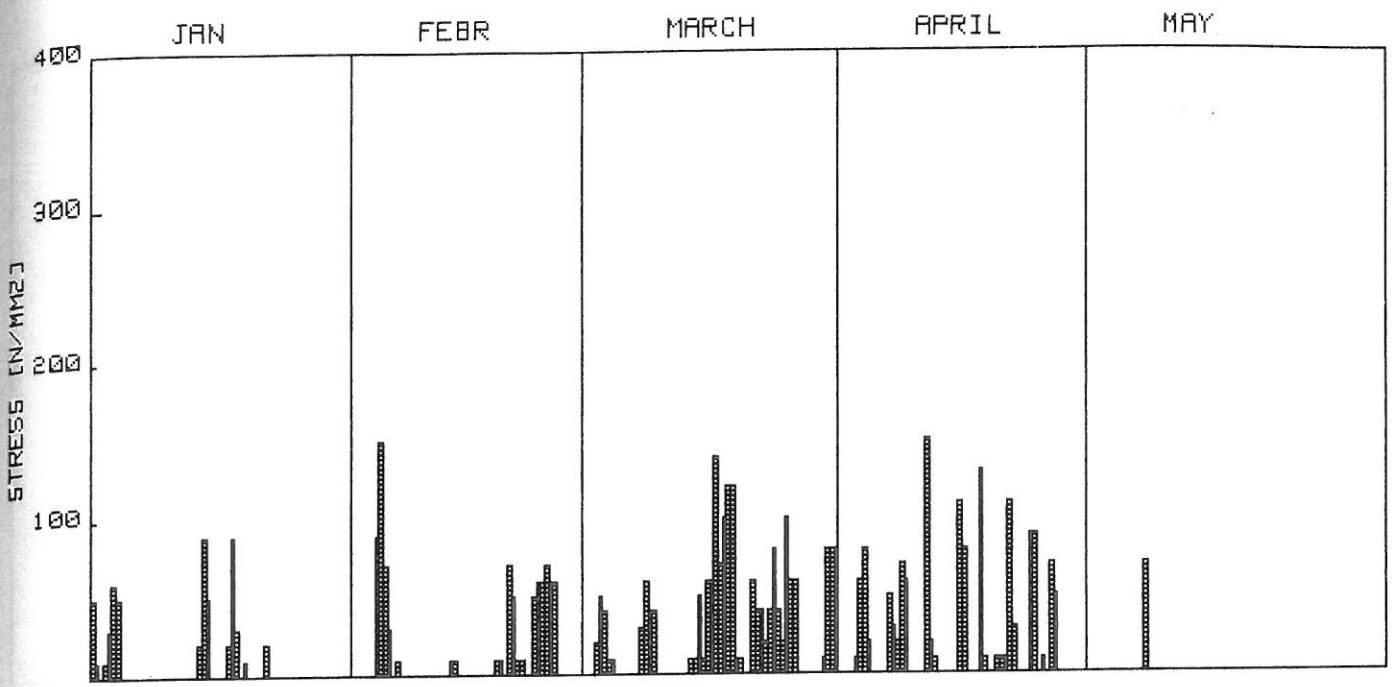


FFR3

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	33	0	*	*	*	*	16	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	50	201	0	0	16	16	0	33	0	0
4	151	0	0	83	67	0	33	151	0	0
5	*	*	100	67	117	0	16	0	0	0
6	*	*	16	0	50	16	<0	0	0	0
7	*	*	16	0	0	16	0	33	0	0
8	0	0	0	0	0	16	16	0	0	50
9	0	0	0	0	100	0	117	<0	*	*
10	0	0	0	0	50	0	0	0	*	*
11	0	0	0	0	0	0	0	0	*	*
12	0	0	0	0	0	0	151	16	*	*
13	0	0	0	0	0	0	16	0	*	*
14	<0	67	0	<0	0	16	0	0	*	*
15	50	0	16	0	0	33	0	0	*	*
16	0	0	0	0	33	50	117	67	*	*
17	0	67	0	0	0	151	0	0	*	*
18	117	33	0	0	100	117	16	117	*	*
19	0	16	<0	16	134	184	0	0	*	*
20	0	0	<0	50	0	16	0	0	*	*
21	0	0	33	83	0	0	<0	<0	*	*
22	<0	0	134	0	100	16	67	50	*	*
23	*	*	<0	33	50	33	0	0	*	*
24	*	*	33	50	50	134	0	33	*	*
25	*	*	50	0	100	16	100	0	*	*
26	*	*	83	*	83	184	<0	0	*	*
27	*	*	**	***	134	0	50	50	*	*
28	*	*	*	*	0	33	0	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			0	33	0	0	*	*
31	*	*			134	83			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

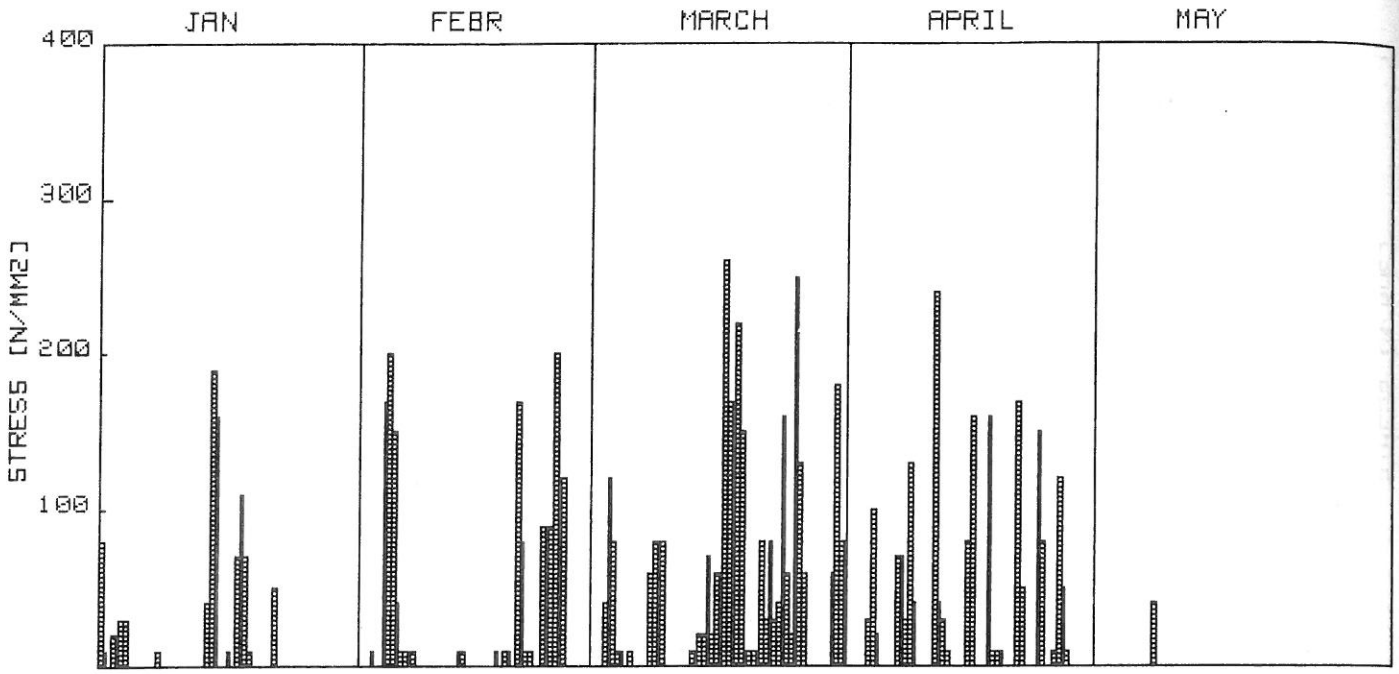


FN4

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	50	10	*	*	*	*	10	0	0	0
2	0	10	*	*	*	*	0	0	0	0
3	30	60	0	0	20	50	0	10	0	0
4	50	0	0	90	40	10	60	80	0	0
5	*	*	150	70	10	<0	20	0	0	0
6	*	*	30	0	<0	<0	<0	0	0	0
7	*	*	10	<0	0	0	0	50	0	0
8	<0	0	<0	0	0	30	30	20	0	70
9	0	0	0	0	60	0	70	60	*	*
10	0	0	0	0	40	0	0	0	*	*
11	0	0	0	0	0	0	0	0	*	*
12	0	0	0	0	0	0	150	20	*	*
13	0	0	0	10	0	0	10	0	*	*
14	20	90	10	<0	0	10	0	0	*	*
15	50	0	<0	0	10	50	0	<0	*	*
16	0	0	0	0	10	60	110	80	*	*
17	0	20	0	0	0	140	0	0	*	*
18	90	30	0	0	70	100	0	130	*	*
19	0	10	10	10	120	120	10	0	*	*
20	<0	0	0	70	0	10	<0	10	*	*
21	0	0	50	10	0	0	10	0	*	*
22	20	0	10	0	60	40	110	30	*	*
23	*	*	0	50	40	20	0	0	*	*
24	*	*	60	60	40	80	0	90	*	*
25	*	*	70	0	40	20	90	0	*	*
26	*	*	60	*	100	60	10	<0	*	*
27	*	*	*	*	60	0	70	50	*	*
28	*	*	*	*	0	<0	0	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			0	10	0	0	*	*
31	*	*			80	80			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

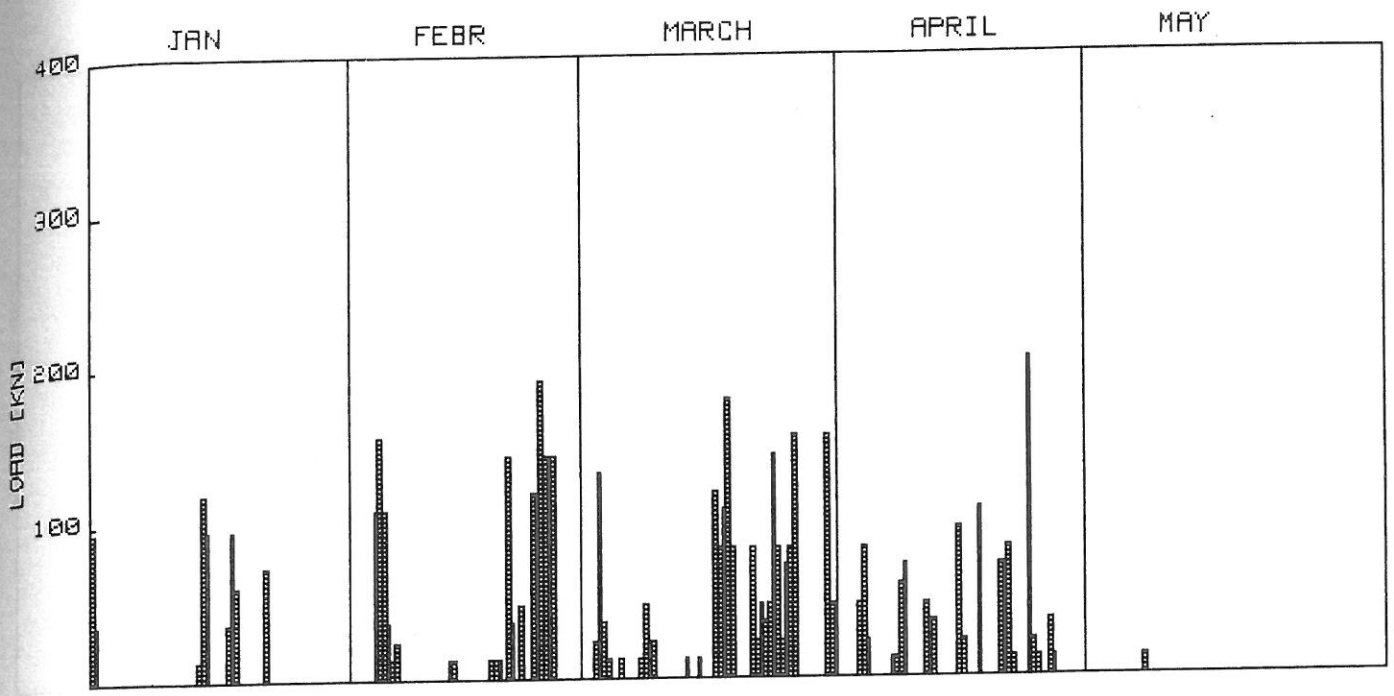


PLS

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	80	10	*	*	*	*	20	0	0	0
2	0	20	*	*	*	*	0	0	0	0
3	20	30	10	0	40	120	0	0	0	0
4	30	0	0	170	80	10	30	100	0	0
5	*	*	200	150	10	0	20	0	0	0
6	*	*	40	10	10	0	0	0	0	0
7	*	*	10	0	0	0	0	70	0	0
8	10	0	10	0	0	60	70	30	0	40
9	0	0	0	0	80	0	130	40	*	*
10	0	0	0	0	80	0	0	0	*	*
11	0	0	0	0	0	0	0	0	*	*
12	0	0	0	0	0	0	240	40	*	*
13	0	0	0	10	0	10	30	10	*	*
14	40	190	10	<0	0	20	0	0	*	*
15	160	0	<0	0	20	70	0	0	*	*
16	0	10	0	0	20	60	80	160	*	*
17	0	70	0	0	0	260	0	0	*	*
18	110	70	10	0	170	170	0	160	*	*
19	10	0	10	10	220	150	10	10	*	*
20	0	0	0	170	0	10	10	0	*	*
21	0	0	80	10	10	10	0	0	*	*
22	50	0	10	0	80	30	170	50	*	*
23	*	*	0	90	80	30	0	0	*	*
24	*	*	70	90	40	160	0	150	*	*
25	*	*	200	0	60	20	80	0	*	*
26	*	*	120	*	250	130	0	10	*	*
27	*	*	*	*	60	0	120	50	*	*
28	*	*	*	*	0	0	10	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			0	60	0	0	*	*
31	*	*			180	80			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

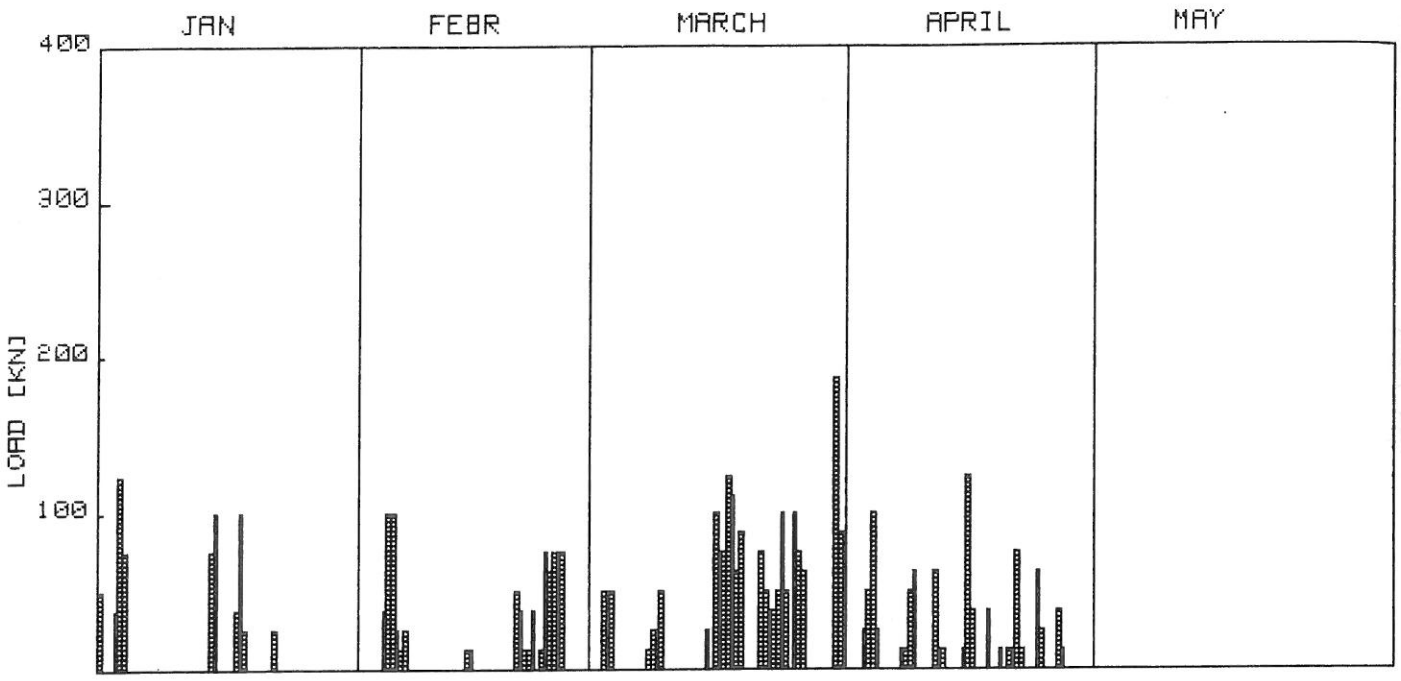


FFR6

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	95	35	*	*	*	*	23	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	0	<0	0	0	23	131	0	0	0	0
4	<0	0	0	107	35	11	47	83	0	0
5	*	*	155	107	<0	0	23	0	0	0
6	*	*	35	11	11	0	0	0	0	0
7	*	*	23	0	0	0	0	0	0	0
8	0	0	0	0	0	11	11	11	0	11
9	0	0	0	0	47	0	59	71	*	*
10	0	0	0	0	23	0	0	0	*	*
11	0	0	0	0	0	0	47	11	*	*
12	0	0	0	0	0	0	35	0	*	*
13	0	0	0	11	0	0	0	0	*	*
14	11	119	11	0	11	0	0	0	*	*
15	95	0	0	0	0	11	0	0	*	*
16	0	0	0	0	0	<0	95	23	*	*
17	0	35	0	0	0	119	0	0	*	*
18	95	59	0	11	83	107	0	107	*	*
19	0	0	11	11	179	83	0	0	*	*
20	0	0	0	143	0	0	0	<0	*	*
21	0	0	35	0	0	0	71	0	*	*
22	71	0	47	0	83	23	83	11	*	*
23	*	*	0	119	47	35	0	0	*	*
24	*	*	59	191	47	143	0	203	*	*
25	*	*	143	0	83	23	23	11	*	*
26	*	*	143	*	71	83	0	0	*	*
27	*	*	*	*	155	0	35	11	*	*
28	*	*	*	*	0	0	0	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			0	0			*	*
31	*	*			155	47			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

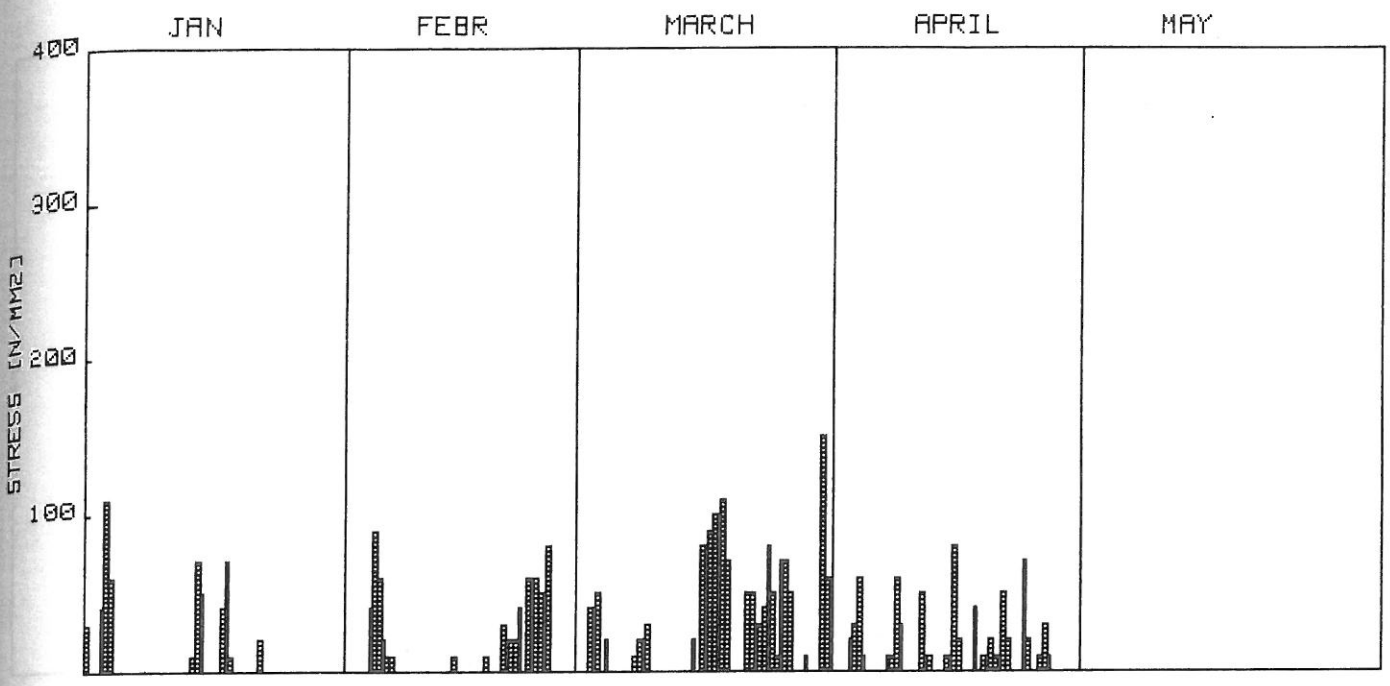


FFR?

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	49	<0	*	*	*	*	24	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	37	124	0	0	49	49	0	24	0	0
4	74	0	0	37	49	0	49	99	0	0
5	*	*	99	99	0	0	24	0	0	0
6	*	*	24	12	0	0	0	0	0	0
7	*	*	24	<0	0	0	<0	0	0	0
8	0	0	<0	<0	0	12	12	12	0	0
9	0	0	<0	<0	24	0	49	62	*	*
10	0	0	<0	0	49	0	0	0	*	*
11	0	0	0	0	0	0	0	0	*	*
12	0	<0	0	0	0	0	62	12	*	*
13	<0	<0	0	0	0	0	12	0	*	*
14	<0	74	0	12	0	0	0	0	*	*
15	99	0	12	0	<0	24	<0	12	*	*
16	0	0	0	0	0	99	124	37	*	*
17	0	37	0	0	0	74	0	0	*	*
18	99	24	0	<0	124	112	0	37	*	*
19	0	0	<0	<0	62	87	0	0	*	*
20	0	0	<0	49	0	0	12	0	*	*
21	0	0	37	12	<0	<0	12	12	*	*
22	24	0	12	37	74	49	74	12	*	*
23	*	*	0	12	37	37	0	0	*	*
24	*	*	74	62	49	99	0	62	*	*
25	*	*	74	0	49	<0	24	0	*	*
26	*	*	74	*	99	74	0	0	*	*
27	*	*	*	*	62	0	37	12	*	*
28	*	*	*	*	0	0	0	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			<0	<0	0	<0	*	*
31	*	*			186	87			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

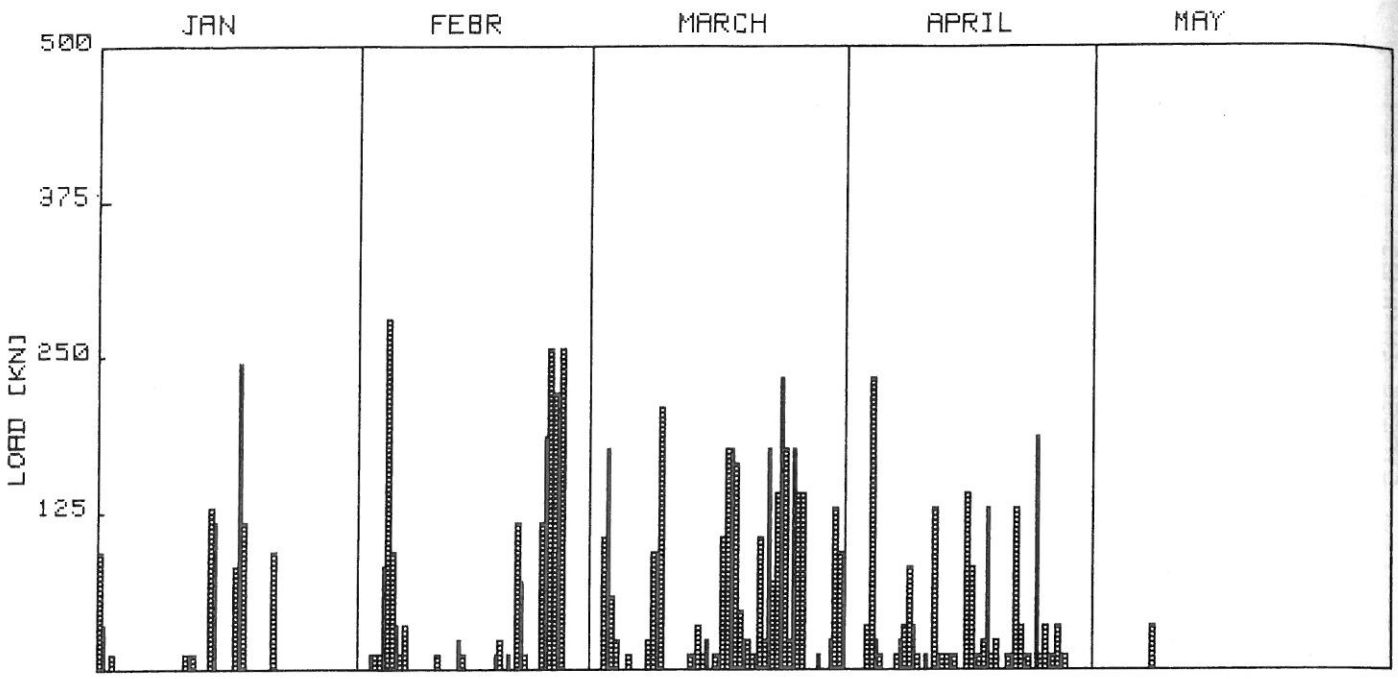


FN9

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	30	<0	*	*	*	*	10	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	40	110	0	0	40	40	0	20	0	0
4	60	0	0	40	50	0	30	60	0	0
5	*	*	90	60	20	0	10	0	0	0
6	*	*	20	10	0	0	0	0	0	0
7	*	*	10	<0	0	0	<0	<0	0	0
8	0	0	<0	<0	0	10	10	10	0	0
9	0	0	<0	<0	20	0	60	30	*	*
10	0	0	<0	<0	30	0	0	0	*	*
11	0	0	0	0	0	0	0	0	*	*
12	0	<0	0	0	0	0	50	10	*	*
13	<0	<0	0	0	0	0	10	0	*	*
14	10	70	<0	10	0	0	0	0	*	*
15	50	0	<0	0	<0	20	10	10	*	*
16	0	0	0	0	<0	80	80	20	*	*
17	0	40	0	0	0	90	0	<0	*	*
18	70	10	0	10	100	100	0	40	*	*
19	0	0	<0	<0	110	70	0	10	*	*
20	<0	0	<0	30	0	0	10	20	*	*
21	0	<0	20	20	<0	<0	10	10	*	*
22	20	0	20	40	50	50	50	20	*	*
23	*	*	0	60	30	30	0	0	*	*
24	*	*	50	60	40	80	0	70	*	*
25	*	*	50	0	50	10	20	0	*	*
26	*	*	80	*	70	70	0	10	*	*
27	*	*	*	*	50	0	30	10	*	*
28	*	*	*	*	0	0	<0	0	*	*
29	*	*			10	<0	0	<0	*	*
30	*	*			<0	<0	<0	<0	*	*
31	*	*			150	60			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

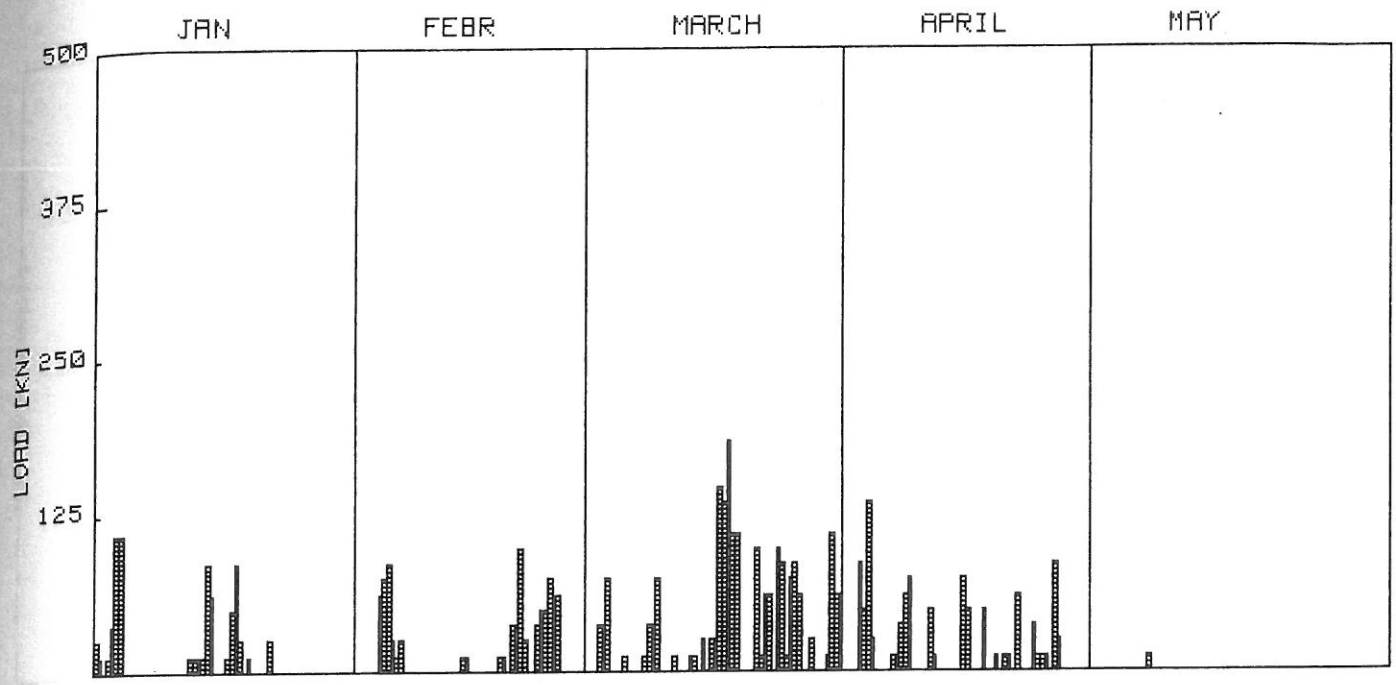


FFR11

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	93	35	*	*	*	*	46	0	0	0
2	0	11	*	*	*	*	0	0	0	0
3	<0	<0	11	11	105	175	0	<0	0	0
4	<0	0	11	81	58	23	35	234	0	0
5	*	*	280	93	0	0	23	11	0	0
6	*	*	35	11	11	0	0	0	0	0
7	*	*	35	0	0	0	0	11	0	0
8	0	0	0	0	0	23	23	35	0	35
9	0	0	0	0	93	0	81	35	*	*
10	0	0	0	0	210	0	11	0	*	*
11	0	11	11	0	0	0	11	0	*	*
12	11	11	0	0	0	0	128	11	*	*
13	0	0	0	23	0	11	11	11	*	*
14	0	128	11	0	11	35	0	11	*	*
15	117	0	0	0	11	23	0	0	*	*
16	0	0	0	0	0	11	140	81	*	*
17	0	81	0	0	0	105	11	11	*	*
18	245	117	11	23	175	175	23	128	*	*
19	0	0	0	11	183	46	11	23	*	*
20	0	0	0	117	0	23	0	0	*	*
21	0	0	70	11	11	0	11	0	*	*
22	93	0	0	0	105	23	128	35	*	*
23	*	*	0	117	175	70	11	11	*	*
24	*	*	187	257	140	234	0	187	*	*
25	*	*	222	11	175	23	11	35	*	*
26	*	*	257	*	175	140	11	11	*	*
27	*	*	*	*	140	0	35	11	*	*
28	*	*	*	*	0	0	11	0	*	*
29	*	*			11	<0	0	0	*	*
30	*	*			0	23	0	0	*	*
31	*	*			128	93			*	*

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

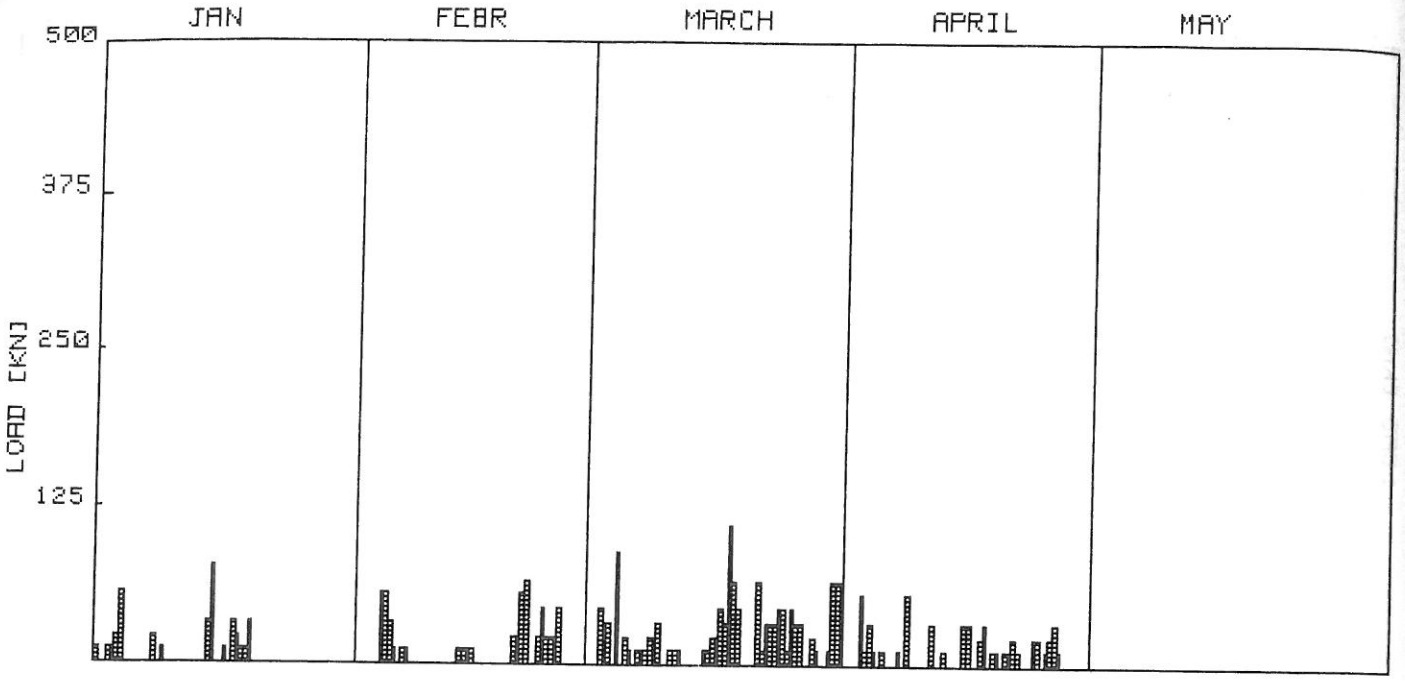


FFR12

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	24	12	*	*	*	*	<0	0	0	0
2	0	12	*	*	*	*	0	0	0	0
3	36	110	0	0	36	36	0	85	0	0
4	110	0	0	61	73	0	49	134	0	0
5	*	*	73	85	<0	0	24	0	0	0
6	*	*	24	12	12	0	0	0	0	0
7	*	*	24	<0	0	0	0	12	0	0
8	0	0	<0	<0	0	12	12	36	0	12
9	0	0	<0	<0	36	0	61	73	*	*
10	0	0	<0	0	73	0	0	0	*	*
11	0	0	0	0	0	0	0	0	*	*
12	0	12	0	0	12	0	49	12	*	*
13	12	0	0	0	0	0	0	0	*	*
14	12	85	0	12	12	12	0	0	*	*
15	61	0	12	0	0	24	0	0	*	*
16	0	0	0	0	0	24	73	49	*	*
17	12	49	0	0	0	147	0	0	*	*
18	85	24	0	<0	134	183	0	49	*	*
19	<0	12	12	12	110	110	0	0	*	*
20	0	0	<0	36	0	0	12	0	*	*
21	0	0	36	98	0	0	12	12	*	*
22	24	0	24	0	98	12	<0	61	*	*
23	*	*	0	36	61	61	0	0	*	*
24	*	*	49	49	<0	98	0	36	*	*
25	*	*	73	0	85	12	12	12	*	*
26	*	*	61	*	73	85	12	0	*	*
27	*	*	*	*	61	0	85	24	*	*
28	*	*	*	*	0	24	0	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			<0	12	0	0	*	*
31	*	*			110	61			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

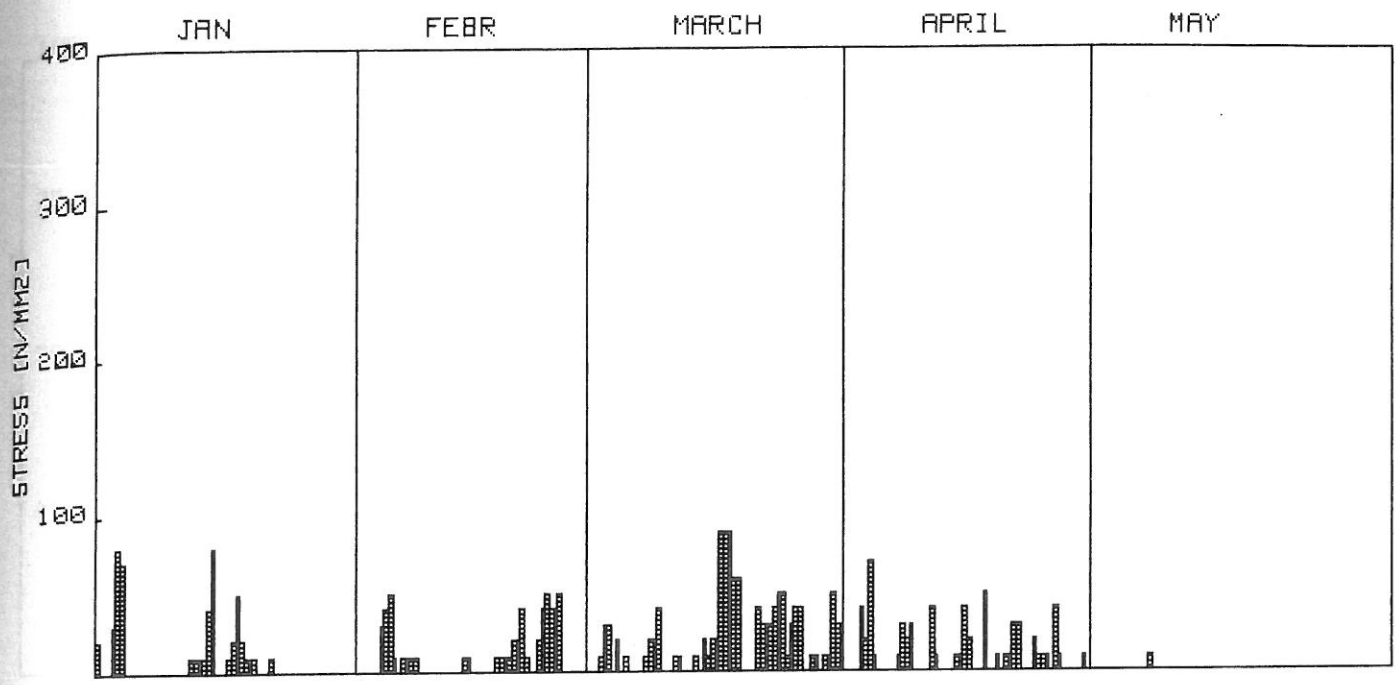


FFR13

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	11	0	*	*	*	*	0	0	0	0
2	0	11	*	*	*	*	0	0	0	0
3	<0	22	0	0	45	22	0	56	0	0
4	56	0	0	56	33	0	11	33	0	0
5	*	*	56	33	90	0	11	0	0	0
6	*	*	11	0	22	11	11	0	0	0
7	*	*	11	11	0	11	0	0	0	0
8	22	0	<0	0	0	11	11	<0	0	0
9	11	0	0	0	22	0	56	<0	*	*
10	0	0	0	0	33	0	0	0	*	*
11	0	0	0	0	0	11	0	0	*	*
12	0	<0	0	0	11	11	33	0	*	*
13	<0	0	0	0	0	0	0	11	*	*
14	<0	33	11	11	0	0	0	0	*	*
15	78	0	11	11	0	11	33	33	*	*
16	0	11	0	0	11	22	0	0	*	*
17	0	33	0	0	0	45	22	33	*	*
18	22	11	0	0	33	112	0	11	*	*
19	11	33	<0	<0	67	45	11	0	*	*
20	0	0	<0	22	0	0	11	11	*	*
21	0	0	22	56	0	0	22	11	*	*
22	<0	0	67	0	67	11	0	0	*	*
23	*	*	0	22	33	33	0	22	*	*
24	*	*	45	22	33	45	22	<0	*	*
25	*	*	22	0	45	11	11	22	*	*
26	*	*	45	*	45	33	33	11	*	*
27	*	*	*	*	33	0	0	0	*	*
28	*	*	*	*	0	22	0	0	*	*
29	*	*			11	0	0		*	*
30	*	*			0	11	0		*	*
31	*	*			67	67	0		*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

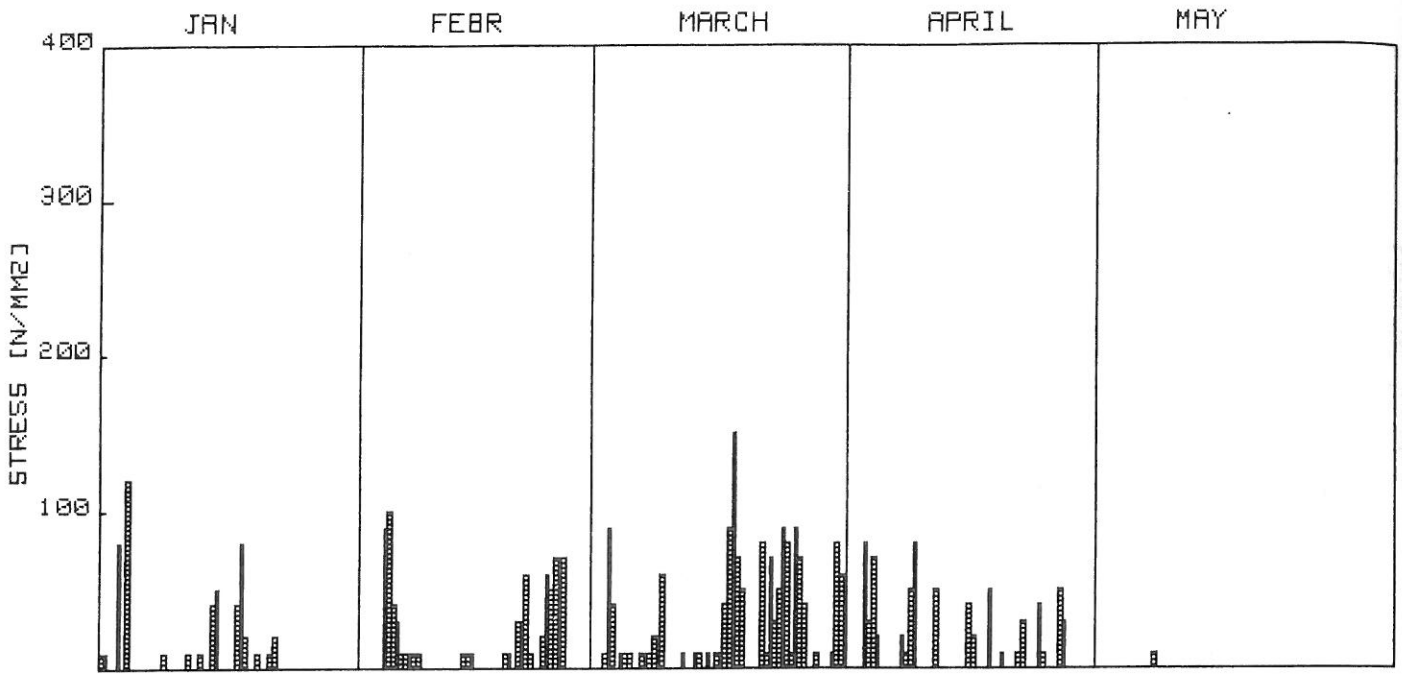


FN14

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	20	<0	*	*	*	*	10	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	30	80	0	0	10	30	0	40	0	0
4	70	0	0	30	30	0	20	70	0	0
5	*	*	40	50	20	0	10	0	0	0
6	*	*	10	0	10	0	0	0	0	0
7	*	*	10	10	0	0	<0	<0	0	0
8	0	0	10	10	0	10	10	30	0	10
9	0	0	<0	<0	20	0	20	30	*	*
10	0	0	<0	0	40	0	0	0	*	*
11	0	<0	0	0	0	0	0	0	*	*
12	0	10	0	0	10	10	40	10	*	*
13	10	10	0	0	0	0	0	0	*	*
14	10	40	0	10	0	10	0	0	*	*
15	80	0	10	0	<0	20	10	<0	*	*
16	0	0	0	0	10	20	40	20	*	*
17	10	20	0	0	0	90	0	0	*	*
18	50	20	0	10	90	90	0	50	*	*
19	10	10	10	10	60	60	0	0	*	*
20	10	0	10	20	0	0	10	0	*	*
21	0	0	10	40	0	0	10	10	*	*
22	10	0	10	0	40	30	30	30	*	*
23	*	*	0	20	30	30	0	0	*	*
24	*	*	40	50	40	50	0	20	*	*
25	*	*	40	0	50	10	10	10	*	*
26	*	*	50	*	30	40	10	0	*	*
27	*	*	*	*	40	0	40	10	*	*
28	*	*	*	*	0	10	0	0	*	*
29	*	*			10	0	0	0	*	*
30	*	*			10	<0	0	10	*	*
31	*	*			50	30			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

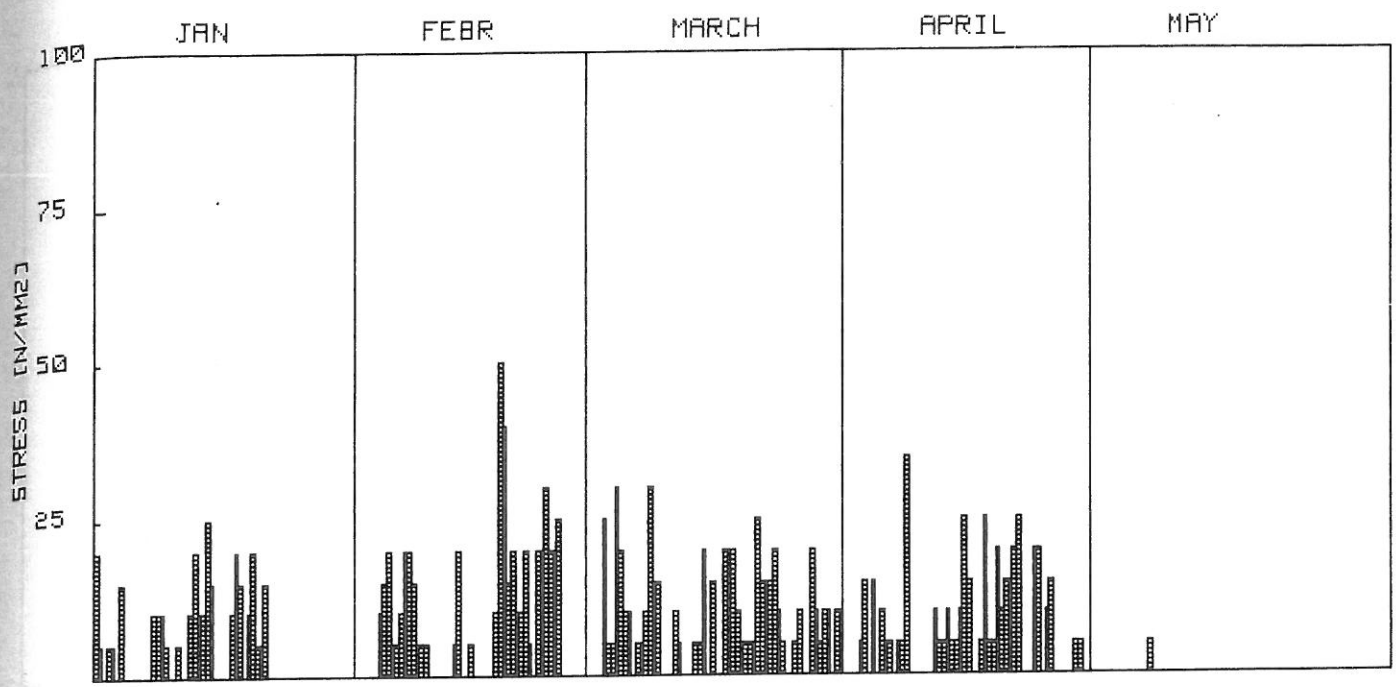


PL15

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	10	10	*	*	*	*	10	0	0	0
2	0	0	*	*	*	*	0	0	0	0
3	80	0	0	0	10	90	0	80	0	0
4	120	0	0	90	40	0	30	70	0	0
5	*	*	100	40	10	10	20	0	0	0
6	*	*	30	10	10	0	0	0	0	0
7	*	*	10	10	0	10	0	0	0	0
8	0	10	10	10	0	10	20	10	0	10
9	<0	0	0	0	20	0	50	80	*	*
10	0	0	0	0	60	0	0	0	*	*
11	0	10	0	0	0	0	0	0	*	*
12	0	0	0	0	0	10	50	0	*	*
13	10	0	0	0	0	0	0	0	*	*
14	0	40	10	10	10	10	0	0	*	*
15	50	0	10	0	0	10	0	0	*	*
16	0	0	0	0	0	10	40	20	*	*
17	0	40	0	0	0	40	0	0	*	*
18	80	20	0	0	90	150	0	50	*	*
19	0	<0	10	10	70	50	0	0	*	*
20	10	0	0	30	0	0	10	0	*	*
21	0	10	30	60	0	0	0	0	*	*
22	20	0	10	0	80	10	10	30	*	*
23	*	*	0	20	70	30	0	0	*	*
24	*	*	60	50	50	90	0	40	*	*
25	*	*	70	0	80	10	10	0	*	*
26	*	*	70	*	90	70	0	0	*	*
27	*	*	*	*	40	0	50	30	*	*
28	*	*	*	*	0	10	0	0	*	*
29	*	*			0	0	0	0	*	*
30	*	*			0	10	0	0	*	*
31	*	*			80	60			*	*

* NOT MEASURED

KEMIRA 1986 MEASURED 12-HOUR MAXIMA

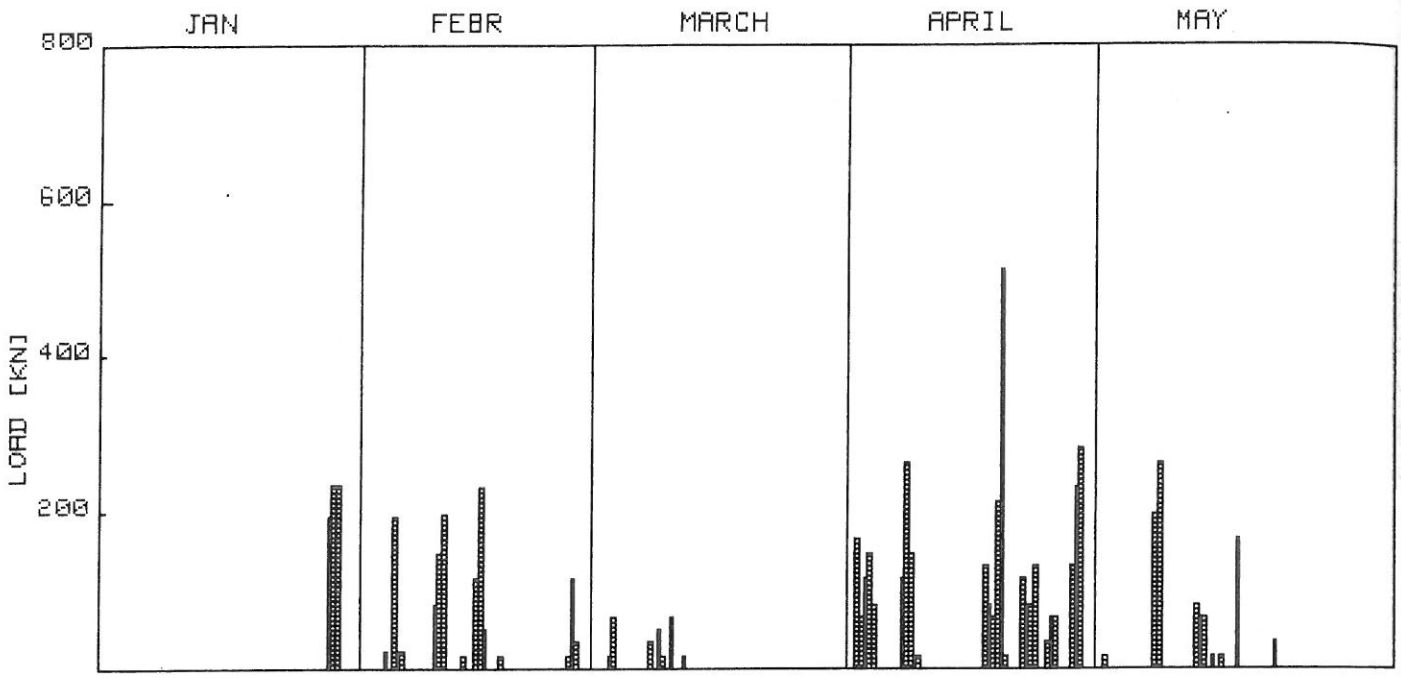


HB16 (DYNAMIC)

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	20	5	*	*	*	*	0	0	0	0
2	0	5	*	*	*	*	0	0	0	0
3	5	0	0	0	<0	25	0	5	0	0
4	15	0	0	10	5	5	15	<0	0	0
5	*	*	15	20	30	20	15	<0	0	0
6	*	*	5	5	10	10	10	<0	0	0
7	*	*	10	20	0	5	5	<0	0	0
8	10	10	20	15	0	10	5	<0	0	5
9	10	5	5	5	30	0	35	<0	*	*
10	0	0	5	0	15	0	0	0	*	*
11	5	<0	0	0	0	<0	<0	0	*	*
12	0	10	0	0	10	5	<0	10	*	*
13	20	5	0	5	0	0	5	5	*	*
14	10	25	20	<0	0	5	10	5	*	*
15	15	0	<0	5	5	20	5	10	*	*
16	0	0	0	0	<0	15	25	15	*	*
17	0	10	0	0	0	<0	0	0	*	*
18	20	15	0	10	20	5	5	25	*	*
19	0	10	50	40	20	10	5	5	*	*
20	20	5	15	20	0	5	20	10	*	*
21	0	15	5	10	5	0	15	<0	*	*
22	<0	0	20	5	25	15	20	25	*	*
23	*	*	0	20	<0	15	0	0	*	*
24	*	*	10	30	20	10	0	20	*	*
25	*	*	20	0	5	0	20	0	*	*
26	*	*	25	*	<0	5	10	15	*	*
27	*	*	*	*	10	0	<0	<0	*	*
28	*	*	*	*	0	20	<0	0	*	*
29	*	*			10	5	0	5	*	*
30	*	*			10	10	5	0	*	*
31	*	*			<0	10			*	*

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

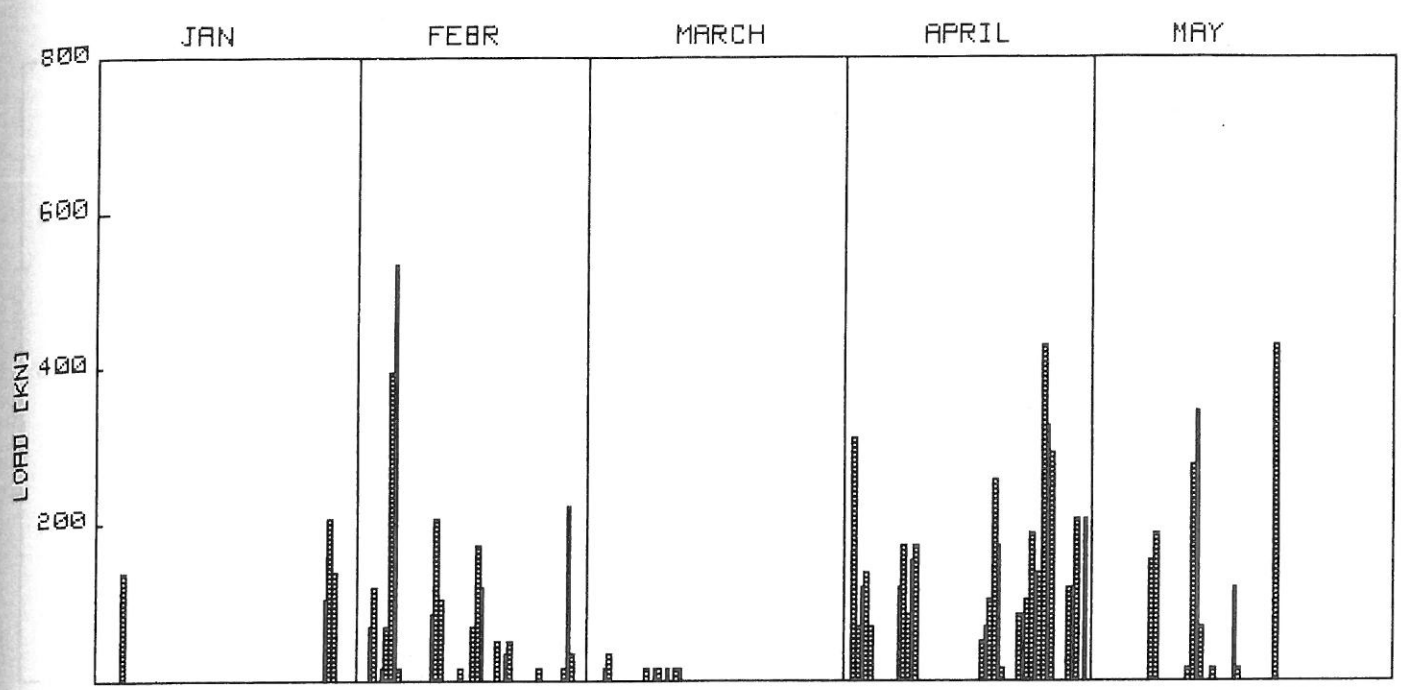


FFR1

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	0	0	<0	<0	0	0
2	0	0	0	0	0	0	0	165	0	16
3	<0	0	<0	<0	0	16	66	115	0	0
4	<0	0	0	21	66	0	148	82	0	<0
5	*	*	<0	192	0	0	0	0	<0	0
6	*	*	<0	21	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	0	0
8	*	*	0	0	0	33	115	264	0	198
9	*	*	0	0	0	49	148	16	264	0
10	*	*	0	82	16	0	16	0	0	0
11	*	*	148	198	66	0	0	0	0	0
12	*	*	0	0	<0	16	0	0	0	0
13	*	*	<0	<0	<0	0	0	0	0	82
14	*	*	16	0	*	*	<0	0	<0	66
15	*	*	0	115	*	*	0	0	<0	16
16	*	*	231	49	*	*	0	0	<0	16
17	*	*	0	<0	*	*	0	0	0	<0
18	*	*	<0	16	*	*	132	82	0	165
19	*	*	0	<0	*	*	66	214	0	0
20	*	*	<0	0	*	*	512	16	0	0
21	*	*	0	0	*	*	0	0	0	0
22	*	*	0	0	*	*	0	115	0	0
23	*	*	0	<0	*	*	49	82	33	0
24	*	*	<0	<0	*	*	132	0	0	0
25	*	*	0	0	*	*	0	33	0	0
26	*	*	0	16	*	*	66	66	0	0
27	*	*	115	33	*	*	0	0	0	0
28	0	192	0	0	*	*	0	132	0	0
29	235	235			*	*	231	280	0	0
30	0	0			0	0	0	<0	0	0
31	0	0			0	0			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

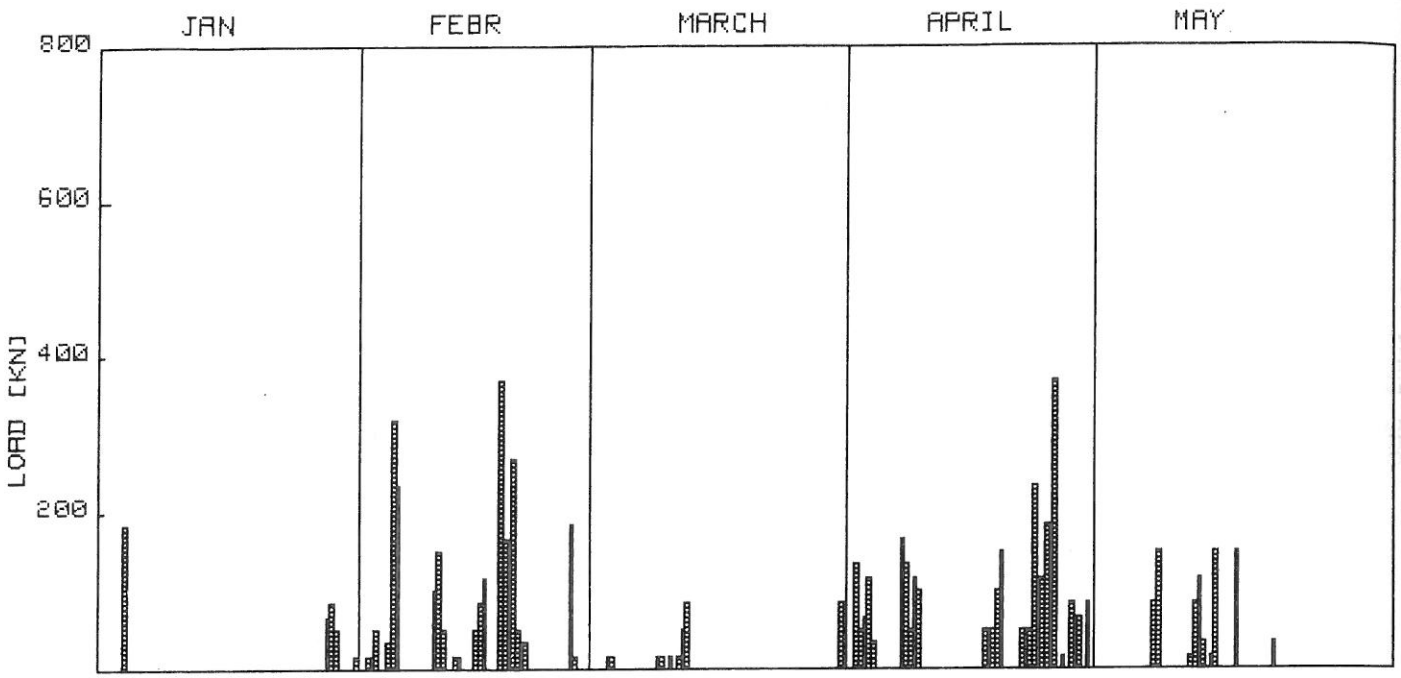


FFR2

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	309	0	0
3	0	0	68	120	0	17	68	120	0	0
4	137	0	0	17	34	0	137	68	0	0
5	*	*	68	395	0	0	0	0	0	0
6	*	*	533	17	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	0	0
8	*	*	0	0	0	17	120	172	0	154
9	*	*	0	0	0	17	86	154	189	0
10	*	*	0	86	17	0	172	0	0	0
11	*	*	206	103	17	0	0	0	0	0
12	*	*	0	0	17	17	0	0	0	0
13	*	*	0	0	0	0	0	0	17	275
14	*	*	17	0	*	*	0	0	344	68
15	*	*	0	68	*	*	0	0	0	<0
16	*	*	172	120	*	*	0	0	17	0
17	*	*	0	0	*	*	0	0	0	0
18	*	*	0	51	*	*	51	68	0	120
19	*	*	<0	34	*	*	103	258	17	0
20	*	*	51	0	*	*	172	17	0	0
21	*	*	0	0	*	*	0	0	0	0
22	*	*	0	0	*	*	0	86	0	0
23	*	*	0	17	*	*	34	103	0	490
24	*	*	0	0	*	*	189	0	0	0
25	*	*	0	0	*	*	137	430	0	0
26	*	*	0	17	*	*	326	292	0	0
27	*	*	223	34	*	*	0	0	0	0
28	0	103	0	0	*	*	0	120	0	0
29	206	137			*	*	120	206	0	0
30	0	0			0	0	0	206	0	0
31	0	0			0	0			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

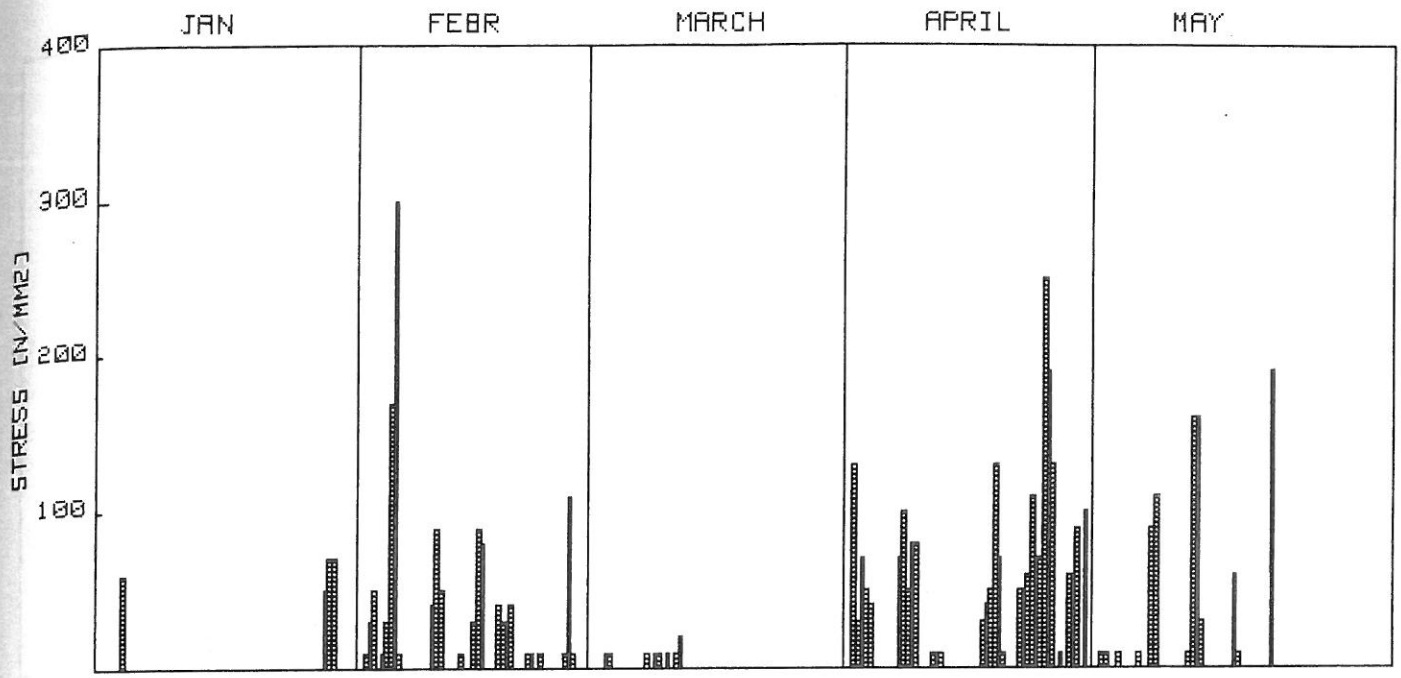


FFR3

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	0	0	16	0	0	0	33	0	0	0
2	0	0	0	16	0	0	0	134	0	0
3	0	0	16	50	0	16	50	67	0	0
4	184	0	0	0	16	0	117	33	0	0
5	*	*	33	318	0	0	0	0	0	0
6	*	*	234	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	<0	0
8	*	*	0	0	0	0	167	134	0	83
9	*	*	0	0	0	16	50	117	151	<0
10	*	*	0	100	16	0	100	0	0	0
11	*	*	151	50	16	0	0	0	0	0
12	*	*	0	0	16	50	0	0	0	0
13	*	*	16	16	83	0	0	0	16	83
14	*	*	<0	0	*	*	0	0	117	33
15	*	*	0	50	*	*	0	0	0	16
16	*	*	83	117	*	*	0	0	151	0
17	*	*	0	0	*	*	0	0	0	0
18	*	*	0	369	*	*	50	16	<0	151
19	*	*	167	151	*	*	50	100	<0	0
20	*	*	268	50	*	*	151	0	0	0
21	*	*	33	33	*	*	0	0	0	0
22	*	*	0	0	*	*	0	50	0	0
23	*	*	0	0	*	*	0	50	33	0
24	*	*	0	0	*	*	234	<0	0	0
25	*	*	0	0	*	*	117	184	0	0
26	*	*	0	0	*	*	167	369	0	0
27	*	*	184	16	*	*	0	16	0	0
28	0	67	0	0	*	*	0	83	0	0
29	83	50			*	*	50	67	0	0
30	0	0			0	0	0	83	0	0
31	0	0			0	83			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

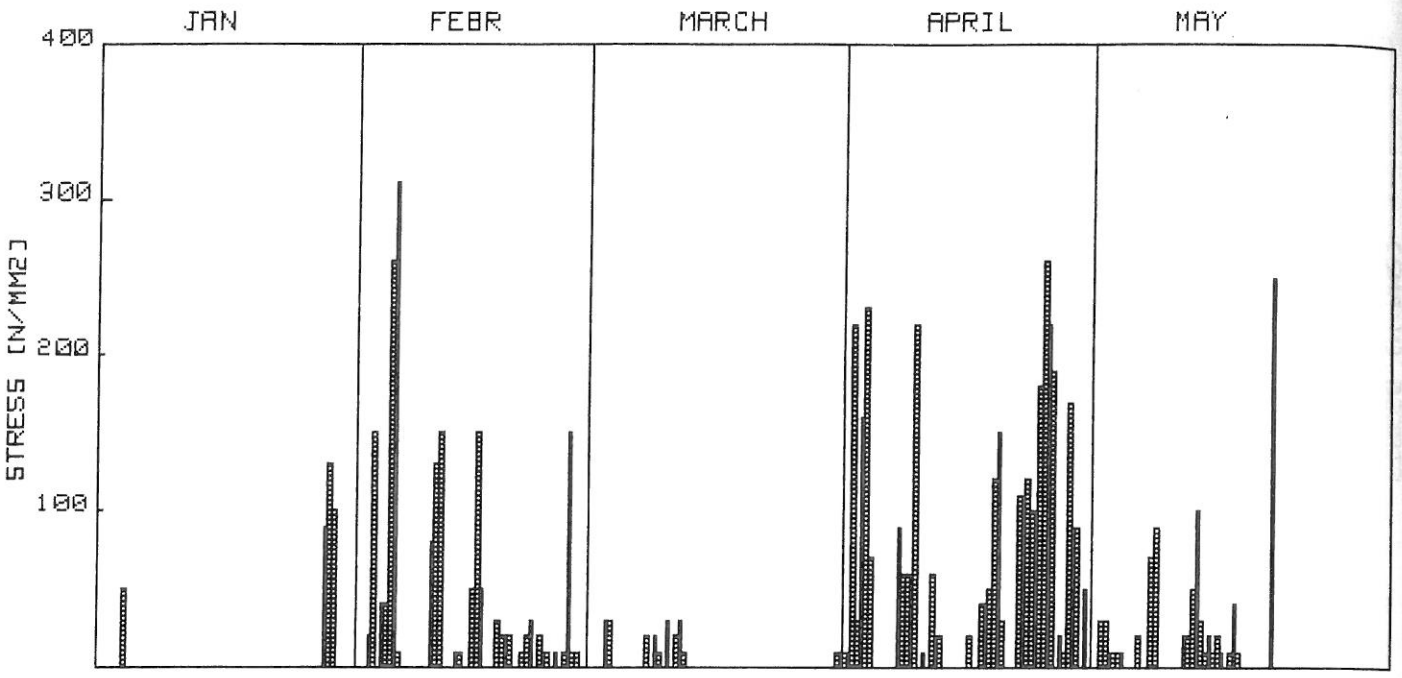


FN4

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	0	0	<0	<0	0	0
2	0	0	0	10	0	0	0	130	0	10
3	0	0	30	50	0	10	30	70	10	0
4	60	0	0	10	10	0	50	40	0	10
5	*	*	30	170	0	0	0	0	0	0
6	*	*	300	10	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	10	<0
8	*	*	0	0	0	10	70	100	<0	90
9	*	*	0	0	0	10	50	80	110	0
10	*	*	0	40	10	0	80	0	0	0
11	*	*	90	50	10	0	<0	0	0	0
12	*	*	0	0	10	20	10	0	0	0
13	*	*	<0	<0	<0	0	10	0	10	160
14	*	*	10	0	*	*	0	0	160	30
15	*	*	0	30	*	*	0	0	0	<0
16	*	*	90	80	*	*	0	0	<0	<0
17	*	*	0	0	*	*	0	0	<0	0
18	*	*	0	40	*	*	30	40	0	60
19	*	*	30	30	*	*	50	130	10	0
20	*	*	40	0	*	*	70	10	0	0
21	*	*	0	0	*	*	0	0	0	0
22	*	*	10	10	*	*	0	50	0	0
23	*	*	0	10	*	*	10	60	190	0
24	*	*	0	0	*	*	110	10	0	0
25	*	*	0	0	*	*	70	250	0	0
26	*	*	<0	10	*	*	190	130	0	0
27	*	*	10	10	*	*	0	10	0	0
28	0	50	0	0	*	*	0	60	0	0
29	70	70			*	*	60	90	0	0
30	0	0			0	0	0	100	0	0
31	0	0			0	0			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

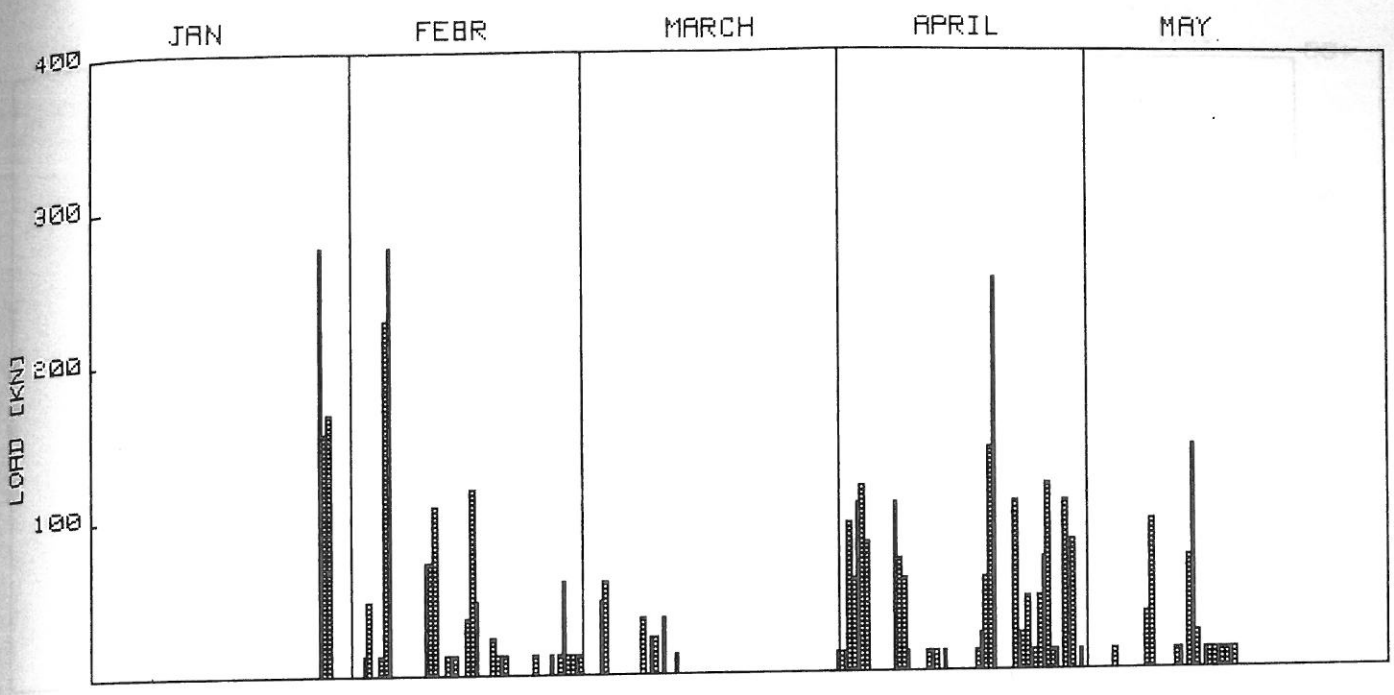


PL5

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	0	0	10	10	0	0
2	0	0	0	0	0	0	10	220	0	30
3	0	0	20	150	0	30	30	160	30	10
4	50	0	0	40	30	0	230	70	10	10
5	*	*	40	260	0	0	0	0	10	0
6	*	*	310	10	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	20	0
8	*	*	0	0	0	20	90	60	0	70
9	*	*	0	0	0	20	60	50	90	0
10	*	*	0	80	10	0	220	0	0	0
11	*	*	130	150	30	0	10	0	0	0
12	*	*	0	0	20	30	60	10	0	20
13	*	*	0	10	10	0	20	0	20	50
14	*	*	10	0	*	*	0	0	100	30
15	*	*	0	50	*	*	0	0	10	20
16	*	*	150	50	*	*	0	20	10	20
17	*	*	0	0	*	*	0	0	10	0
18	*	*	0	30	*	*	40	40	10	40
19	*	*	20	20	*	*	50	120	10	0
20	*	*	20	0	*	*	150	30	0	0
21	*	*	0	10	*	*	0	0	0	0
22	*	*	20	30	*	*	0	110	0	0
23	*	*	0	20	*	*	20	120	250	0
24	*	*	0	10	*	*	100	30	0	0
25	*	*	0	10	*	*	180	260	0	0
26	*	*	0	10	*	*	220	190	0	0
27	*	*	150	10	*	*	0	20	0	0
28	0	90	10	0	*	*	10	170	0	0
29	130	100			*	*	60	90	0	0
30	0	0			0	0	0	50	0	0
31	0	0			0	10			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

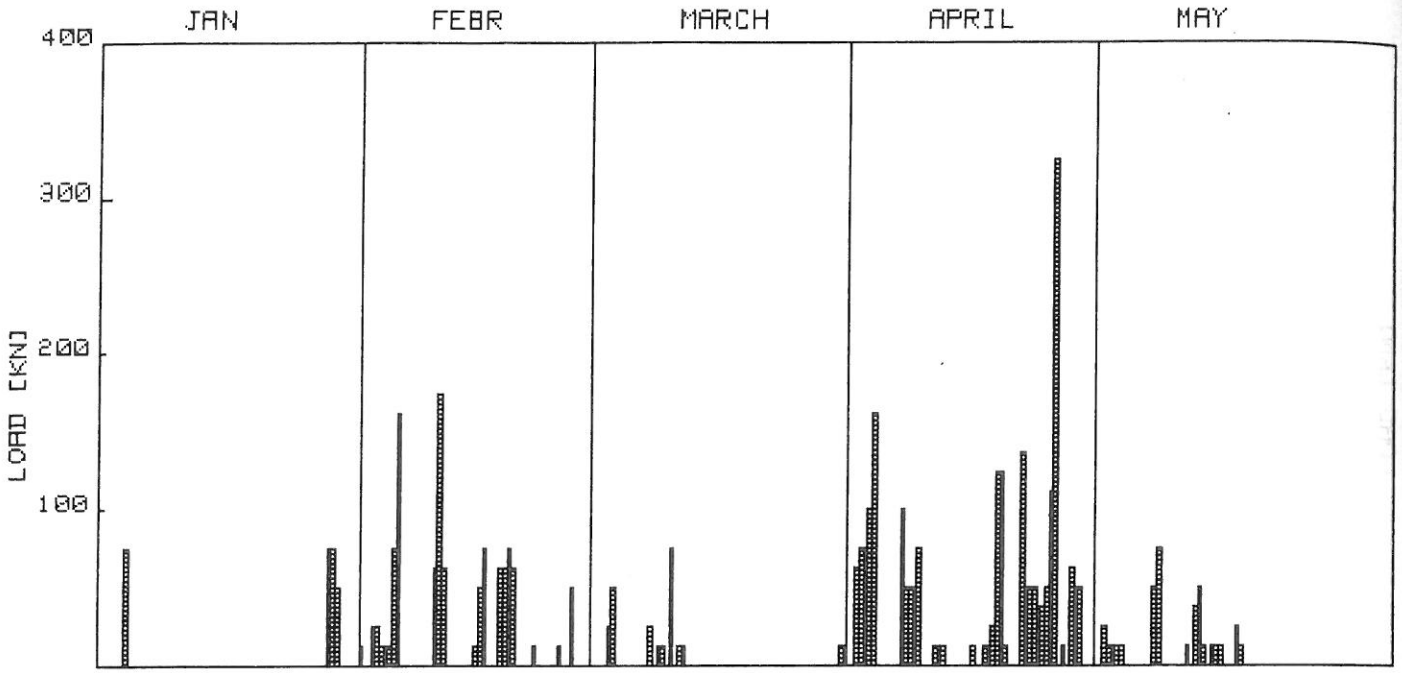


FFRG

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	11	0	11	11	0	0
2	0	0	0	0	0	0	0	95	0	0
3	0	0	11	47	0	47	59	107	0	0
4	<0	0	0	0	59	0	119	83	0	11
5	*	*	11	227	0	0	0	0	0	0
6	*	*	275	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	0	35
8	*	*	0	0	0	35	107	71	95	0
9	*	*	0	0	0	23	59	11	0	0
10	*	*	0	71	23	0	<0	0	0	0
11	*	*	71	107	35	0	0	0	11	11
12	*	*	0	0	<0	11	11	0	0	71
13	*	*	11	11	0	0	11	0	143	23
14	*	*	11	0	*	*	0	0	0	11
15	*	*	0	35	*	*	0	0	11	11
16	*	*	119	47	*	*	0	0	11	11
17	*	*	0	0	*	*	11	23	11	11
18	*	*	0	23	*	*	59	143	11	0
19	*	*	11	11	*	*	251	0	0	0
20	*	*	11	0	*	*	0	0	0	0
21	*	*	0	0	*	*	0	107	0	0
22	*	*	0	11	*	*	11	23	0	0
23	*	*	0	0	*	*	47	11	0	0
24	*	*	0	11	*	*	11	47	0	0
25	*	*	0	11	*	*	71	119	0	0
26	*	*	59	11	*	*	11	11	0	0
27	*	*	11	0	*	*	0	107	0	0
28	0	275			0	0	47	83	0	0
29	155	167			0	0	0	11	0	0
30	0	0								
31	0	0								

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

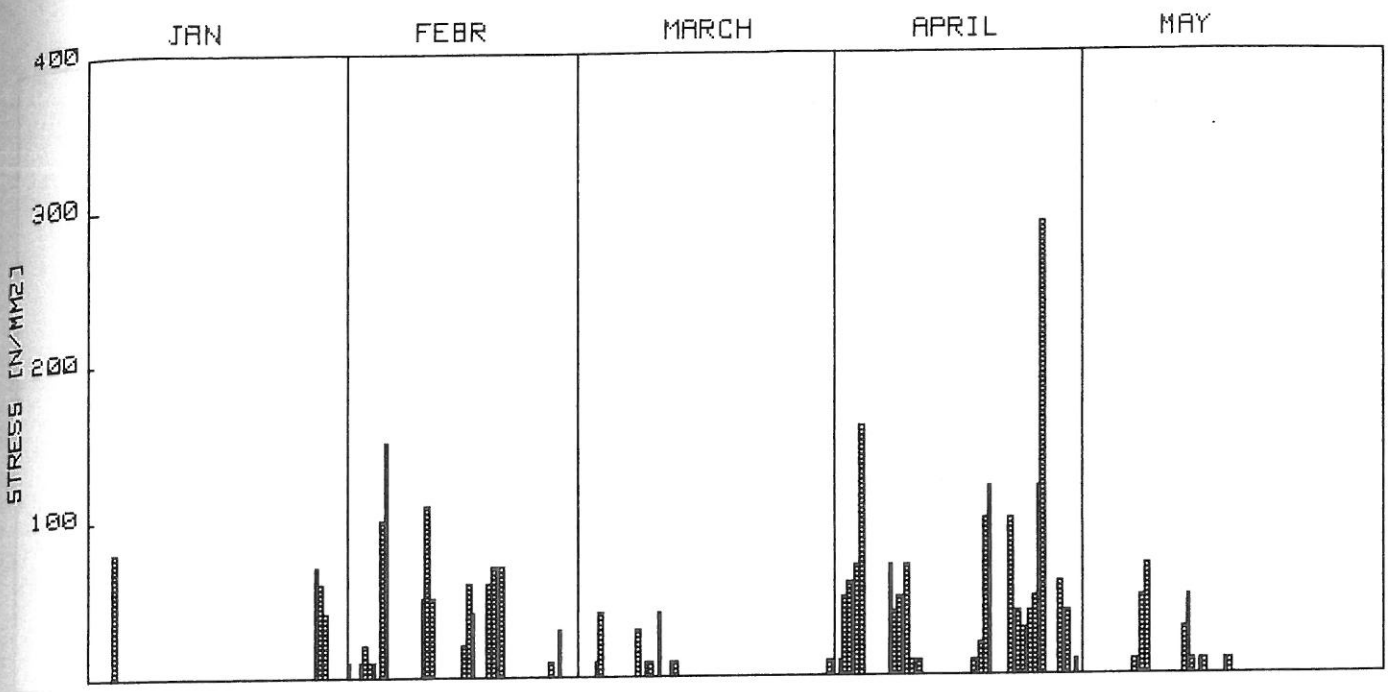


FFR7

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	12	0	0	0	0	0	0
2	0	0	0	0	0	0	<0	62	0	24
3	0	0	24	24	0	24	74	74	12	0
4	74	0	12	<0	49	0	99	161	12	12
5	*	*	12	74	0	0	0	0	0	0
6	*	*	161	<0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	0	<0
8	*	*	0	0	0	24	99	49	<0	49
9	*	*	0	0	0	12	49	49	74	0
10	*	*	0	62	12	0	74	0	0	0
11	*	*	174	62	74	0	<0	<0	0	0
12	*	*	0	0	12	12	12	0	0	12
13	*	*	0	<0	0	0	12	0	0	37
14	*	*	<0	0	*	*	0	0	49	12
15	*	*	0	12	*	*	0	0	0	12
16	*	*	49	74	*	*	<0	12	12	12
17	*	*	0	0	*	*	0	0	0	0
18	*	*	0	62	*	*	12	12	0	24
19	*	*	62	74	*	*	24	124	12	0
20	*	*	62	0	*	*	124	12	0	0
21	*	*	0	0	*	*	0	0	0	0
22	*	*	0	12	*	*	0	137	0	0
23	*	*	0	0	*	*	37	49	0	0
24	*	*	0	0	*	*	49	12	0	0
25	*	*	0	12	*	*	37	49	0	0
26	*	*	<0	<0	*	*	112	323	0	0
27	*	*	49	0	*	*	0	12	0	0
28	0	74	0	0	*	*	0	62	0	0
29	74	49			*	*	37	49	0	0
30	0	0			0	0	0	<0	0	0
31	0	0			0	12			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

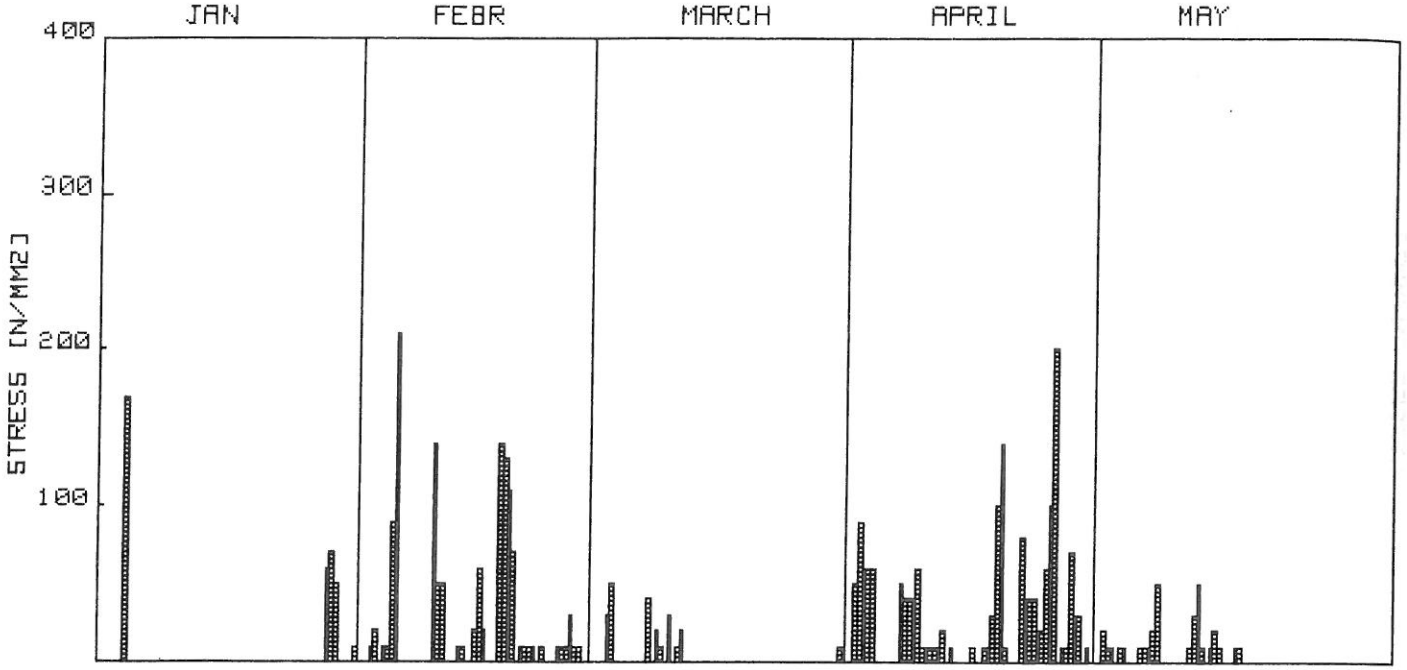


FN9

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	0	0	0	10	0	0	10	0	<0	0
2	0	0	0	0	0	0	10	50	<0	0
3	0	0	10	20	0	10	60	50	0	<0
4	80	0	10	10	40	0	70	160	0	<0
5	*	*	0	100	0	0	0	0	<0	0
6	*	*	150	<0	0	0	0	0	<0	0
7	*	*	0	0	0	0	0	0	<0	10
8	*	*	0	0	0	30	70	40	10	50
9	*	*	0	0	0	10	50	30	70	<0
10	*	*	0	50	10	0	70	10	<0	<0
11	*	*	110	50	40	0	10	10	0	<0
12	*	*	0	0	0	10	<0	<0	<0	0
13	*	*	0	<0	10	0	<0	0	<0	30
14	*	*	<0	0	*	*	<0	0	50	10
15	*	*	0	20	*	*	<0	<0	0	10
16	*	*	60	40	*	*	<0	0	10	0
17	*	*	0	0	*	*	<0	<0	<0	<0
18	*	*	0	60	*	*	10	10	0	10
19	*	*	70	60	*	*	20	100	10	<0
20	*	*	70	0	*	*	120	<0	0	0
21	*	*	0	0	*	*	0	0	0	0
22	*	*	0	0	*	*	0	100	0	0
23	*	*	0	0	*	*	30	40	0	0
24	*	*	0	0	*	*	30	10	0	0
25	*	*	0	<0	*	*	40	50	0	0
26	*	*	10	<0	*	*	120	290	0	0
27	*	*	30	0	*	*	0	<0	0	0
28	0	70	0	0	*	*	0	60	0	0
29	60	40			*	*	40	40	0	0
30	0	0			0	0	0	10	0	0
31	0	0			0	10			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

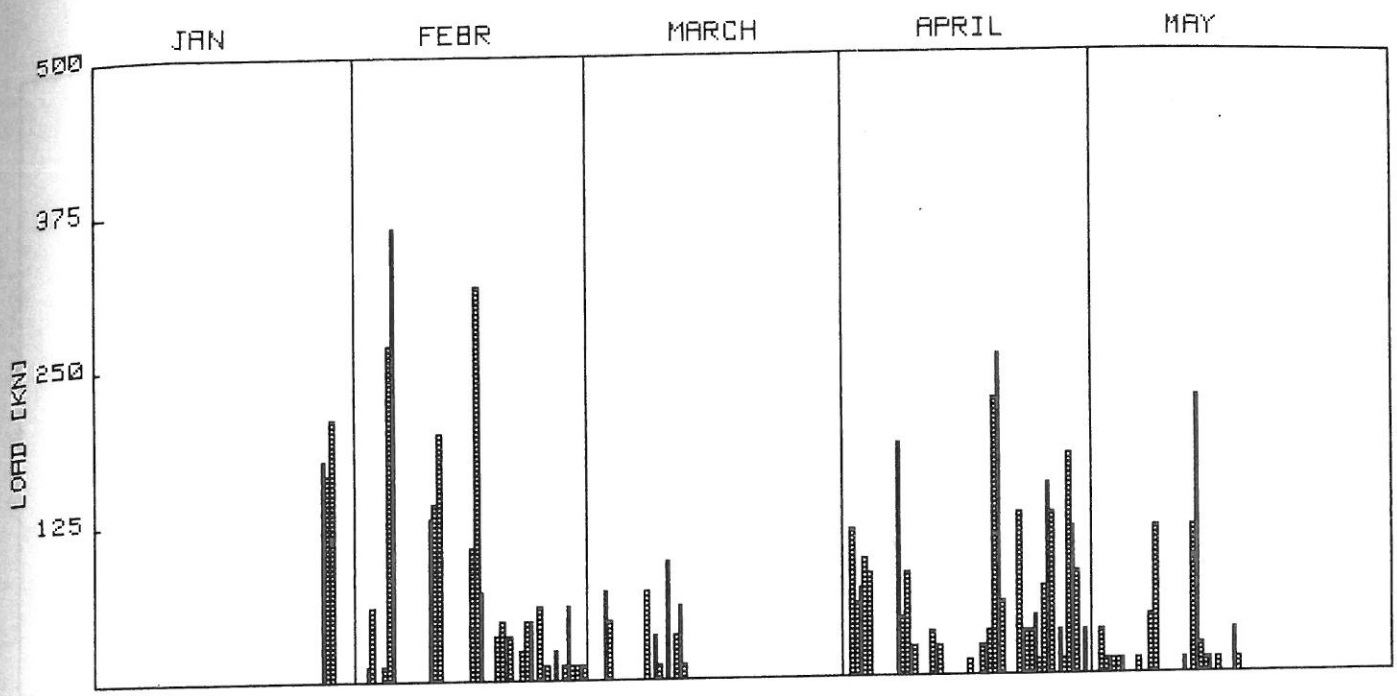


PL10

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	0	0	10	0	0	0	10	0	0	0
2	0	0	0	0	0	0	0	50	0	20
3	0	0	10	20	0	30	90	60	10	10
4	170	0	0	10	50	0	60	60	0	10
5	*	*	10	90	0	0	0	0	10	0
6	*	*	210	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	10	10
8	*	*	0	0	0	40	50	40	10	20
9	*	*	0	0	0	20	40	30	50	0
10	*	*	0	140	10	0	60	10	0	0
11	*	*	50	50	30	0	10	10	0	0
12	*	*	0	0	10	20	10	0	0	0
13	*	*	0	10	0	0	20	0	10	30
14	*	*	10	0	*	*	10	0	50	10
15	*	*	0	20	*	*	0	0	0	10
16	*	*	60	20	*	*	0	10	20	10
17	*	*	0	0	*	*	0	0	0	0
18	*	*	0	140	*	*	10	10	0	10
19	*	*	130	110	*	*	30	100	10	0
20	*	*	70	0	*	*	140	10	0	0
21	*	*	10	10	*	*	0	0	0	0
22	*	*	10	10	*	*	0	80	0	0
23	*	*	0	10	*	*	30	40	0	0
24	*	*	0	0	*	*	40	0	0	0
25	*	*	0	10	*	*	20	60	0	0
26	*	*	10	10	*	*	100	200	0	0
27	*	*	30	10	*	*	0	10	0	0
28	0	50	10	0	*	*	10	70	0	0
29	70	50			*	*	30	30	0	0
30	0	0			0	0	0	10	0	0
31	0	0			0	10			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

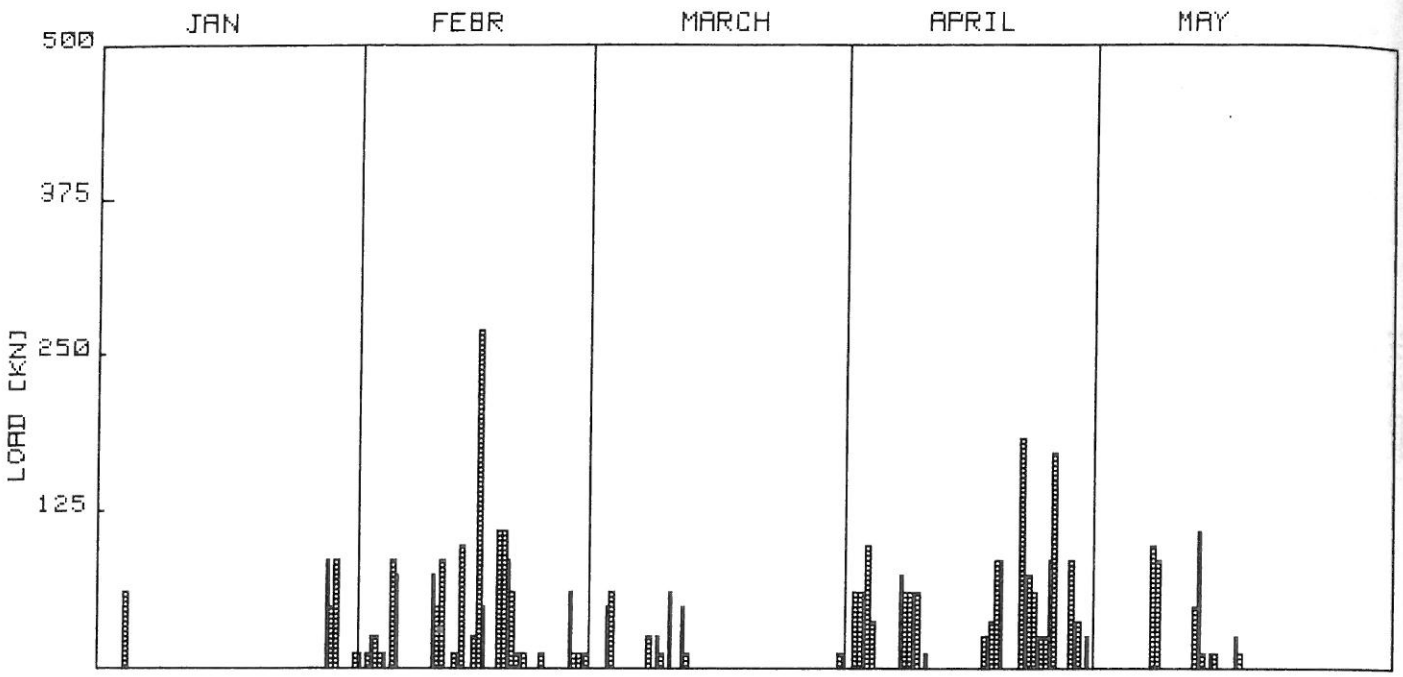


FFR11

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	11	0	0	<0	0	0
2	0	0	0	0	0	0	0	117	0	35
3	0	0	11	58	0	70	58	70	11	11
4	<0	0	0	0	46	0	93	81	11	11
5	*	*	11	269	0	0	0	0	11	0
6	*	*	362	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	11	0
8	*	*	0	0	0	70	187	46	0	46
9	*	*	0	0	0	35	81	23	117	0
10	*	*	0	128	11	0	23	<0	0	<0
11	*	*	140	198	93	0	0	0	0	0
12	*	*	0	0	35	58	35	23	<0	11
13	*	*	<0	0	11	0	23	0	0	117
14	*	*	<0	105	*	*	0	0	222	23
15	*	*	315	70	*	*	0	0	11	11
16	*	*	0	0	*	*	0	11	0	11
17	*	*	0	35	*	*	0	0	0	0
18	*	*	46	<0	*	*	23	11	0	35
19	*	*	35	0	*	*	35	222	11	0
20	*	*	0	23	*	*	257	58	0	0
21	*	*	46	46	*	*	0	0	0	0
22	*	*	0	58	*	*	0	128	0	0
23	*	*	0	11	*	*	11	35	0	0
24	*	*	0	23	*	*	35	46	0	0
25	*	*	0	11	*	*	11	70	0	0
26	*	*	58	11	*	*	152	128	0	0
27	*	*	11	0	*	*	0	35	0	0
28	0	175			*	*	11	175	0	0
29	163	210			0	0	117	81	0	0
30	0	0			0	0	0	35	0	0
31	0	0								

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

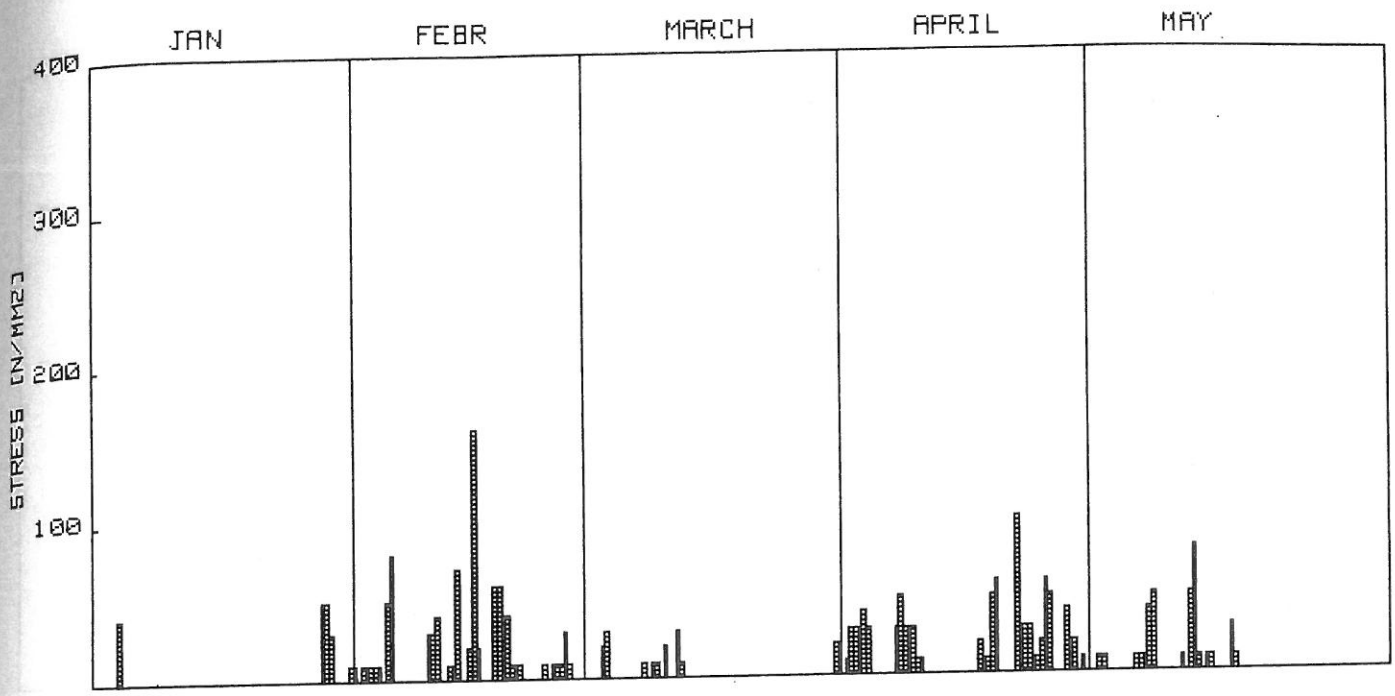


FFR12

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	12	12	12	0	12	0	0	0
2	0	0	0	12	0	0	<0	61	0	0
3	0	0	24	24	0	49	61	61	0	0
4	61	0	12	12	61	0	98	36	0	0
5	*	*	0	85	0	0	0	0	0	0
6	*	*	73	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	0	<0
8	*	*	0	0	0	24	73	61	0	98
9	*	*	0	0	0	24	61	49	85	0
10	*	*	0	73	12	0	61	0	0	0
11	*	*	49	85	61	0	12	0	0	0
12	*	*	0	0	0	49	0	0	0	0
13	*	*	12	<0	12	0	0	0	0	49
14	*	*	98	0	*	*	0	0	110	12
15	*	*	0	24	*	*	0	0	0	12
16	*	*	269	49	*	*	0	0	12	0
17	*	*	0	0	*	*	0	0	0	0
18	*	*	0	110	*	*	24	12	0	24
19	*	*	110	85	*	*	36	85	12	0
20	*	*	61	12	*	*	85	0	0	0
21	*	*	12	12	*	*	0	0	0	0
22	*	*	0	0	*	*	0	183	0	0
23	*	*	0	12	*	*	12	73	0	0
24	*	*	0	0	*	*	61	0	0	0
25	*	*	0	0	*	*	24	24	0	0
26	*	*	0	0	*	*	85	171	0	0
27	*	*	61	12	*	*	0	0	0	0
28	0	85	12	0	*	*	0	85	0	0
29	49	85			*	*	24	36	0	0
30	0	0			0	0	0	24	0	0
31	0	0			0	12			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

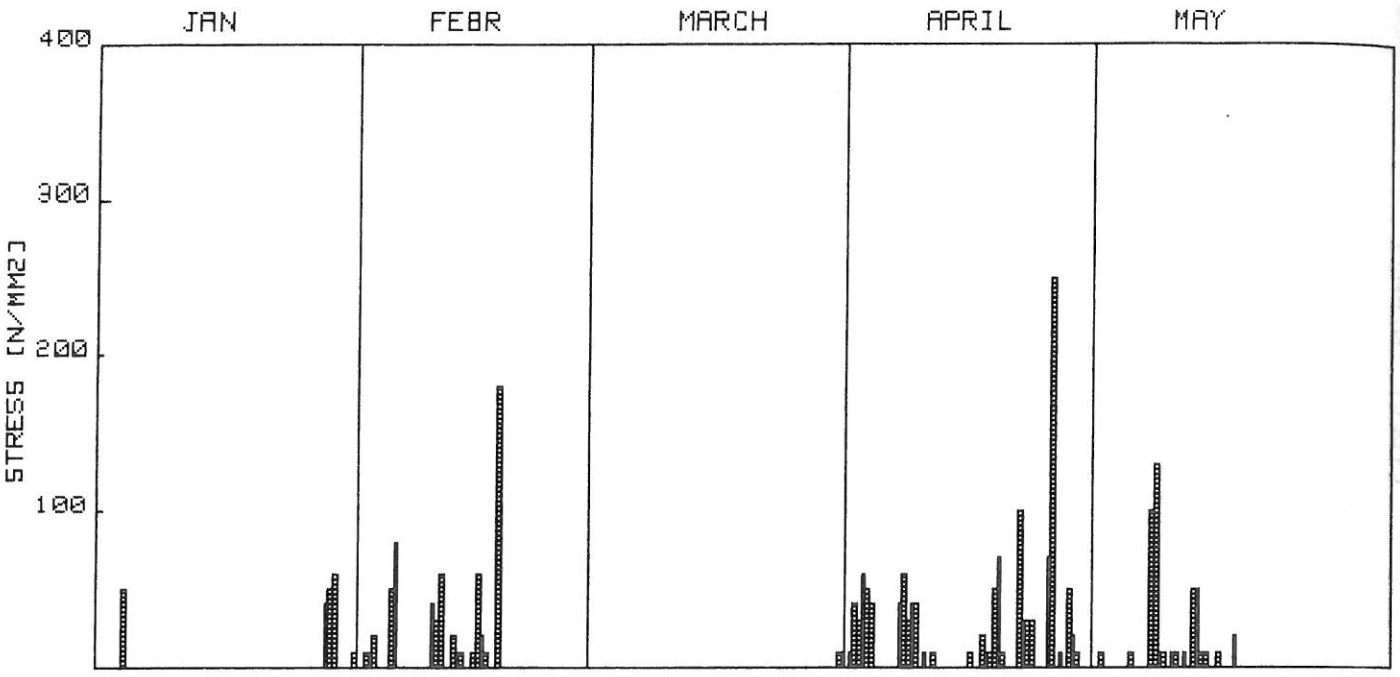


FN14

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	10	10	0	0	10	0	0	0
2	0	0	0	10	0	20	10	30	0	10
3	0	0	10	10	0	0	30	30	10	0
4	40	0	10	10	30	0	40	30	0	0
5	*	*	0	50	0	0	0	0	0	0
6	*	*	80	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	10	10
8	*	*	0	0	0	10	30	50	10	40
9	*	*	0	30	0	10	30	20	50	0
10	*	*	30	40	10	0	30	10	0	0
11	*	*	0	0	20	0	10	0	0	10
12	*	*	10	10	0	30	0	0	0	50
13	*	*	70	0	0	0	0	0	80	10
14	*	*	0	20	*	*	0	0	0	10
15	*	*	160	20	*	*	0	0	10	0
16	*	*	0	0	*	*	0	0	0	30
17	*	*	0	60	*	*	20	10	10	0
18	*	*	60	40	*	*	10	50	0	0
19	*	*	40	10	*	*	60	0	0	0
20	*	*	10	10	*	*	0	0	0	0
21	*	*	0	0	*	*	0	100	0	0
22	*	*	0	0	*	*	10	30	0	0
23	*	*	0	10	*	*	30	10	0	0
24	*	*	0	10	*	*	10	20	0	0
25	*	*	10	10	*	*	60	50	0	0
26	*	*	30	10	*	*	0	0	0	0
27	*	*	0	0	*	*	0	40	0	0
28	0	50			*	0	20	20	0	0
29	50	30			0	0	0	10	0	0
30	0	0								
31	0	0								

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

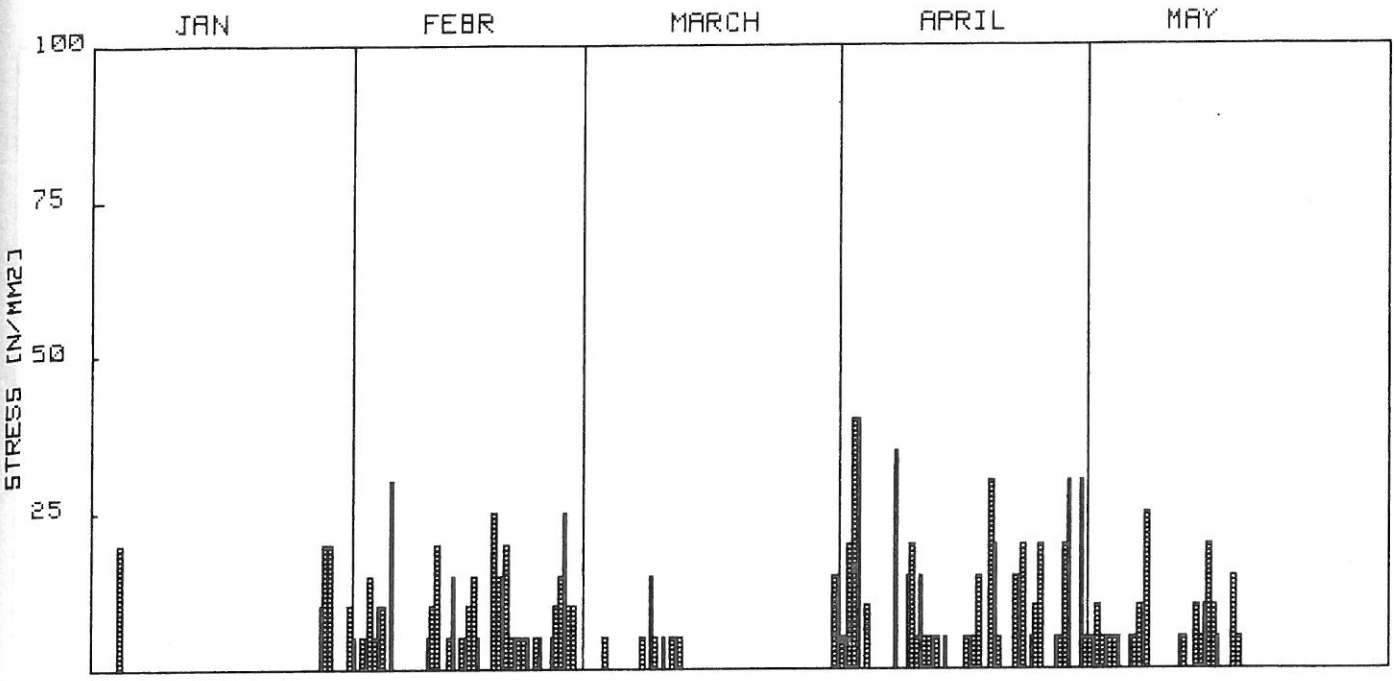


PL15

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	10	0	0	0	0	0	0	0
2	0	0	0	10	0	0	10	40	0	10
3	0	0	10	20	0	0	30	60	0	0
4	50	0	0	0	0	0	50	40	0	0
5	*	*	0	50	0	0	0	0	0	0
6	*	*	80	0	0	0	0	0	10	0
7	*	*	0	0	0	0	0	0	0	0
8	*	*	0	0	0	0	40	60	0	100
9	*	*	0	0	0	0	30	40	130	0
10	*	*	0	40	0	0	40	0	10	0
11	*	*	30	60	0	0	10	0	10	10
12	*	*	0	0	0	0	10	0	0	10
13	*	*	20	10	0	0	0	0	0	50
14	*	*	10	0	*	*	0	0	50	10
15	*	*	0	10	*	*	0	0	10	0
16	*	*	60	20	*	*	0	10	0	10
17	*	*	10	0	*	*	0	0	0	0
18	*	*	0	100	*	*	20	0	0	20
19	*	*	0	0	*	*	10	50	0	0
20	*	*	0	0	*	*	70	10	0	0
21	*	*	0	0	*	*	0	0	0	0
22	*	*	0	0	*	*	0	100	0	0
23	*	*	0	0	*	*	10	30	0	0
24	*	*	0	0	*	*	30	0	0	0
25	*	*	0	0	*	*	0	0	0	0
26	*	*	0	0	*	*	70	250	0	0
27	*	*	0	0	*	*	0	10	0	0
28	0	40	0	0	*	*	0	50	0	0
29	50	60			*	*	20	10	0	0
30	0	0			0	0	0	0	0	0
31	0	0			0	10			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

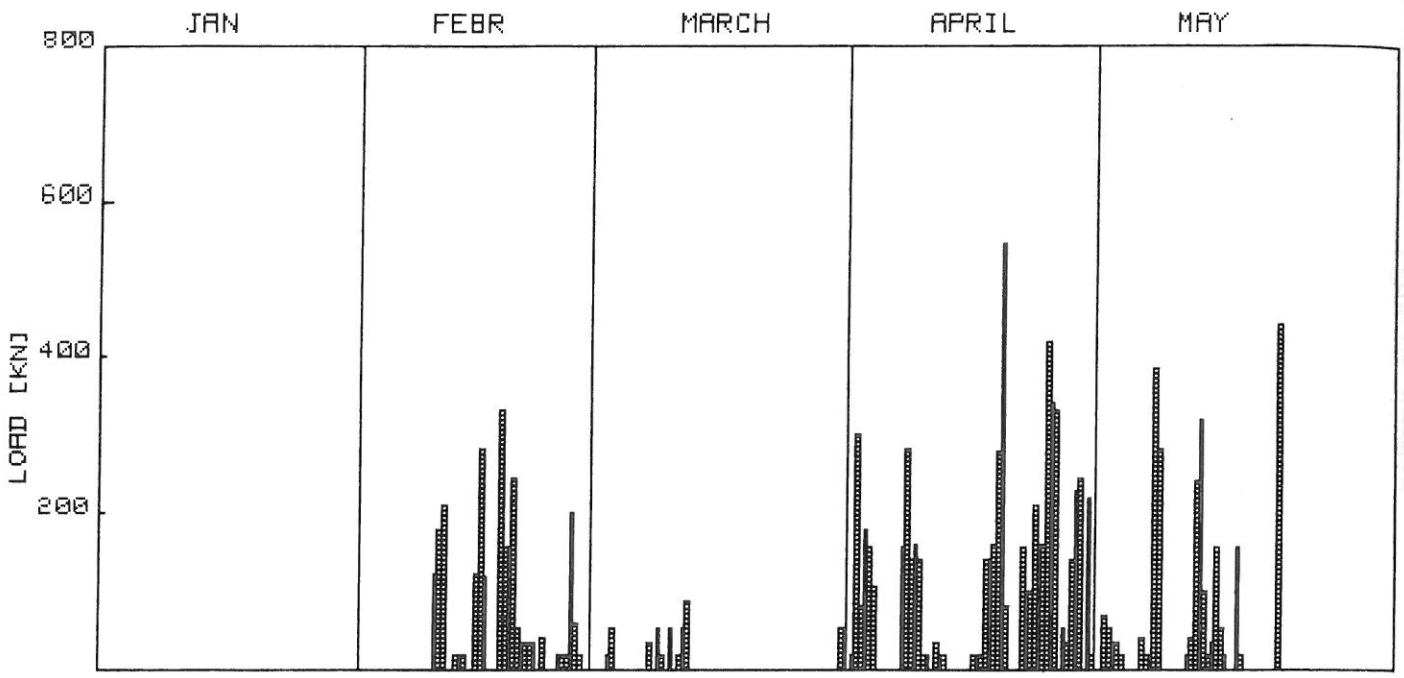


HB16 (DYNAMIC)

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	0	0	10	5	0	0	15	5	5	5
2	0	0	0	5	0	0	5	20	5	10
3	0	0	<0	15	0	<0	40	40	5	5
4	20	0	5	10	5	0	<0	10	5	5
5	*	*	10	<0	0	0	0	0	0	0
6	*	*	30	0	0	0	0	0	0	5
7	*	*	0	0	0	0	0	0	5	10
8	*	*	0	0	0	5	35	<0	5	25
9	*	*	0	0	0	15	<0	15	<0	0
10	*	*	0	5	5	0	20	5	0	0
11	*	*	10	20	5	0	15	5	0	0
12	*	*	0	0	5	5	5	5	0	5
13	*	*	5	15	5	0	5	0	5	<0
14	*	*	<0	5	*	*	5	0	<0	10
15	*	*	0	10	*	*	0	0	5	10
16	*	*	15	5	*	*	0	5	20	10
17	*	*	0	0	*	*	5	5	5	0
18	*	*	0	25	*	*	15	<0	0	<0
19	*	*	15	15	*	*	<0	30	15	5
20	*	*	20	5	*	*	20	5	0	0
21	*	*	5	5	*	*	0	<0	0	0
22	*	*	5	5	*	*	0	15	0	0
23	*	*	0	5	*	*	<0	20	<0	0
24	*	*	5	<0	*	*	<0	5	0	0
25	*	*	0	5	*	*	10	20	0	0
26	*	*	10	15	*	*	<0	<0	0	0
27	*	*	25	10	*	*	0	5	0	0
28	0	10	10	0	*	*	5	20	0	0
29	20	20			*	*	30	<0	0	0
30	0	0			0	0	0	30	0	0
31	0	0			0	15			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

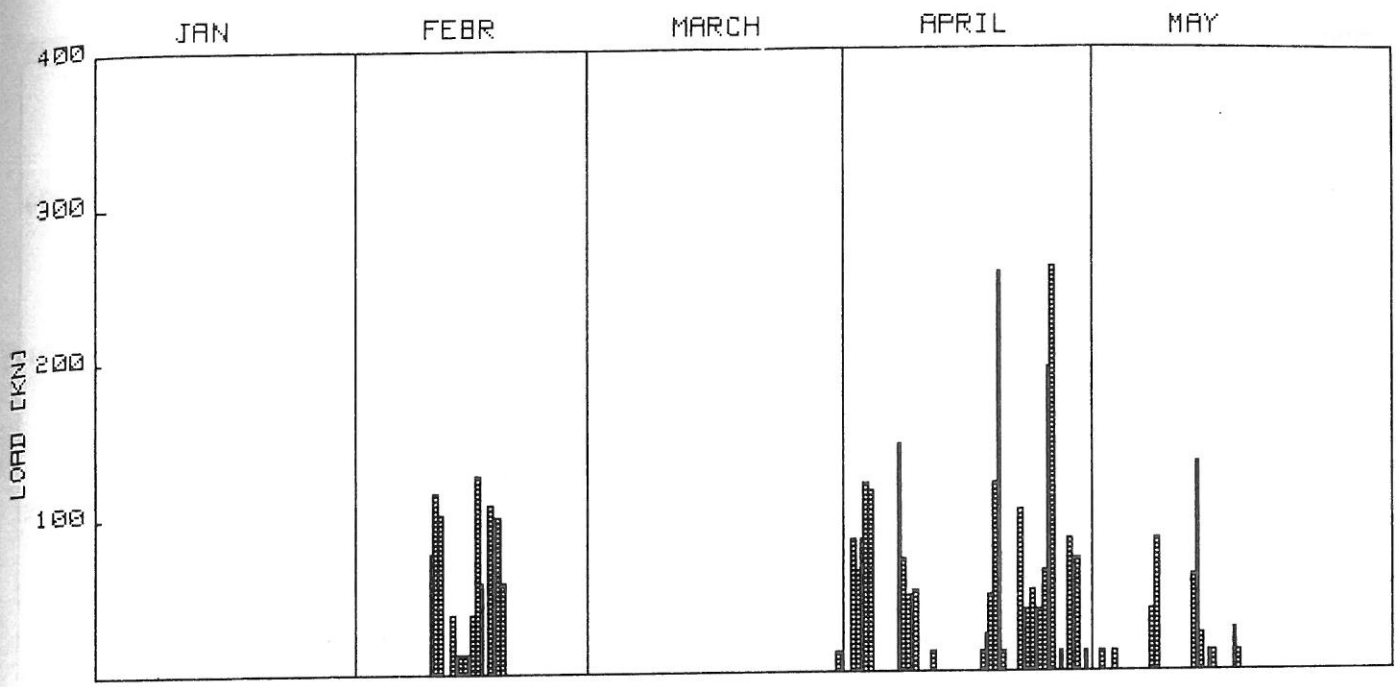


FT17

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	0	0	35	0	17	0
2	0	0	0	0	0	0	17	300	0	70
3	0	0	0	0	0	20	80	180	52	17
4	0	0	0	0	52	0	158	105	35	17
5	*	*	0	0	0	0	0	0	0	0
6	*	*	0	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	40	17
8	*	*	0	0	0	35	158	280	17	386
9	*	*	0	0	0	52	140	160	280	0
10	*	*	0	122	20	0	140	17	0	0
11	*	*	180	210	52	0	17	0	0	0
12	*	*	0	0	20	52	35	17	0	17
13	*	*	17	17	87	0	17	0	40	240
14	*	*	20	0	*	*	0	0	320	100
15	*	*	0	122	*	*	0	0	17	35
16	*	*	280	120	*	*	0	17	158	52
17	*	*	0	0	*	*	0	17	17	0
18	*	*	0	333	*	*	140	105	0	158
19	*	*	158	140	*	*	160	280	20	0
20	*	*	245	52	*	*	544	80	0	0
21	*	*	35	35	*	*	0	0	0	0
22	*	*	35	35	*	*	0	158	0	0
23	*	*	0	40	*	*	70	100	0	440
24	*	*	0	0	*	*	210	40	0	0
25	*	*	0	17	*	*	160	420	0	0
26	*	*	17	20	*	*	340	333	0	0
27	*	*	200	60	*	*	0	52	0	0
28	0	0	17	0	*	*	35	140	0	0
29	0	0			*	*	220	245	0	0
30	0	0			0	0	0	220	0	0
31	0	0			0	52			0	0

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

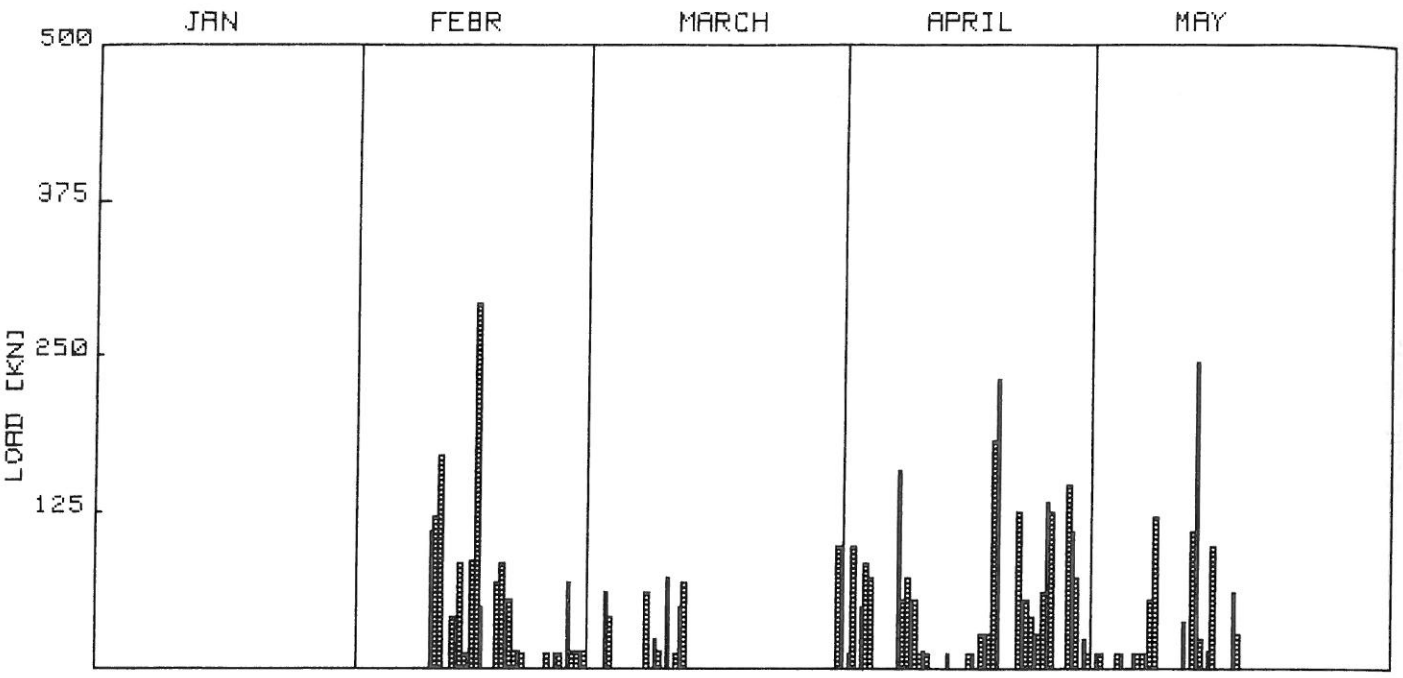


FT18

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	0	0	12	0	0	0
2	0	0	0	0	0	0	0	84	0	12
3	0	0	0	0	0	0	64	84	0	0
4	0	0	0	0	0	0	121	116	12	0
5	*	*	0	0	0	0	0	0	0	0
6	*	*	0	0	0	0	0	0	0	0
7	*	*	0	0	0	0	0	0	0	0
8	*	*	0	0	0	0	145	72	0	38
9	*	*	0	0	0	0	48	38	84	0
10	*	*	0	76	0	0	51	0	0	0
11	*	*	115	101	0	0	0	0	0	0
12	*	*	0	0	0	0	12	0	0	0
13	*	*	38	12	0	0	0	0	0	60
14	*	*	12	12	*	*	0	0	133	24
15	*	*	0	38	*	*	0	0	0	12
16	*	*	127	57	*	*	0	0	12	0
17	*	*	0	108	*	*	0	0	0	0
18	*	*	0	101	*	*	12	24	0	25
19	*	*	57	0	*	*	48	121	12	0
20	*	*	0	0	*	*	254	12	0	0
21	*	*	0	0	*	*	0	0	0	0
22	*	*	0	0	*	*	0	103	0	0
23	*	*	0	0	*	*	25	38	0	0
24	*	*	0	0	*	*	51	12	0	0
25	*	*	0	0	*	*	38	64	0	0
26	*	*	0	0	*	*	194	259	0	0
27	*	*	0	0	*	*	0	12	0	0
28	0	0	0	0	*	*	0	84	0	0
29	0	0			0	0	36	72	0	0
30	0	0			0	12	0	12	0	0
31	0	0								

* NOT MEASURED

KEMIRA 1987 MEASURED 12-HOUR MAXIMA

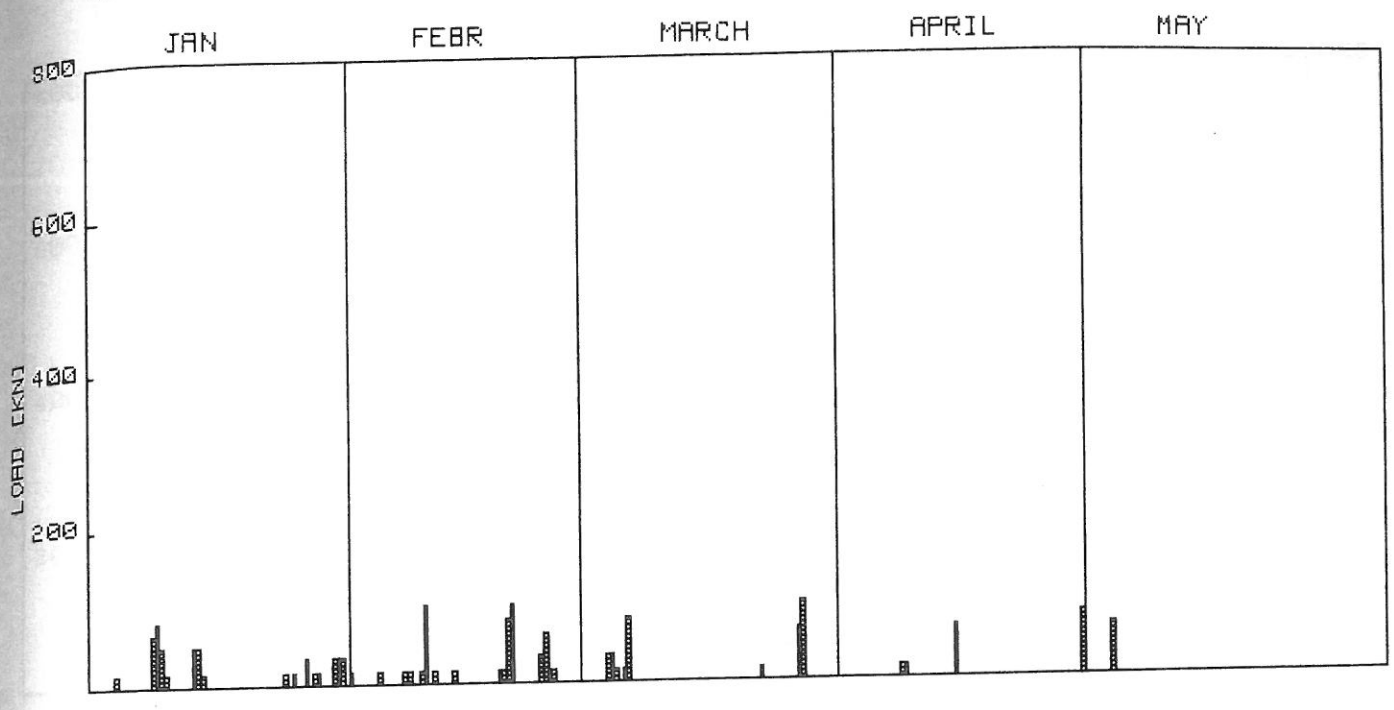


FT19

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	0	0	13	0	55	0	11	0
2	0	0	0	0	0	0	11	97	11	12
3	0	0	0	0	0	61	0	48	0	0
4	0	0	0	0	41	0	83	73	0	12
5	*	*	0	0	0	0	0	0	12	0
6	*	*	0	0	0	0	0	0	0	11
7	*	*	0	0	0	0	0	0	12	11
8	*	*	0	0	0	61	158	55	11	55
9	*	*	0	0	0	24	73	27	122	0
10	*	*	0	109	13	0	55	11	0	0
11	*	*	122	170	73	0	13	11	0	0
12	*	*	0	0	12	48	0	0	0	36
13	*	*	41	94	69	0	0	0	0	109
14	*	*	83	11	*	*	11	0	244	24
15	*	*	0	85	*	*	0	0	0	13
16	*	*	293	48	*	*	0	12	97	0
17	*	*	0	0	*	*	11	0	0	0
18	*	*	0	69	*	*	27	13	0	61
19	*	*	83	41	*	*	27	183	27	0
20	*	*	55	13	*	*	231	0	0	0
21	*	*	13	12	*	*	0	0	0	0
22	*	*	0	0	*	*	0	125	0	0
23	*	*	0	0	*	*	27	55	0	0
24	*	*	0	12	*	*	41	0	0	0
25	*	*	0	12	*	*	27	61	0	0
26	*	*	11	0	*	*	134	125	0	0
27	*	*	69	13	*	*	0	0	0	0
28	0	0	13	0	*	*	0	146	0	0
29	0	0			*	*	109	73	0	0
30	0	0			0	0	0	24	0	0
31	0	0			0	97			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

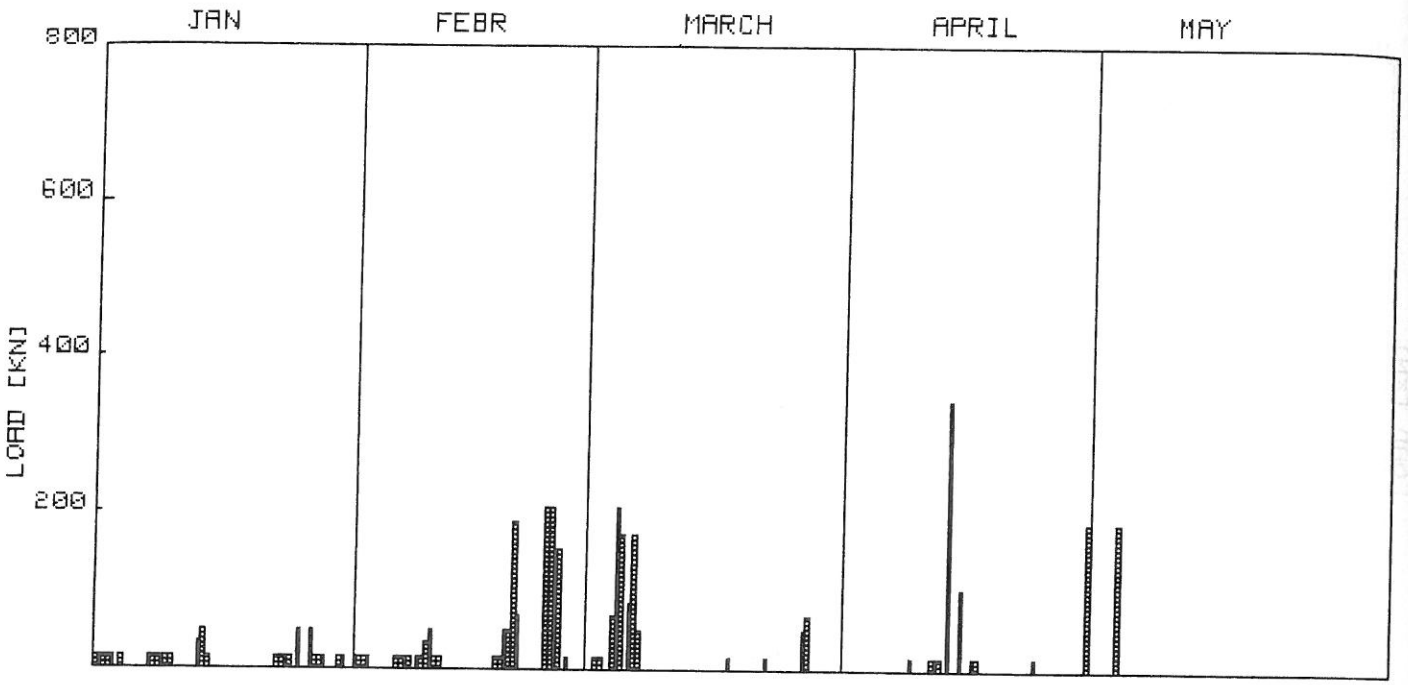


FFR1

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	0	0	0	16	0	0	*	*	*	*
2	0	0	0	0	0	0	*	*	*	*
3	0	0	0	0	0	33	*	*	*	66
4	16	0	0	0	33	16	*	*	0	0
5	0	0	16	0	<0	16	*	*	0	0
6	0	0	0	0	82	0	*	*	0	0
7	0	0	0	0	*	*	16	16	0	0
8	0	66	16	16	*	*	0	0	0	0
9	82	49	0	0	*	*	0	0	0	0
10	16	0	16	99	*	*	0	0	0	0
11	0	0	0	16	*	*	0	0	0	0
12	0	<0	0	0	*	*	0	0	0	0
13	<0	49	0	0	*	*	0	0	0	0
14	49	16	16	0	*	*	0	0	0	0
15	<0	0	0	0	*	*	0	0	0	0
16	0	0	0	0	*	*	0	0	0	0
17	0	<0	0	0	*	*	0	0	0	0
18	0	0	0	0	*	*	0	0	0	0
19	0	0	0	16	*	*	0	0	0	0
20	0	0	16	82	*	*	0	0	0	0
21	0	0	99	0	*	*	0	0	0	0
22	0	0	0	0	*	*	0	0	0	0
23	0	0	0	33	*	*	0	0	0	0
24	0	16	64	0	*	*	0	0	0	0
25	0	16	16	<0	*	*	0	0	0	0
26	<0	0	0	0	*	*	0	0	0	0
27	33	0	0	0	*	*	0	0	0	0
28	16	16	0	0	*	*	0	0	0	0
29	0	0	0	0	*	*	0	0	0	0
30	0	33					0	0	0	0
31	0	33					82		0	

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

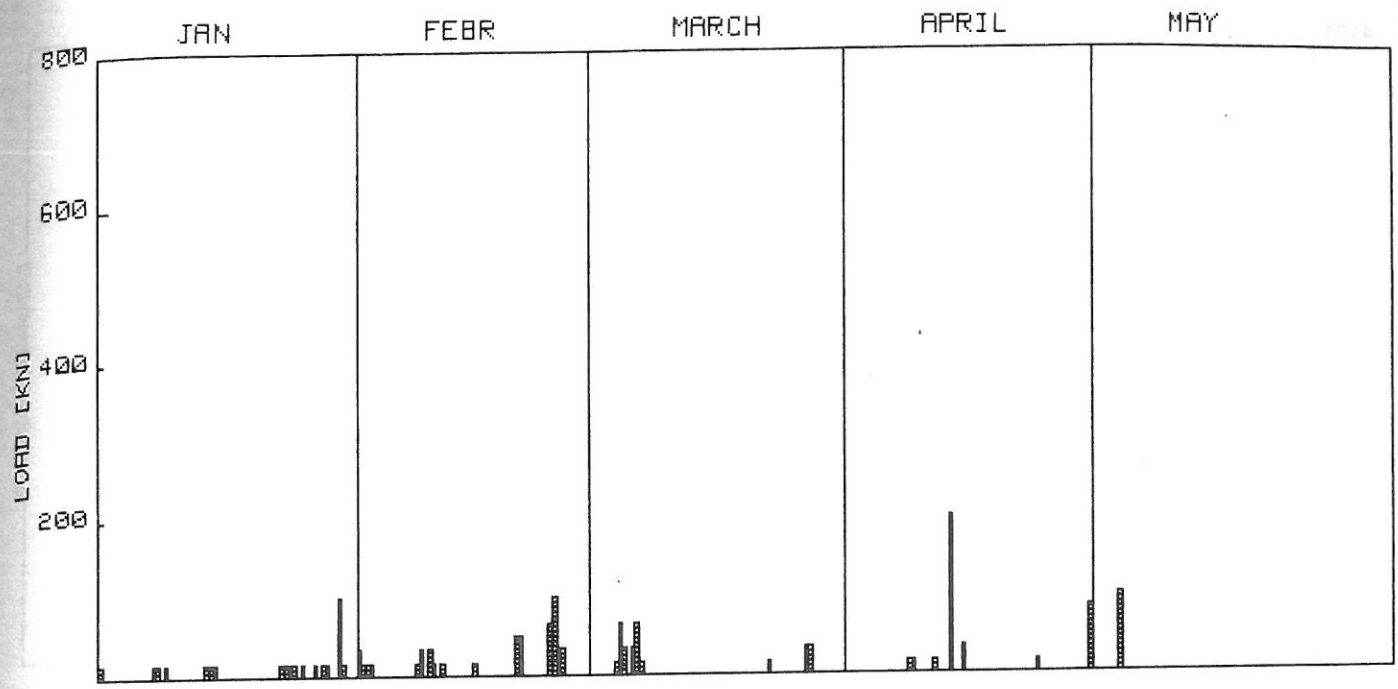


FFR2

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	17	17	0	0	0	17	*	*	*	*
2	17	17	17	17	17	0	*	*	*	*
3	17	0	17	0	0	68	*	*	*	189
4	17	0	0	0	206	172	*	*	0	0
5	0	0	0	0	0	86	*	*	0	0
6	0	0	0	17	172	51	*	*	0	0
7	0	17	17	0	*	*	*	*	0	0
8	17	17	17	0	*	*	<0	17	0	0
9	17	17	17	17	*	*	0	0	0	0
10	17	0	34	51	*	*	0	0	0	0
11	0	0	17	17	*	*	17	17	0	0
12	0	0	0	0	*	*	17	0	0	0
13	0	34	0	0	*	*	344	0	0	0
14	51	17	0	0	*	*	0	103	0	0
15	0	0	0	0	*	*	0	0	0	0
16	0	0	0	0	0	0	17	17	0	0
17	0	0	0	0	0	17	0	0	0	0
18	0	0	0	17	*	*	0	0	0	0
19	0	0	17	51	*	*	0	0	0	0
20	0	0	51	189	*	*	0	0	0	0
21	0	0	68	0	*	0	0	0	0	0
22	0	0	0	0	17	0	0	0	0	0
23	17	17	0	0	*	0	0	17	0	0
24	17	17	0	206	*	*	0	0	0	0
25	0	51	206	51	*	0	0	0	0	0
26	0	0	154	0	0	51	0	0	0	0
27	51	17	17	0	68	*	0	0	0	0
28	17	17	0	0	*	*	0	0	0	0
29	0	0	0	0	*	*	0	0	0	0
30	<0	17			*	*	189	0	0	0
31	17	0			*	*				

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

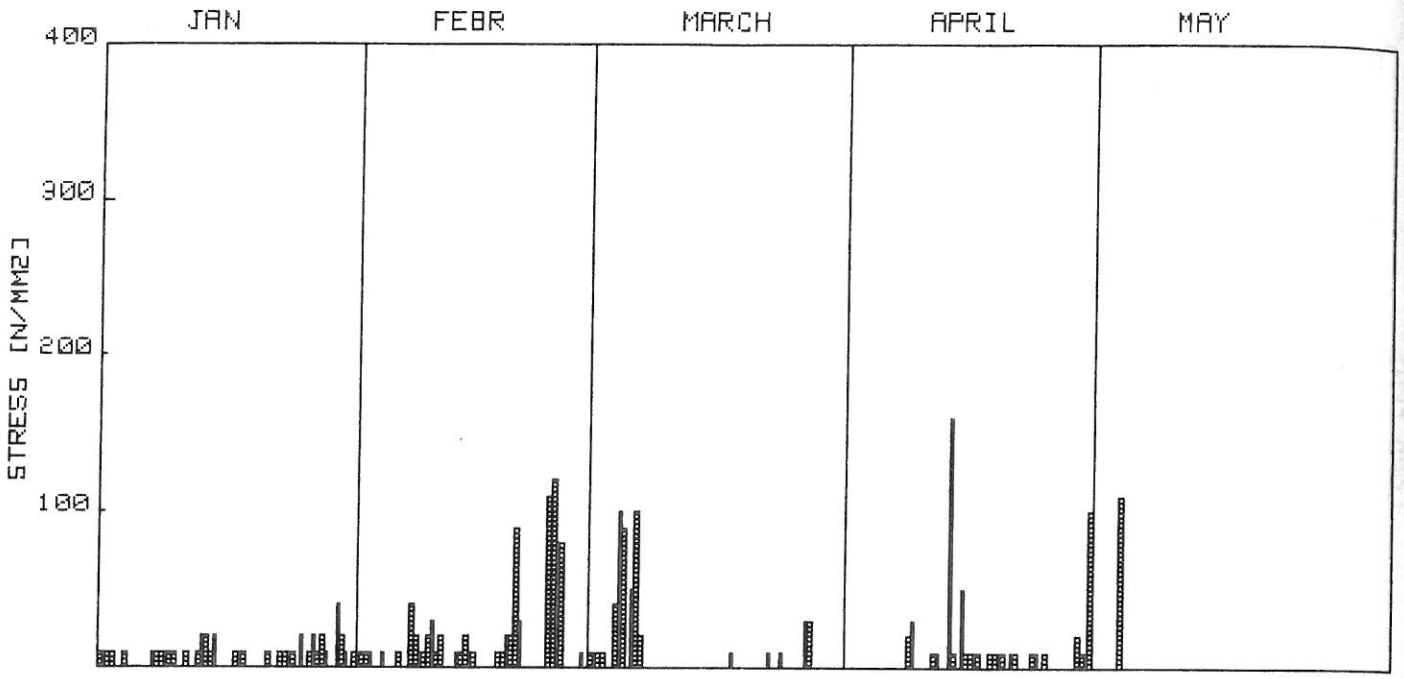


FFR3

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	16	0	0	33	0	0	*	*	*	*
2	0	0	16	16	0	0	*	*	*	*
3	0	0	16	0	0	16	*	*	*	100
4	0	0	0	0	67	33	*	*	0	0
5	0	0	0	0	0	33	*	*	0	0
6	0	0	0	0	67	16	*	*	0	0
7	0	16	0	0	*	*	*	*	0	0
8	16	0	0	16	*	*	16	16	0	0
9	16	0	33	0	*	*	0	0	0	0
10	0	0	33	16	*	*	0	0	0	0
11	0	0	<0	16	*	*	16	0	0	0
12	0	0	0	0	*	*	0	0	0	0
13	0	0	0	0	*	*	201	0	0	0
14	16	16	0	0	*	*	0	33	0	0
15	16	0	0	16	*	*	0	0	0	0
16	0	0	0	0	0	0	<0	<0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	<0	*	*	0	0	0	0
19	0	0	<0	0	*	*	0	0	0	0
20	0	0	0	50	*	*	0	0	0	0
21	0	0	50	0	*	0	0	0	0	0
22	0	0	0	0	16	0	0	0	0	0
23	16	16	0	0	*	0	0	16	0	0
24	0	16	0	67	*	*	0	0	0	0
25	0	16	100	33	*	0	0	0	0	0
26	0	0	33	0	0	33	0	0	0	0
27	16	<0	0	0	33	*	0	0	0	0
28	16	16	0	0	*	*	0	0	0	0
29	0	0	0	0	*	*	0	0	0	0
30	100	16			*	*	83	0	0	0
31	0	0			*	*				

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

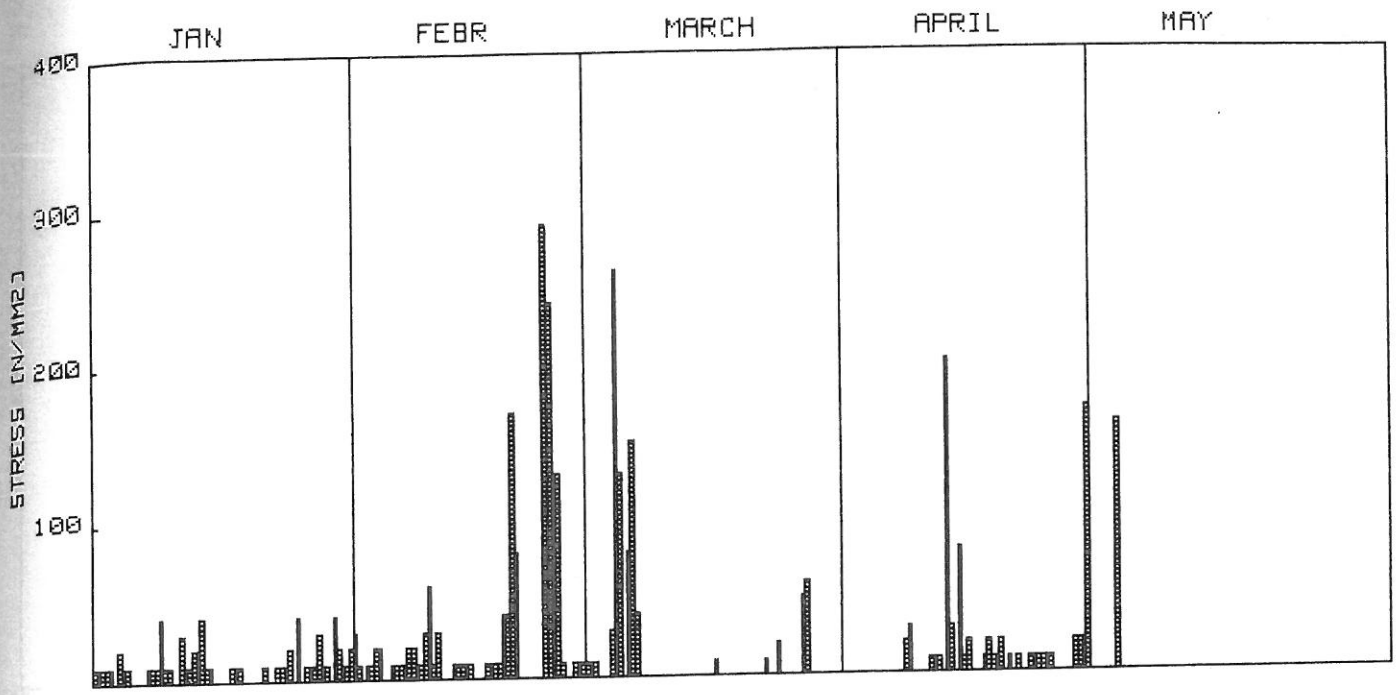


FN4

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	10	10	10	10	0	10	*	*	*	*
2	10	10	10	10	10	0	*	*	*	*
3	0	0	10	0	0	40	*	*	*	110
4	10	0	0	10	100	90	*	*	0	0
5	0	0	0	0	0	50	*	*	0	0
6	0	0	0	10	100	20	*	*	0	0
7	0	10	0	0	*	*	*	*	0	0
8	10	10	40	20	*	*	20	30	0	0
9	10	10	10	10	*	*	0	0	0	0
10	10	0	20	30	*	*	0	0	0	0
11	0	10	10	20	*	*	10	10	0	0
12	0	0	0	0	*	*	0	0	0	0
13	10	20	0	10	*	*	160	10	0	0
14	20	10	10	20	*	*	0	50	0	0
15	20	0	0	10	*	*	10	10	0	0
16	0	0	0	0	0	0	10	10	0	0
17	0	10	0	0	0	10	0	0	0	0
18	0	10	<0	10	*	*	10	10	0	0
19	0	0	10	20	*	*	0	10	0	0
20	0	0	20	90	*	*	0	10	0	0
21	0	10	30	0	*	0	10	0	0	0
22	0	<0	0	0	10	0	0	0	0	0
23	10	10	0	0	*	10	10	10	0	0
24	10	10	0	110	*	*	0	10	0	0
25	0	20	120	20	*	0	0	0	0	0
26	0	10	80	0	0	30	0	0	0	0
27	20	10	<0	0	30	*	0	0	0	0
28	20	10	<0	10	*	*	0	20	0	0
29	0	0	0	10	*	*	10	0	0	0
30	40	20			*	*	100	0	0	0
31	10	0			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

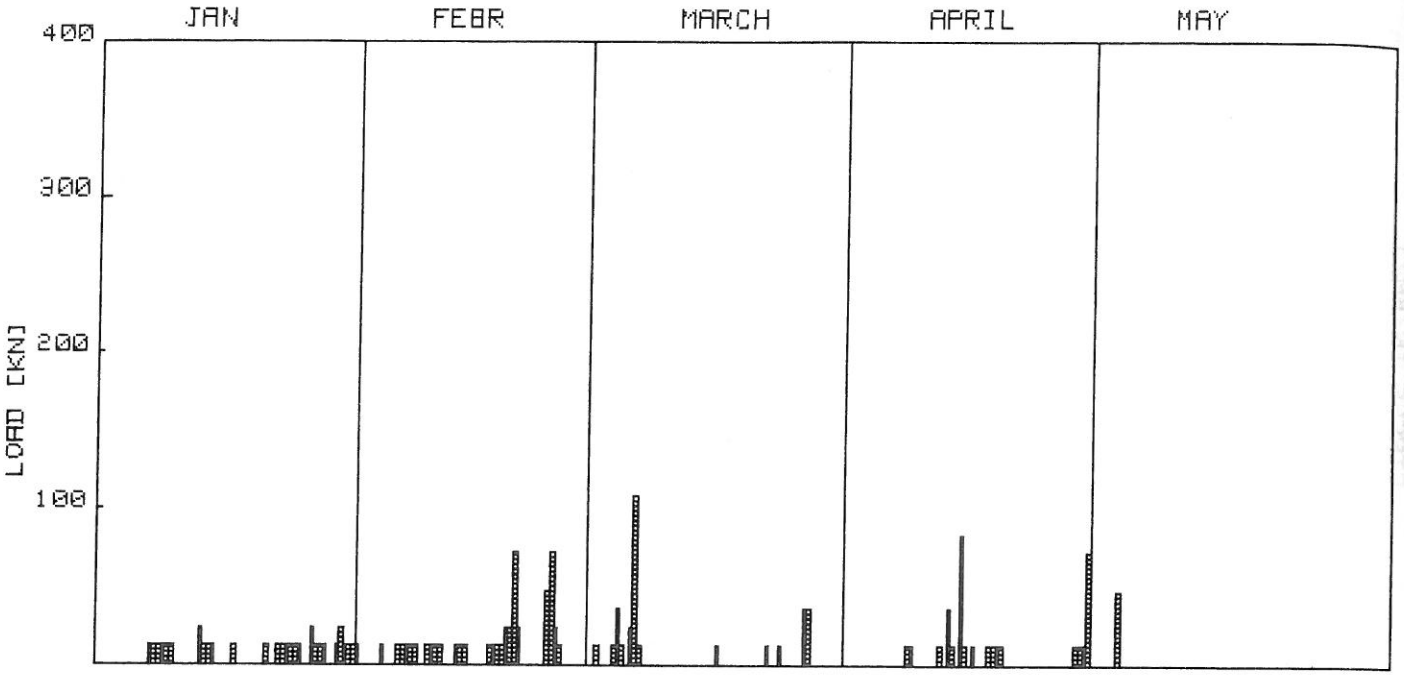


PL5

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	10	10	20	30	0	10	*	*	*	*
2	10	10	10	0	0	0	*	*	*	*
3	10	0	10	10	0	30	*	*	*	160
4	20	0	20	20	260	130	*	*	0	0
5	10	0	0	0	0	80	*	*	0	0
6	0	0	10	10	150	40	*	*	0	0
7	0	10	10	10	*	*	20	30	0	0
8	10	10	200	20	*	*	0	0	0	0
9	40	10	10	10	*	*	0	0	0	0
10	10	0	30	60	*	*	10	10	0	0
11	0	30	10	30	*	*	10	0	0	0
12	0	10	0	0	*	*	200	30	0	0
13	20	20	0	10	*	*	0	80	0	0
14	40	10	10	10	*	*	10	20	0	0
15	10	0	0	10	10	0	0	0	0	0
16	0	0	0	0	0	0	0	10	0	0
17	0	10	0	10	*	*	20	10	0	0
18	0	10	10	10	*	*	0	20	0	0
19	0	0	10	40	*	*	0	10	0	0
20	0	0	40	170	*	*	0	10	0	0
21	0	10	80	0	0	0	0	0	0	0
22	0	0	0	0	10	0	10	10	0	0
23	10	10	0	0	*	20	10	10	0	0
24	10	20	0	290	*	*	0	10	0	0
25	0	40	240	40	0	0	0	0	0	0
26	0	10	130	10	0	50	0	0	0	0
27	10	10	0	0	60	*	0	20	0	0
28	30	10	10	10	*	*	20	10	0	0
29	10	0	10	10	*	*	170	0	0	0
30	40	20			*	*			0	0
31	10	10								

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

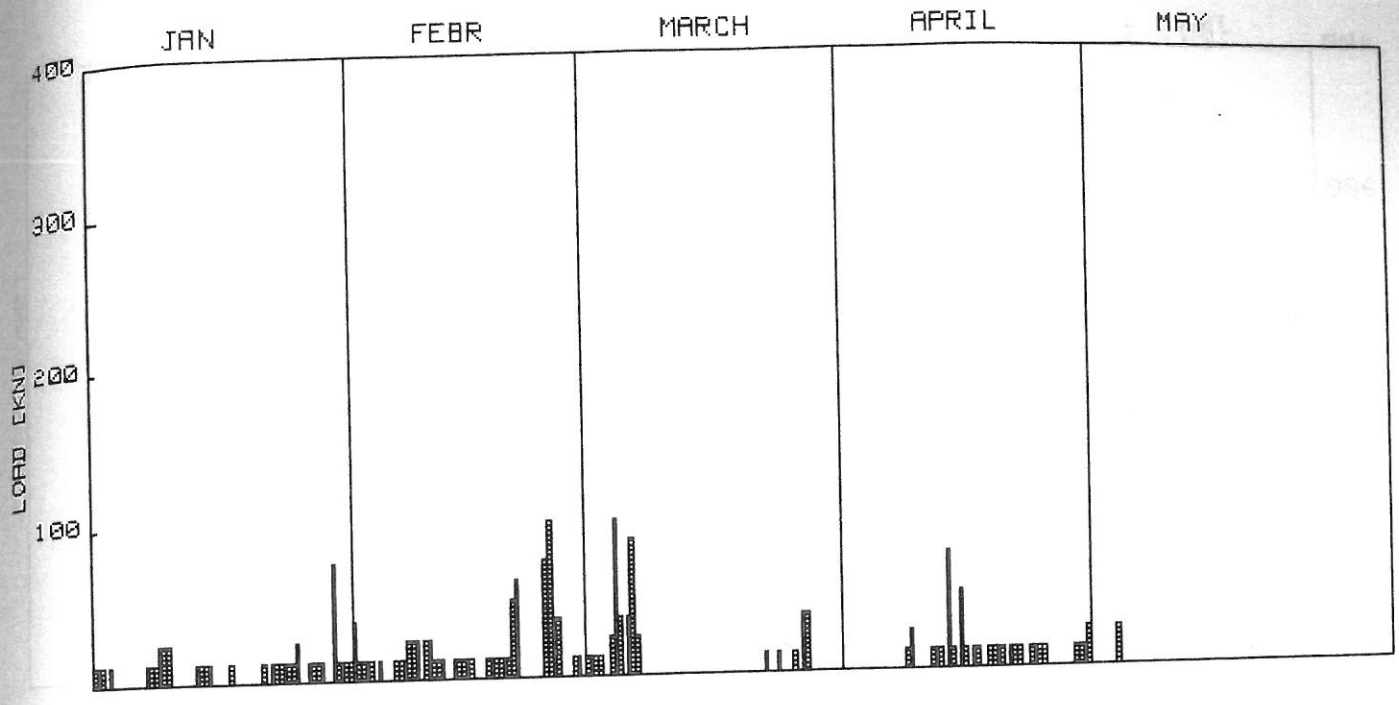


FFR6

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	0	0	11	11	0	11	*	*	*	*
2	0	0	0	0	0	0	*	*	*	*
3	0	0	0	0	0	11	*	*	*	47
4	0	0	0	11	35	11	*	*	0	0
5	0	0	0	0	0	23	*	*	0	0
6	0	0	0	11	107	11	*	*	0	0
7	0	11	11	11	*	*	*	*	0	0
8	11	11	11	11	*	*	11	11	0	0
9	11	11	0	0	*	*	0	0	0	0
10	11	0	11	11	*	*	0	0	0	0
11	0	0	11	11	*	*	0	0	0	0
12	0	0	0	0	*	*	11	0	0	0
13	0	23	0	11	*	*	35	11	0	0
14	11	11	11	11	*	*	0	83	0	0
15	11	0	0	0	*	*	11	0	0	0
16	0	0	0	0	11	0	11	0	0	0
17	0	11	0	11	0	0	0	0	0	0
18	0	0	0	11	*	*	11	11	0	0
19	0	0	11	23	*	*	0	11	0	0
20	0	0	23	71	*	*	0	0	0	0
21	0	11	23	0	*	0	0	0	0	0
22	0	0	0	0	11	0	0	0	0	0
23	11	11	0	0	*	11	0	0	0	0
24	11	11	0	47	*	*	0	0	0	0
25	11	11	71	23	*	0	0	0	0	0
26	0	0	11	0	0	35	0	0	0	0
27	23	11	0	0	35	*	0	0	0	0
28	11	11	0	0	*	*	0	11	0	0
29	0	0	0	0	*	*	11	0	0	0
30	11	23			*	*	71	0	0	0
31	11	11			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

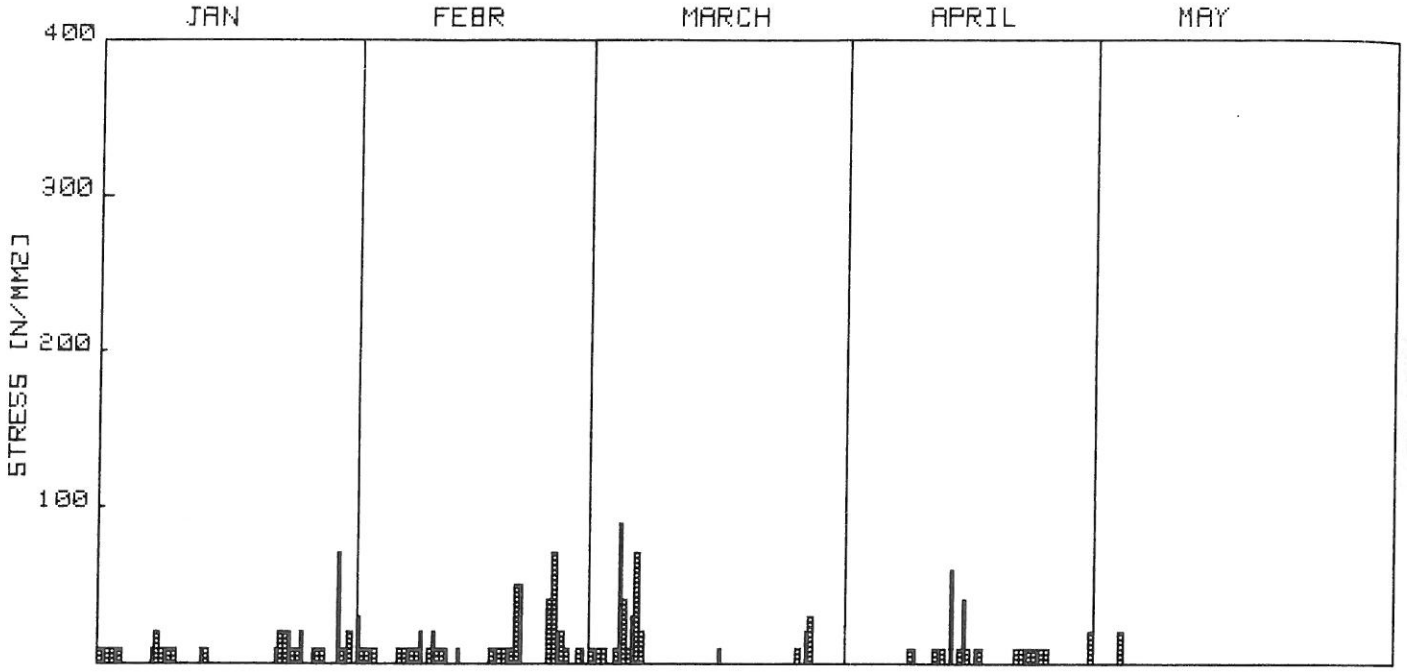


FFR7

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	12	12	12	37	0	12	*	*	*	*
2	12	0	12	12	12	0	*	*	*	*
3	12	0	12	12	0	24	*	*	*	24
4	0	0	0	12	99	37	*	*	0	0
5	0	0	0	0	0	37	*	*	0	0
6	0	0	0	12	87	24	*	*	0	0
7	0	12	12	12	*	*	*	*	0	0
8	12	12	24	24	*	*	*	*	0	0
9	24	24	24	0	*	*	*	*	0	0
10	24	0	24	24	*	*	12	24	0	0
11	0	0	12	12	*	*	0	0	0	0
12	0	0	0	0	*	*	12	12	0	0
13	0	12	0	12	*	*	12	0	0	0
14	12	12	12	12	*	*	74	12	0	0
15	12	0	0	12	*	*	0	49	0	0
16	0	0	0	0	*	*	12	0	0	0
17	0	12	0	12	*	*	12	12	0	0
18	0	0	12	12	*	*	0	12	0	0
19	0	0	12	12	*	*	0	12	0	0
20	0	0	12	49	*	*	0	12	0	0
21	0	12	62	0	*	*	0	12	0	0
22	0	12	0	0	*	*	12	12	0	0
23	12	12	0	0	*	*	12	12	0	0
24	12	12	0	74	*	*	0	0	0	0
25	12	24	99	37	*	*	0	0	0	0
26	0	0	37	0	*	*	0	0	0	0
27	12	12	0	12	*	*	0	0	0	0
28	12	12	12	12	*	*	0	0	0	0
29	0	0	0	12	*	*	0	12	0	0
30	74	12	0	0	*	*	12	0	0	0
31	12	12	0	0	*	*	24	0	0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

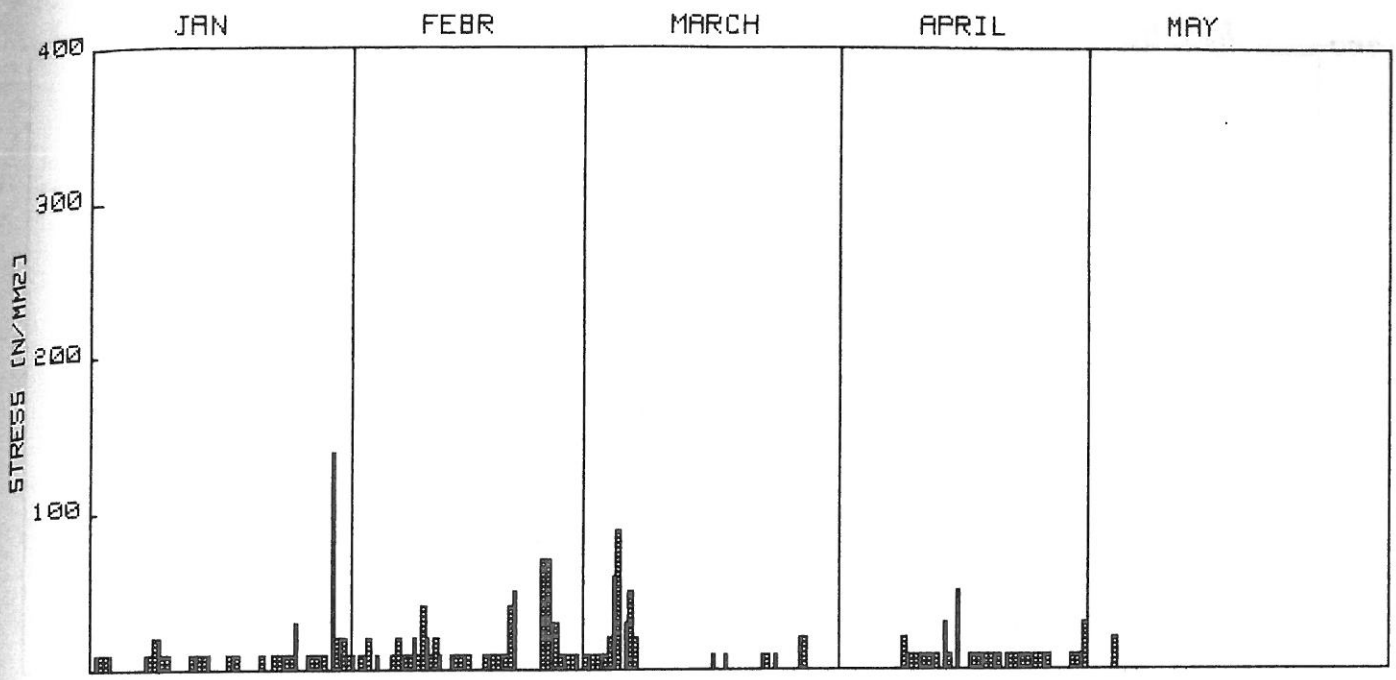


FN9

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	10	10	0	30	10	10	*	*	*	*
2	10	10	10	10	10	0	*	*	*	*
3	10	10	10	10	0	10	*	*	*	20
4	<0	0	0	0	90	40	*	*	0	0
5	0	0	0	0	10	30	*	*	0	0
6	0	0	0	10	70	20	*	*	0	0
7	0	10	10	10	*	*	*	*	0	0
8	20	10	10	10	*	*	10	10	0	0
9	10	10	20	0	*	*	0	0	0	0
10	10	0	10	20	*	*	0	0	0	0
11	0	0	10	10	*	*	10	10	0	0
12	0	0	10	0	*	*	10	0	0	0
13	0	10	0	10	*	*	60	0	0	0
14	10	0	0	0	*	*	10	40	0	0
15	0	0	0	0	*	*	10	0	0	0
16	0	0	0	0	10	0	10	10	0	0
17	0	0	0	10	0	0	0	0	0	0
18	0	0	10	10	*	*	0	0	0	0
19	0	0	10	10	*	*	0	0	0	0
20	0	0	10	50	*	*	0	0	0	0
21	0	0	50	0	*	0	10	10	0	0
22	0	10	0	0	0	0	0	10	0	0
23	20	20	0	0	*	0	10	10	0	0
24	20	10	0	40	*	*	10	10	0	0
25	10	20	70	20	*	10	0	0	0	0
26	0	0	20	10	<0	20	0	0	0	0
27	10	10	0	0	30	*	0	0	0	0
28	10	0	10	10	*	*	0	0	0	0
29	0	0	0	10	*	*	0	0	0	0
30	70	10			*	*	20	0	0	0
31	10	20			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

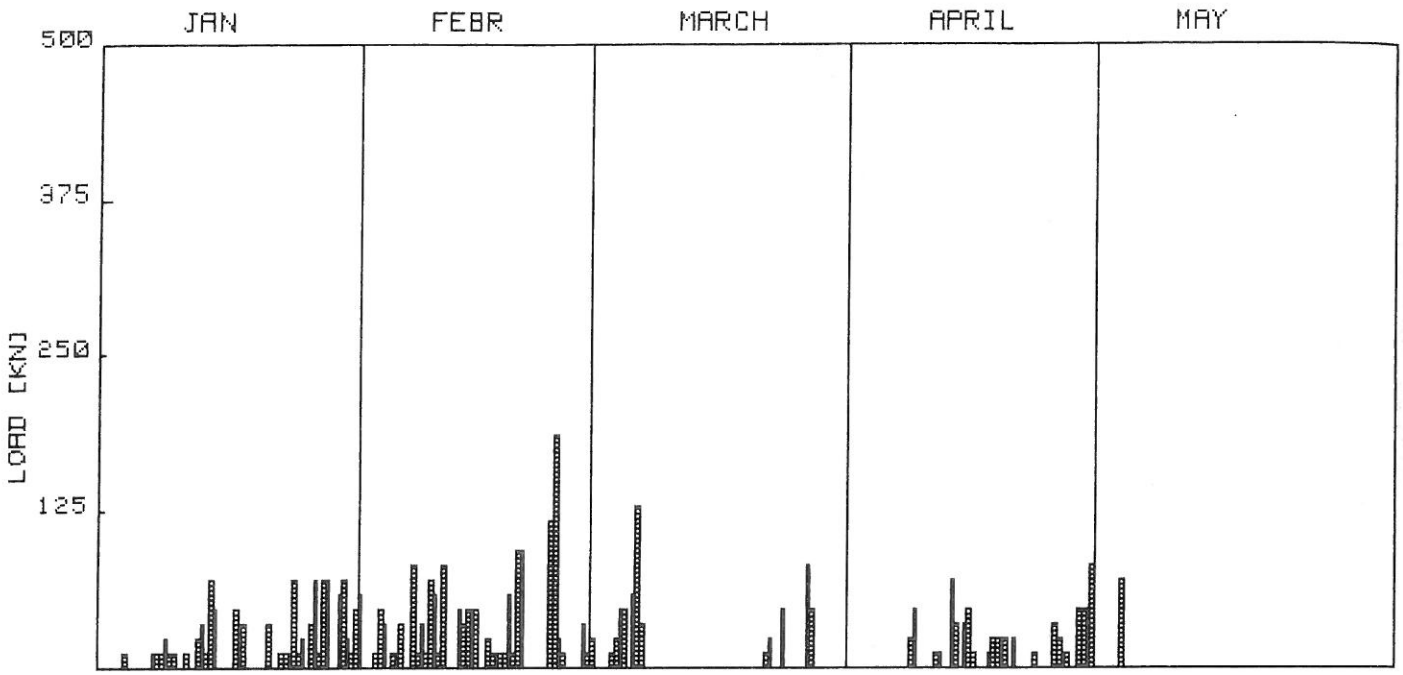


PL10

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	<0	10	10	10	10	10	*	*	*	*
2	10	10	<0	10	10	0	*	*	*	*
3	10	0	10	20	10	20	*	*	*	20
4	0	0	0	10	60	90	*	*	0	0
5	0	0	0	0	0	30	*	*	0	0
6	0	0	0	10	50	20	*	*	0	0
7	0	10	20	10	*	*	*	*	0	0
8	10	20	10	10	*	*	20	10	0	0
9	20	10	20	10	*	*	10	10	0	0
10	10	0	40	20	*	*	10	10	0	0
11	0	0	10	20	*	*	10	10	0	0
12	0	0	10	0	*	*	10	0	0	0
13	10	10	0	10	*	*	30	10	0	0
14	10	10	10	10	*	*	0	50	0	0
15	10	0	0	10	*	*	0	0	0	0
16	0	0	0	0	10	0	10	10	0	0
17	0	10	0	10	0	10	10	0	0	0
18	0	10	10	10	*	*	10	10	0	0
19	0	0	10	10	*	*	0	10	0	0
20	0	0	10	40	*	*	0	10	0	0
21	0	10	50	0	*	0	10	10	0	0
22	0	0	0	0	10	10	10	10	0	0
23	10	10	0	0	*	10	10	10	0	0
24	10	10	0	70	*	*	10	10	0	0
25	10	30	70	20	*	0	10	10	0	0
26	0	0	30	10	0	20	0	0	0	0
27	10	10	10	10	20	*	0	0	0	0
28	10	10	10	10	*	*	0	10	0	0
29	10	0	0	10	*	*	10	0	0	0
30	140	20			*	*	30	0	0	0
31	10	20			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

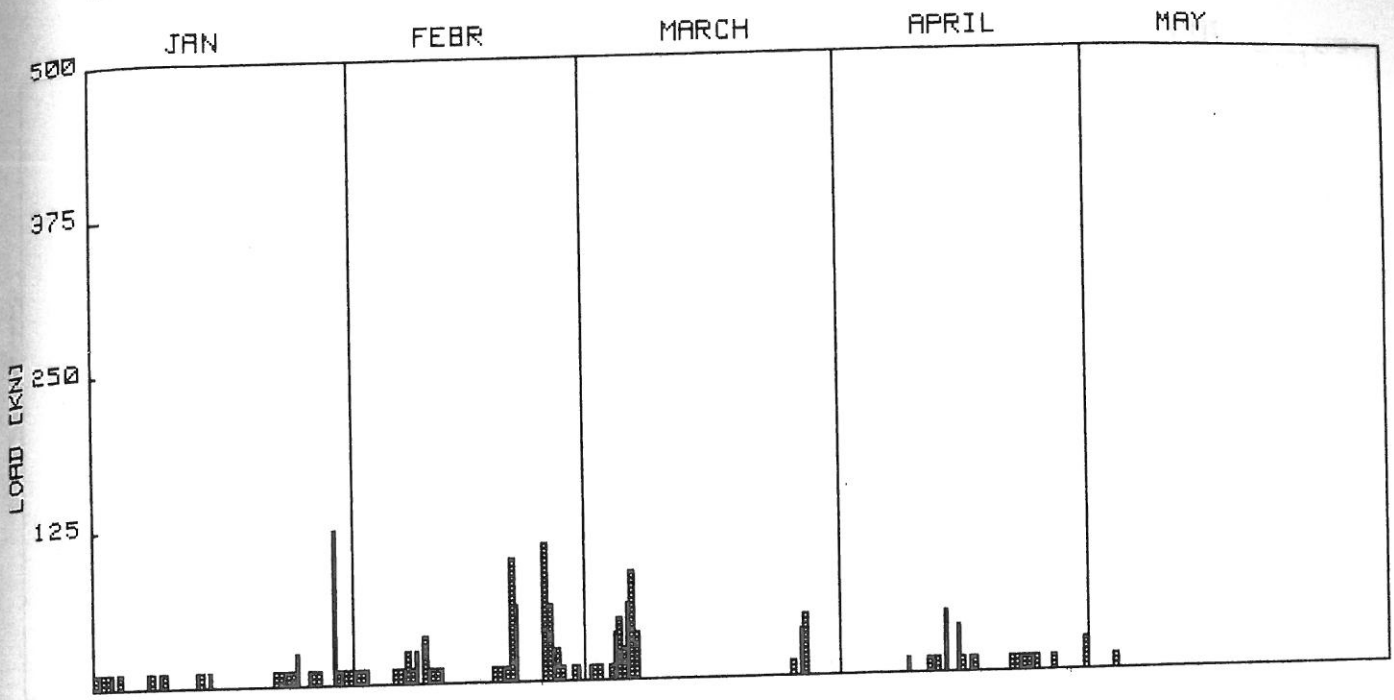


FFR11

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	0	0	46	58	0	0	*	*	*	*
2	0	0	0	0	0	0	*	*	*	*
3	0	0	0	11	11	23	*	*	*	70
4	11	0	46	35	46	46	*	*	0	0
5	0	0	0	11	0	58	*	*	0	0
6	0	0	11	35	128	35	*	*	0	0
7	0	11	0	0	*	*	*	*	0	0
8	11	11	81	11	*	*	23	46	0	0
9	23	11	35	11	*	*	0	0	0	0
10	11	0	70	58	*	*	0	0	0	0
11	0	11	11	81	*	*	11	11	0	0
12	0	0	0	0	*	*	0	0	0	0
13	23	35	0	46	*	*	70	35	0	0
14	11	70	35	46	*	*	0	35	0	0
15	46	0	0	46	*	*	46	11	0	0
16	0	0	0	0	0	0	0	0	0	0
17	0	46	23	11	0	0	0	11	0	0
18	0	35	0	11	*	*	23	23	0	0
19	0	0	11	58	*	*	0	23	0	0
20	0	0	11	93	*	*	0	23	0	0
21	0	35	93	0	*	11	0	0	0	0
22	0	0	0	0	23	0	0	0	0	0
23	11	11	0	0	*	46	11	0	0	0
24	11	70	0	117	*	*	0	0	0	0
25	11	23	187	23	*	0	0	35	0	0
26	0	35	11	0	0	81	23	0	0	0
27	70	11	0	0	46	*	11	0	0	0
28	70	70	0	35	*	*	0	46	0	0
29	0	0	11	23	*	*	46	11	0	0
30	58	70			*	*	81	0	0	0
31	23	11			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

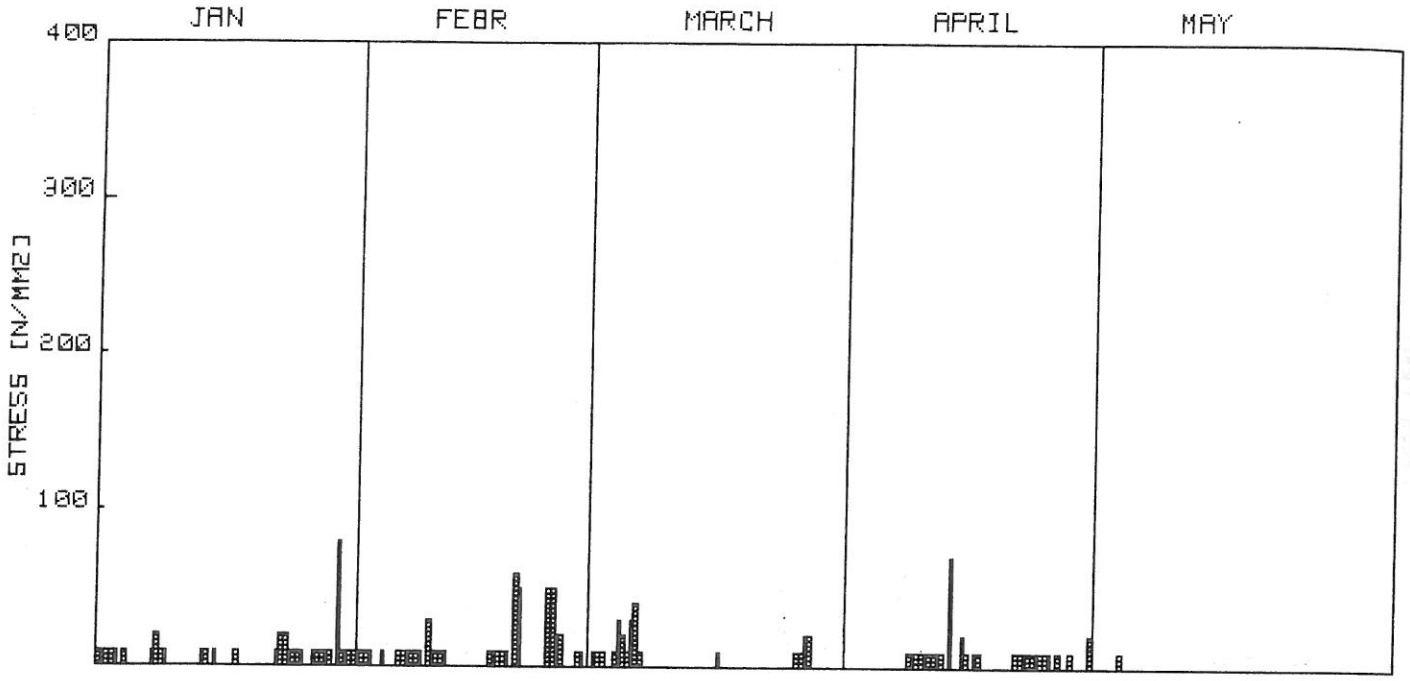


FFR12

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	12	12	12	12	12	12	*	*	*	*
2	12	12	12	12	12	0	*	*	*	12
3	12	0	12	0	0	12	*	*	0	0
4	12	0	0	0	36	49	*	*	0	0
5	0	0	0	0	24	61	*	*	0	0
6	0	0	0	12	85	36	*	*	0	0
7	0	12	12	12	*	*	*	*	0	0
8	12	0	24	12	*	*	0	12	0	0
9	12	12	24	<0	*	*	0	0	0	0
10	0	0	36	12	*	*	12	12	0	0
11	0	0	12	12	*	*	12	0	0	0
12	0	0	0	0	*	*	49	0	0	0
13	0	12	0	0	*	*	0	36	0	0
14	12	0	0	0	*	*	12	0	0	0
15	12	0	0	0	*	*	12	12	0	0
16	0	0	0	0	*	0	0	0	0	0
17	0	0	0	0	*	0	0	0	0	0
18	0	0	0	12	*	*	0	0	0	0
19	0	0	12	12	*	*	0	0	0	0
20	0	0	12	98	*	*	0	0	0	0
21	0	0	61	0	*	0	0	12	0	0
22	0	<0	0	0	*	*	0	12	0	0
23	12	12	0	0	*	*	0	12	0	0
24	12	12	0	110	*	*	0	0	0	0
25	12	24	24	12	*	*	0	0	0	0
26	0	0	0	12	*	0	0	0	0	0
27	12	12	0	0	*	49	0	0	0	0
28	12	0	12	12	*	*	0	0	0	0
29	0	0	0	0	*	*	0	0	0	0
30	122	12			*	*	0	0	0	0
31	12	12					24	0		

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

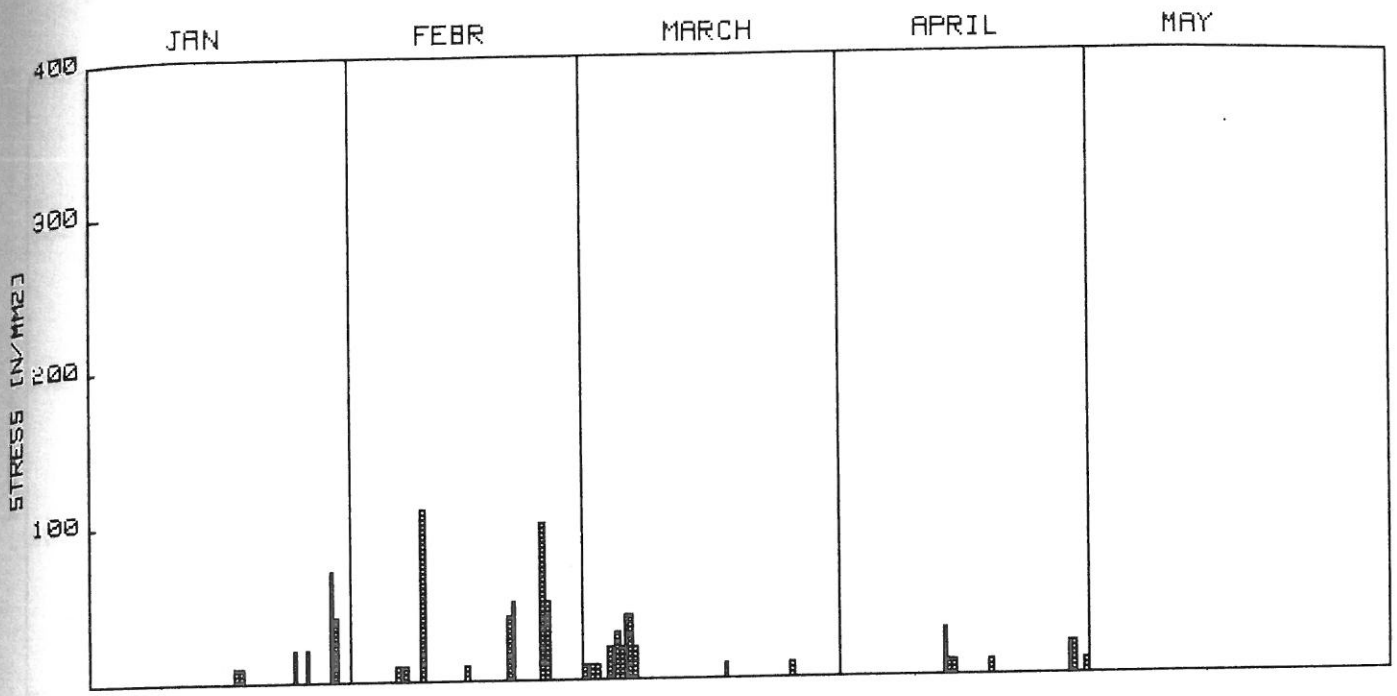


FN14

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	10	10	10	10	10	10	*	*	*	*
2	10	10	10	10	10	0	*	*	*	*
3	10	0	10	0	0	10	*	*	*	10
4	10	0	0	10	30	20	*	*	0	0
5	0	0	0	0	10	30	*	*	0	0
6	0	0	0	10	40	10	*	*	0	0
7	0	10	10	10	*	*	*	*	0	0
8	20	10	10	10	*	*	10	10	0	0
9	10	0	10	0	*	*	10	10	0	0
10	0	0	30	10	*	*	0	10	0	0
11	0	0	10	10	*	*	10	10	0	0
12	0	0	10	0	*	*	10	0	0	0
13	0	10	0	0	*	*	70	0	0	0
14	10	0	0	0	*	*	0	20	0	0
15	10	0	0	0	*	*	10	0	0	0
16	0	0	0	0	10	0	10	10	0	0
17	0	10	0	10	0	0	0	0	0	0
18	0	0	10	10	*	*	0	0	0	0
19	0	0	10	10	*	*	0	0	0	0
20	0	0	0	60	*	*	0	0	0	0
21	0	0	50	0	*	0	10	10	0	0
22	0	10	0	0	0	0	10	10	0	0
23	20	20	0	0	*	0	10	10	0	0
24	10	10	0	50	*	*	10	0	0	0
25	10	10	50	10	*	10	10	0	0	0
26	0	0	20	0	10	20	0	10	0	0
27	10	10	0	0	20	*	0	0	0	0
28	10	10	10	10	*	*	0	0	0	0
29	10	0	0	0	*	*	20	0	0	0
30	80	10			*	*			0	0
31	10	10			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

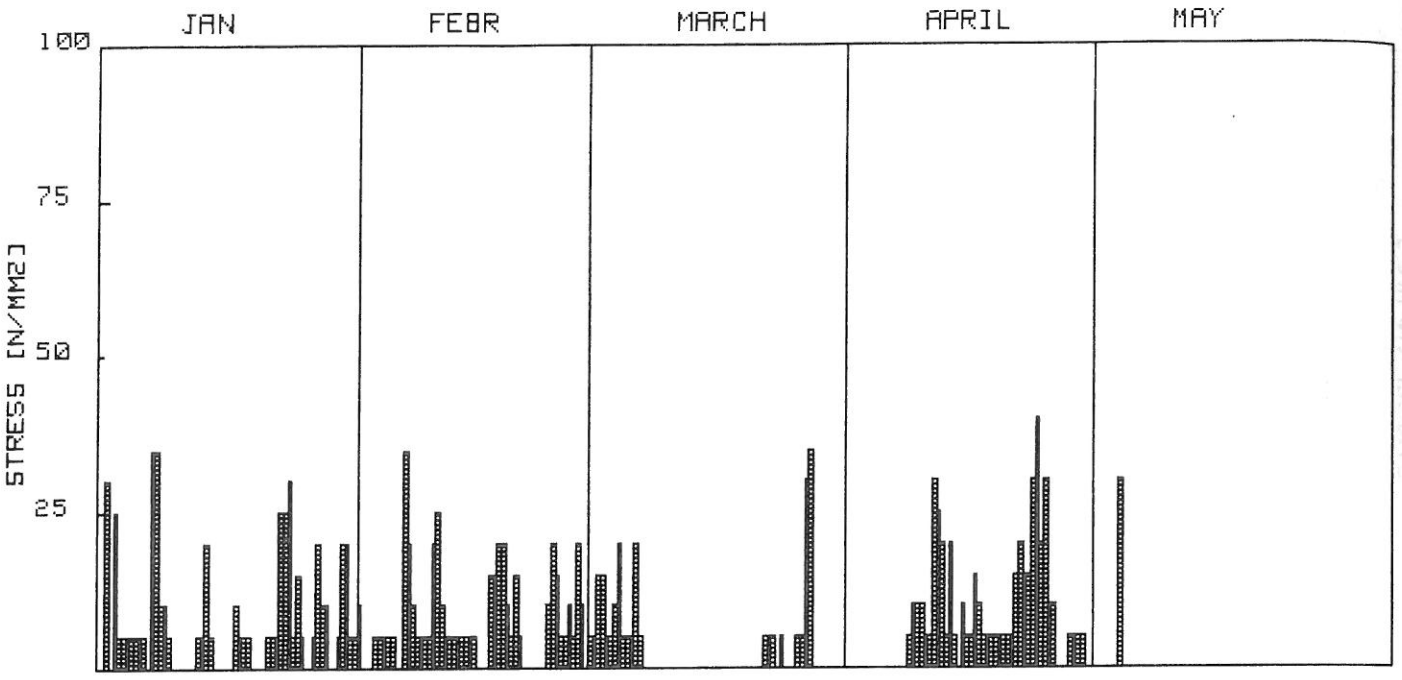


PL15

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	<0	<0	0	0	0	10	*	*	*	*
2	<0	<0	<0	<0	10	0	*	*	*	<0
3	<0	<0	<0	0	0	20	*	*	0	0
4	<0	<0	0	0	20	30	*	*	0	0
5	<0	<0	<0	<0	20	40	*	*	0	0
6	<0	<0	<0	<0	40	20	*	*	0	0
7	<0	0	10	10	*	*	<0	<0	0	0
8	0	0	10	<0	*	*	0	0	0	0
9	0	0	<0	0	*	*	<0	0	0	0
10	0	0	10	0	*	*	<0	0	0	0
11	0	0	0	<0	*	*	30	0	0	0
12	0	<0	0	0	*	*	10	0	0	0
13	0	<0	0	0	*	*	0	0	0	0
14	0	0	<0	<0	*	*	0	0	0	0
15	0	0	0	10	<0	<0	0	0	0	0
16	0	0	<0	0	0	10	<0	0	0	0
17	0	0	0	<0	*	*	0	0	0	0
18	0	10	0	0	*	*	<0	0	0	0
19	10	0	0	40	*	*	<0	<0	0	0
20	0	<0	50	0	<0	<0	<0	<0	0	0
21	<0	<0	0	0	*	*	<0	<0	0	0
22	0	0	0	100	*	10	<0	0	0	0
23	<0	0	50	0	<0	<0	0	20	0	0
24	0	20	0	0	*	*	<0	<0	0	0
25	20	0	0	<0	*	*	10	<0	0	0
26	0	0	0	0	*	*			0	0
27	<0	0	0	10	*	*				
28	70	40								
29	0	0								
30										
31										

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

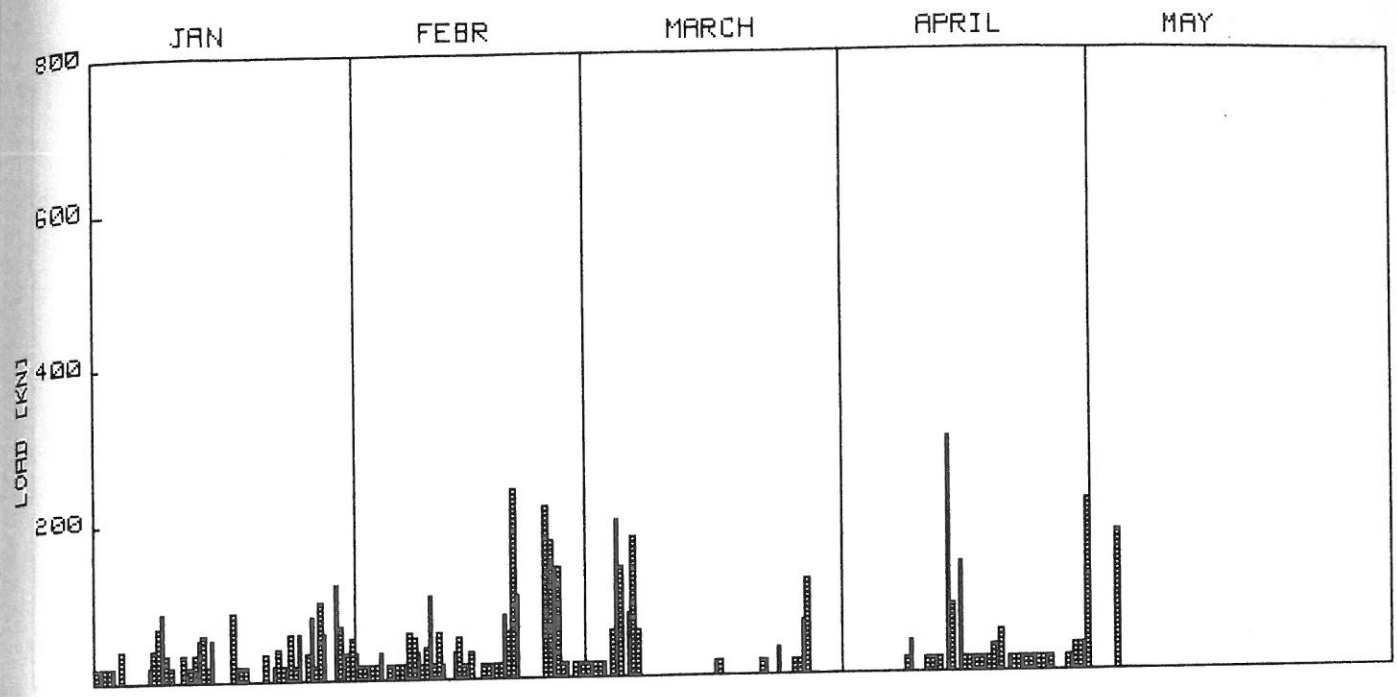


HB16 (DYNAMIC)

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	<0	<0	5	10	<0	15	*	*	*	*
2	30	<0	<0	<0	15	5	*	*	*	*
3	25	5	<0	5	5	10	*	*	*	30
4	5	5	5	5	20	5	*	*	0	0
5	5	5	5	5	5	5	*	*	0	0
6	5	5	0	<0	20	5	*	*	0	0
7	0	35	35	20	*	*	*	*	0	0
8	35	10	10	5	*	*	5	10	0	0
9	10	5	5	5	*	*	10	10	0	0
10	0	0	5	20	*	*	5	5	0	0
11	0	0	25	10	*	*	30	25	0	0
12	0	0	<0	5	*	*	20	5	0	0
13	5	5	5	5	*	*	20	5	0	0
14	20	5	5	5	*	*	0	10	0	0
15	<0	0	5	5	*	*	5	5	0	0
16	0	0	0	0	0	0	15	10	0	0
17	0	10	0	15	0	0	5	5	0	0
18	0	5	15	20	*	*	5	5	0	0
19	5	0	20	10	*	*	0	5	0	0
20	0	0	5	15	*	*	5	5	0	0
21	0	5	5	0	*	5	15	20	0	0
22	5	5	0	0	*	5	10	15	0	0
23	25	25	0	0	*	*	30	40	0	0
24	30	5	0	10	*	*	20	30	0	0
25	15	5	20	15	*	5	<0	10	0	0
26	0	0	5	5	5	30	0	0	0	0
27	5	20	10	5	35	*	0	5	0	0
28	10	10	20	10	*	*	5	5	0	0
29	<0	0	0	5	*	*	5	0	0	0
30	5	20			*	*	<0	0	0	0
31	20	5			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

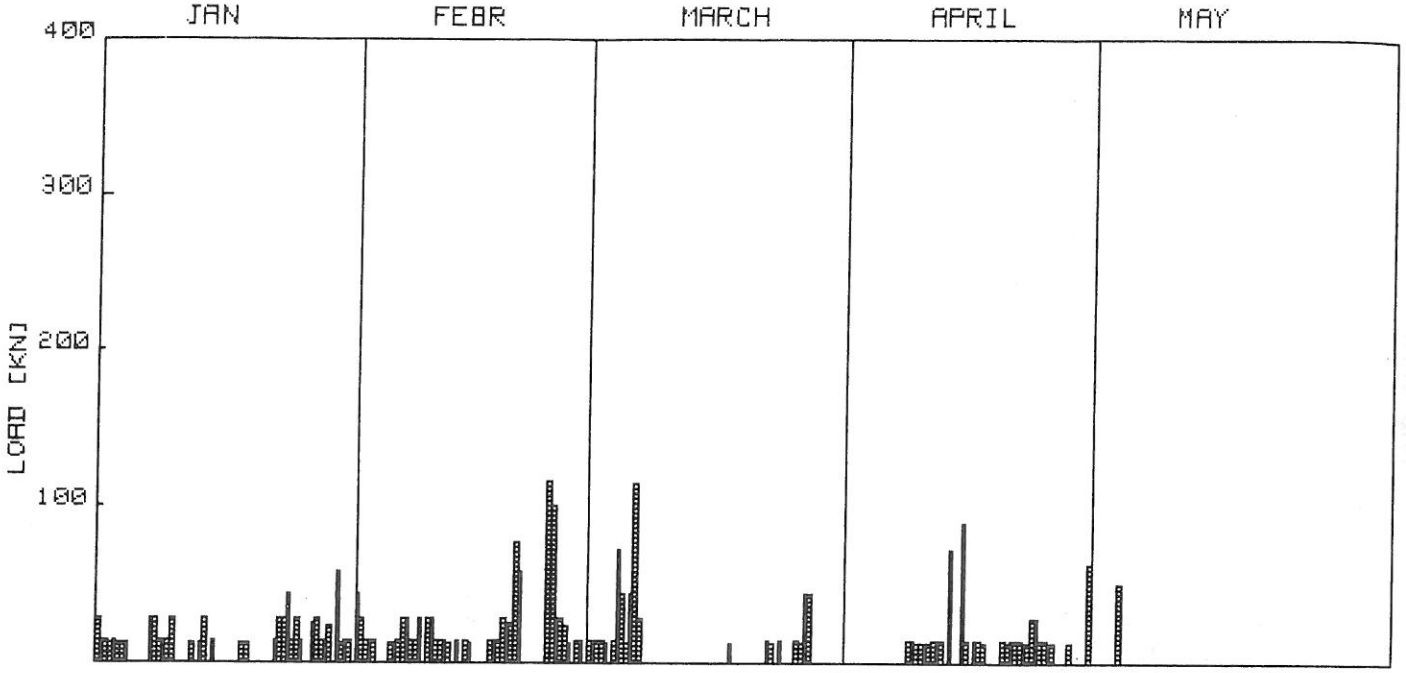


FT17

[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	20	20	52	35	17	20	*	*	*	*
2	20	20	20	20	20	17	*	*	*	180
3	20	0	20	17	0	60	*	*	0	0
4	40	0	17	35	200	140	*	*	0	0
5	0	0	0	17	0	80	*	*	0	0
6	0	0	0	20	180	60	*	*	0	0
7	0	20	20	17	*	*	17	40	0	0
8	40	70	60	52	*	*	0	0	0	0
9	87	35	35	20	*	*	0	17	0	0
10	20	0	40	105	*	*	20	20	0	0
11	0	35	20	60	*	*	20	0	0	0
12	0	17	17	0	*	*	300	87	0	0
13	35	52	0	35	*	*	0	140	0	0
14	60	20	52	17	*	*	17	17	0	0
15	52	0	0	35	*	*	20	20	0	0
16	0	0	0	0	17	17	17	17	0	0
17	0	87	17	17	0	0	17	35	0	0
18	0	17	17	20	*	*	17	52	0	0
19	17	0	20	80	*	*	0	17	0	0
20	0	0	60	240	*	17	17	17	0	0
21	0	35	105	0	20	0	0	17	0	0
22	0	17	0	0	*	35	17	20	0	0
23	40	20	0	220	*	*	17	17	0	0
24	20	60	175	60	*	17	17	17	0	0
25	17	60	140	17	17	70	0	0	0	0
26	0	35	20	0	122	*	0	17	0	0
27	80	20	17	17	*	*	0	35	0	0
28	100	60	17	17	*	*	35	17	0	0
29	0	0			*	*	220	0	0	0
30	122	70								
31	20	35								

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

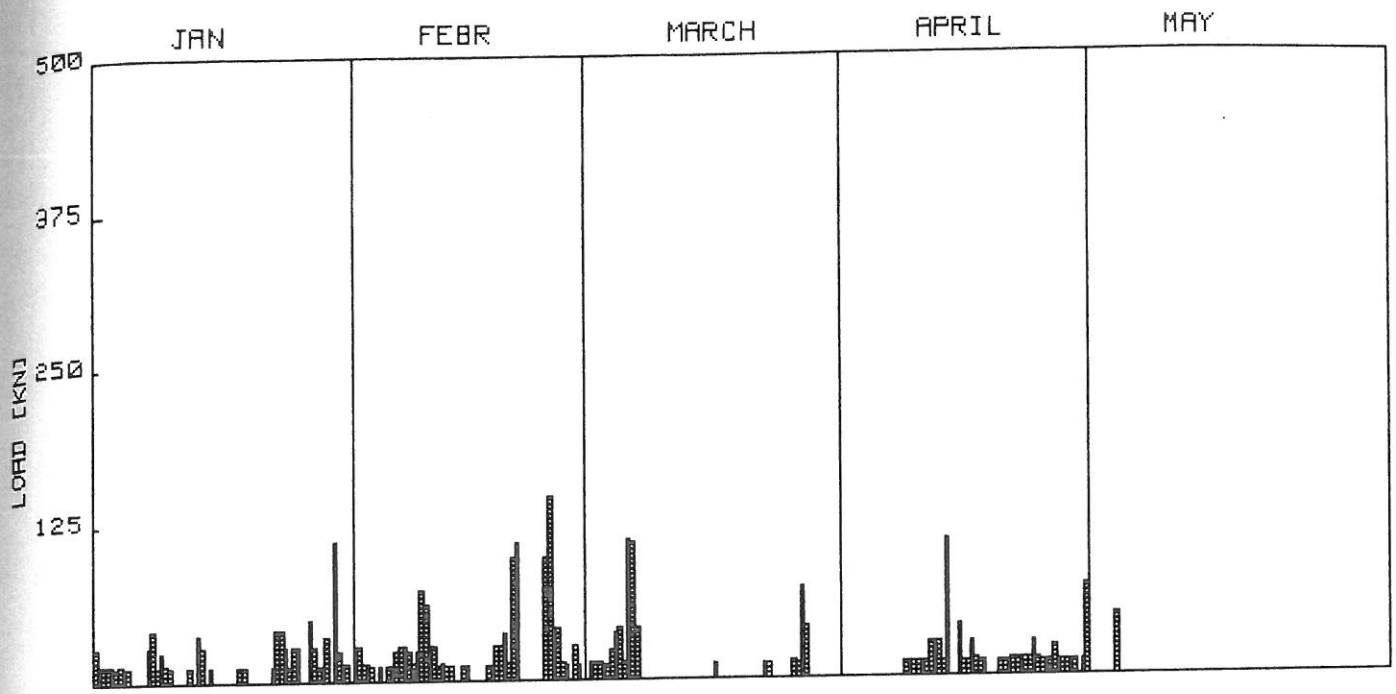


FT1B

	JAN		FEBR		MARCH		APRIL		MAY	
[day]	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.	a.m.	p.m.
1	28	14	0	43	12	14	*	*	*	*
2	14	12	28	14	14	12	*	*	*	*
3	14	12	14	14	0	14	*	*	*	50
4	12	12	0	0	72	43	*	*	0	0
5	0	0	0	12	12	43	*	*	0	0
6	0	0	0	14	114	28	*	*	0	0
7	0	28	28	28	*	*	*	*	0	0
8	28	14	14	14	*	*	14	14	0	0
9	14	14	28	0	*	*	12	12	0	0
10	28	0	28	28	*	*	12	12	0	0
11	0	0	14	14	*	*	14	14	0	0
12	0	12	14	12	*	*	14	0	0	0
13	0	12	0	14	*	*	72	0	0	0
14	28	0	0	14	*	*	0	88	0	0
15	14	0	12	0	*	*	14	0	0	0
16	0	0	0	0	0	0	14	14	0	0
17	0	0	0	14	0	12	12	0	0	0
18	0	12	14	14	*	*	0	0	0	0
19	12	0	28	25	*	*	0	14	0	0
20	0	0	25	76	*	*	12	14	0	0
21	0	0	57	0	*	0	14	14	0	0
22	0	14	0	0	14	12	12	12	0	0
23	28	28	0	0	*	14	28	28	0	0
24	43	14	0	115	*	*	14	14	0	0
25	28	14	101	28	*	14	12	12	0	0
26	0	0	28	24	12	43	0	0	0	0
27	25	28	12	0	43	*	0	12	0	0
28	14	14	14	14	*	*	0	0	0	0
29	24	0	0	14	*	*	0	0	0	0
30	57	12			*	*	63	0	0	0
31	14	14			*	*			0	0

* NOT MEASURED

KEMIRA 1988 MEASURED 12-HOUR MAXIMA

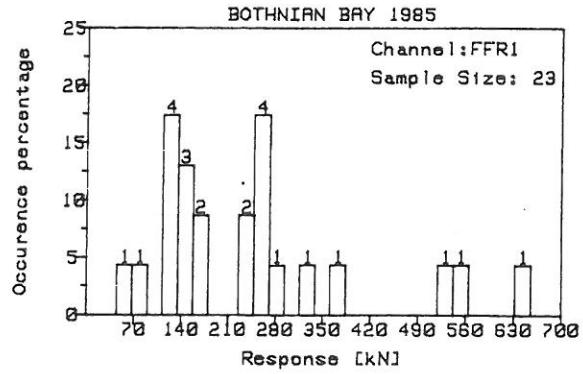


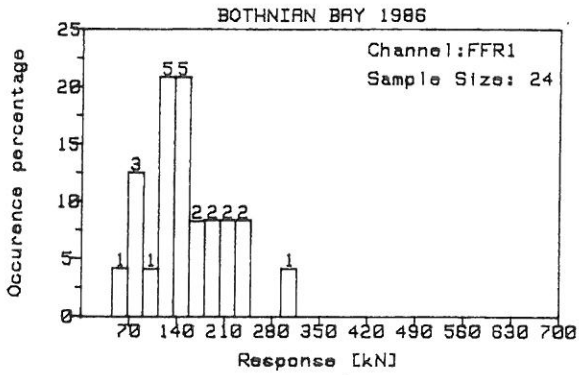
FT19

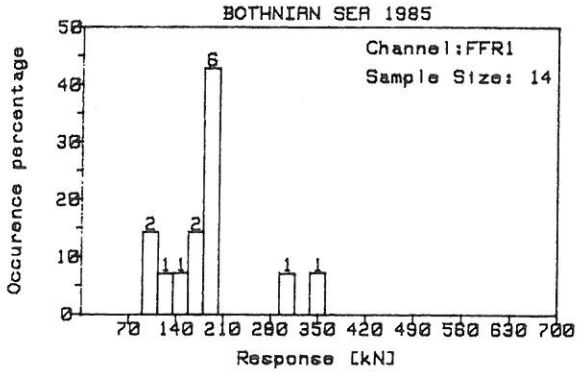
[day]	JAN a.m.	JAN p.m.	FEBR a.m.	FEBR p.m.	MARCH a.m.	MARCH p.m.	APRIL a.m.	APRIL p.m.	MAY a.m.	MAY p.m.
1	27	13	0	12	13	13	*	*	*	*
2	13	13	27	13	13	11	*	*	*	*
3	13	11	13	12	12	24	*	*	*	48
4	13	11	0	12	38	41	*	*	0	0
5	11	0	0	12	13	111	*	*	0	0
6	0	0	0	24	109	41	*	*	0	0
7	0	27	27	27	*	*	*	*	0	0
8	41	12	24	13	*	*	12	12	0	0
9	24	13	24	73	*	*	11	11	0	0
10	12	0	61	24	*	*	11	11	0	0
11	0	0	27	12	*	*	27	13	0	0
12	0	11	13	11	*	*	27	11	0	0
13	0	36	11	0	*	*	109	0	0	0
14	27	0	0	12	*	*	0	41	0	0
15	12	0	11	0	*	*	12	12	0	0
16	0	0	0	0	11	0	27	13	0	0
17	0	0	0	12	0	0	11	12	0	0
18	0	12	11	27	*	*	0	0	0	0
19	11	0	27	36	*	*	0	12	0	0
20	0	0	13	97	*	*	11	12	0	0
21	0	0	109	0	*	0	13	13	0	0
22	0	11	0	0	12	11	11	13	0	0
23	41	41	0	0	*	0	13	27	0	0
24	27	12	0	97	*	*	13	11	0	0
25	27	27	146	24	*	13	11	12	0	0
26	0	0	41	13	11	73	24	0	0	0
27	48	27	11	0	41	*	12	11	0	0
28	12	12	27	12	*	*	0	12	0	0
29	34	0	0	0	*	*	0	12	0	0
30	111	24			*	*	73	0	0	0
31	12	13			*	*				

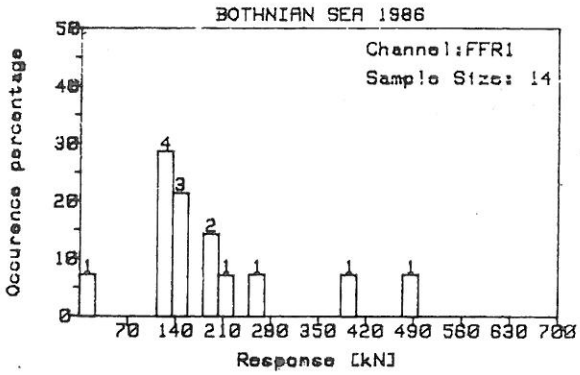
* NOT MEASURED

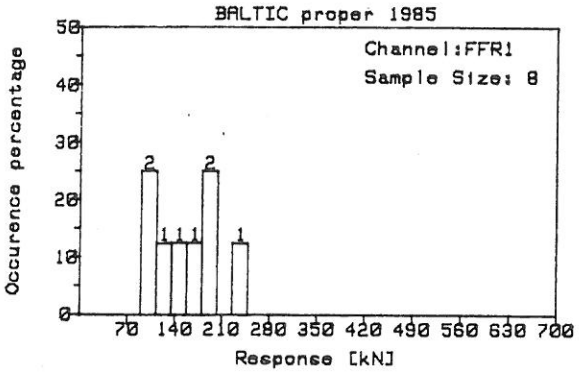
MEASURED 12-HOUR MAXIMA, CHANNEL FFR1

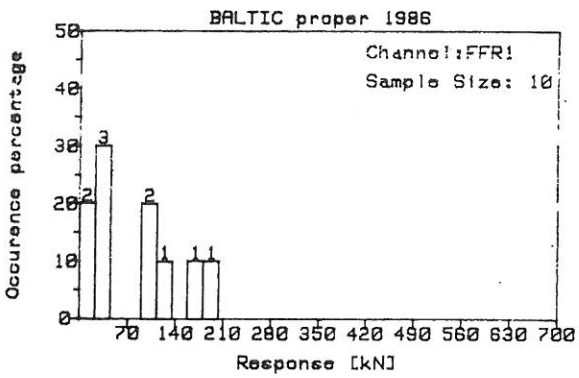


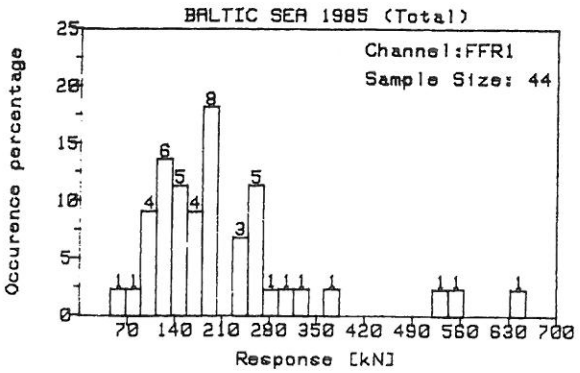


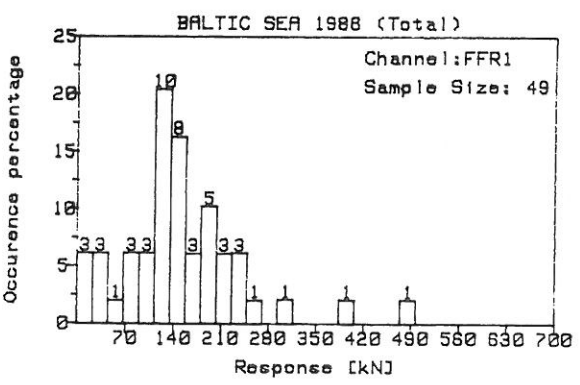




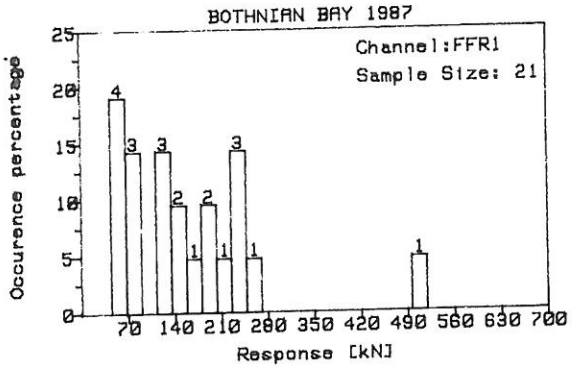


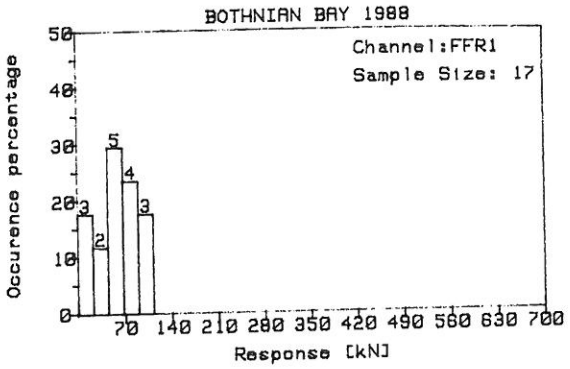


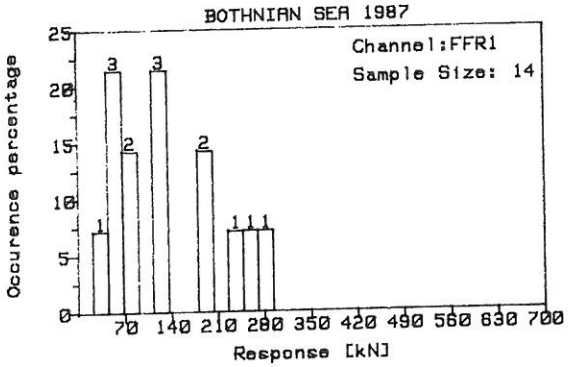


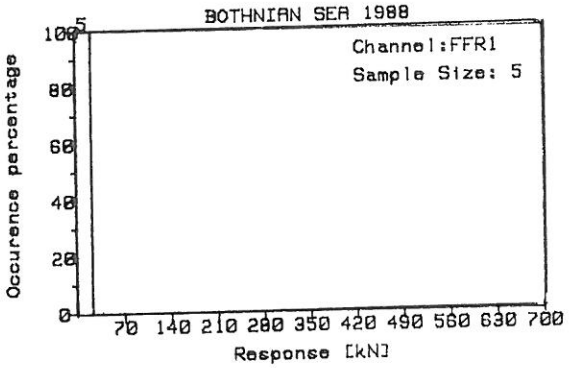


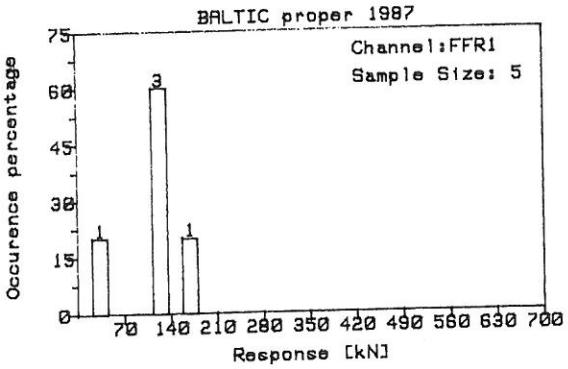
MEASURED 12-HOUR MAXIMA, CHANNEL FFR1

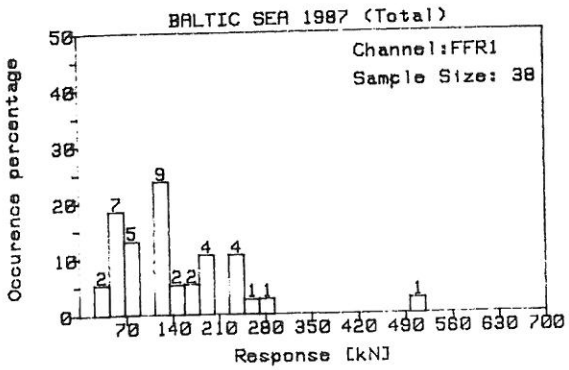


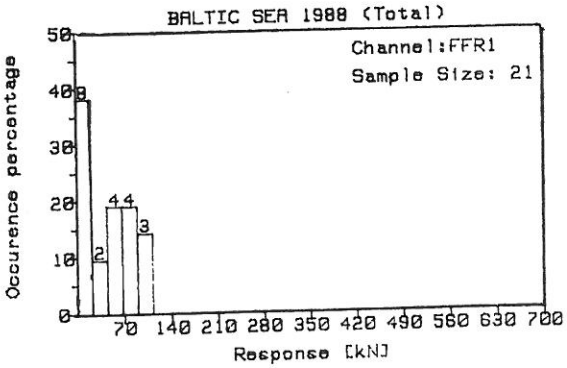




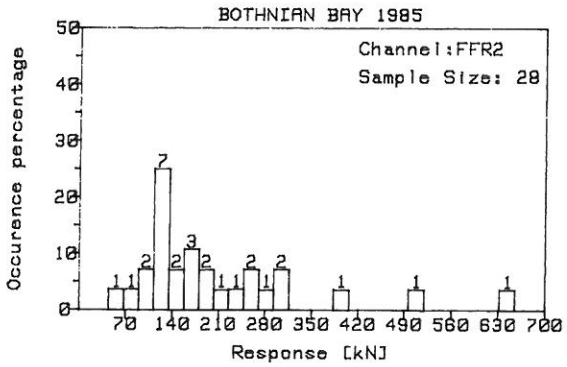


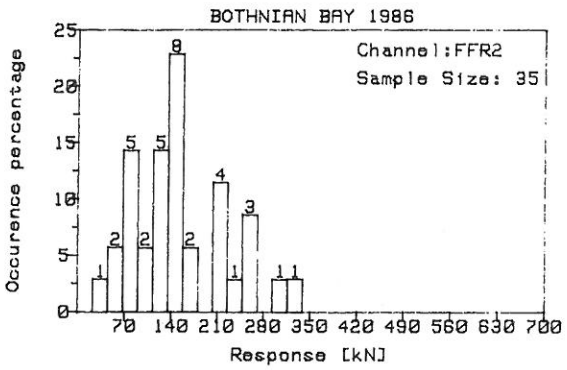


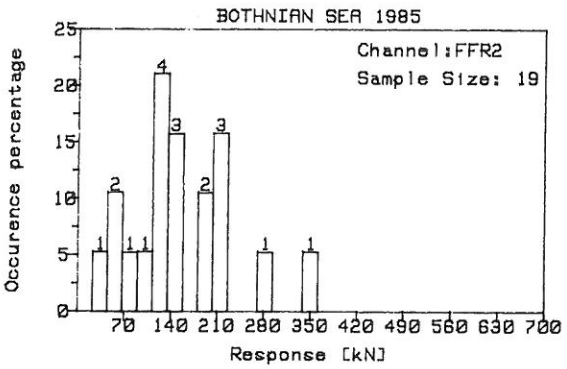


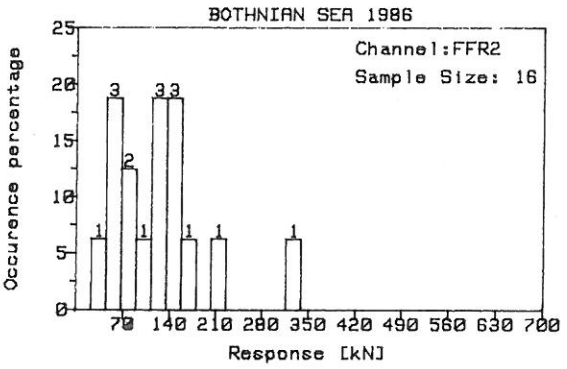


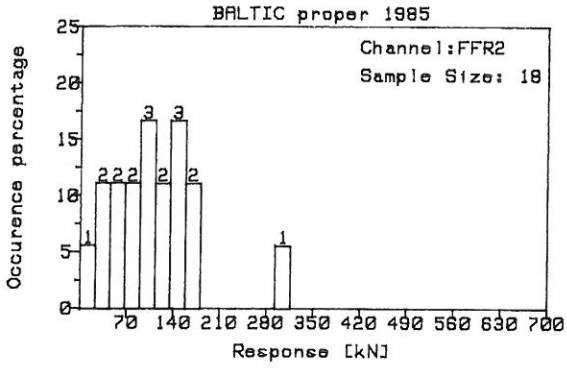
MEASURED 12-HOUR MAXIMA, CHANNEL FFR2

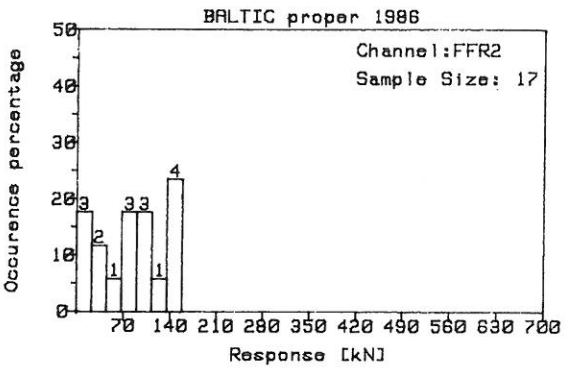


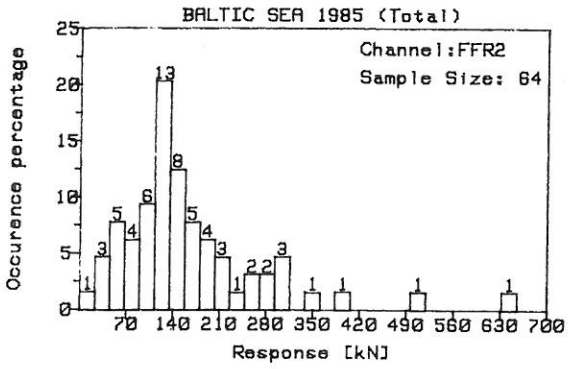


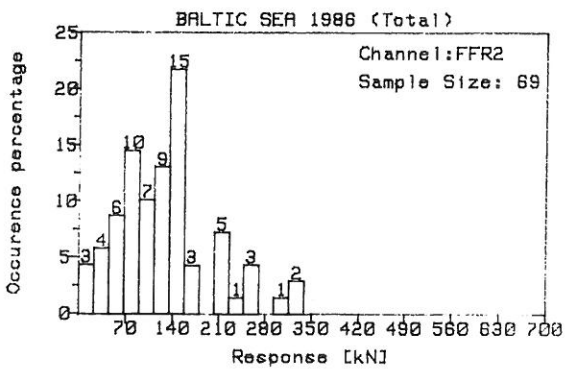




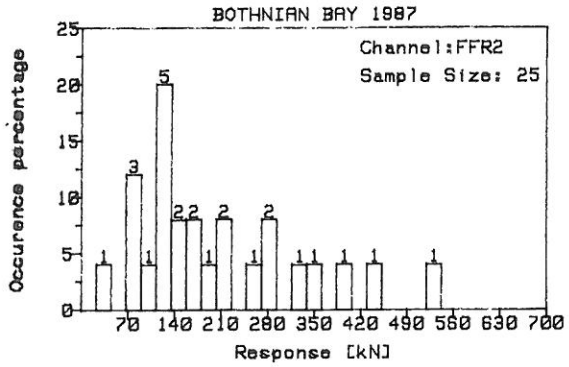


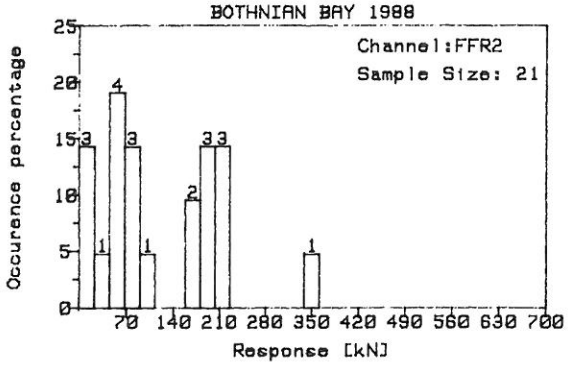


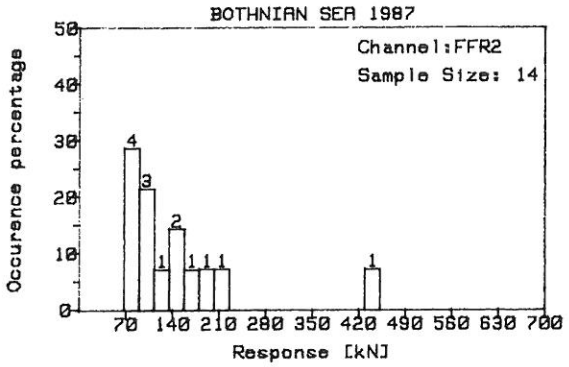


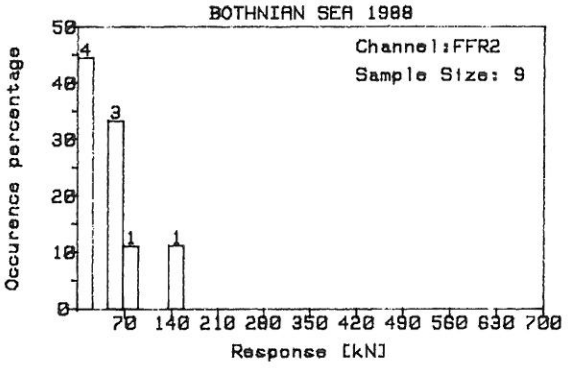


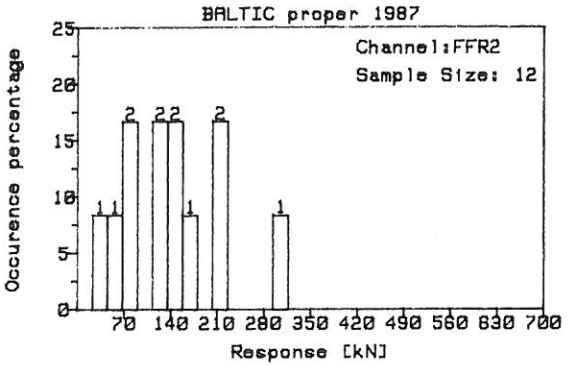
MEASURED 12-HOUR MAXIMA, CHANNEL FFR2

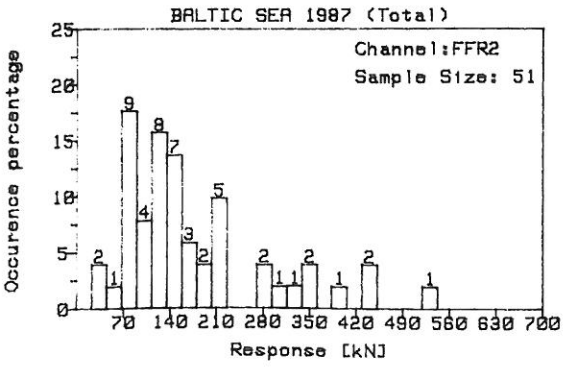


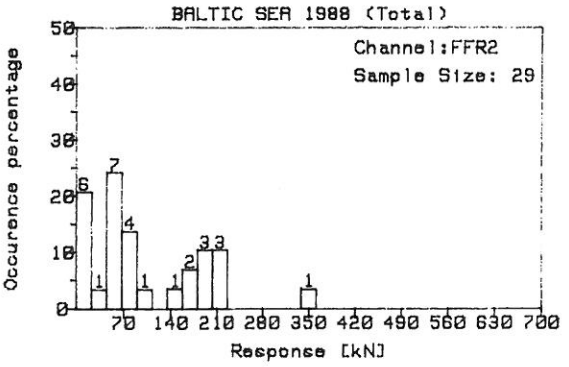




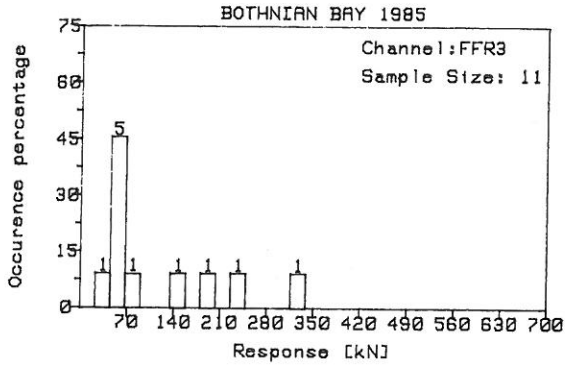


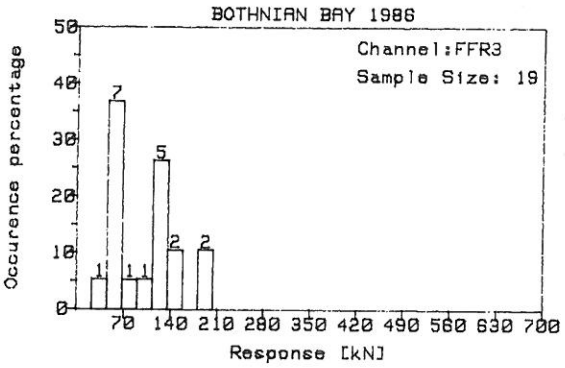


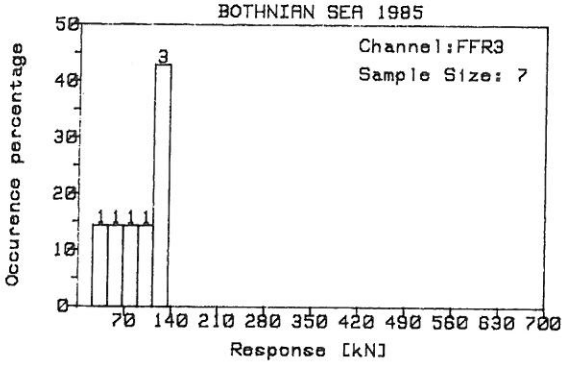


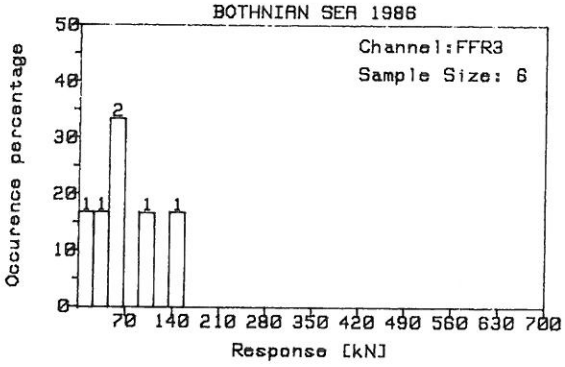


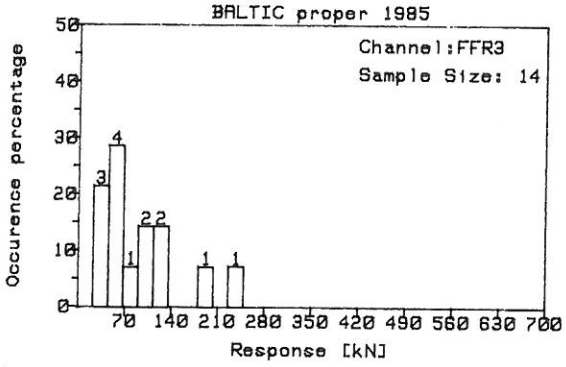
MEASURED 12-HOUR MAXIMA, CHANNEL FFR3

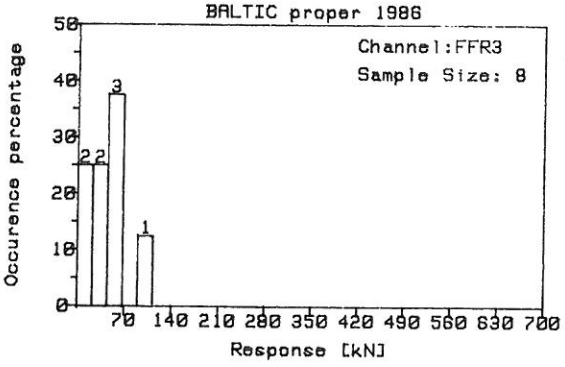


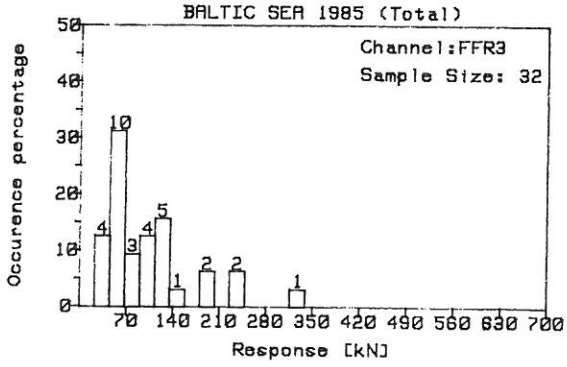


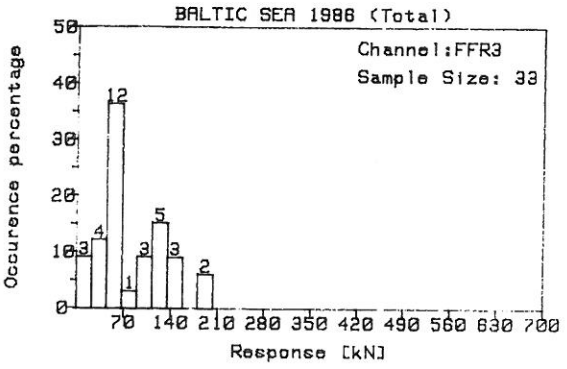




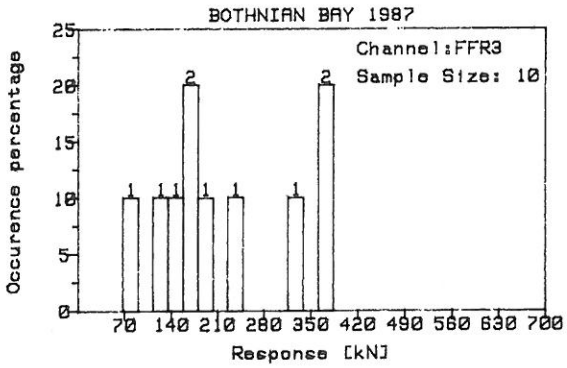


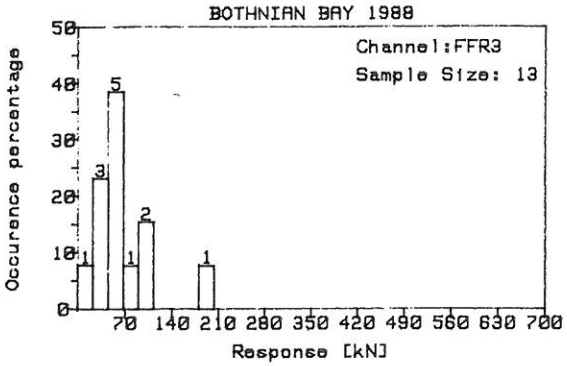


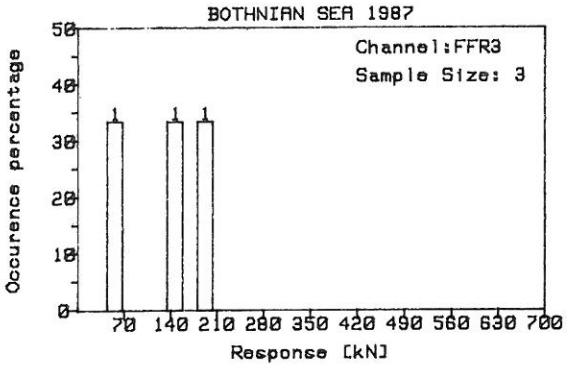


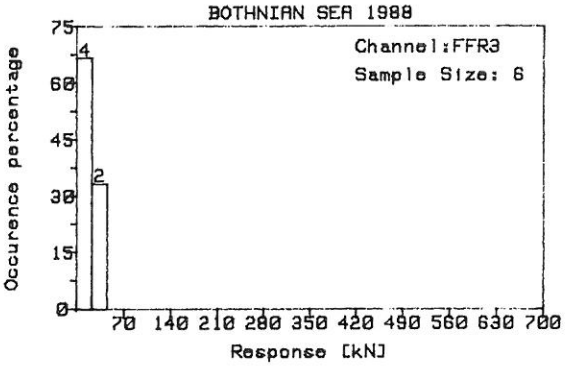


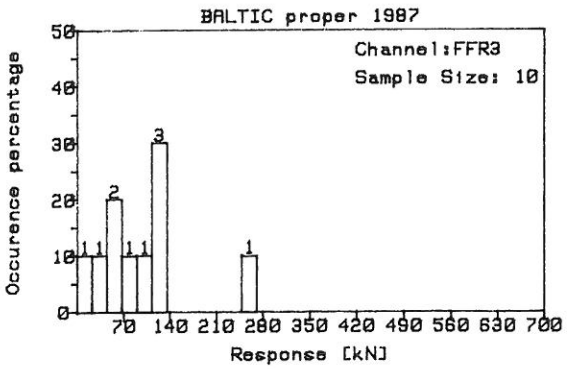
MEASURED 12-HOUR MAXIMA, CHANNEL FFR3

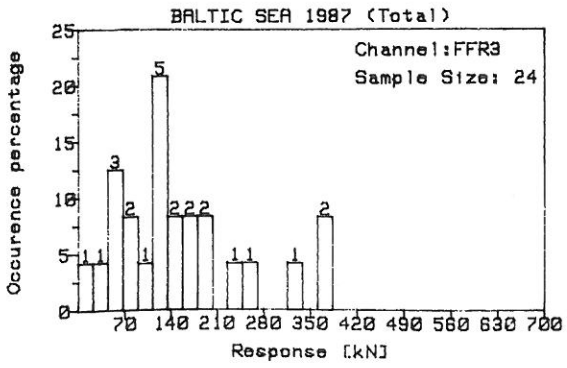


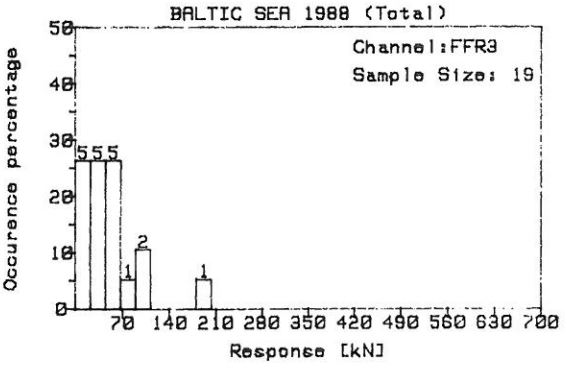




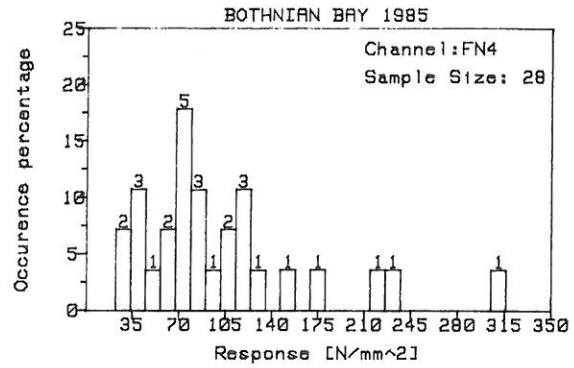


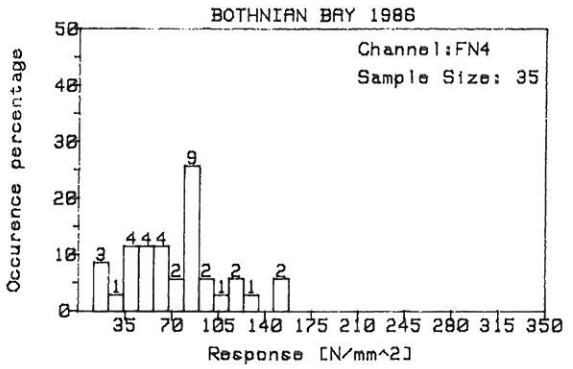


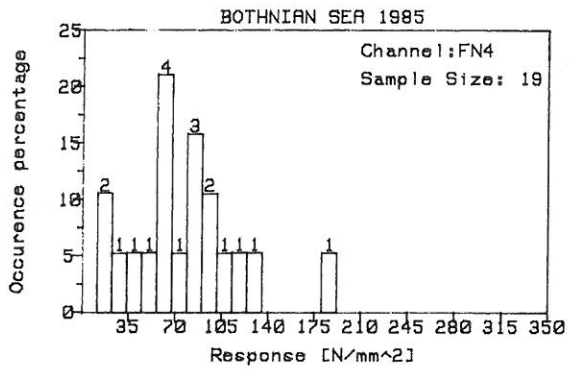


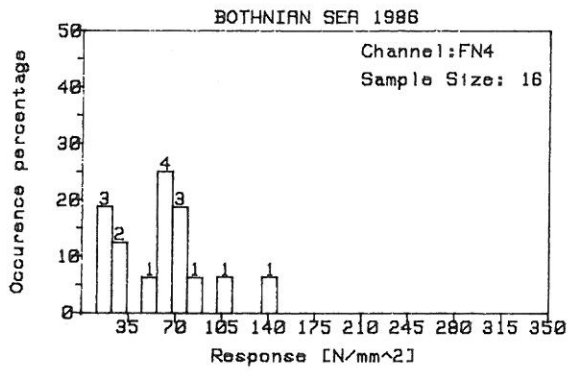


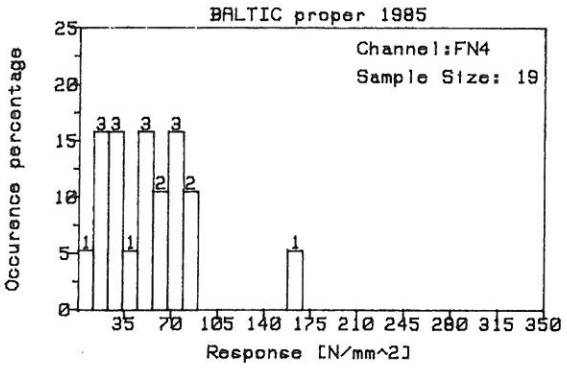
MEASURED 12-HOUR MAXIMA, CHANNEL FN4

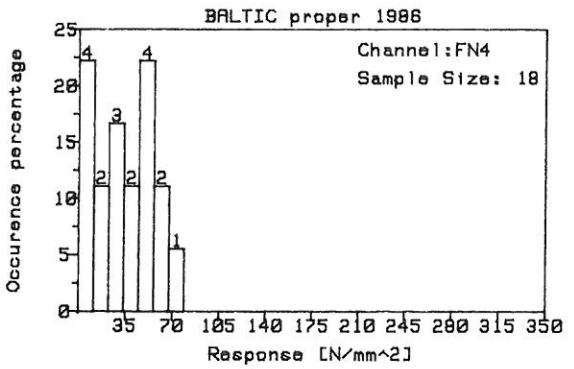


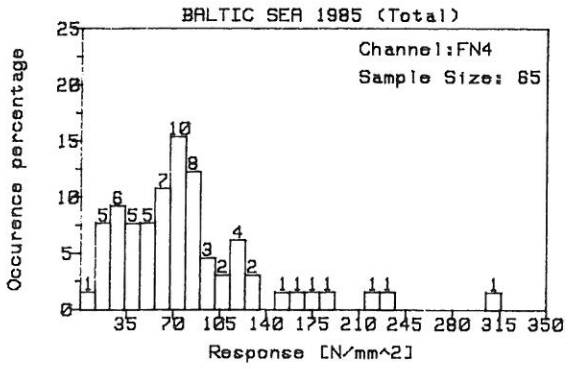


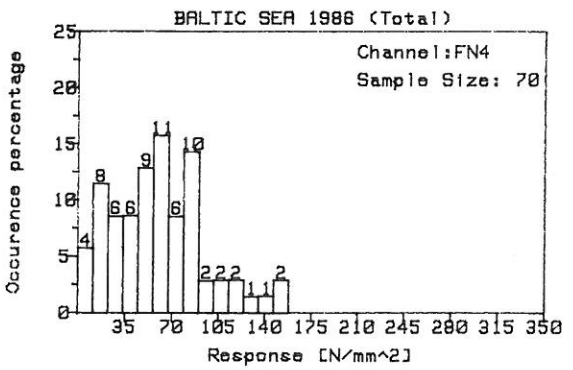




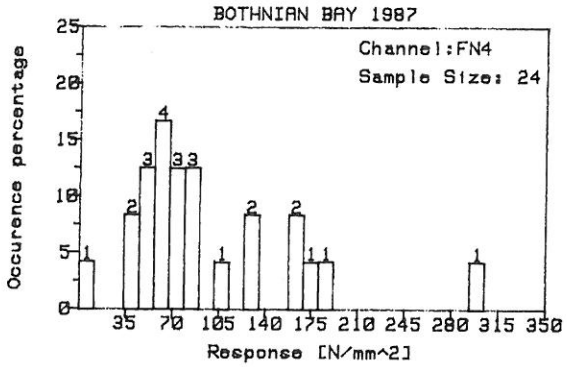


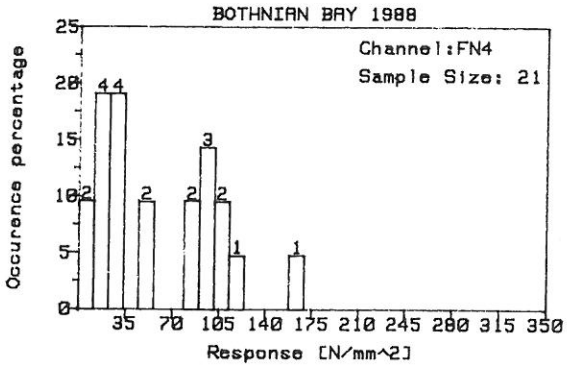


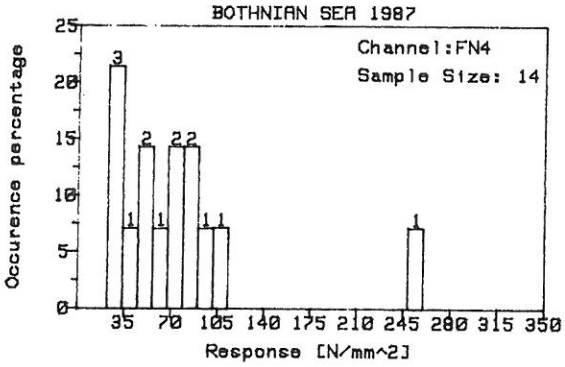


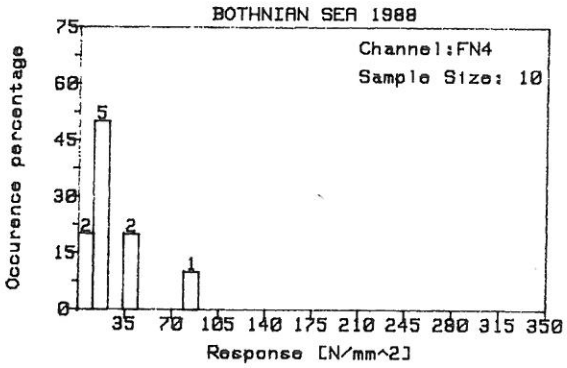


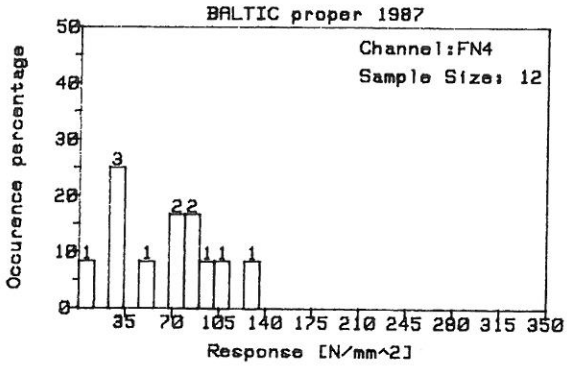
MEASURED 12-HOUR MAXIMA, CHANNEL FN4

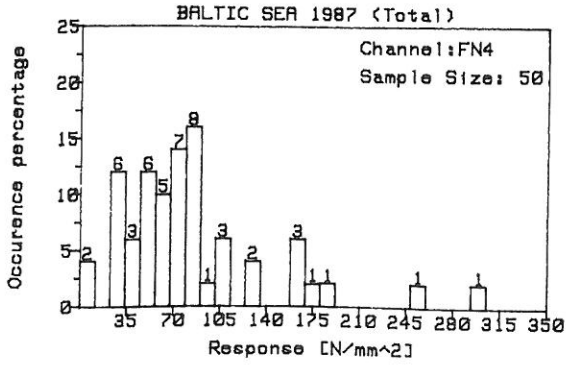


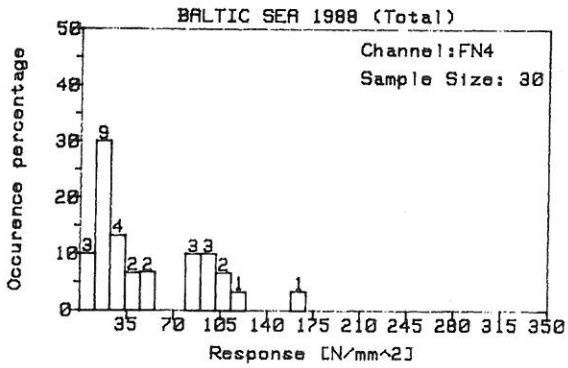




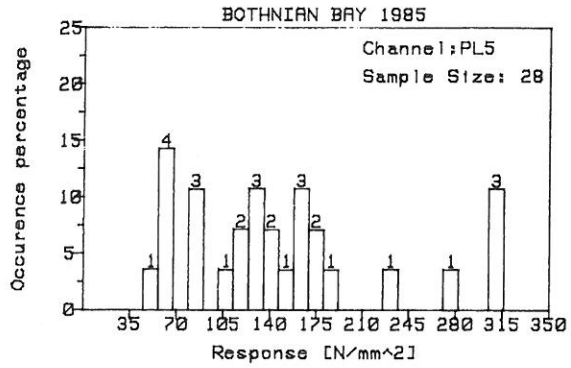


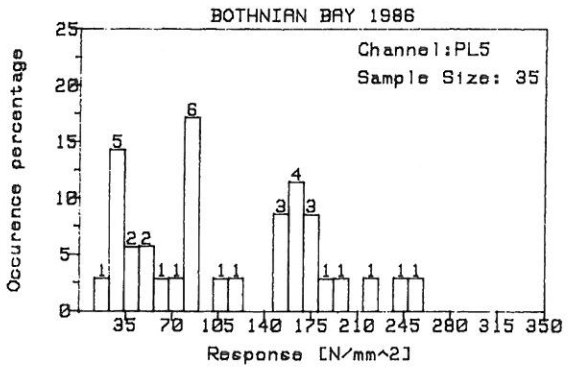


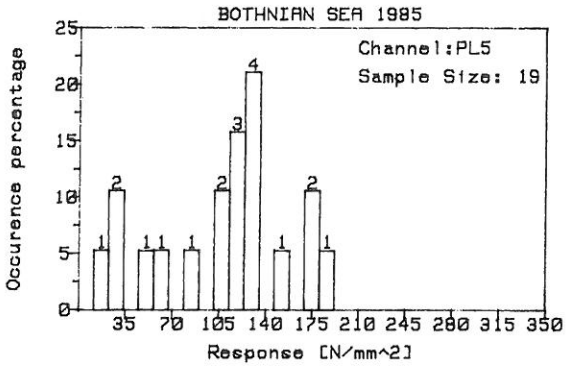


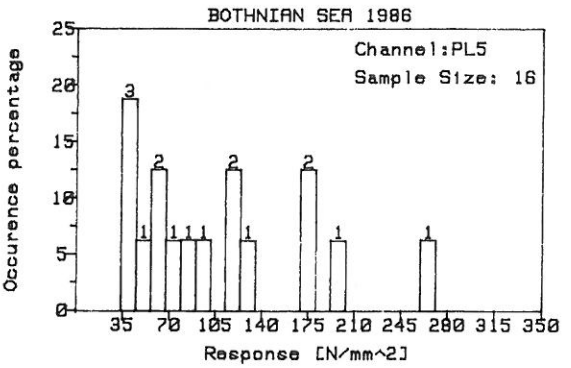


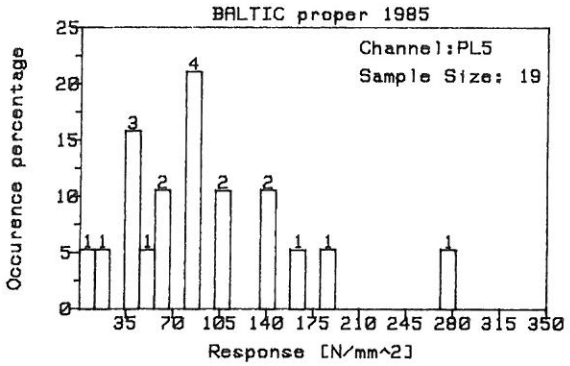
MEASURED 12-HOUR MAXIMA, CHANNEL PL5

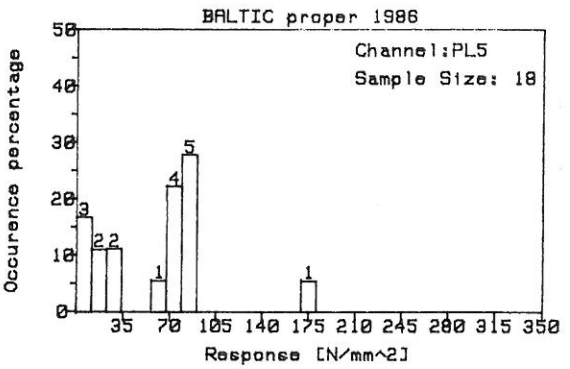


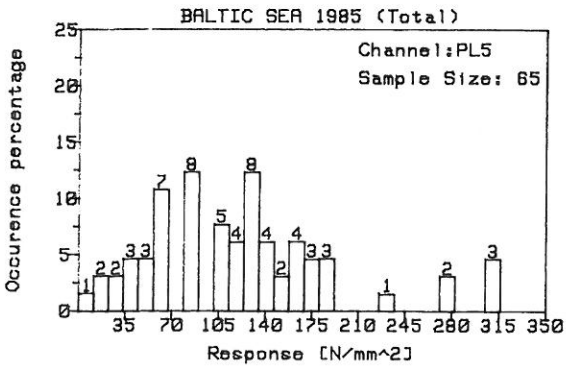


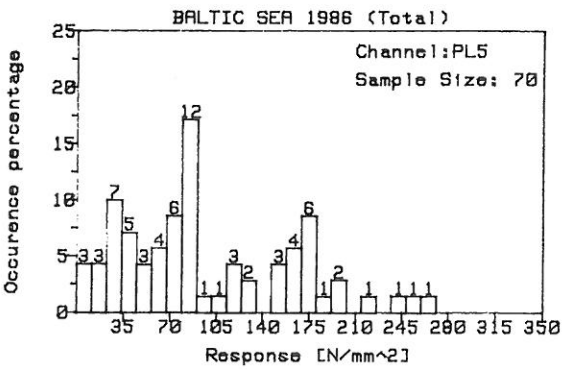




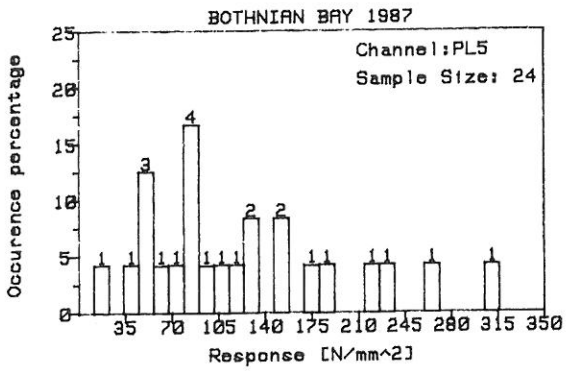


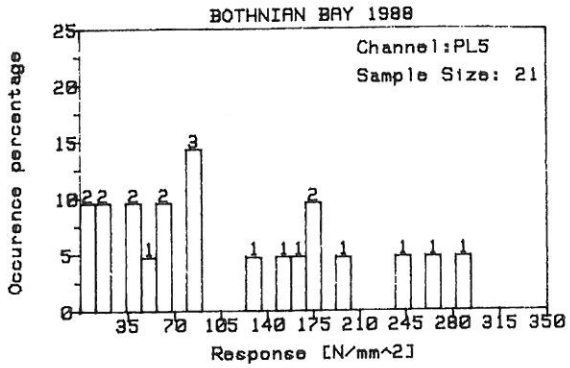


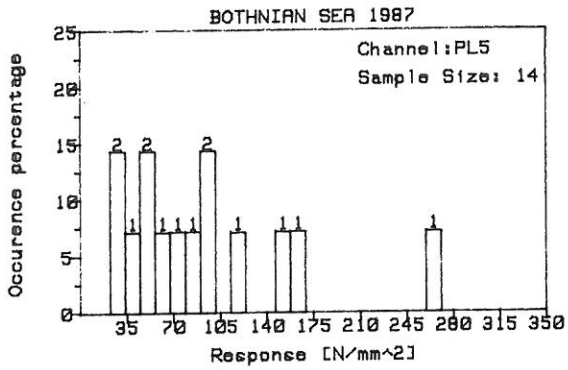


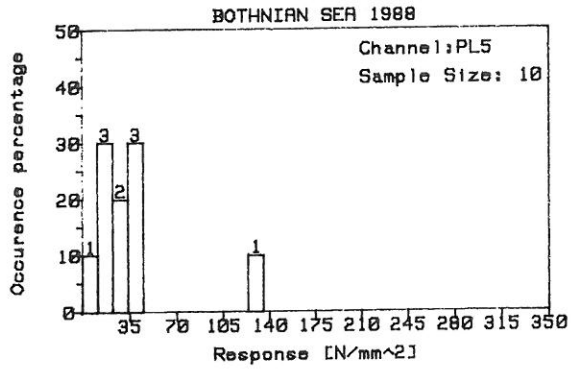


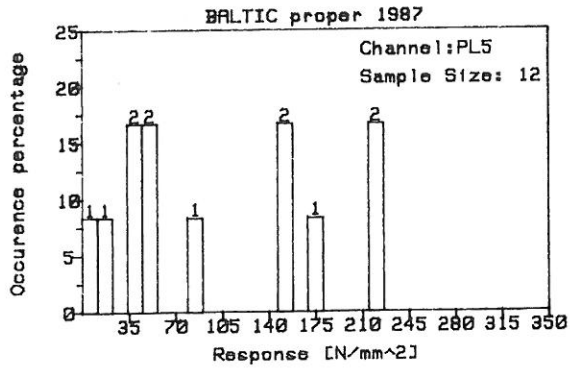
MEASURED 12-HOUR MAXIMA, CHANNEL PL5

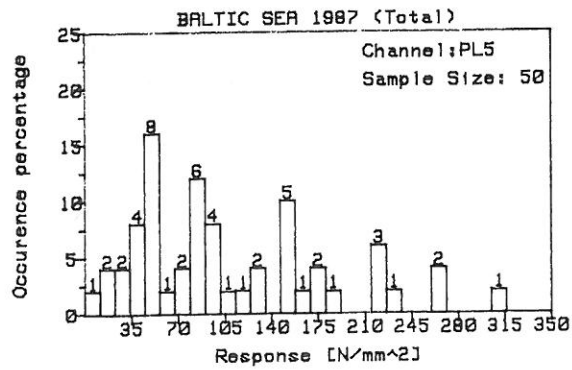


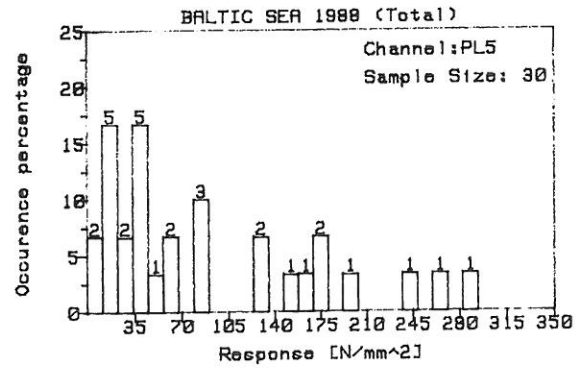




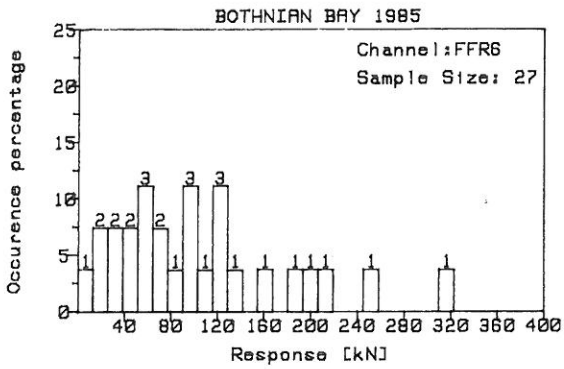


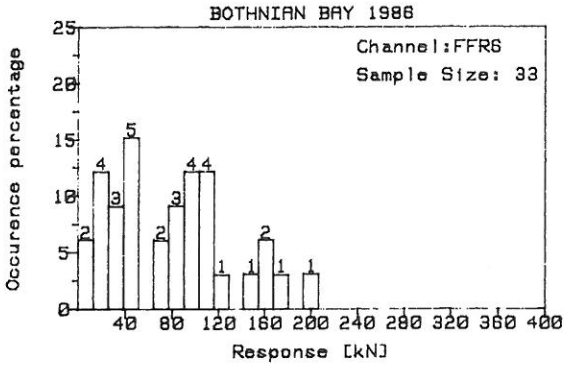


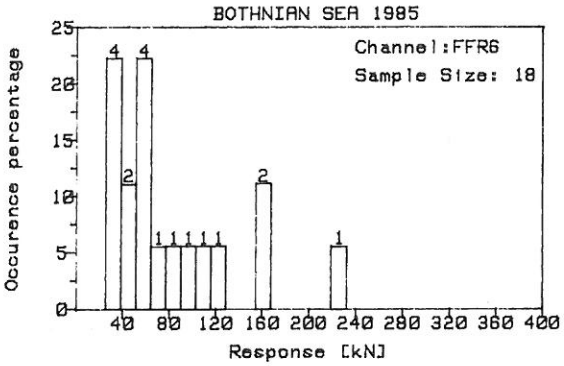


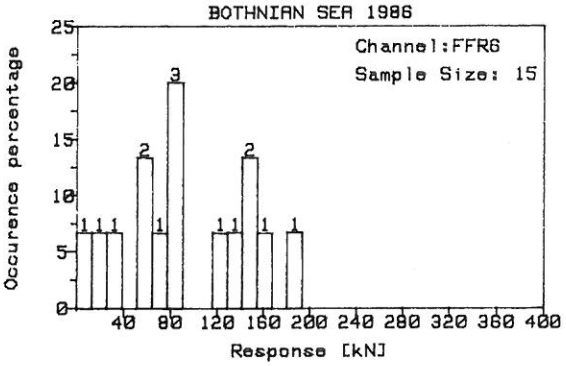


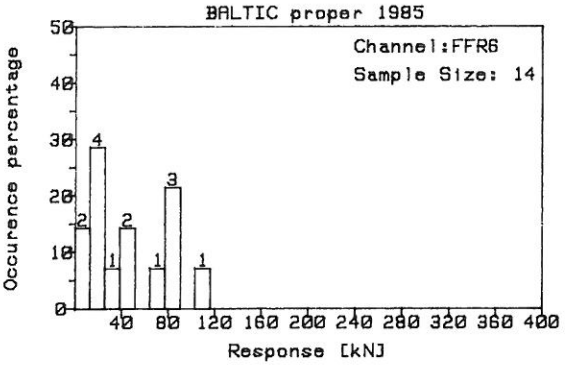
MEASURED 12-HOUR MAXIMA, CHANNEL FFR6

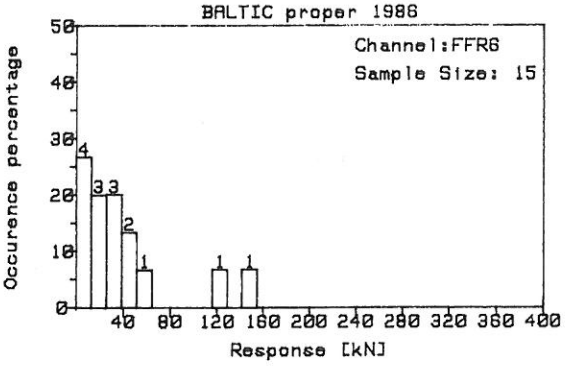


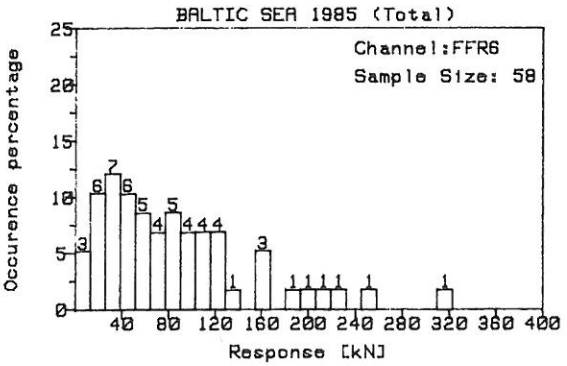


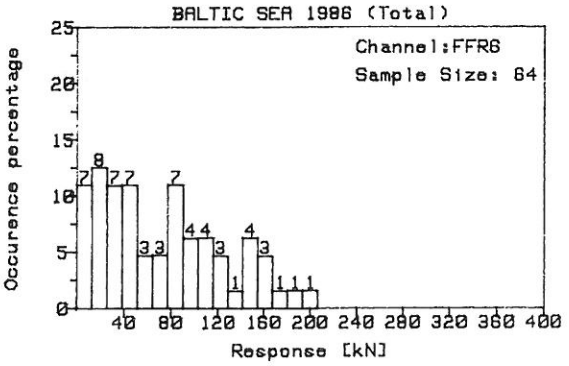




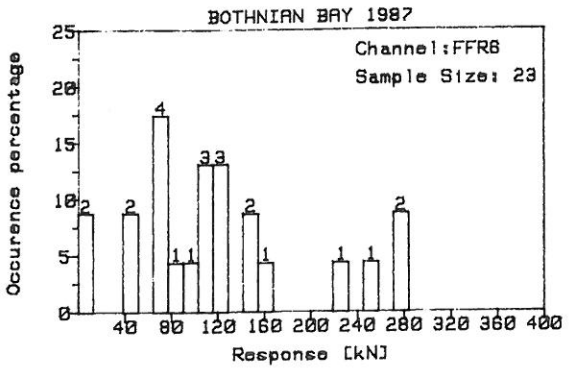


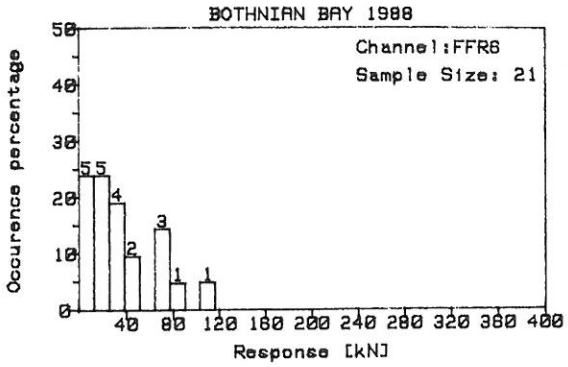


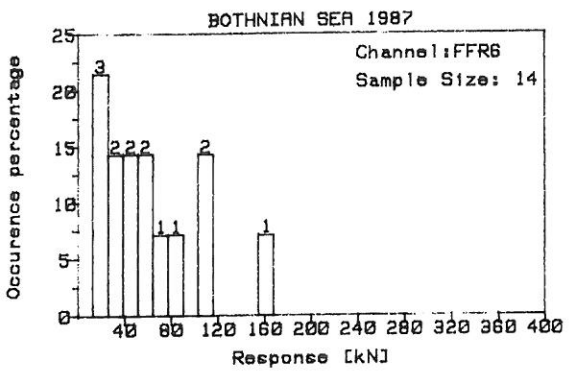


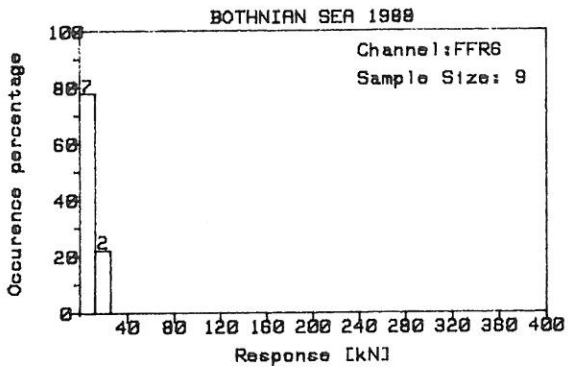


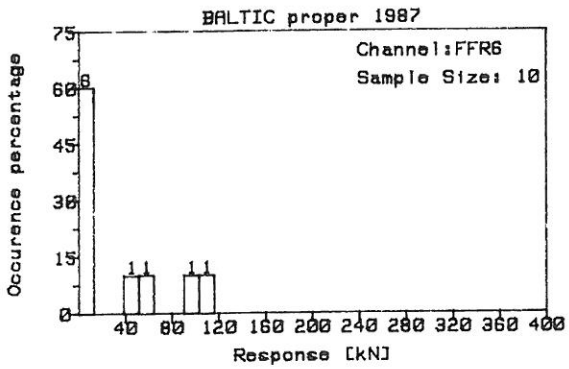
MEASURED 12-HOUR MAXIMA, CHANNEL FFR6

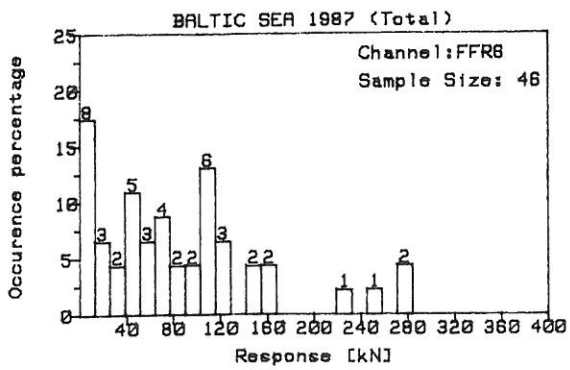


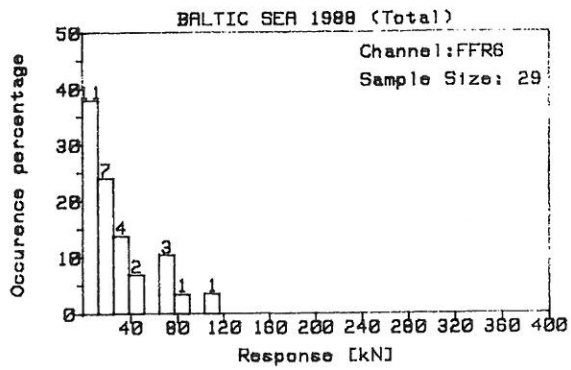




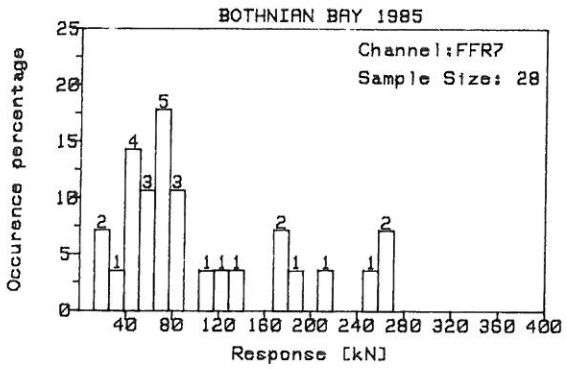


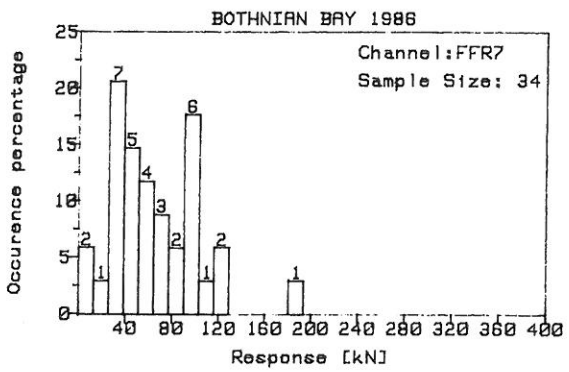


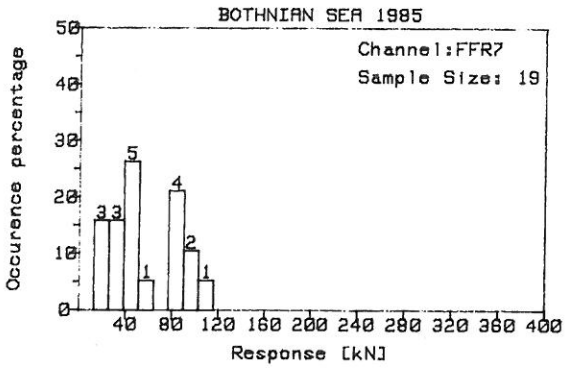


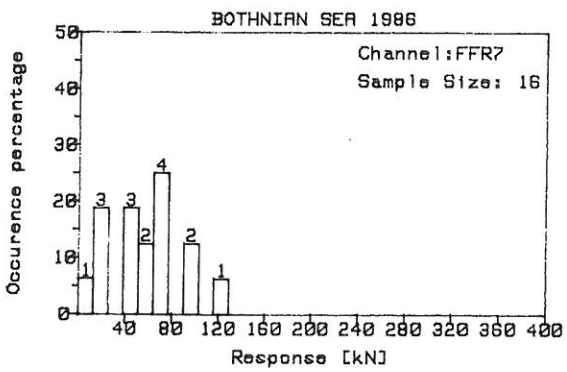


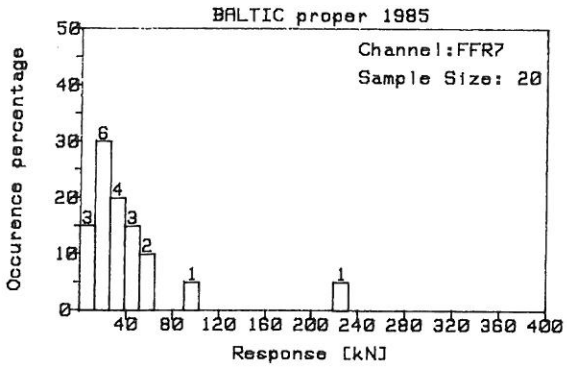
MEASURED 12-HOUR MAXIMA, CHANNEL FFR7

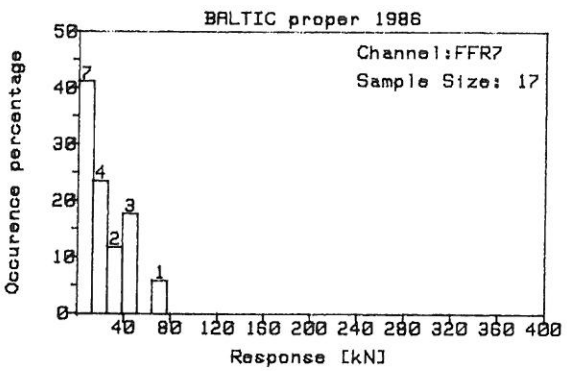


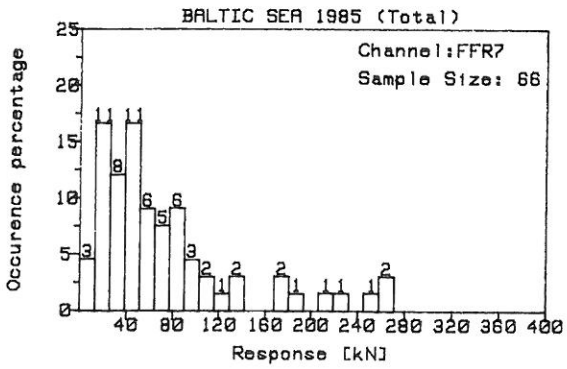


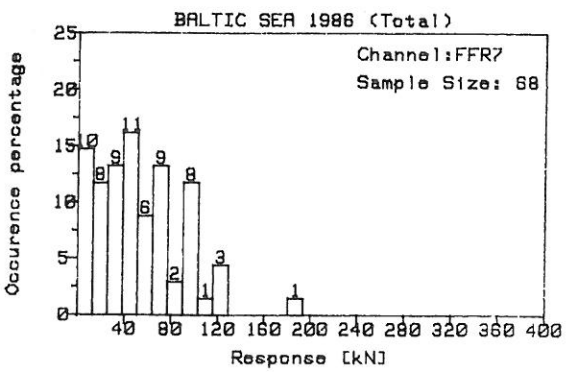




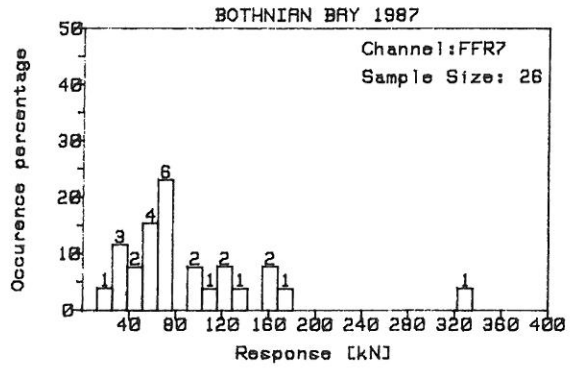


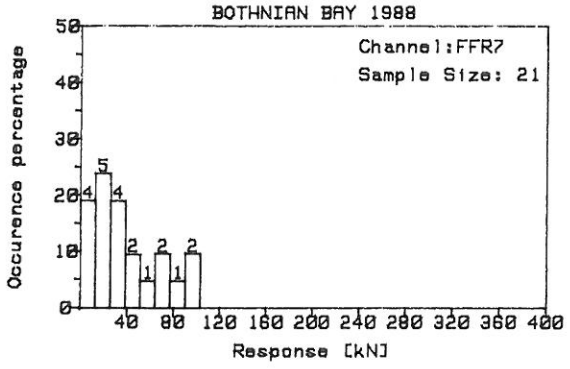


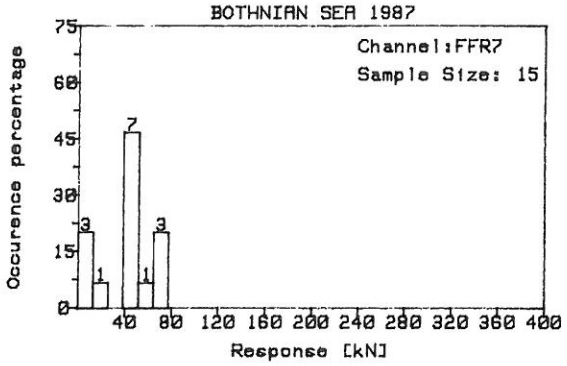


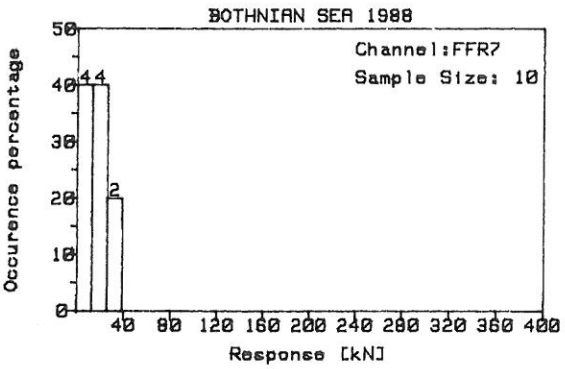


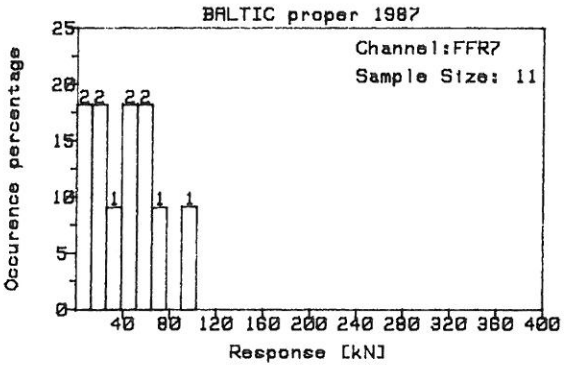
MEASURED 12-HOUR MAXIMA, CHANNEL FFR7

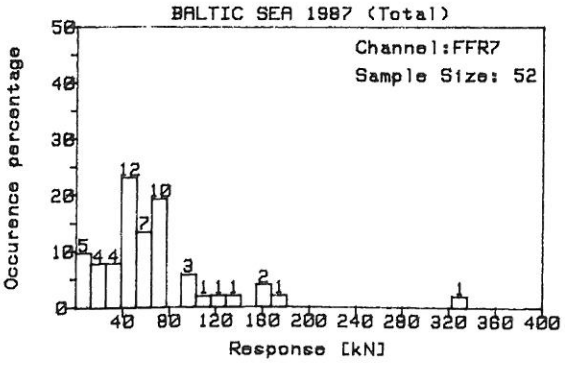


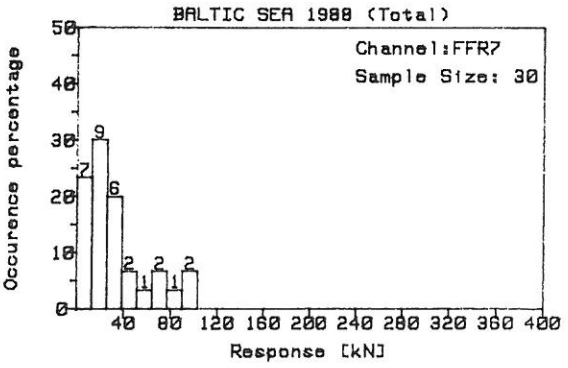




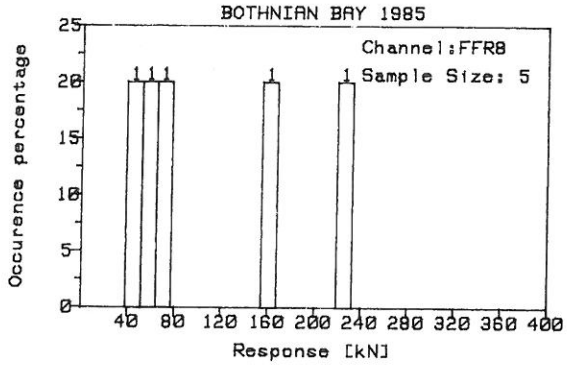


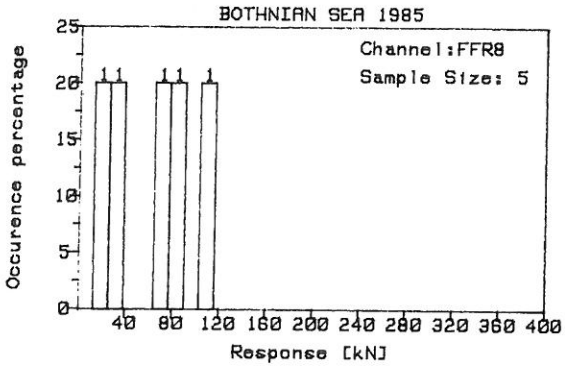


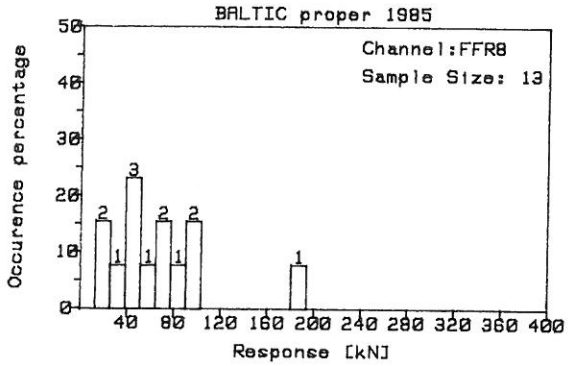


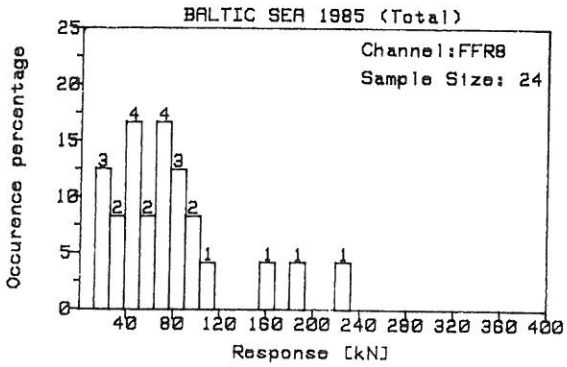


MEASURED 12-HOUR MAXIMA, CHANNEL FFR8

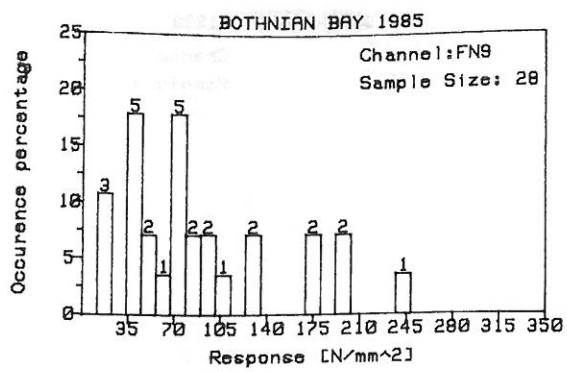


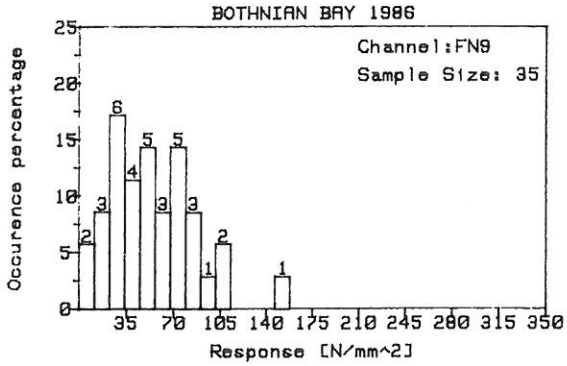


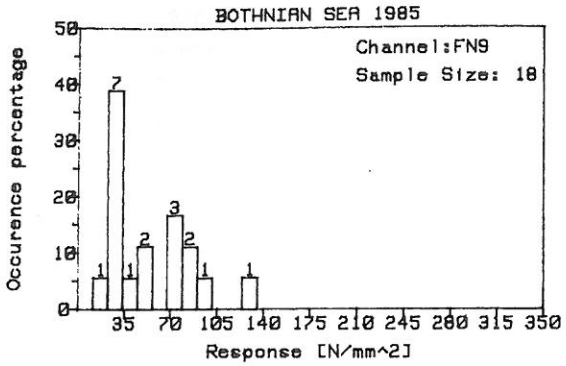


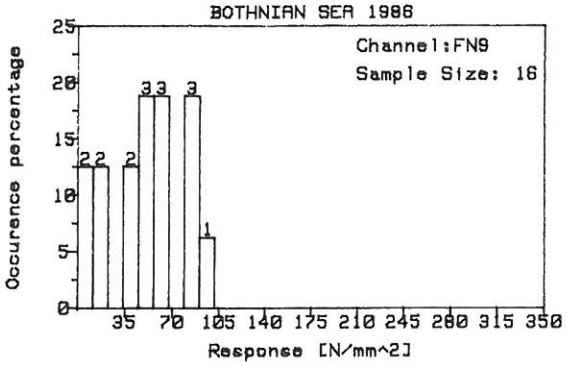


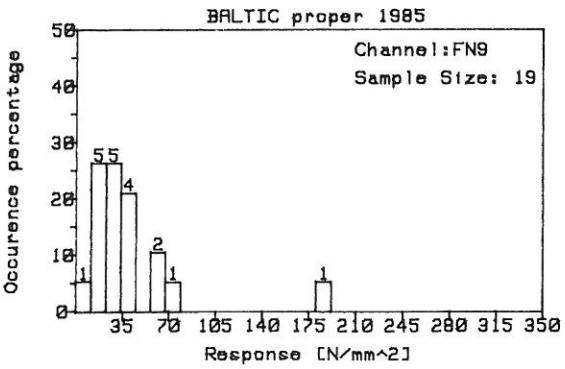
MEASURED 12-HOUR MAXIMA, CHANNEL FN9

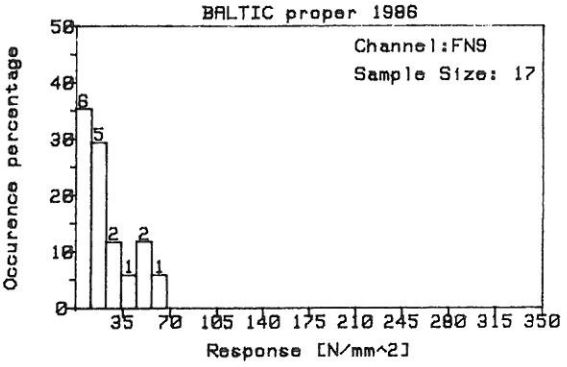


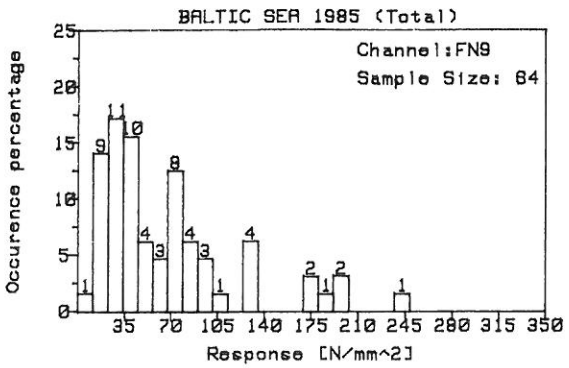


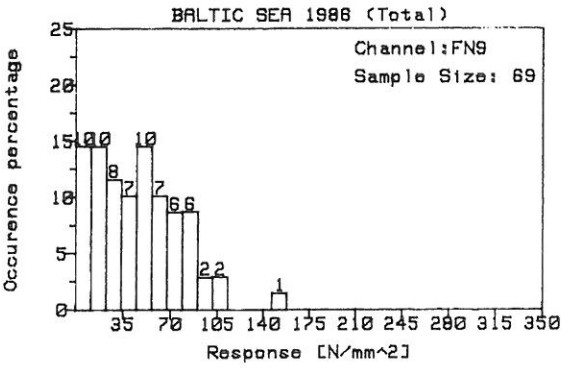




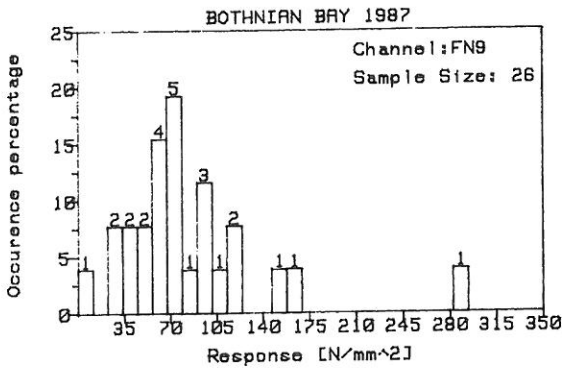


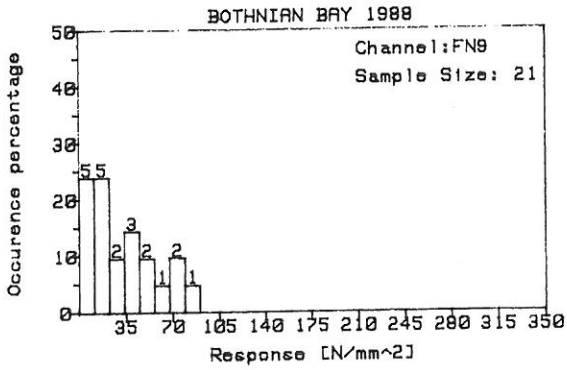


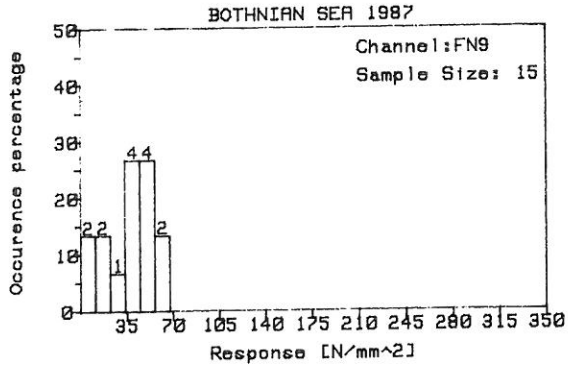


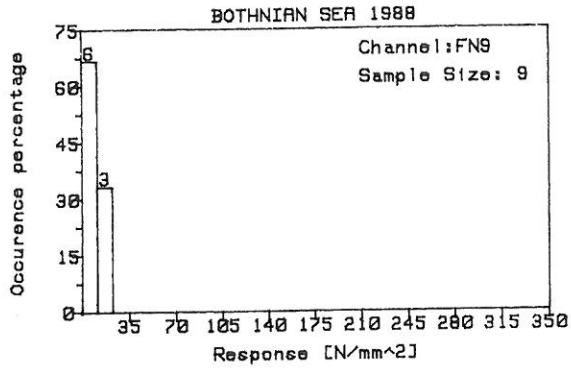


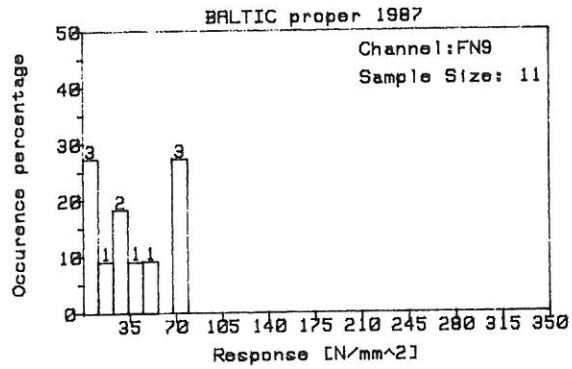
MEASURED 12-HOUR MAXIMA, CHANNEL FN9

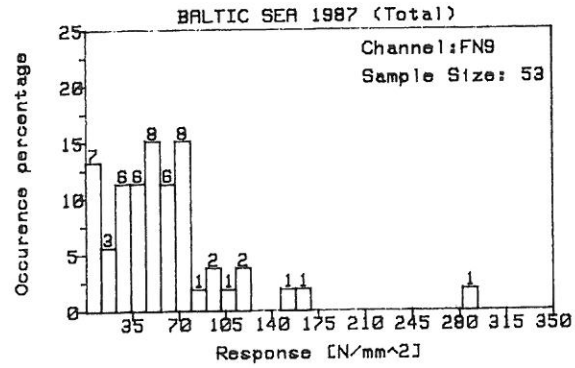


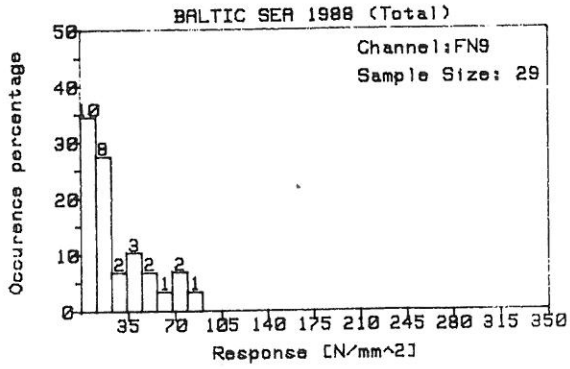




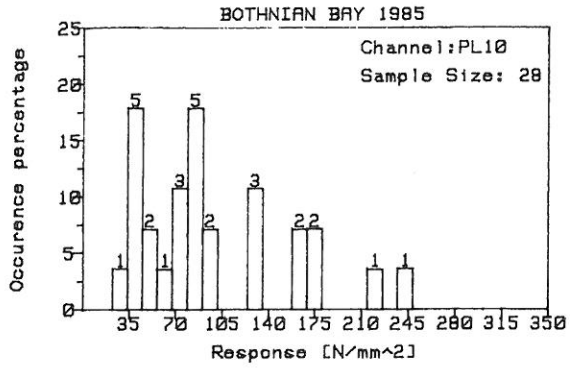


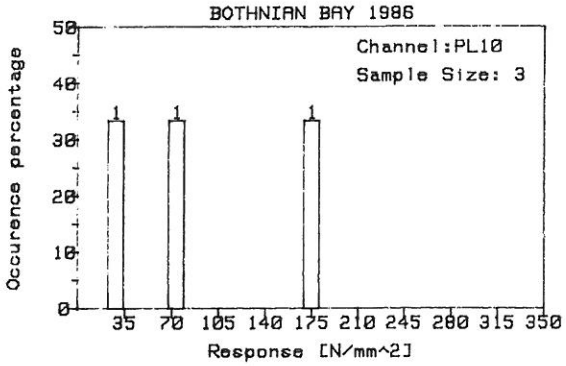


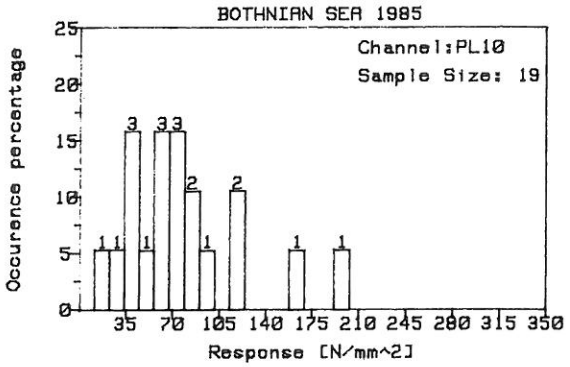


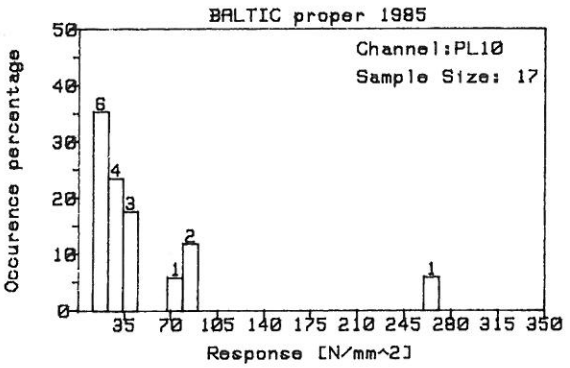


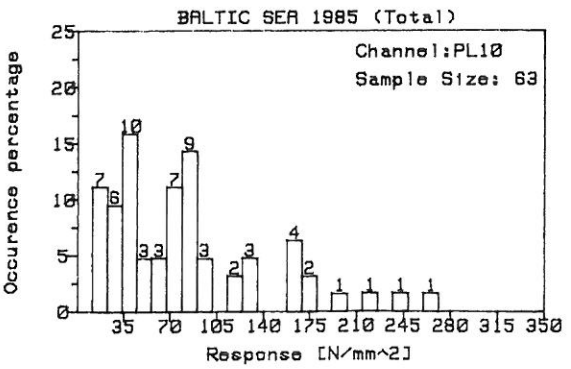
MEASURED 12-HOUR MAXIMA, CHANNEL PL10



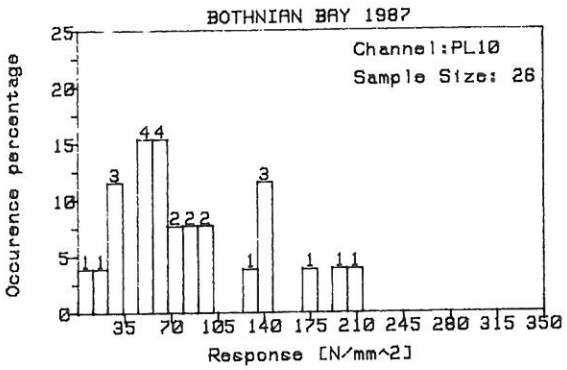


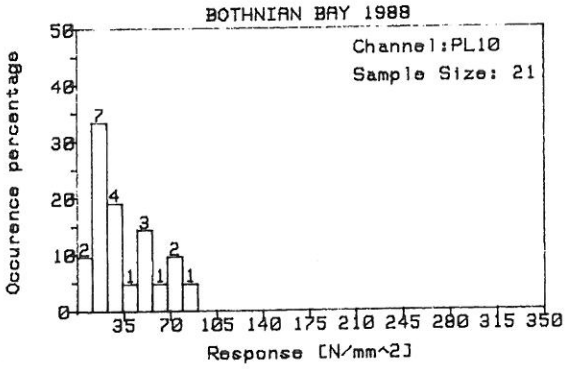


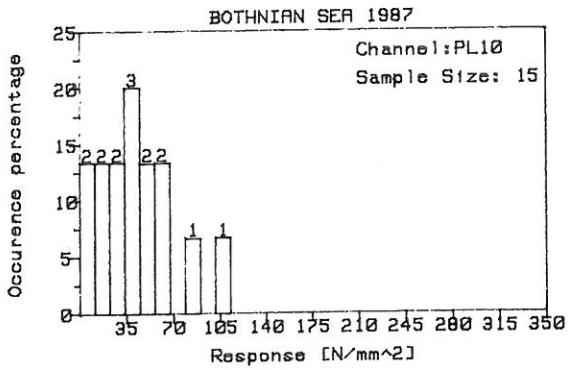


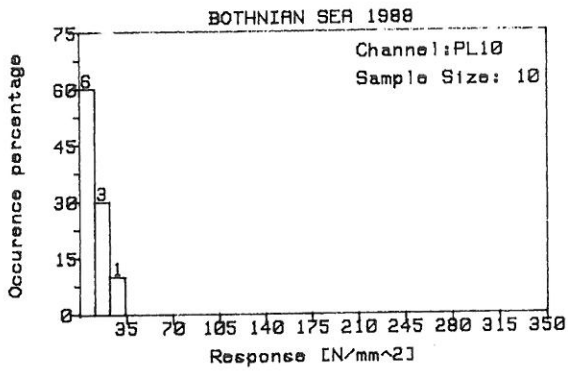


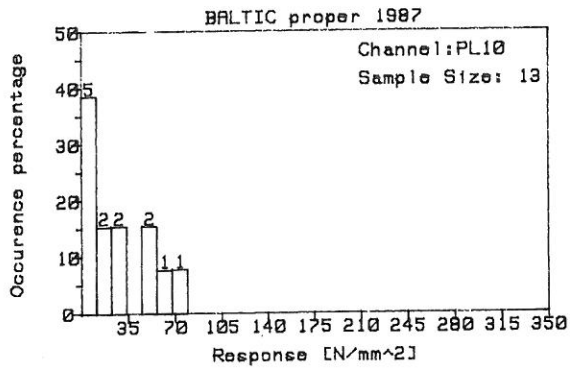
MEASURED 12-HOUR MAXIMA, CHANNEL PL10

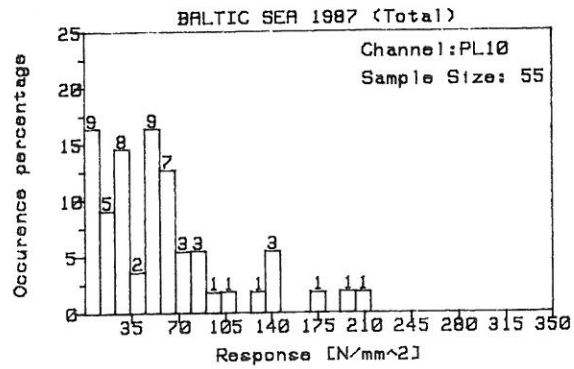


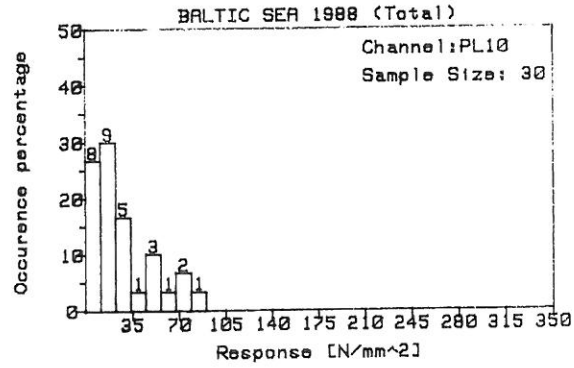




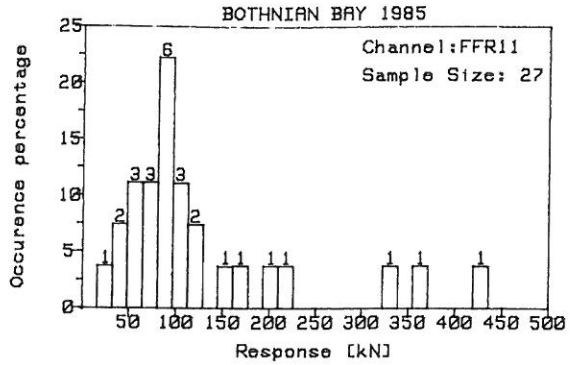


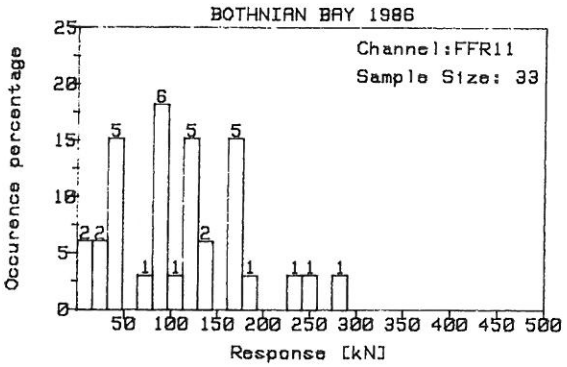


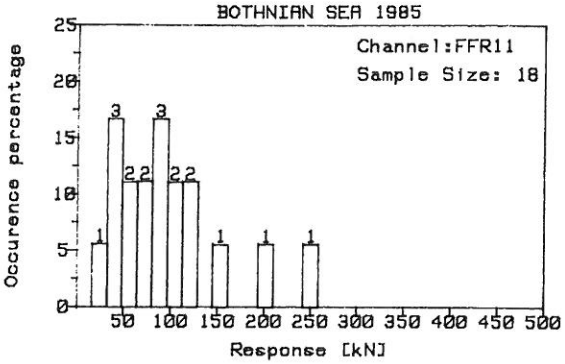


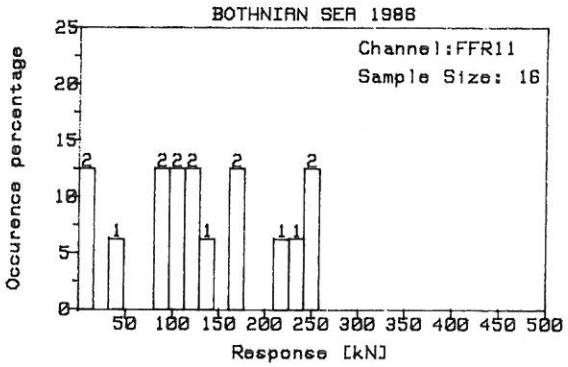


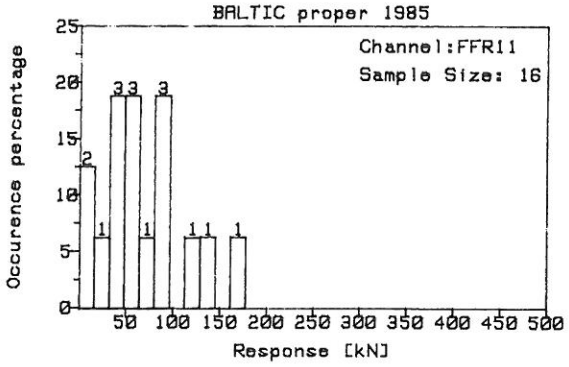
MEASURED 12-HOUR MAXIMA, CHANNEL FFR11

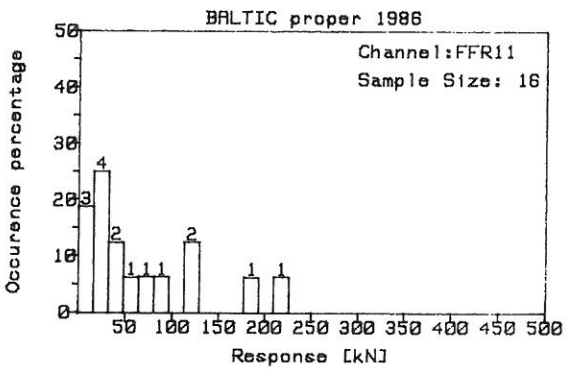


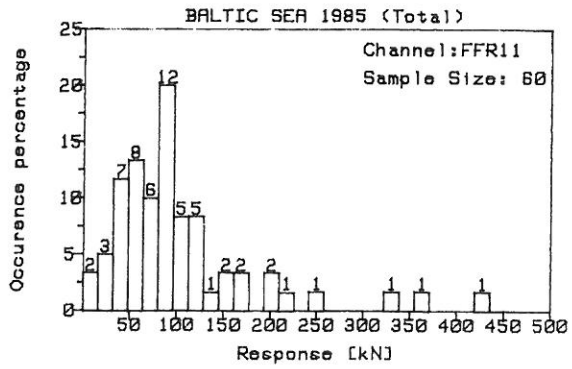


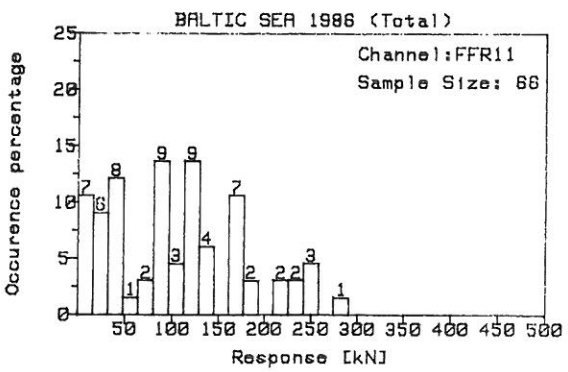




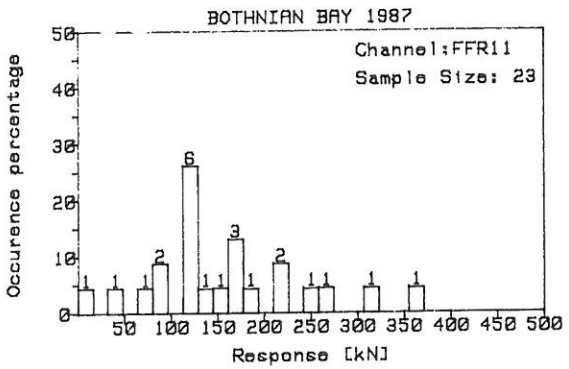


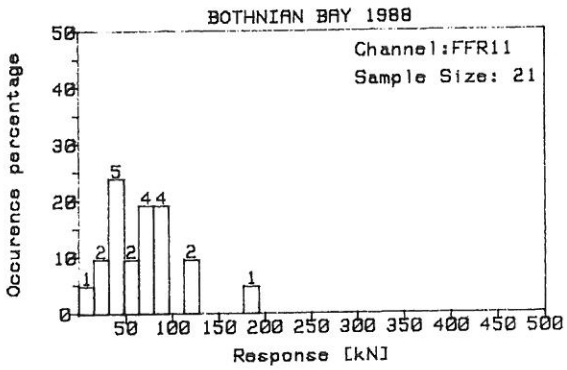


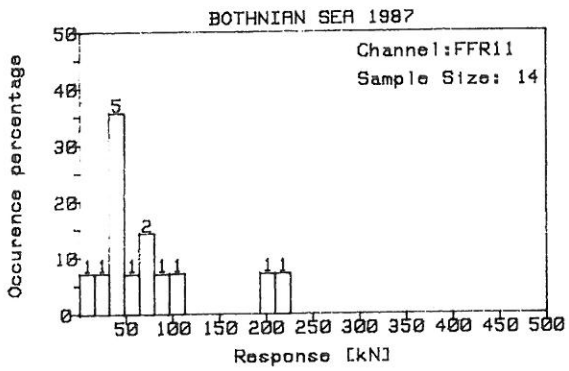


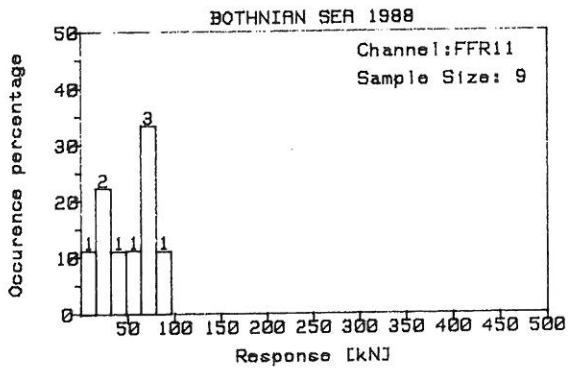


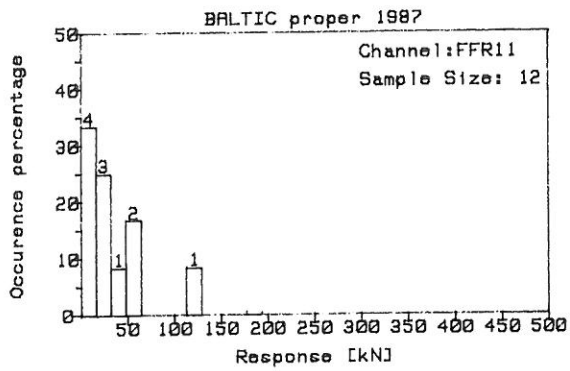
MEASURED 12-HOUR MAXIMA, CHANNEL FFR11

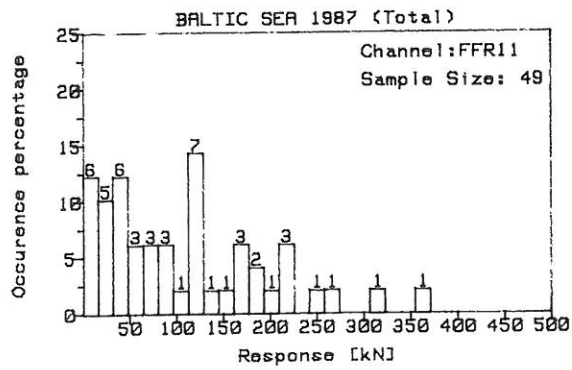


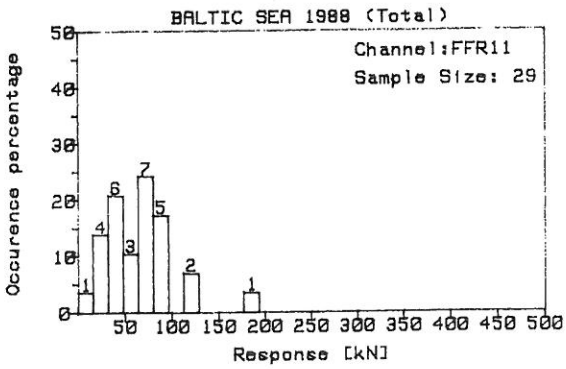




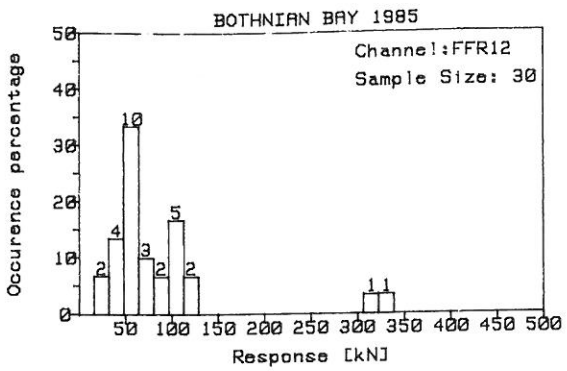


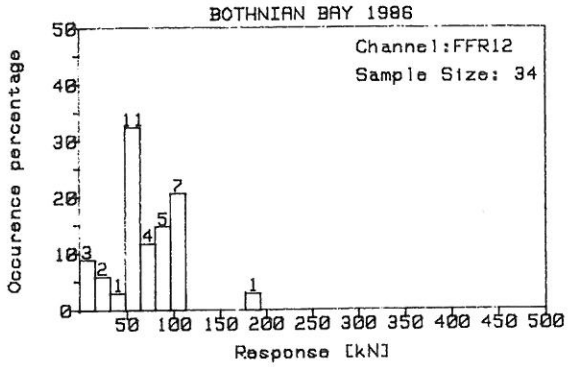


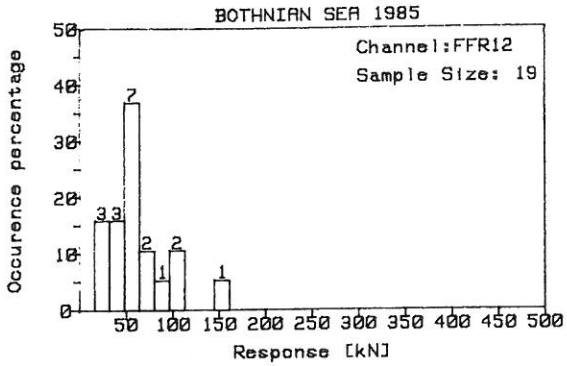


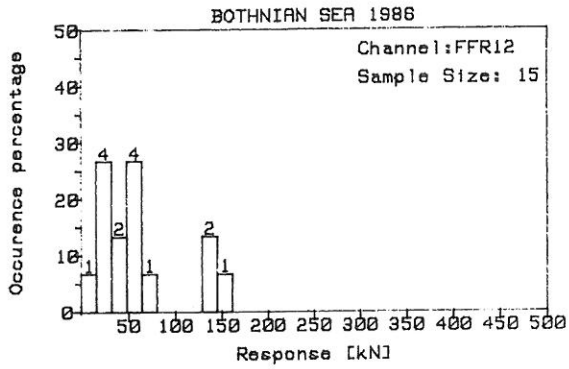


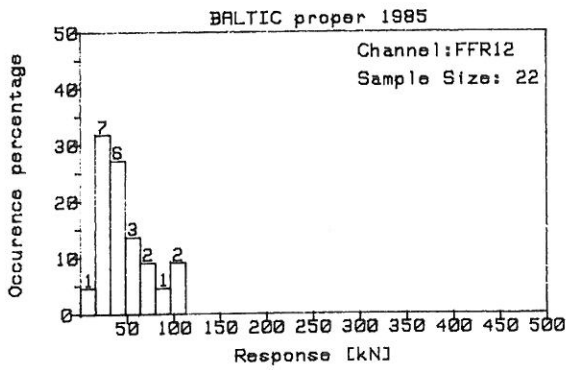
MEASURED 12-HOUR MAXIMA, CHANNEL FFR12

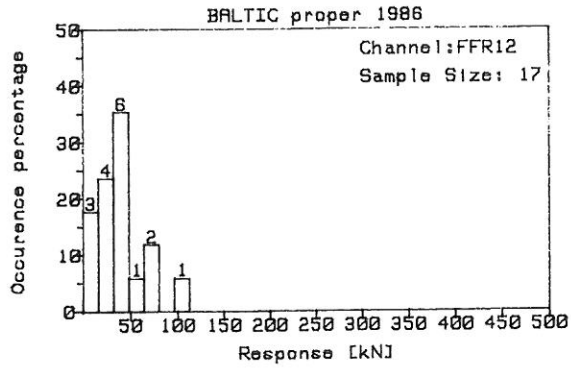


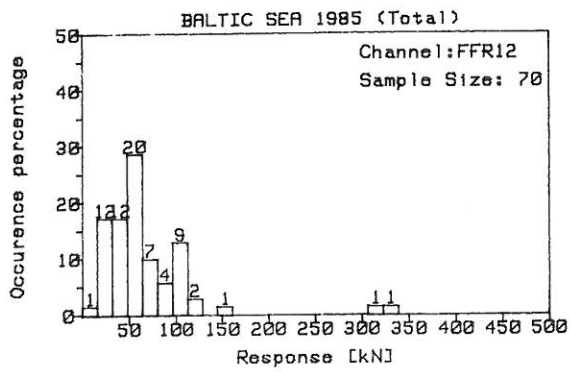


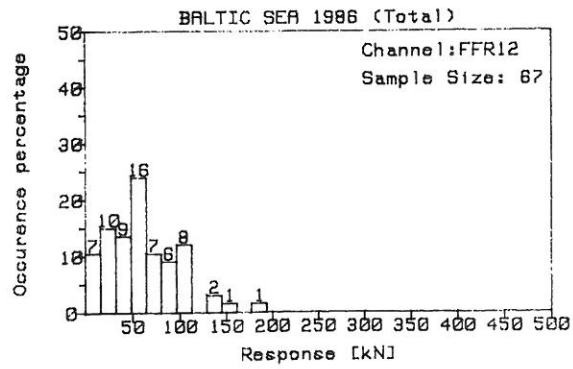




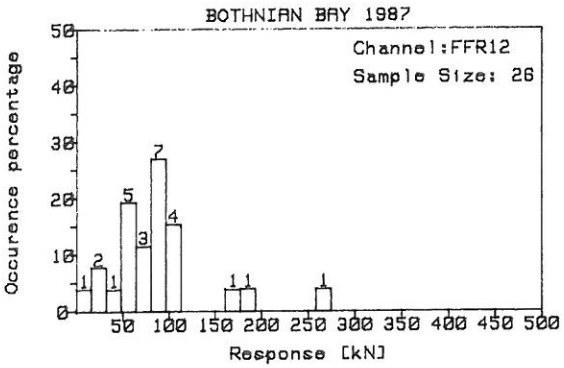


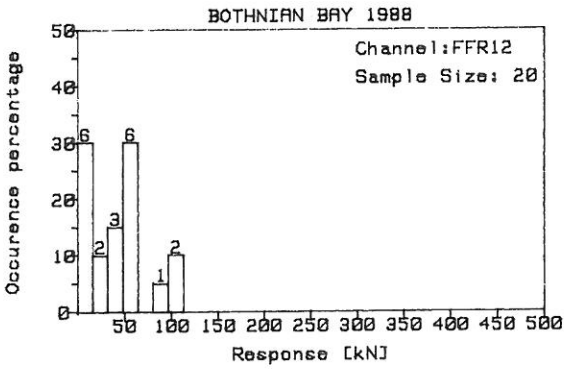


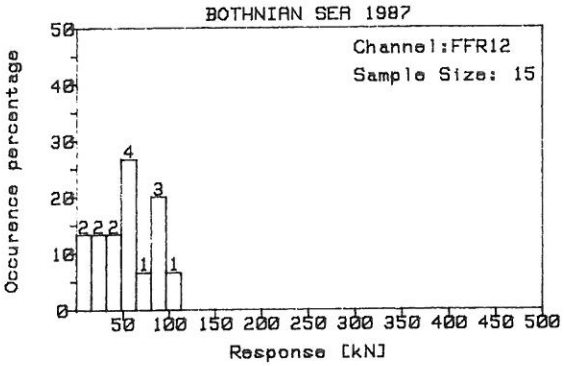


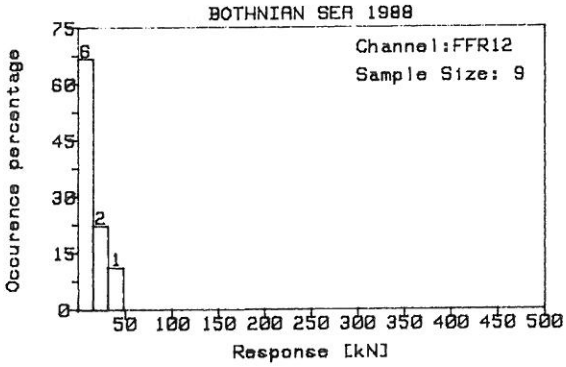


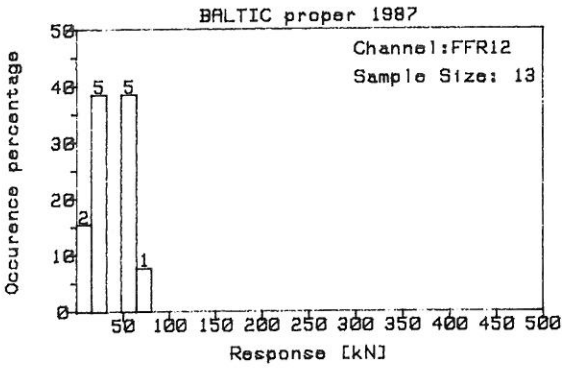
MEASURED 12-HOUR MAXIMA, CHANNEL FFR12

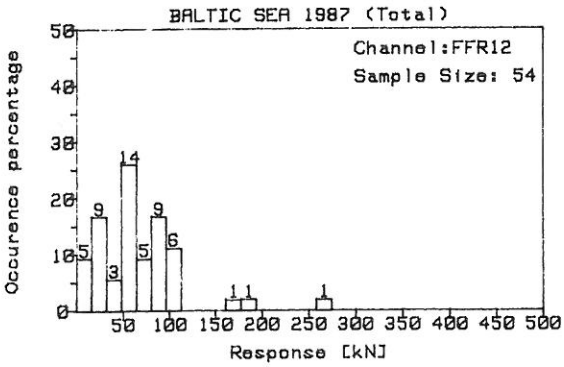


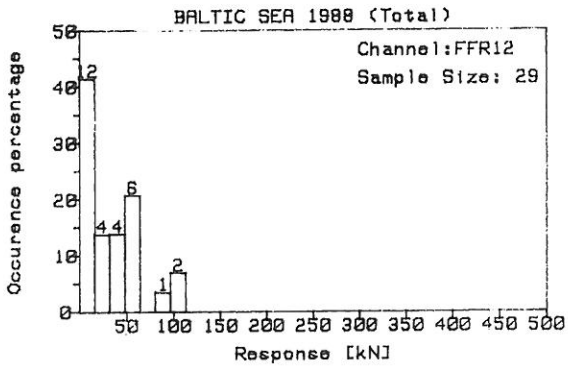




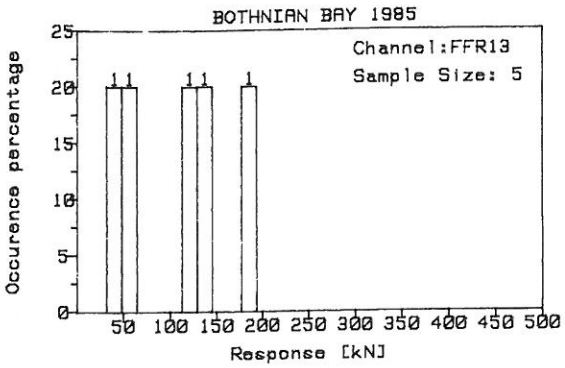


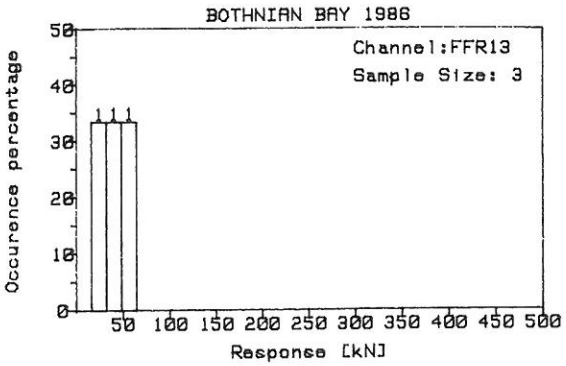


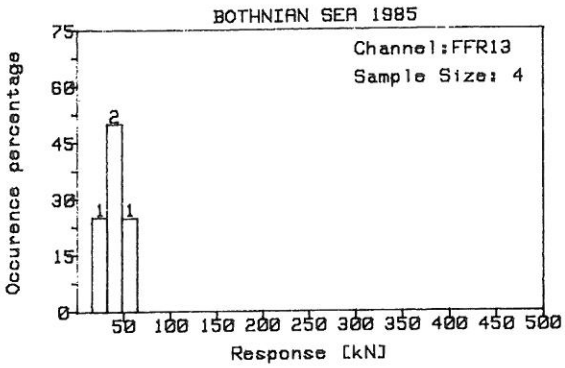


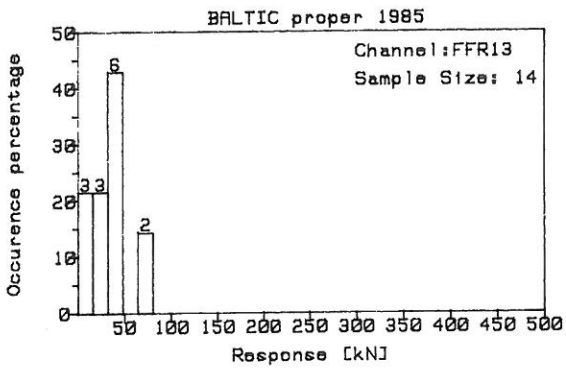


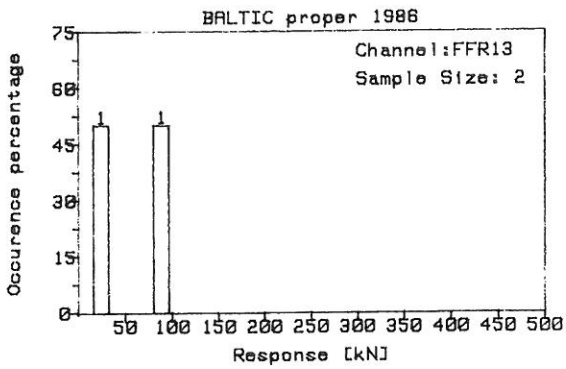
MEASURED 12-HOUR MAXIMA, CHANNEL FFR13

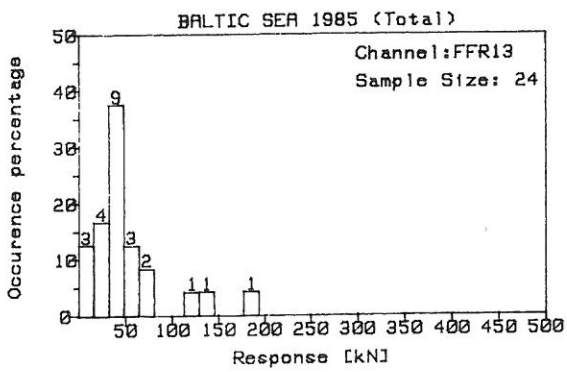


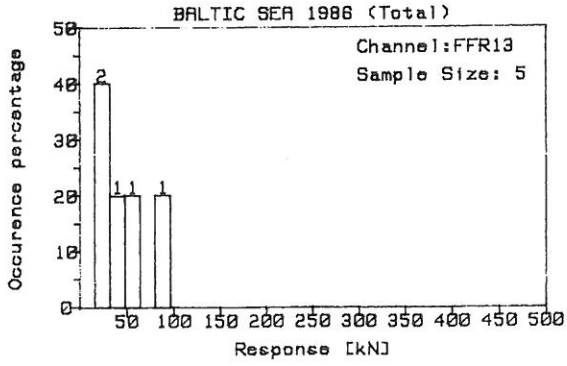




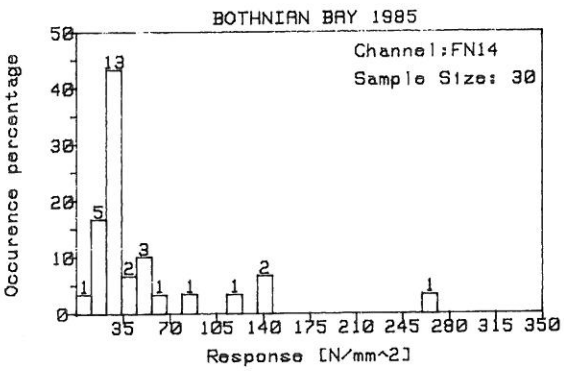


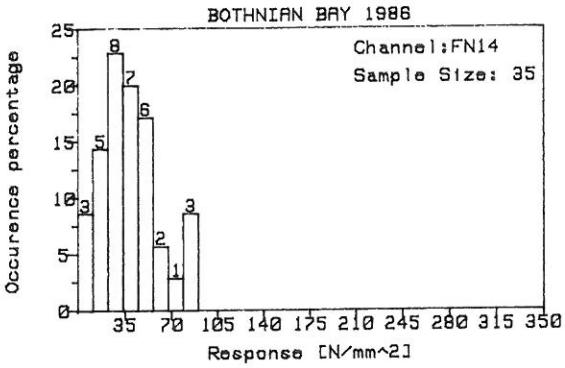


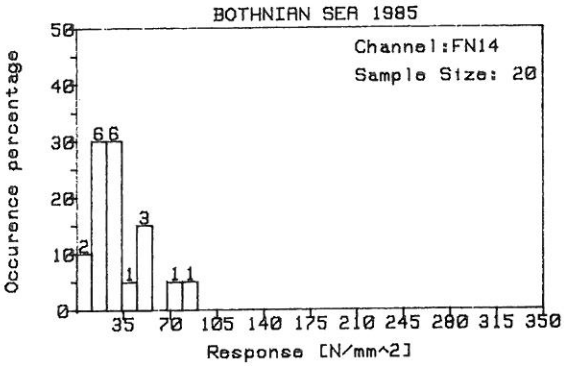


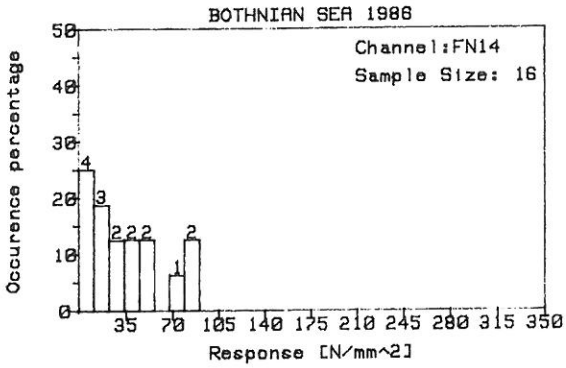


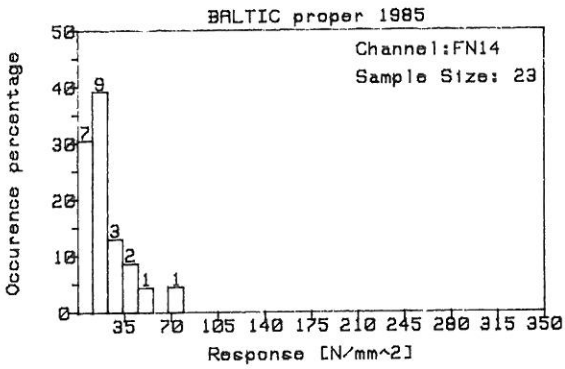
MEASURED 12-HOUR MAXIMA, CHANNEL FN14

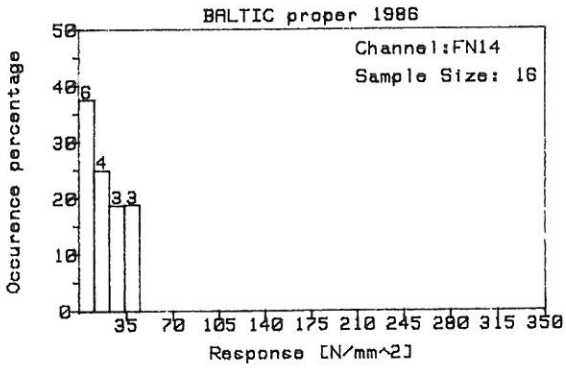


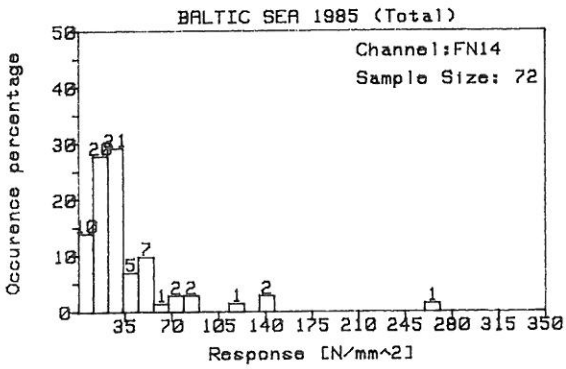


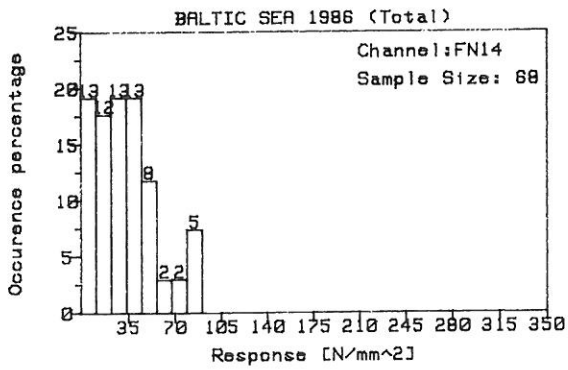




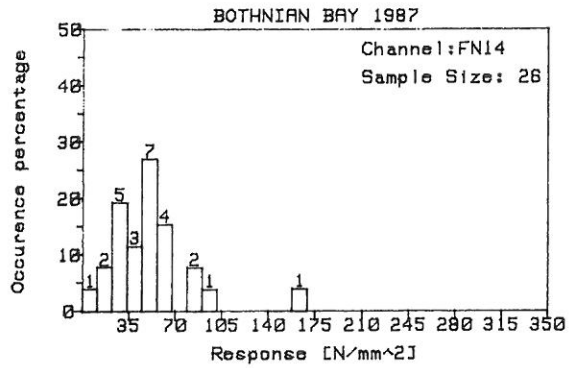


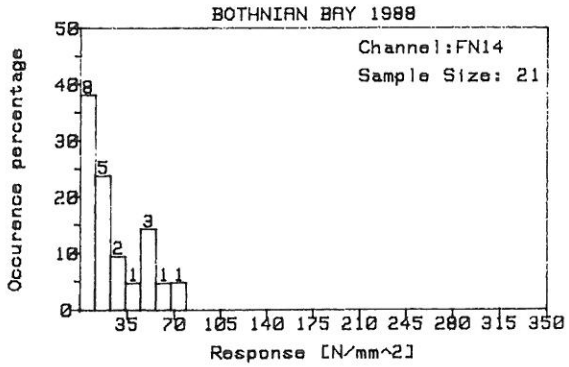


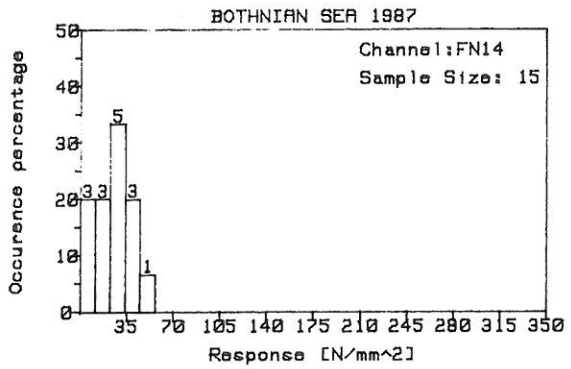


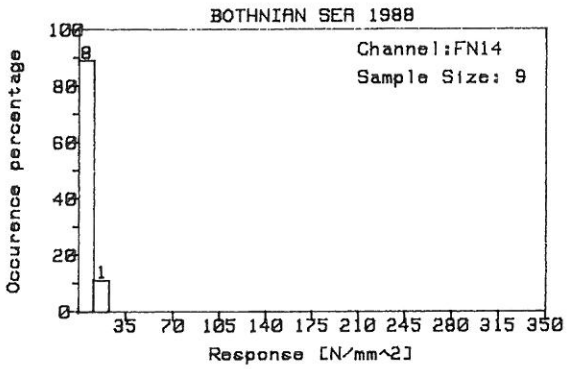


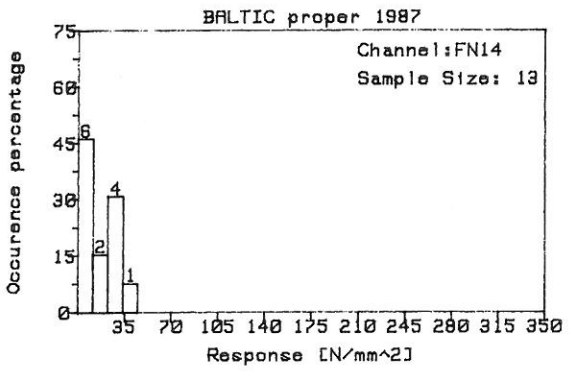
MEASURED 12-HOUR MAXIMA, CHANNEL FN14

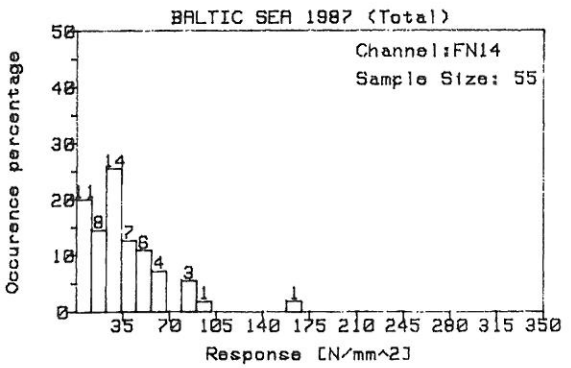


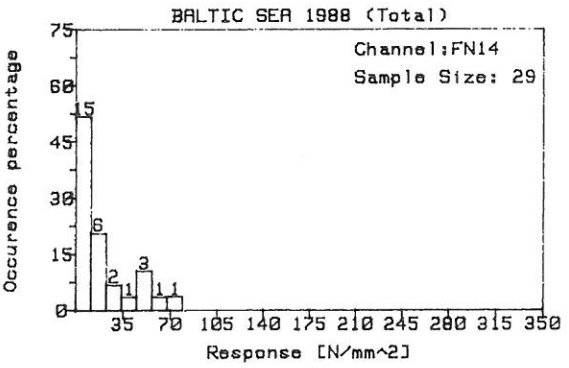




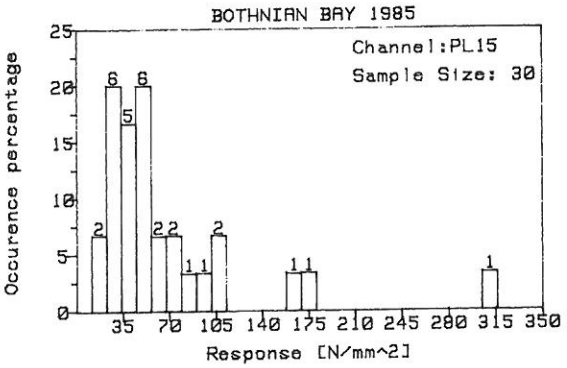


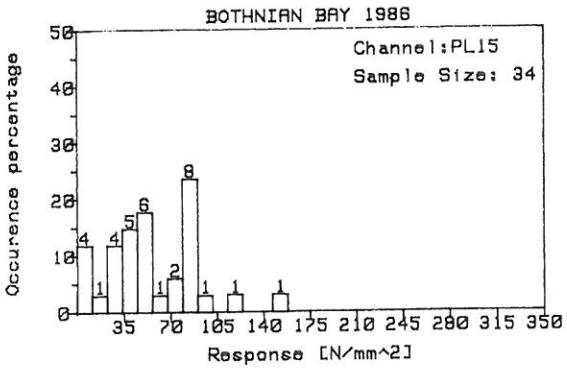


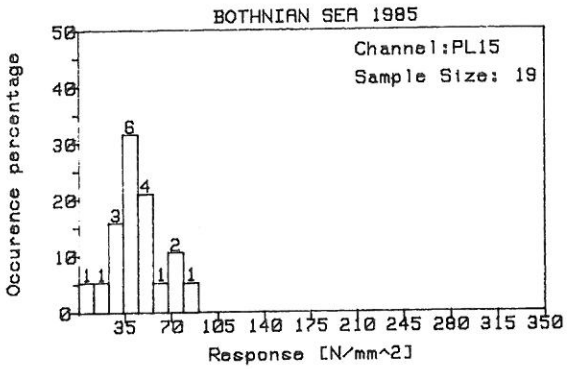


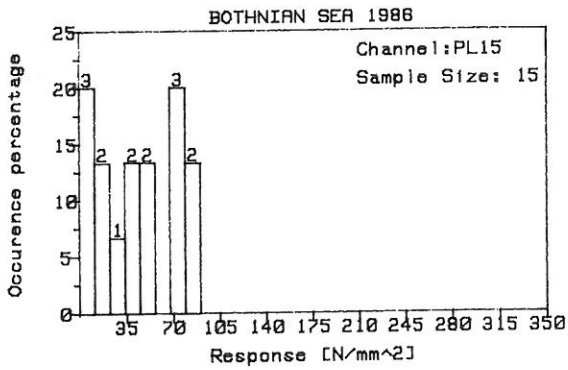


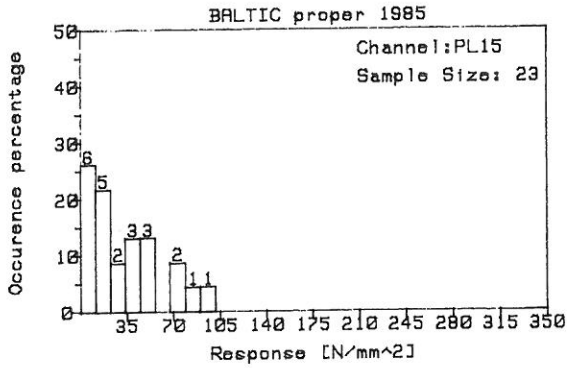
MEASURED 12-HOUR MAXIMA, CHANNEL PL15

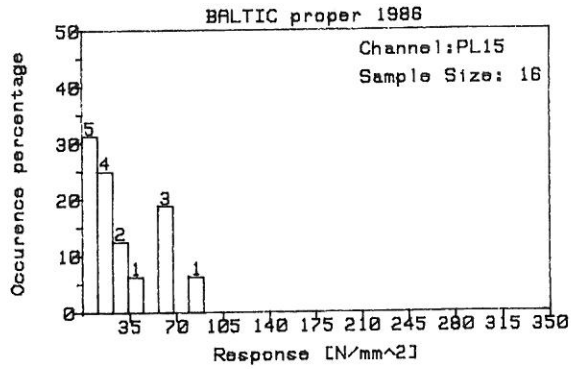


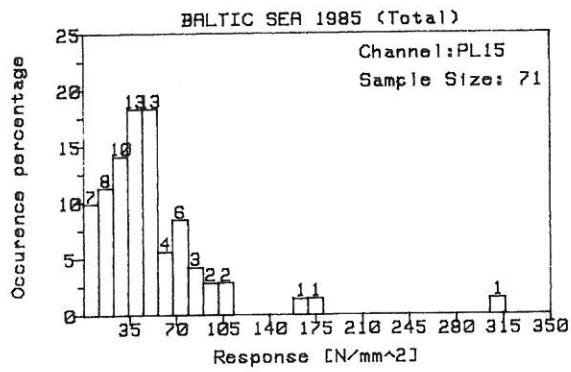


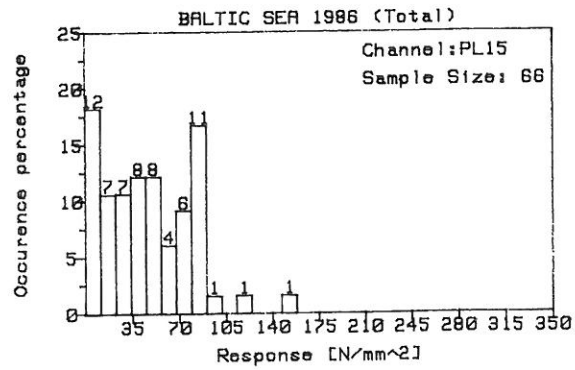




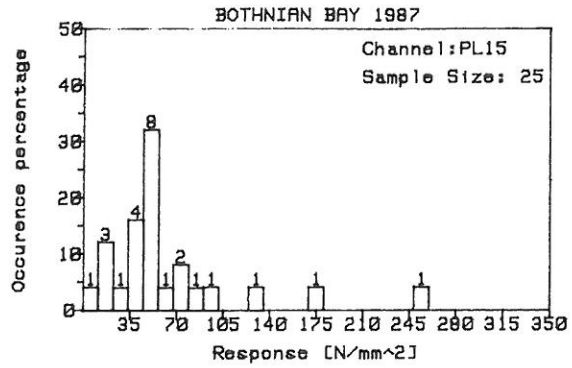


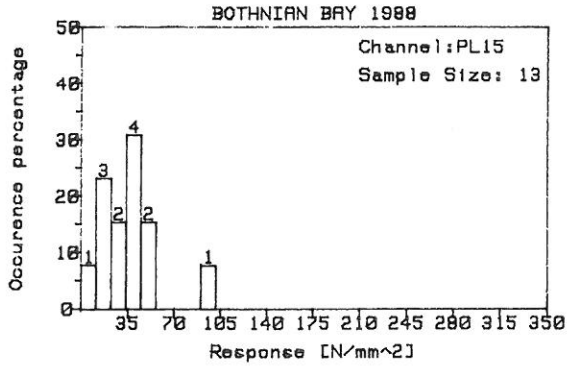


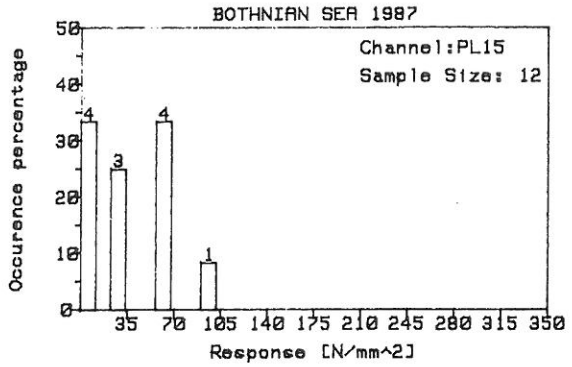


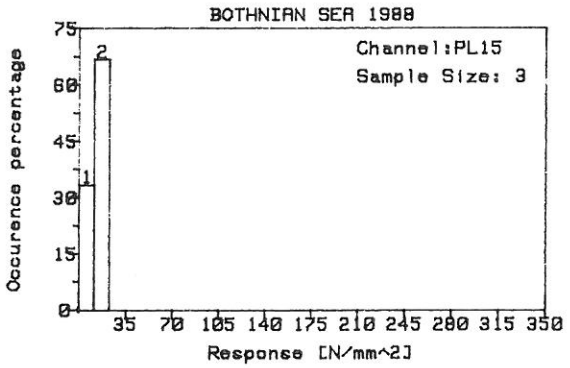


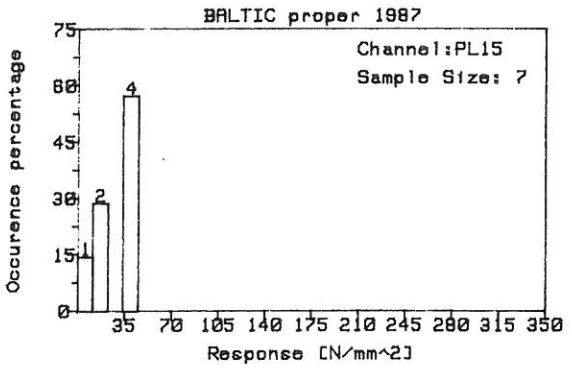
MEASURED 12-HOUR MAXIMA, CHANNEL PL15

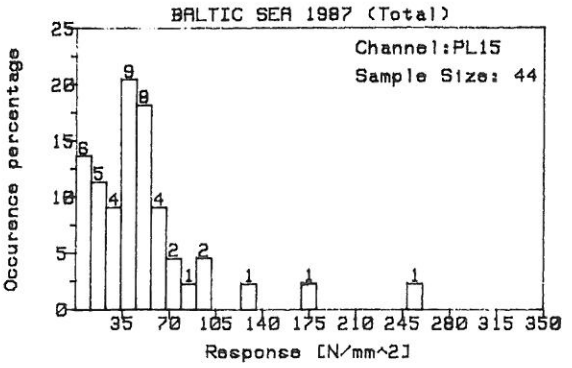


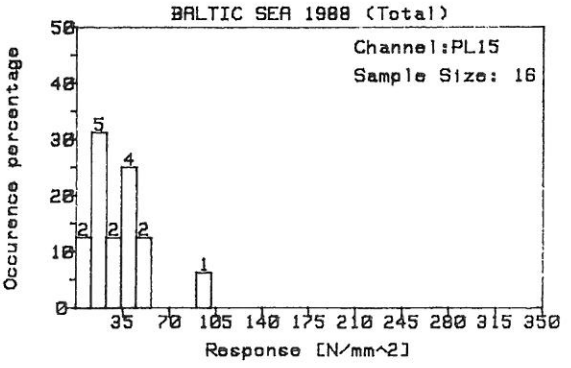












ISBN 951-47-3109-3

The Finnish Government Printing Centre
Kampin VALTIMO
Helsinki 1989