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Research Report No 58

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TRAFFIC RESTRICTIONS TO FINNISH AND SWEDISH PORTS
Setting the Restrictions based on Ice Thickness and Distance Sailed in Ice

Sjöfartsverket
Finland

Finnish Maritime Administration

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FOREWORD

In its report no 58, the Winter Navigation Research Board presents an analysis of the basis of the traffic restrictions given for winter shipping. First the present traffic restrictions are compared with the recommendation given by HELCOM using four Finnish ports (Kotka, Helsinki, Vaasa and Kemi) and data from winter 2005 – 2006. The conclusion from the winter analyzed is that the guidelines for setting traffic restrictions in the Baltic Sea area given in HELCOM recommendation 25/7, Safety of Winter Navigation in the Baltic Sea area, follow closely the present practice of giving the traffic restrictions.

The Winter Navigation Research Board warmly thanks Mr. Patrick Eriksson, Professor Kaj Riska and Mr. Jouni Vainio for this report.

Helsinki

March 2007



Märkku Mylly

TRAFFIC RESTRICTIONS TO FINNISH AND SWEDISH PORTS

Setting the Restrictions based on Ice Thickness and Distance Sailed in Ice

Kaj Riska

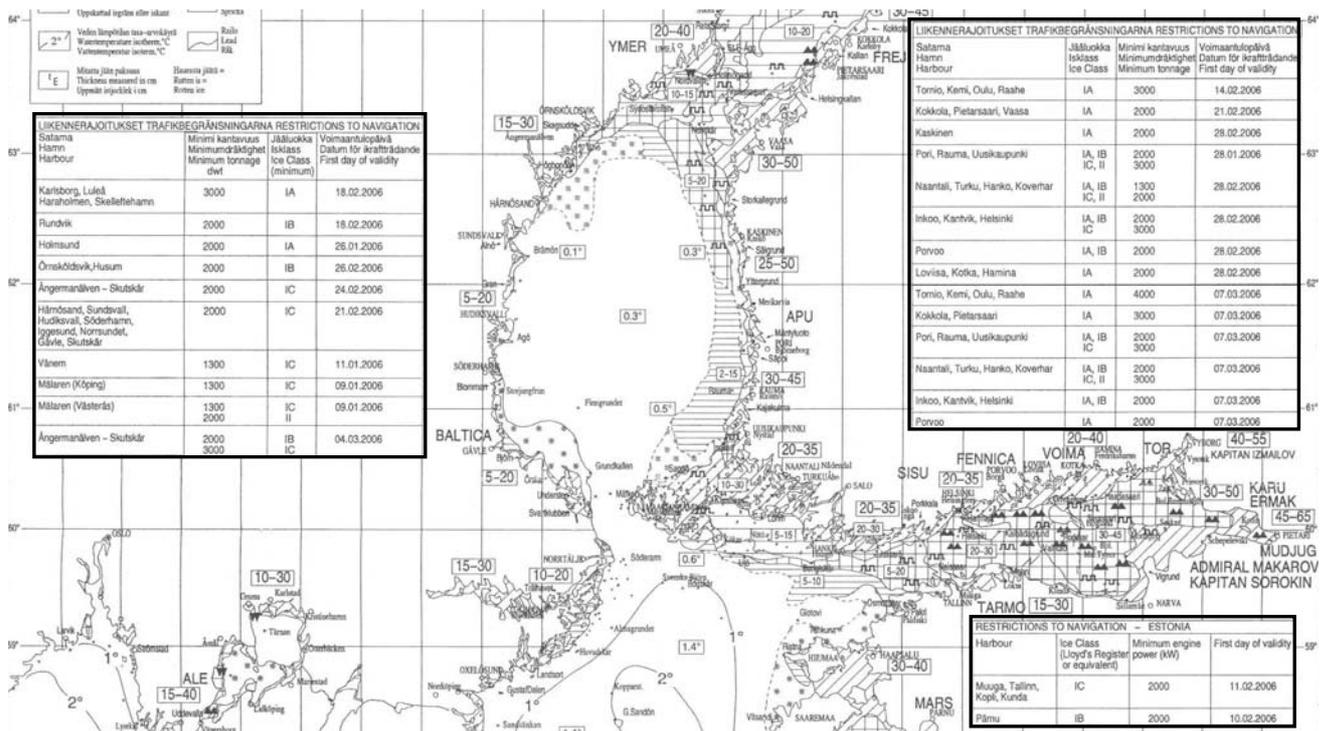


ILS Oy

Patrick Eriksson, Jouni Vainio



The Finnish Institute of Marine Research



Helsinki 23.1.2007

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1. INTRODUCTION

Fluent winter navigation to and from Finnish ports is a necessity for the Finnish economy to function properly. If some northern ports would be closed even some time during the winter, the economy in that area would suffer. Also present export and import is much dependent on the delivery time – with JOT deliveries required – and thus no delays in the transport chain can be allowed.

Most of the Finnish ports are ice bound during winter. Thus the merchant ships must sail through ice to reach these ports. It is not economical to require these ships to navigate independently in winter as the extensive ice strengthening and high ice performance would make these merchant vessels uncompetitive during summer when they must compete with pure open water ships.

The solution selected for these transport requirements in Finland (and also in Sweden and Russia) is that ships are given icebreaker escort in ice. In order to limit the number of icebreakers required, the escorted ships must have some ice going capability of their own in order to smoothly and efficiently be able to follow the escorting icebreakers. This has created the system of ice classes stated in the Finnish-Swedish Ice Class Rules, and also the Finnish system of fairway dues being tied with ice classes.

The fairway due system requires a fairway due payment which is proportional to the net tonnage of the vessel (NT) and her ice class – the higher the ice class, the lower the fairway due. The rationale behind this is that if the ship has a high ice class, she can navigate longer distances without icebreaker escort. This icebreaking/fairway due system requires also some requirement for not only the structural strength of the vessels but also for the ice performance. These performance requirements for the ice classes are stated in the Finnish-Swedish Ice Class Rules.

The system of ice-strengthened merchant vessels escorted by icebreakers with the ice strengthening defined in the ice class rules requires additionally a requirement to have a specific ice class. This could be stated by date and area as in the Canadian zone-date system. In Finland and Sweden the system, however, is adapted to the ice conditions present at each winter day. When the ice cover starts to grow, the maritime authorities start to place requirements for an ice class for ships bound to each port.

This requirements for ice class – these requirements are called traffic restrictions - are first increased as the winter proceeds and eventually in spring decreased. The traffic requirement includes additionally a requirement for a minimum deadweight of the vessels escorted. The minimum deadweight is stated because it is better to concentrate the export/import to fewer ship units – then these units get icebreaker escort quicker. The form of traffic restriction is: In order to get icebreaker escort the ships bound to/coming from ports of Tornio, Kemi, Oulu and Raahé after 14.2.2006 have to have at minimum ice class IA and deadweight 3000 t.

The traffic restrictions are set based on the ice conditions existing in the area. Ice conditions are mostly described in terms of ice thickness. It is the topic of this report to investigate the possibility to include a bit more data about ice cover in the basis of the traffic restrictions. The data from winter 2005 – 2006 for four ports; Kemi, Vaasa, Helsinki and Kotka is used as validation data for this study.

2. TRAFFIC RESTRICTIONS

At present the traffic restrictions are given by the icebreaking management at the Finnish Maritime Administration, based on their experience and also on reports from icebreakers operating in the sea area in question. The traffic restrictions are given as a minimum ice class AND a minimum deadweight required. The deadweight categories used in the restrictions are 1300, 2000, 3000 and 4000 dwt. The ships in the highest ice class IA Super are always given icebreaker escort – which partly is based on the fact that the minimum propulsion power in this ice class is 2000 kW. The development of the traffic restrictions to four Finnish ports considered in this study are given in Fig. 1 up to the moment in spring when the traffic restrictions started to be lifted. This date was 31.3. The ice conditions on the dates when a new restriction was issued are given by ice charts presented in the Appendix 1.

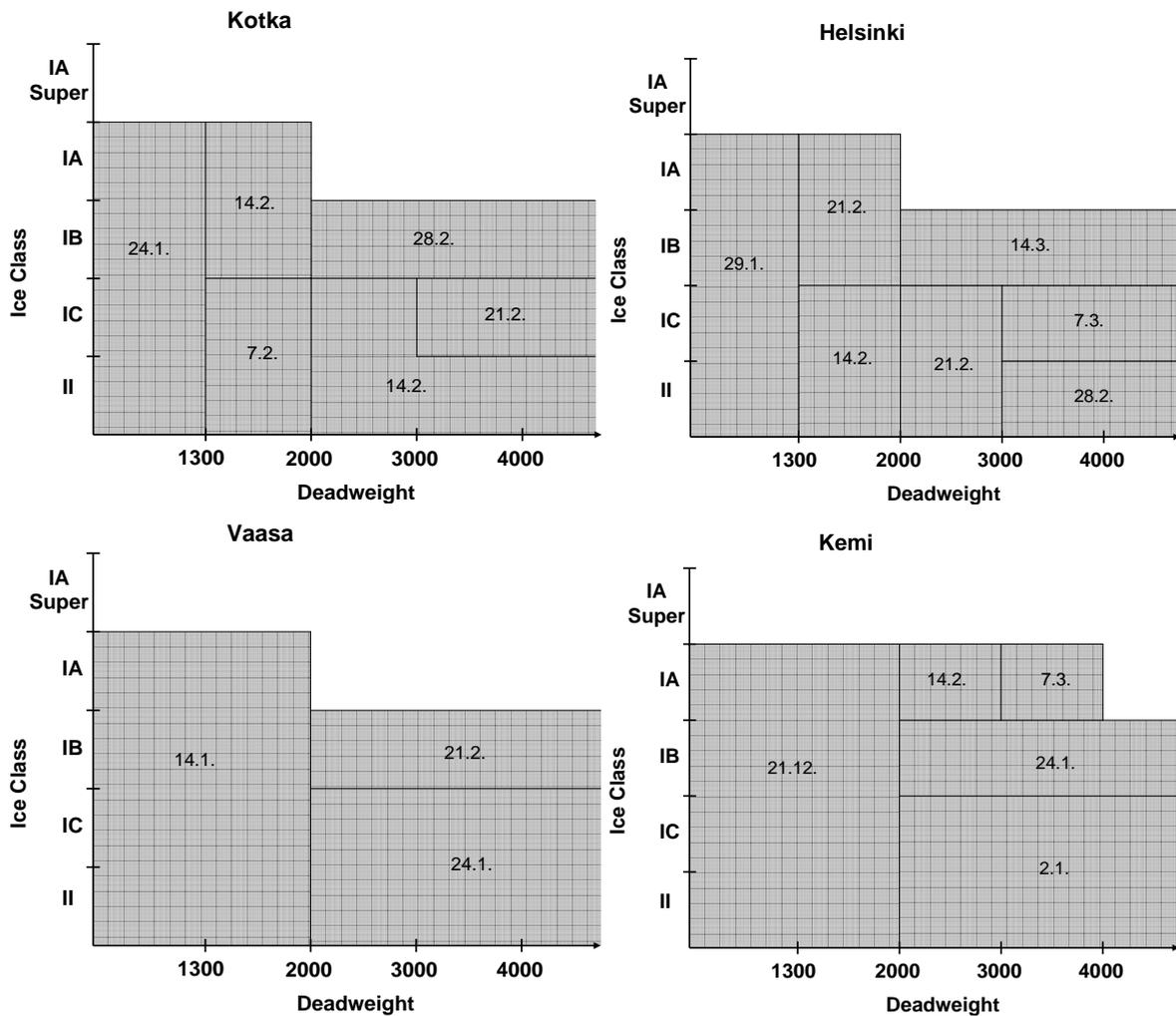


Fig. 1. Graphic description of the traffic restrictions in winter 2005-2006 for four Finnish ports considered in this report up to the date (31.3.) when the restrictions began to decrease. The numbers in the boxes represents dates when this requirement came in force. The ice class / deadweight combination in each box represent the ships not given icebreaker escort.

The distance to be navigated in ice to ports of Kemi, Vaasa, Helsinki and Kotka was determined for each ice chart published twice a week. The maximum level ice thickness was also extracted from these ice charts for each port – and the maximum stated ice thickness was used in this analysis. These data is given in Appendix 2. The data suggest immediately that the extent of ice cover and the maximum level ice thickness correlate, see

Fig. 2. It is clear from the plots that the ice extent and the maximum level ice thickness correlate; the extent of ice is proportional to roughly the square of the ice thickness. The correlation would be clearer if the data from spring would be omitted as during the spring the ice thickness is not decreasing much while the ice extent decreases strongly.

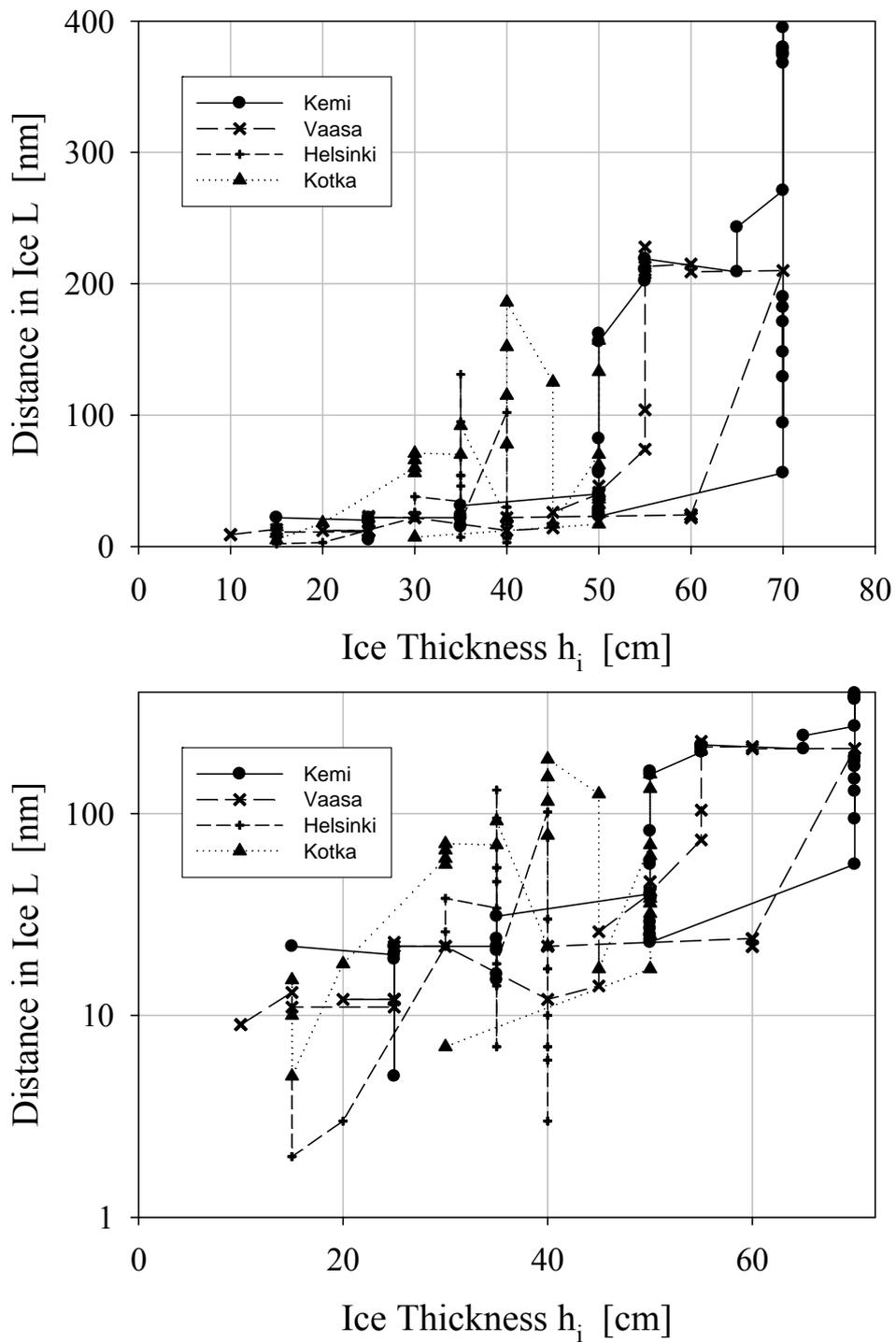


Fig. 2. Plots of distance sailed in ice to each port versus the ice thickness in linear and log-linear scales.

3. BASIS FOR TRAFFIC RESTRICTIONS

The traffic restrictions are given partly in order to guarantee the safety of navigation but mainly to ensure the continuity of the winter traffic. When the ice thickness increases, the ice causes higher loads and ice damage on ships would result if they do not have an adequate strength – and this adequate strength is achieved by having a proper ice class. The ships in each ice class are required to have certain ice performance stated in the ice class rules. This is done because this way ships do not need icebreaker escort immediately when they enter ice. This, again, reduces the need for icebreakers and the icebreaker fleet needs not to be too extensive. This short analysis suggests that ice thickness is the main ice parameter controlling the level of traffic restrictions. Some other parameters like the amount of ridging and extent of ice cover may also influence the proper selection of the traffic restriction. This basis for traffic restrictions is investigated here.

The HELCOM Agreement

A need for making the basis for traffic restrictions similar in all the Baltic countries was expressed by the Helsinki Commission (HELCOM). The advantage of the uniform restrictions is that the winter navigation systems could operate in a similar fashion making cooperation in the Baltic easier. This development of the basis for traffic restrictions was one of the agenda items when HELCOM convened an Ice Expert Working Group (Ice EWG) in year 2004. The work of this Ice EWG resulted in a recommendation that the traffic restrictions would be based on maximum level ice thickness at each port. The ice thickness limits suggested were (HELCOM Maritime 2/2004):

Ice thickness [cm]	Ice class required
10 – 15	LU1
15 – 30	IC / LU2
30 – 50	IB / LU3
> 50	IA / LU4

The recommendation was given using both the Finnish-Swedish ice classes (IC, IB and IA) and the Russian Maritime Register of Shipping ice classes (LU-classes).

The maximum level ice thickness h_i , if it is not given in ice charts, can be calculated using the Zubov equation

$$h_i^2 + 50 \cdot h_i = 8 \cdot R, \quad (1)$$

where the quantity R is the accumulated number of degree days of frost i.e.

$$R = \int_{T_0}^T (\theta_F - \theta(t)) dt, \text{ if } \theta_F - \theta(t) \geq 0. \quad (2)$$

The current air temperature is $\theta(t)$, θ_F freezing temperature (for the Baltic brackish water about -0.5°C) and T_0 is the date when the permanent ice cover is formed (T is the present time). It is noteworthy that the HELCOM recommendations are given in terms of ice thickness and for ice class only (i.e. the deadweight or the propulsion power is not given in the requirement).

The Finnish ports of Kemi, Vaasa, Helsinki and Kotka are used as the validation ports in this study. The imposed restrictions and level ice thicknesses are shown in Fig. 3. For the early and middle winter the restrictions conform well the HELCOM recommendation except IC/3000dwt seems to be treated as a quasi IB. On the other hand, during the melting season (April-May), the restrictions apparently take the rotting of the ice cover into account.

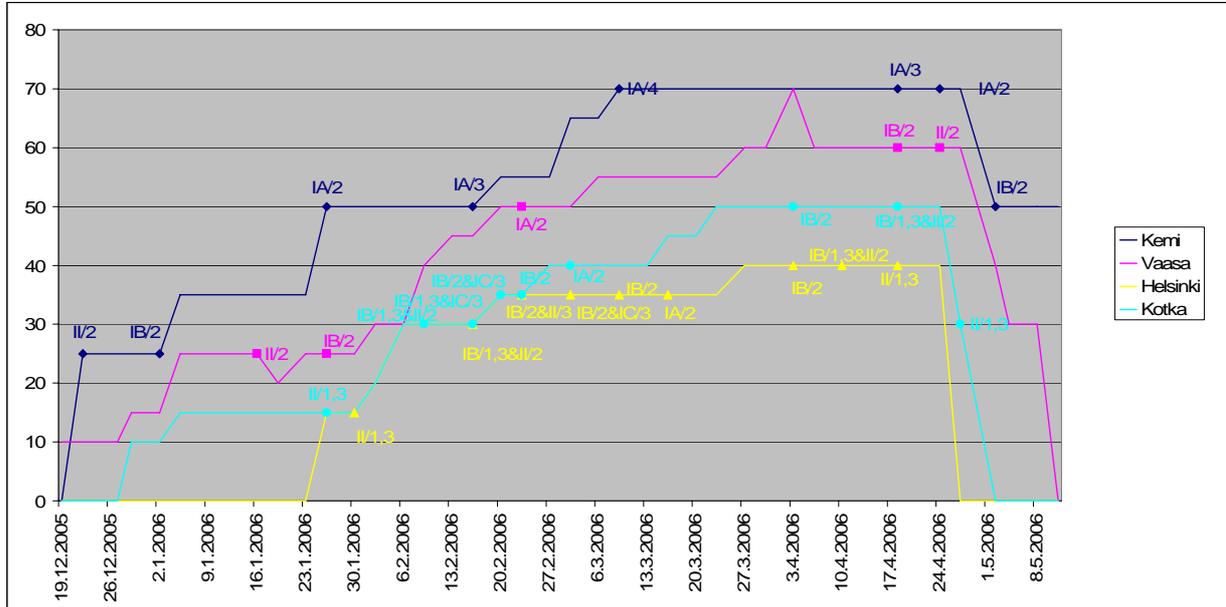


Fig. 3. The level ice thicknesses and imposed traffic restrictions in terms of ice classes (IC, IB, IA) and deadweight (1,3=1300 dwt, 2=2000 dwt, 3=3000 dwt, 4=4000 dwt).

Further Development of the Traffic Restrictions

In the work of the Ice EWG a suggestion was presented for the basis of the traffic restrictions that would take into account – apart from the level ice thickness - the extent of ice cover and ridging (Hänninen 2003). This suggestion is based on the ice loading on ship hull and the fact that ice loads are statistical. Thus the longer time or distance the ship navigates in ice, the higher probability there is to encounter high ice loads. Also ridged ice may cause higher ice loads because the consolidated layer of the ridges may be thicker than the surrounding level ice.

The suggestion presented is based on defining a quantity termed equivalent ice thickness h_{eq} . The equivalent ice thickness depends on the amount of ridging in the ice cover and also on the distance navigated in ice. This quantity is defined as follows.

Consider, say, a sea area of the extent of 1 km^2 . From this area $C \text{ km}^2$ is covered by ice while $1-C \text{ km}^2$ is open water; C is the ice coverage usually given in tenths. If the ice is deformed, consider a level ice sheet of the same area 1 km^2 that has been created by levelling the deformed ice into a layer of constant thickness. Equivalent thickness is then the thickness of this layer. On the other hand, the report of Daley (2004) studies the defining of equivalent ice thickness from an ice navigation point of view. Two definitions are given there. The first is based on the ice induced loads experienced by the ship. The strategy is to define the equivalent thickness as the thickness of such level ice that would induce the same loading level as the actual deformed ice. The other is based on ship performance and is defined as the thickness of such level ice in which the ship would have

the same transit time as in the actual deformed ice. Only the definition based on loading level is considered here.

In Daley (2004), following Hänninen (2003), the ship hull loading level is described by the maximum ice load expectation x_L for an ice transit of L nautical miles. This means that if the ship would make the same transit N times, and the maximum load x_i would be experienced for each transit, then the average of the maxima $x_1, x_2 \dots x_N$ would be close to x_L . The expectation x_L increases with L and is given by

$$x_L = c (L)^H \text{ [kN/m] }, \quad 1 \text{ nm} < L < L^* \quad (3)$$

$$x_L = c (1 + H \ln(L/L^*))(L^*)^H \text{ [kN/m]}, \quad L > L^* \quad (4)$$

where the constant is

$$c = 690 h_i^{1.7} \text{ [kN/m]} \quad (5)$$

It is assumed, that the average maximum load experienced anywhere in the bow area during a 1 nm transit is given by (5). It is assumed also, that (5) is not affected significantly by the presence of ridging – also the influence of hull shape is neglected.

The parameter H describes ridging; it has values 0.3-0.4 in level ice and 0.4-0.6 in ridged ice (Lensu 2002). As typical for level and ridged ice the values $H' = 0.35$ and $H = 0.5$ are suggested. The limits of variation are thus 0.3...0.6 and the loads increase with the exponent, which acts as a ridging index. L^* indicates a regime change; for transits shorter than L^* the loads increase more rapidly as a function of L than for transits longer than L^* .

The equations (3) and (4) are written for the two exponents

$$\begin{array}{ll} x_L = 690 h_i^{1.7} f(H) & \text{for ridged ice} \\ x_L' = 690 h_i^{1.7} f(H') & \text{for level ice} \end{array}$$

where the function $f(H)$ indicates the dependency on the exponent H . The equivalent thickness is defined as follows

$$x_L = 690 h_i^{1.7} f(H) = 690 h_i^{1.7} (f(H)/f(H'))f(H') = 690 h_{eq}^{1.7} f(H') \quad (6)$$

from which the equivalent ice thickness is obtained as

$$h_{eq} = (x_L' / x_L)^{1/1.7} h_i \quad (7)$$

Thus h_{eq} is the thickness of such level ice field which, during a transit of L nm, induces the same loading level as the ridged ice field where the level ice sections have thickness h_i . In other words, a ridged ice field with level ice thicknesses h_i is as safe to navigate as a level ice field with thickness h_{eq} . Note that the definition is not dependent on the magnitude of (5), only on the exponent 1.7.

The ratio h_{eq}/h_i has a limit value with large distances given in the following table. It is clear that the value for the reference length L^* is close to 1 nm and the lower values for the exponents should be used; otherwise the equivalent ice thickness becomes unrealistically large.

$L^* \setminus H' \ \& \ H$	0.35 & 0.5	0.3 & 0.6
1 nm	1.43	2.0
5 nm	1.82	2.55
50 nm	10.71	15.0

In the following the equivalent thickness is calculated using values 1 nm, 5 nm and 50 nm for L^* , typical values 0.35 and 0.5 for H' and H , and extremal values 0.3 and 0.6 for H' and H . The results are shown in Fig. 4.

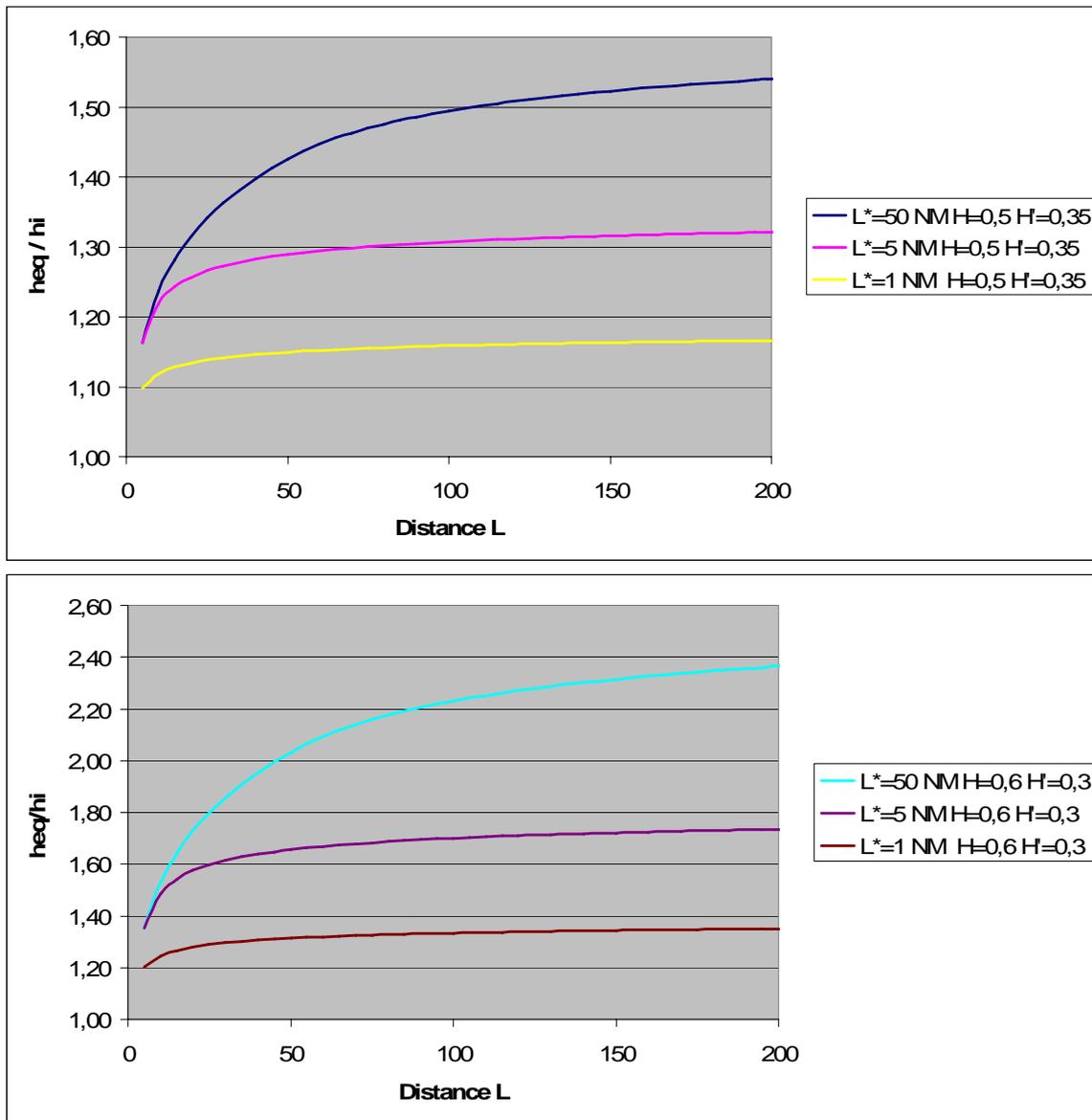


Fig. 4. The influence of the reference length value L^* and the value of the exponents H' and H on the ratio h_{eq}/h_i .

The influence of the parameter values on the resulting equivalent ice thickness is studied next using the thickness and ice extent values to each of the four ports used in this study. The data for these ports is given in Appendix 2. The results of the parameter variation are shown in Fig. 5a-c.

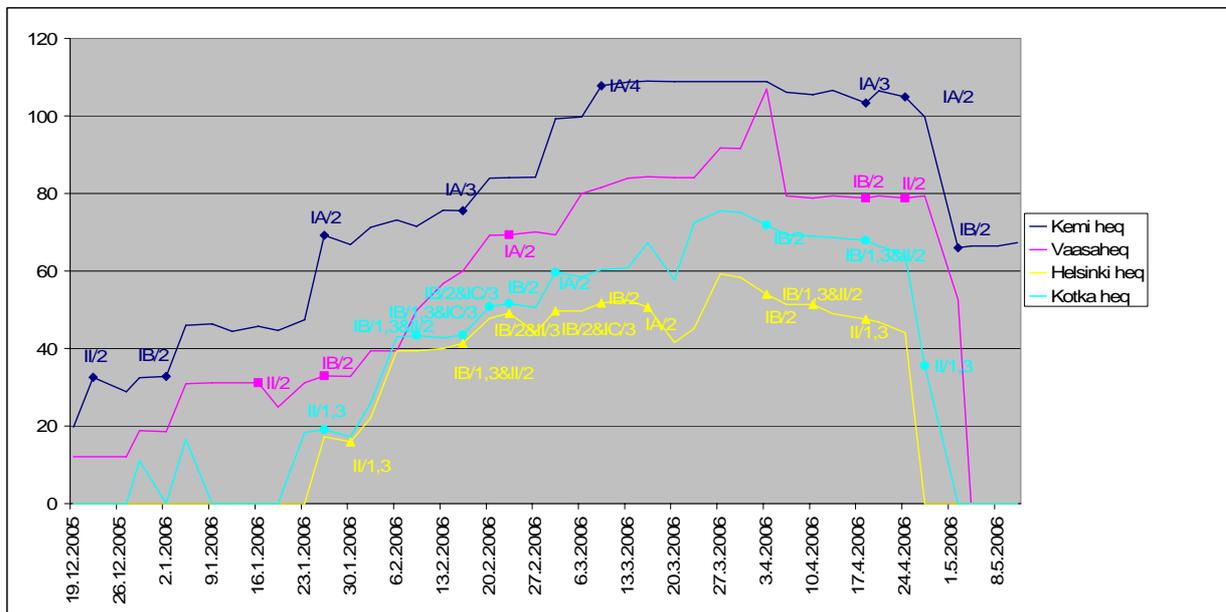
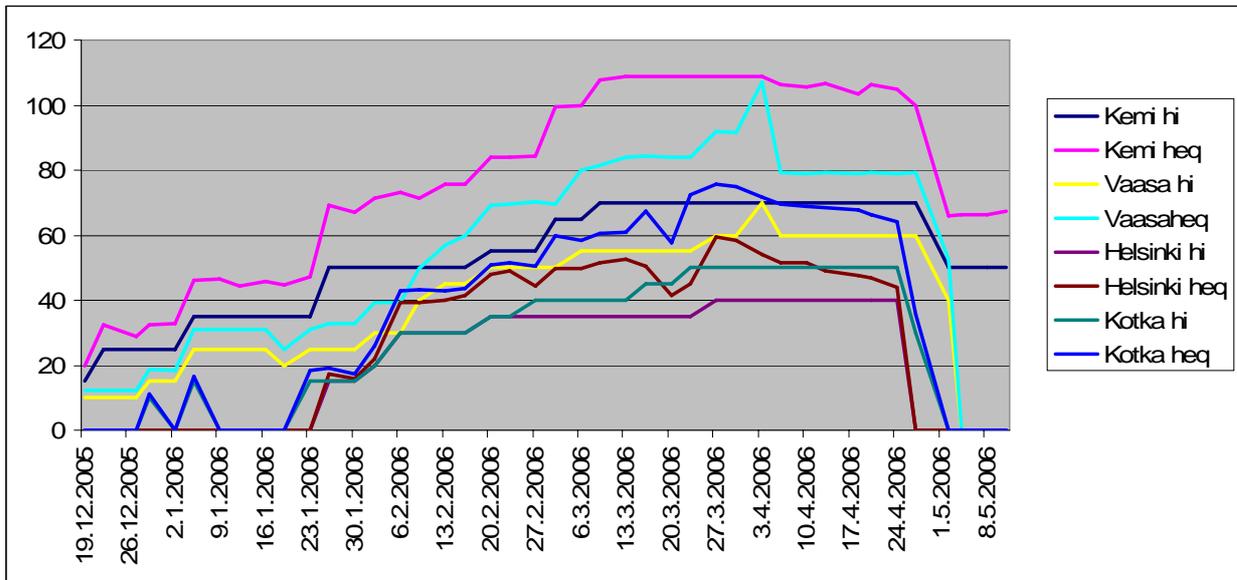
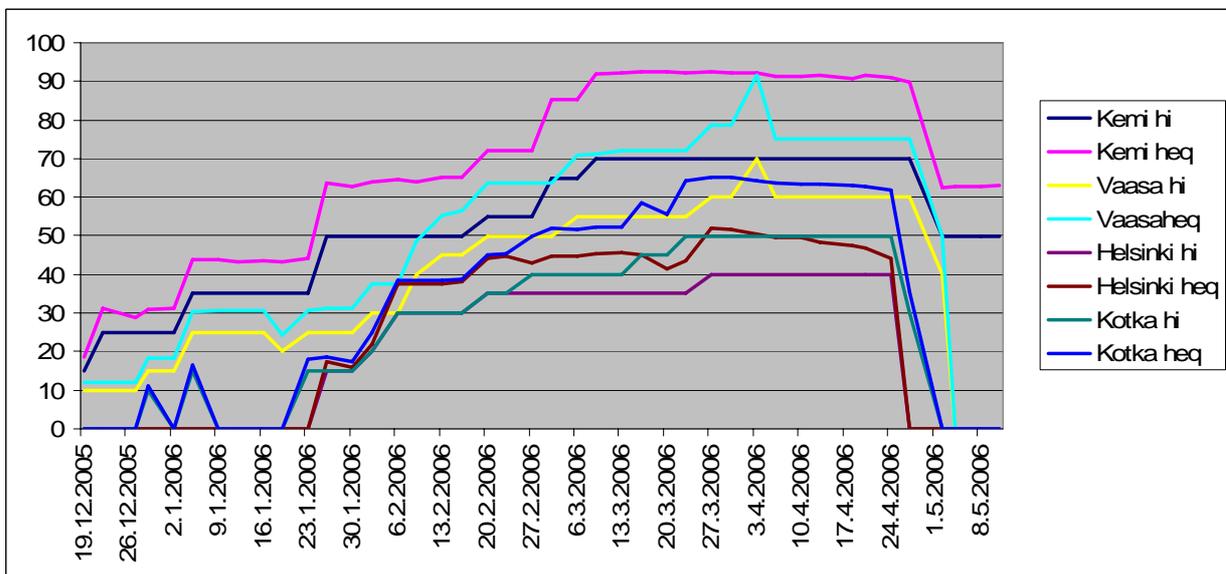


Fig. 5a. The equivalent ice thickness with parameter values $L^*=50$ nm, $H=0.5$ and $H^I=0.35$.



The results of parameter variation suggests that most suitable value of the parameters is $L^* = 5$ nm, $H' = 0.35$ and $H = 0.5$ as this combination gives a reasonable increase in the equivalent ice thickness. It is also clear from the plots that the ratio h_{eq}/h_i remains quite constant throughout the winter. This means that both the level ice thickness h_i and the equivalent ice thickness h_{eq} could be used as the basis for the traffic restrictions as which one to use is just a matter of scaling.

4. CONCLUSION

An analysis of the basis of the traffic restrictions given for winter shipping is presented in this report. First the present traffic restrictions are compared with the recommendation given by HELCOM using four Finnish ports (Kotka, Helsinki, Vaasa and Kemi) and data from winter 2005 – 2006. The conclusion from the winter analyzed is that the HELCOM recommendation follows closely the present practice of giving the traffic restrictions.

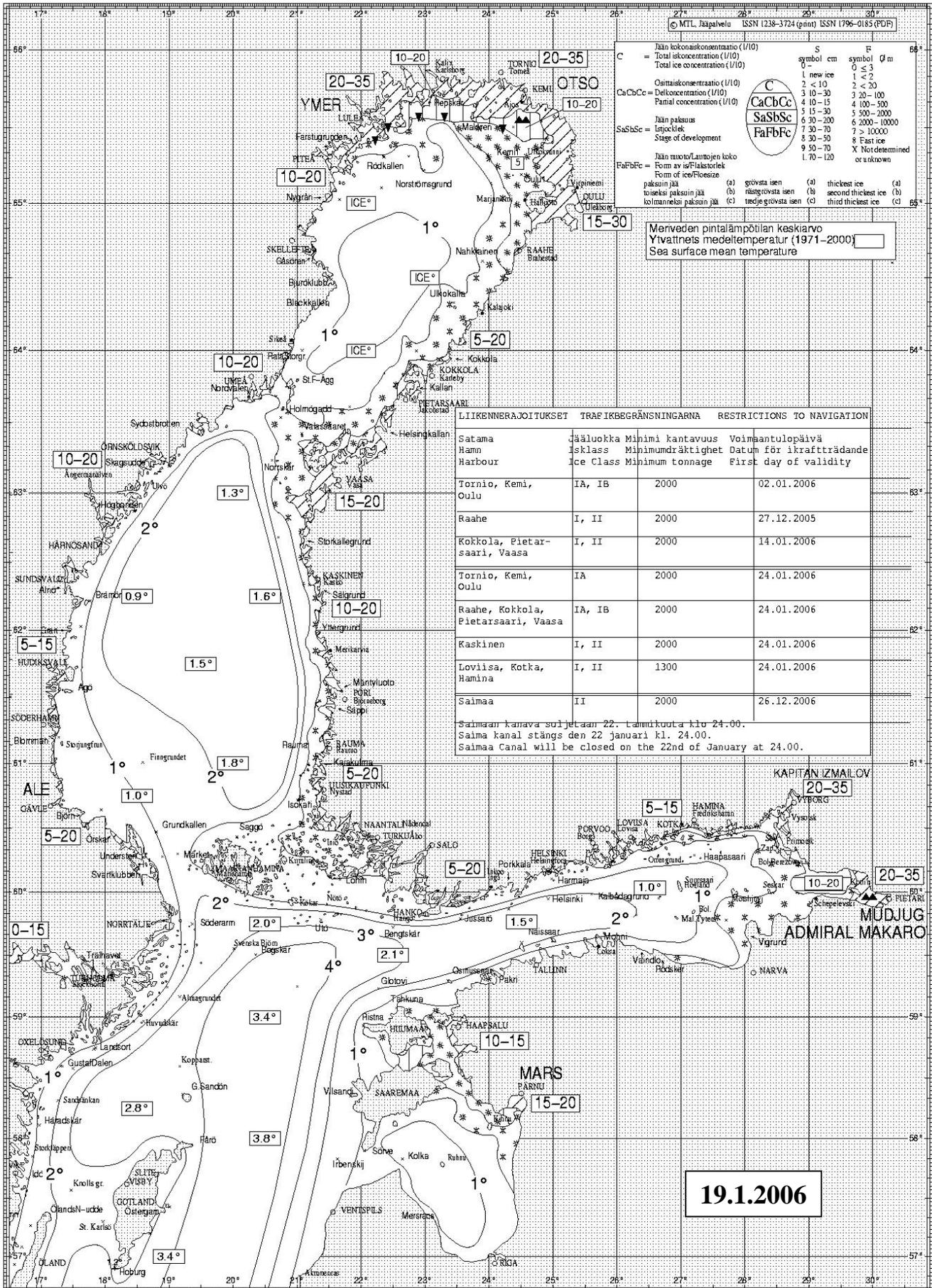
The next topic analyzed here is whether it is possible to include some more parameters in the basis for traffic restrictions than only the maximum level ice thickness. Particularly, the use of the distance to be sailed in ice and the amount of ridging was studied. The background of the decision parameter suggested, the equivalent ice thickness, is in ice loading. A parametric study of the influence on the distance sailed in ice and the amount of ridging was carried out and a suitable combination of parameters was determined. It was, however, concluded that the equivalent ice thickness correlated strongly with the maximum level ice thickness. This is natural as when the level ice thickness increases, the ice extent increases at the same time – because the same cause lies behind both; the air temperature. Thus the use of equivalent ice thickness did not bring much new information about the ice cover, compared with using only the maximum level ice thickness. The conclusion thus is that unless some more penetrating parameter for ridging is developed, the maximum level ice thickness serves well as the decision parameter for traffic restrictions.

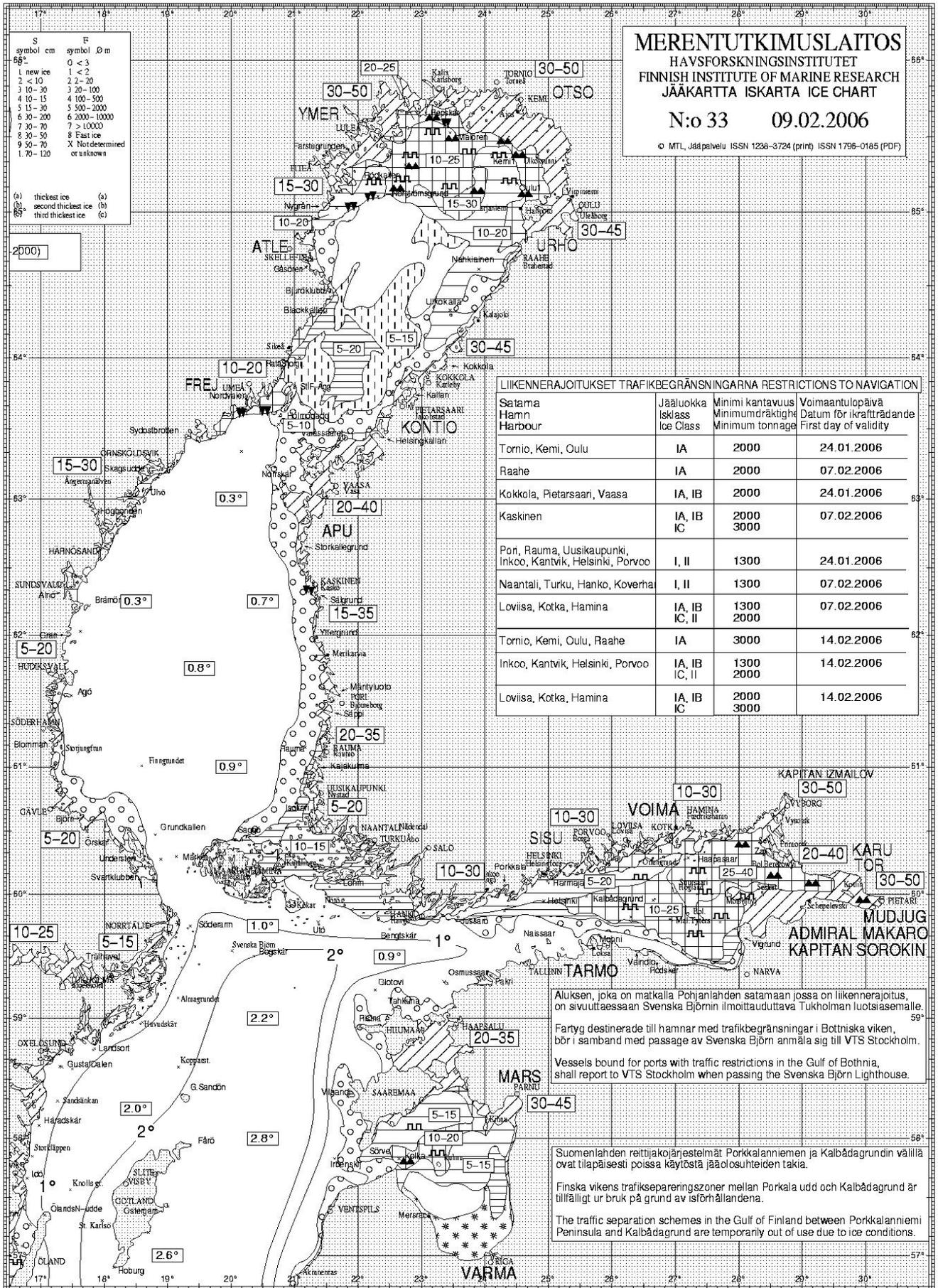
ACKNOWLEDGEMENTS

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- Lensu, M. 2002: Ice navigation assisted by short term ice load monitoring, Helsinki University of Technology, Ship Laboratory Rep. series M-275.





S	cm	F	Øm
1	new ice	0	< 3
2	< 10	2	2-20
3	10-30	3	20-100
4	10-15	4	100-500
5	15-30	5	500-2000
6	30-200	6	2000-10000
7	30-70	7	> 10000
8	30-50	8	Fast ice
9	50-70	X	Not determined or unknown
1	70-120		

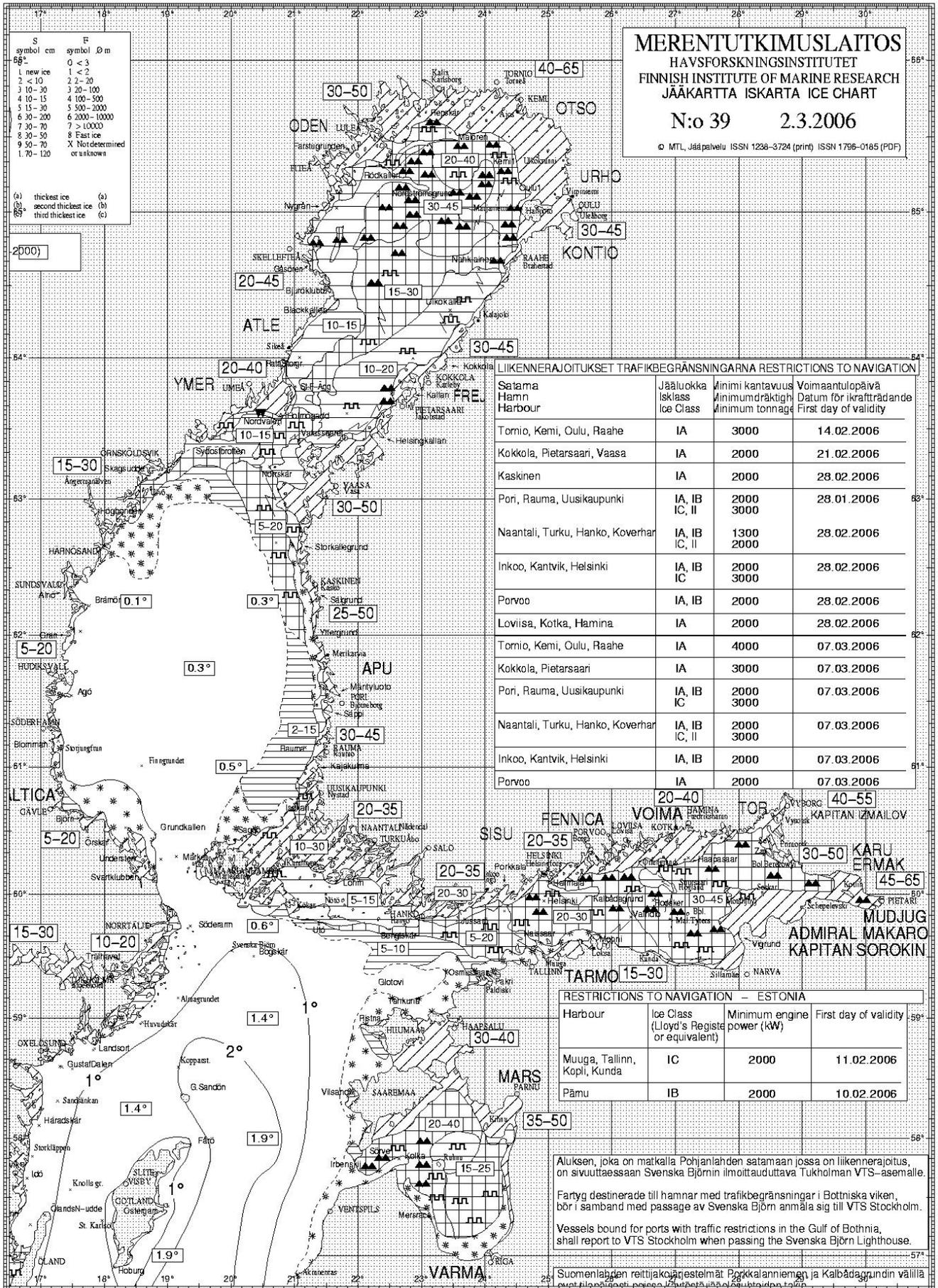
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 JÄÄKARTTA ISKARTA ICE CHART
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LIIKENNERAJOITUKSET TRAFIKBEGRÄNSNINGARNA RESTRICTIONS TO NAVIGATION

Satama Hamn Harbour	Jääluokka Isklass Ice Class	Minimi kantavuus Minimumdräktighet Minimum tonnage	Voimaantulopäivä Datum för ikraftträdande First day of validity
Tornio, Kemi, Oulu	IA	2000	24.01.2006
Raahe	IA	2000	07.02.2006
Kokkola, Pietarsaari, Vaasa	IA, IB	2000	24.01.2006
Kaskinen	IA, IB IC	2000 3000	07.02.2006
Pori, Rauma, Uusikaupunki, Inkoo, Kantvik, Helsinki, Porvoo	I, II	1300	24.01.2006
Naantali, Turku, Hanko, Koverha	I, II	1300	07.02.2006
Loviisa, Kotka, Hamina	IA, IB IC, II	1300 2000	07.02.2006
Tornio, Kemi, Oulu, Raahe	IA	3000	14.02.2006
Inkoo, Kantvik, Helsinki, Porvoo	IA, IB IC, II	1300 2000	14.02.2006
Loviisa, Kotka, Hamina	IA, IB IC	2000 3000	14.02.2006

Aluksen, joka on matkalla Pohjanlahden satamaan jossa on liikennerajoitus, on sivuuttatessaan Svenska Björnin ilmoitettava Tukholman luotsiasemalle.
 Fartyg destinerade till hamnar med trafikbegränsningar i Bottniska viken, bör i samband med passage av Svenska Björn anmäla sig till VTS Stockholm.
 Vessels bound for ports with traffic restrictions in the Gulf of Bothnia, shall report to VTS Stockholm when passing the Svenska Björn Lighthouse.

Suomenlahden reittijako- ja esteilmät Porkkalan niemien ja Kalbädgrundin välillä ovat tilapäisesti poissa käytöstä jääolosuhteiden takia.
 Finska vikens trafiksepareringszoner mellan Porkkala udden och Kalbädgrund är tillfälligt ur bruk på grund av isförhållandena.
 The traffic separation schemes in the Gulf of Finland between Porkkalan Peninsula and Kalbädgrund are temporarily out of use due to ice conditions.



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S	E
symbol cm	symbol Dm
1 new ice	1 < 2
2 < 10	2 2-20
3 10-30	3 20-100
4 10-15	4 100-500
5 15-30	5 500-2000
6 30-200	6 2000-10000
7 30-70	7 > 10000
8 30-50	8 Fast ice
9 50-70	X Not determined or unknown
1. 70-120	

LIKENNERAJOTUKSET TRAFIKBEGRÄNSNINGARNA RESTRICTIONS TO NAVIGATION

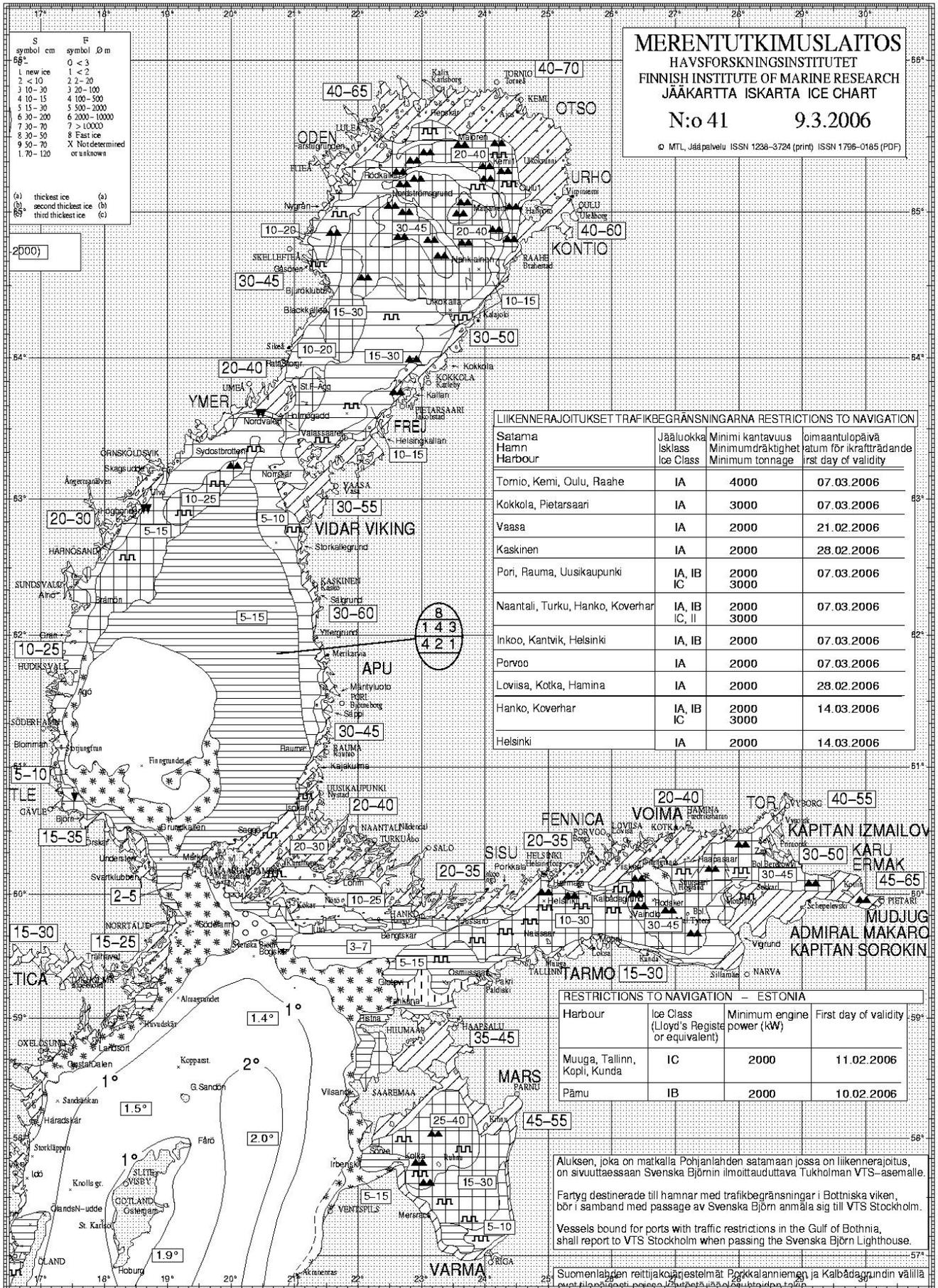
Satama Hamn Harbour	Jääloukka Isklass Ice Class	Minimi kantavuus Minimum draught Minimum tonnage	Voimaantuloapäivä Datum för ikraftträdande First day of validity
Tornio, Kemi, Oulu, Raahе	IA	3000	14.02.2006
Kokkola, Pietarsaari, Vaasa	IA	2000	21.02.2006
Kaskinen	IA	2000	28.02.2006
Pori, Rauma, Uusikaupunki	IA, IB IC, II	2000 3000	28.01.2006
Naantali, Turku, Hanko, Koverhar	IA, IB IC, II	1300 2000	28.02.2006
Inkoo, Kantvik, Helsinki	IA, IB IC	2000 3000	28.02.2006
Porvoo	IA, IB	2000	28.02.2006
Loviisa, Kotka, Hamina	IA	2000	28.02.2006
Tornio, Kemi, Oulu, Raahе	IA	4000	07.03.2006
Kokkola, Pietarsaari	IA	3000	07.03.2006
Pori, Rauma, Uusikaupunki	IA, IB IC	2000 3000	07.03.2006
Naantali, Turku, Hanko, Koverhar	IA, IB IC, II	2000 3000	07.03.2006
Inkoo, Kantvik, Helsinki	IA, IB	2000	07.03.2006
Porvoo	IA	2000	07.03.2006

RESTRICTIONS TO NAVIGATION - ESTONIA

Harbour	Ice Class (Lloyd's Register or equivalent)	Minimum engine power (kW)	First day of validity
Muuga, Tallinn, Kõpi, Kunda	IC	2000	11.02.2006
Pämu	IB	2000	10.02.2006

Aluksen, joka on matkalla Pohjanlahden satamaan jossa on liikennerajoitus, on siivottaessaan Svenska Björnin ilmoitettava Tukholman VTS-asemalle.
 Fartyg destinerade till hamnar med trafikbegränsningar i Bottniska viken, bör i samband med passage av Svenska Björn anmäla sig till VTS Stockholm.
 Vessels bound for ports with traffic restrictions in the Gulf of Bothnia, shall report to VTS Stockholm when passing the Svenska Björn Lighthouse.

Suomenlahden reittijakojärjestelmät Porikalanriemen ja Kalbadgrundin välillä
 (Suomenlahden reittijakojärjestelmät Porikalanriemen ja Kalbadgrundin välillä)



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S	cm	E	Øm
1	< 10	1	< 3
2	10 - 20	2	3 - 10
3	20 - 30	3	10 - 20
4	30 - 40	4	20 - 100
5	40 - 50	5	100 - 500
6	50 - 60	6	500 - 2000
7	60 - 70	7	2000 - 10000
8	70 - 80	8	> 10000
9	80 - 90	8	Fast ice
9	90 - 100	X	Not determined or unknown
1	100 - 120		

(a) thickest ice (a)
 (b) second thickest ice (b)
 (c) third thickest ice (c)

LIIKENNERAJOTUKSET TRAFIKBEGRÄNSNINGARNA RESTRICTIONS TO NAVIGATION

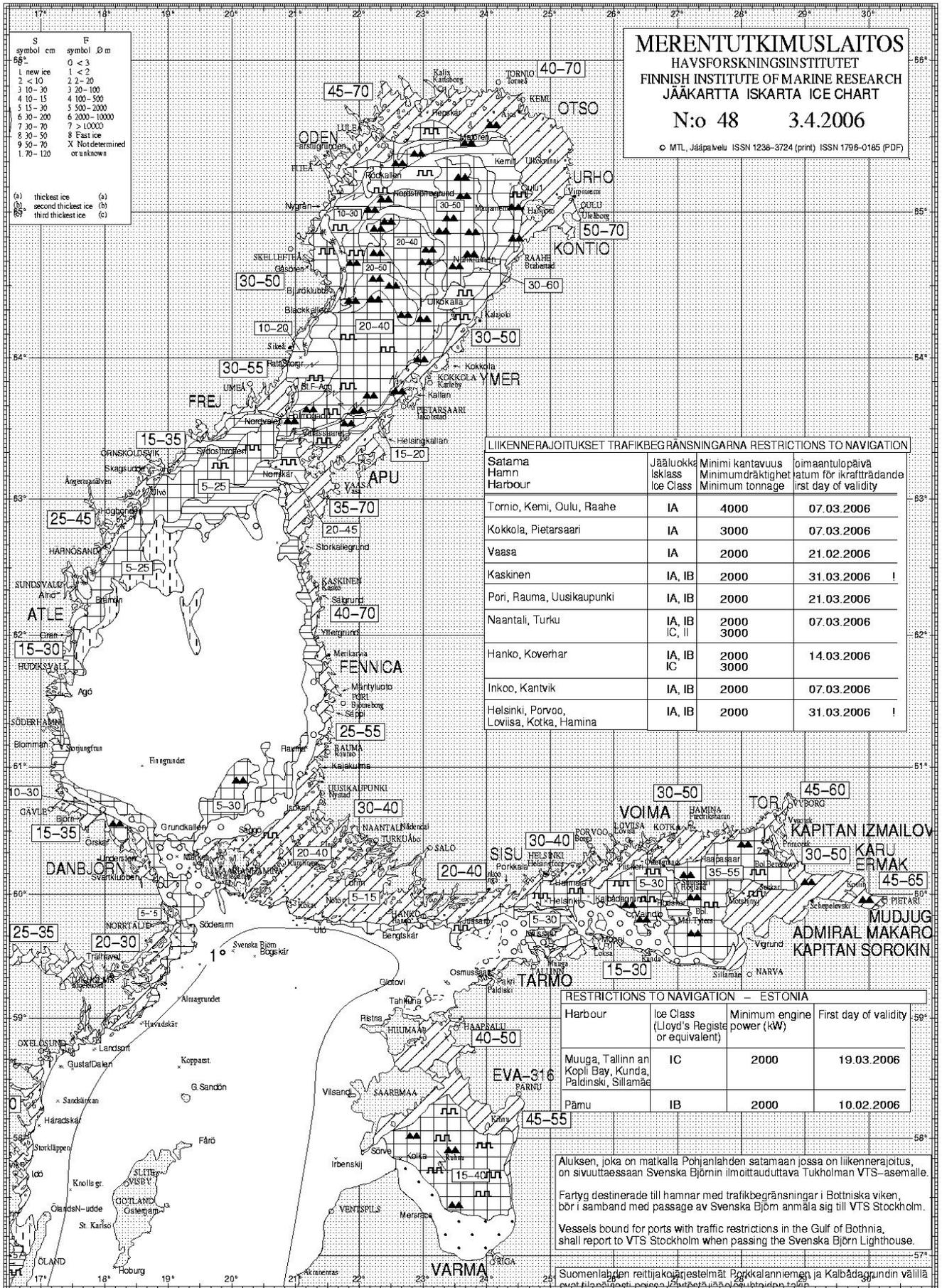
Satama Hamn Harbour	Jääluokka Isklass Ice Class	Minimi kantavuus Minimum dräktighet Minimum tonnage	voimaantulopäivä atum för ikraftträdande 1st day of validity
Tornio, Kemi, Oulu, Raahе	IA	4000	07.03.2006
Kokkola, Pietarsaari	IA	3000	07.03.2006
Vaasa	IA	2000	21.02.2006
Kaskinen	IA	2000	28.02.2006
Pori, Rauma, Uusikaupunki	IA, IB IC	2000 3000	07.03.2006
Naantali, Turku, Hanko, Koverhar	IA, IB IC, II	2000 3000	07.03.2006
Inkoo, Kantvik, Helsinki	IA, IB	2000	07.03.2006
Porvoo	IA	2000	07.03.2006
Loivisa, Kotka, Hamina	IA	2000	28.02.2006
Hanko, Koverhar	IA, IB IC	2000 3000	14.03.2006
Helsinki	IA	2000	14.03.2006

RESTRICTIONS TO NAVIGATION - ESTONIA

Harbour	Ice Class (Lloyd's Register or equivalent)	Minimum engine power (kW)	First day of validity
Muuga, Tallinn, Kopli, Kunda	IC	2000	11.02.2006
Pämu	IB	2000	10.02.2006

Aluksen, joka on matkalla Pohjanlahden satamaan jossa on liikennerajoitus, on siivottaessaan Svenska Björnin ilmoitettava Tukholman VTS-asemalle.
 Fartyg destinerade till hamnar med trafikbegränsningar i Bottniska viken, bör i samband med passage av Svenska Björn anmäla sig till VTS Stockholm.
 Vessels bound for ports with traffic restrictions in the Gulf of Bothnia, shall report to VTS Stockholm when passing the Svenska Björn Lighthouse.

Suomenlahden reittijakojärjestelmät Porikalanien ja Kalbadagrundin välillä
 (Suomenlahden reittijakojärjestelmät Porikalanien ja Kalbadagrundin välillä)



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S	cm	R	Øm
1	new ice	1	< 2
2	< 10	2	2-20
3	10-30	3	20-100
4	10-15	4	100-500
5	15-30	5	500-2000
6	30-200	6	2000-10000
7	30-70	7	> 10000
8	30-50	8	Fast ice
9	50-70	X	Not determined or unknown
1	70-120		

(a) thickest ice (a)
 (b) second thickest ice (b)
 (c) third thickest ice (c)

LIKENNERAJOTUKSET TRAFIKBEGRÄNSNINGARNA RESTRICTIONS TO NAVIGATION

Satama Harbour	Jäälouokka Ice Class	Minimi kantavuus Minimum tonnage	voimaantulopäivä atum för ikraftträdande first day of validity
Tornio, Kemi, Oulu, Raahе	IA	4000	07.03.2006
Kokkola, Pietarsaari	IA	3000	07.03.2006
Vaasa	IA	2000	21.02.2006
Kaskinen	IA, IB	2000	31.03.2006 !
Pori, Rauma, Uusikaupunki	IA, IB	2000	21.03.2006
Naantali, Turku	IA, IB IC, II	2000 3000	07.03.2006
Hanko, Koverhar	IA, IB IC	2000 3000	14.03.2006
Inkoo, Kantvik	IA, IB	2000	07.03.2006
Helsinki, Porvoo, Loviisa, Kotka, Hamina	IA, IB	2000	31.03.2006 !

RESTRICTIONS TO NAVIGATION - ESTONIA

Harbour	Ice Class (Lloyd's Register or equivalent)	Minimum engine power (kW)	First day of validity
Muuga, Tallinn an Kopli Bay, Kunda, Paldiski, Sillamäe	IC	2000	19.03.2006
Pämu	IB	2000	10.02.2006

Aluksen, joka on matkalla Pohjanlahden satamaan jossa on liikennerajoitus, on sivuuttaessaan Svenska Björnin ilmoitettava Tukholman VTS- asemalle.
 Fartyg destinerade till hamnar med trafikbegränsningar i Bottniska viken, bör i samband med passage av Svenska Björn anmäla sig till VTS Stockholm.
 Vessels bound for ports with traffic restrictions in the Gulf of Bothnia, shall report to VTS Stockholm when passing the Svenska Björn Lighthouse.

Suomenlahden reittiäjoa- ja reitistöä ja Kaibadagruundin välillä...

APPENDIX 2. THE ICE COVER DATA FOR THE FOUR PORTS USED IN THE STUDY

Date	Kemi			Vaasa			Helsinki			Kotka		
	Distance (nm)	h _i [cm]	Traffic restriction	Distance (nm)	h _i [cm]	Traffic restriction	Distance (nm)	h _i [cm]	Traffic restriction	Distance (nm)	h _i [cm]	Traffic restriction
19.12.05	22	15		9								
22.12.05	20	25	II/2000	9	10							
27.12.05	5	25	II/2000	9	10							
29.12.05	19	25	II/2000	13	15					3	10	
02.01.06	22	25	IB/2000	11	15						10	
05.01.06	22	35	IB/2000	11	25					3	15	
09.01.06	24	35	IB/2000	12	25						15	
12.01.06	15	35	IB/2000	12	25						15	
16.01.06	21	35	IB/2000	12	25	II/2000					15	
19.01.06	16	35	IB/2000	12	20	II/2000					15	
23.01.06	31	35	IB/2000	12	25	II/2000				10	15	
26.01.06	40	50	IA/2000	23	25	IB/2000	5	15		15	15	II/1300
30.01.06	27	50	IA/2000	22	25	IB/2000	2	15	II/1300	5	15	II/1300
02.02.06	56	50	IA/2000	22	30	IB/2000	3	20	II/1300	18	20	II/1300
06.02.06	82	50	IA/2000	22	30	IB/2000	22	30	II/1300	60	30	II/1300
09.02.06	58	50	IA/2000	12	40	IB/2000	22	30	II/1300	66	30	IB/1300 II/2000
13.02.06	162	50	IA/2000	14	45	IB/2000	26	30	II/1300	56	30	IB/1300 II/2000
16.02.06	156	50	IA/3000	26	45	IB/2000	38	30	IB/1300 II/2000	71	30	IB/1300 IC/3000
20.02.06	202	55	IA/3000	40	50	IB/2000	34	35	IB/1300 II/2000	70	35	IB/2000 IC/3000
23.02.06	211	55	IA/3000	41	50	IA/2000	46	35	IB/2000 II/3000	92	35	IB/2000
27.02.06	219	55	IA/3000	46	50	IA/2000	14	35	IB/2000 II/3000	22	40	IB/2000
02.03.06	209	65	IA/3000	41	50	IA/2000	54	35	IB/2000 IC/3000	115	40	IA/2000
06.03.06	243	65	IA/3000	74	55	IA/2000	54	35	IB/2000 IC/3000	78	40	IA/2000
09.03.06	271	70	IA/4000	104	55	IA/2000	95	35	IB/2000	152	40	IA/2000
13.03.06	368	70	IA/4000	208	55	IA/2000	131	35	IB/2000	186	40	IA/2000

Date	Kemi			Vaasa			Helsinki			Kotka		
	Distance (nm)	h _i [cm]	Traffic restriction	Distance (nm)	h _i [cm]	Traffic restriction	Distance (nm)	h _i [cm]	Traffic restriction	Distance (nm)	h _i [cm]	Traffic restriction
16.03.06	395	70	IA/4000	228	55	IA/2000	68	35	IA/2000	125	45	IA/2000
20.03.06	379	70	IA/4000	210	55	IA/2000	7	35	IA/2000	17	45	IA/2000
23.03.06	374	70	IA/4000	213	55	IA/2000	18	35	IA/2000	70	50	IA/2000
27.03.06	380	70	IA/4000	215	60	IA/2000	102	40	IA/2000	157	50	IA/2000
30.03.06	376	70	IA/4000	209	60	IA/2000	76	40	IA/2000	133	50	IA/2000
03.04.06	375	70	IA/4000	210	70	IA/2000	30	40	IB/2000	62	50	IB/2000
06.04.06	171	70	IA/4000	24	60	IA/2000	17	40	IB/2000	41	50	IB/2000
10.04.06	148	70	IA/4000	22	60	IA/2000	17	40	IB/1300 II/2000	38	50	IB/2000
13.04.06	190	70	IA/4000	24	60	IA/2000	10	40	IB/1300 II/2000	36	50	IB/2000
18.04.06	94	70	IA/3000	22	60	IB/2000	7	40	II/1300	32	50	IB/1300 II/2000
20.04.06	182	70	IA/3000	24	60	IB/2000	6	40	II/1300	25	50	IB/1300 II/2000
24.04.06	129	70	IA/2000	22	60	II/2000	3	40		17	50	II/1300
27.04.06	56	70	IA/2000	24	60	II/2000				7	30	
02.05.06	23	50	IB/2000	22	40							
04.05.06	25	50	IB/2000		30							
08.05.06	25	50	IB/2000		30							
11.05.06	29	50	IB/2000									