STYRELSEN FÖR

# VINTERSJÖFARTSFORSKNING

WINTER NAVIGATION RESEARCH BOARD

Research Report No 20

# ECONOMICS OF WINTER NAVIGATION IN THE NORTHERN PART OF THE GULF OF BOTNIA

Sjöfartsstyrelsen
Finland

Finnish Board of Navigation

Sjöfartsverket
Sverige

Swedish Administration
of Shipping and Navigation

# F O R E W O R D

The Winter Navigation Research Board presents its report No 20. This report is a presentation of a computer programme which calculates the transportation capacity and costs for a specified ship and route for some of the Bothnian Bay ports. The programme is prepared by Oy Wärtsilä Ab Helsinki Shipyard under the direction of mr B M Johansson. The programme is herewith put to the disposal of interested shipowners and shipbuilders.

The Winter Navigation Research Board wishes to express its thanks to Wärtsilä and mr Johansson for the work spend on this report.

Helsingfors and Norrköping August 1977.

Jan-Erik Jansson Lennart Johansson

# E C O N O M I C S  O F  W I N T E R  N A V I G A T I O N  I N  T H E  N O R T H E R N  P A R T  O F  T H E  G U L F  O F  B O T H N I A

Description of a Computer Programme

by B M Johansson
Oy Wärtsilä Ab
Helsinki Shipyard

## 1 GENERAL

Wärtsilä has been given a grant by the Finnish-Swedish Board of Winter Navigation Research for the studying of winter navigation in the Gulf of Bothnia. A general presentation of this research work is given in Ref. [1]. The following is a description of a simple computer programme developed by Wärtsilä and owned by the above-mentioned Board. This programme calculates the transportation capacity and costs for a specified ship and route.

## 2 COMPUTER

The programme has been designed for a mini-computer of the type Hewlett-Packard 9830 A (with a memory capacity of 1760 words) in the standard BASIC language of that computer. The programme as well as the necessary data are stored on a digital cassette tape in the following files:

| No. | Content |
|---|---|
| 0 | empty |
| 1-5 | programme |
| 6-9 | icebreaker data |
| 10-27 | ice data |
| 28-198 | data storage for actually calculated ships |

## 3 PROGRAMME

Owing to the small memory capacity of the computer the programme is divided into five parts, of which the last three are linked together. A printout of the programme is shown in Appendix A, 1 to 5. The various parts of the programme perform the following tasks:

| No. | Task |
|---|---|
| 1 | input data |
| 2 | reserves the necessary memory capacity and takes in the input data for a non-standard icebreaker |
| 3 | calculates the speed of the ship in different ice conditions when the ship is moving on its own or following an icebreaker |
| 4 | prints out the input data and the speeds in ice |
| 5 | calculates the economics of the winter navigation. |

In the following the various parts of the programme are considered in detail.

## 4 INPUT DATA (File No. 1)

The form of the input data is shown in Appendix B. The data for each separate calculation are stored in a file (starting from No. 28) for later use. To facilitate the process, the input data are given in such a form that only the data that have changed from the previous calculation have to be given. The input procedure also rejects impossible or undesired data by asking for the same data over again. The following data are given:

| | |
|---|---|
| 1 | Number of calculations, may only be given once, $1 \leq x \leq 170$ |
| 2 | Total shaft power of ship in kW, $x > 100$ |
| 3 | Propeller diameter in m. If diameter is unknown, then $x = 0$, otherwise $0 < x \leq 15$ |
| 4 | Number of propellers. If previous value = 0, this value will not be asked for. $1 \leq x \leq 4$ |
| 5 | Ship displacement in metric tons |
| 6 | Maximum speed in open water in m/s. If speed is unknown, then $x = 0$. |
| 7 | Ship beam in m |

8 Angle between waterline and stem of ship in degrees, $15 \leq x \leq 90$

9 Ice resistance coefficient. Factor by which sensitivity of changes in level ice resistance may be tested, usually $x = 1$

10 Channel resistance ratio. Figure that shows relation between resistance in ice channel and in level ice of same thickness, usually $x = 0.4$

11 Ridge resistance coefficient. Factor by which sensitivity of changes in ridge resistance may be tested, usually $x = 1$

12 Resistance reduction due to air bubbling, shows reduction in resistance at zero speed of advance. Usually x is taken as 0.2. If there is no air-bubbling system installed, then $x = 0$

13 Type of icebreaker used to assist ship:
URHO-class, 16.2 MW: $x = 6$
APU-class, 8.8 MW: $x = 7$
KARHU-class, 5.5 MW: $x = 8$
If other type of icebreaker is used, then $x = 9$ and icebreaking capability of icebreaker has to be defined as input value in part 2 of programme

14 Price of ship, in any currency consistently used

15 Depreciation time for capital invested in ship, in years

16 Interest rate, in per cent

17 Insurance costs per year, given as per cent of ship's price

18 Repair costs per year, given as per cent of ship's price

19 Crew costs per month in same currency as chosen for 14

20 Loading and unloading time per round trip, in hours

21 Sum of all cargo carried on one round trip, in tons

22 Time lost for waiting, pilot transfer etc. per round trip, in hours

23 Fuel costs per kWh, in same currency as chosen for 14

24 Harbour costs per round trip, in same currency as chosen for 14

25 Miscellaneous costs per year, i. e., office costs etc., in same currency as chosen for 14

26 Total one-way distance in km, $x \geq 1000$ km

27 Off-time in days per year, i. e., dry-docking etc.

28 Name of northern harbour:
Kemi: $x = 10$
Raahe: $x = 13$
Kokkola: $x = 16$

Luleå: x = 19
Piteå: x = 22
Skellefteå: x = 25

5 MEMORY CAPACITY RESERVE (File No. 2)

The following matrixes are named:

D(30): Input data

L(24): Speed of ship in ice, where:
L1 to L8 is speed in level ice of 0.1 m to 0.8 m in thickness
L9 to L16 is speed in channels where surrounding ice is 0.1 m to 0.8 m in thickness
L17 to L24 is speed in ridges of 5 m to 12 m in thickness

C(24) Speed of ship after icebreaker, where:
C1 to C8 is speed in channel after icebreaker where surrounding level ice is 0.1 m to 0.8 m thick
C9 to C16 is speed after one icebreaker in ridges of 5 m to 12 m in thickness
C17 to C24 is speed after two icebreakers in ridges of 5 m to 12 m in thickness

R (25): Icebreaking capability (speed in m/s) of icebreaker (this is shown in Appendix C for icebreakers used):
R1 to R8, R9 to R16, R17 to R24 } as for L(24) above
R25 is beam of icebreaker in m

S(24) Actual calculated speed of convoy in ice, as for L(24) above

I(6, 24) Distance of penetration of various ice thicknesses on one-way trip for each month from December to May in km, see Appendices D10 to D27
E.g. I(1, 3) in D10 is 37 and means that 37 kilometres of 0.3 m thick level ice have to be penetrated when going to Kemi in December during mild winter

I(4, 22) in D10 is 3 and means that 3 kilometres of 10 m thick ridges have to be penetrated when going to Kemi in March during mild winter

Values shown in Appendices D10 to D27 are stored in files 10 to 27

If a non-standard icebreaker is used in any of the calculations, the data for that icebreaker have to be given as input data in the manner shown in Appendix C. In addition, the beam in the waterline for the icebreaker has to be given.

6 CALCULATION OF SPEED IN ICE (File No. 3)

For each ice condition, the actual speed is calculated by finding the crossing point of the available thrust, from which the open water resistance has been subtracted (T), and the ice resistance (R), as shown in Fig. 1.

If the propeller diameter is not specified, the bollard pull is taken as:

$$T_o = 0.012 \times Ps \qquad \text{(units: see nomenclature)} \qquad (1)$$

If the propeller diameter and the number of propellers are specified, the bollard pull calculation is based on a standard propeller with

$K_Q = 0.0405$, $K_T = 0.34$ and $t = 0.06$.

If the speed in open water is not specified, it is calculated from the following simple formula:

$$V_2 = 1.994 \times \sqrt[3]{Ps} \Big/ \sqrt[6]{\Delta} \qquad \text{(units: see nomenclature)} \qquad (2)$$

The tow rope pull between zero and full speed is assumed to follow the formula

$$T = T_o \left( 1 - \frac{1}{3} \frac{v}{v_2} - \frac{2}{3} \left( \frac{v}{v_2} \right)^2 \right) \qquad (3)$$

The ice resistance is calculated from the formula (4)

$$R = 1.7 \times h^{1.5} \times B \times (2 - 0.0325\varphi + 0.00275\varphi^2) \times (1 - C_{AB} + 0.282\, V^{1.2})$$

(units: see nomenclature)

For level ice, this has to be multiplied by the ice resistance coefficient and for ice channels, by the channel resistance ratio. If the ship is wider than the assisting icebreaker, it is assumed that the part of the ship that is outside the channel counters the level ice resistance.

For ridges, the following resistance formula is used:

$$R = 0.6 \times H \times B \times (2 - 0.0325\varphi + 0.00275\varphi^2) \times (1 - C_{AB} + 0.282\, V^{1.2}) \quad (5)$$

(units: see nomenclature)

If the speed is very low or the resistance at zero speed is higher than the bollard pull, the ship will proceed by repeated charges. The following formula is used for the calculation of the mean speed of advance:

$$V = \frac{9\, T_3}{7\, R_3 + 5\, T_3} \quad \text{(m/s)} \quad (6)$$

7 PRINTOUT, CALCULATION OF CAPITAL COSTS (File No. 4)

All the input data and calculated speeds in ice are printed for the facilitation of later use.

In this part of the programme, the capital costs per month are calculated from the following formula:

$$C = \frac{P}{12}\left[\frac{r(1+r)^h}{(1+r)^h - 1} + q\right] \quad (7)$$

8 CALCULATION OF ECONOMICS (File No. 5)

For each month from December to June, the amount of transported cargo as well as the cost of transportation are calculated. Month 0 is December, 1 is January, and so on. In June there is no ice in the Baltic, so that month is representative of the open water period of the year.

For highly powerful ships, it may not be economical to use the full power in open water; this is also tested by the programme.

The economics of winter navigation are first calculated for the ship alone, i.e. without icebreaker assistance.

Then the same calculation is repeated using the speeds of the ship assisted by one icebreaker. If the speed with which the ship is able to move in the channel of the icebreaker is higher than the speed of the icebreaker in unbroken ice, then obviously the latter determines the convoy speed. If the speed of the assisted ship drops below 2.5 m/s in level ice or 0.2 m/s in ridges, it is assumed that the icebreaker starts towing, and the speed under tow is taken as:

$$v = \frac{v_{ib} + v_{ship}}{2} \qquad (8)$$

If the ship is wider than the assisting icebreaker, the whole calculation is repeated for a situation where the ship is assisted by two icebreakers, i.e., where the channel is wider than the ship.

## 9 CALCULATED EXAMPLES

The input data for some not very powerful ships are presented in Appendices E1 and E2, and the results in Appendices F1 to F12. It can be clearly seen from these results that the economics of these ships are governed by the icebreaker.

The input data for two powerful ships with high icebreaking capability are presented in Appendix G, and the results in Appendices H1 and H2. In this case, the ship is able to govern her own economics and a KARHU-class icebreaker is not able to improve the performance of the ship at all.

In Figures 2 and 3 some results of systematic calculations for several different ships are presented. The ships are assisted by URHO-class icebreakers. These figures show a clear optimum for the propulsion power.

## 10 SUMMARY

As a result of the programme, the total transportation capacity and costs for a ship in year-round traffic to a harbour of the northern part of the Gulf of Bothnia 1)alone, 2)assisted by one or 3)assisted by two icebreakers, are obtained. By varying the parametres of the ship, the optimum design can be determined.

It should be noted that the results of the calculations are somewhat conservative as it is assumed that the ship penetrates all the ice there is, whereas in actual ice navigation it would undoubtedly choose the easiest possible route.

## REFERENCE LIST

[1] B M Johansson: "The Influence of Winter on the Navigation in the Northern Part of the Gulf of Bothnia", Styrelsen för vintersjöfartsforskning, Forskningsrapport nr. 7, Sjöfartsverket, Stockholm, 1974.

## NOMENCLATURE

C = capital costs per month
P = price of ship
r = interest ratio
n = depreciation time (years)
q = repair costs per year as a fraction of price of ship
$T_o$ = bollard pull ($10^4$ N)
Ps = shaft power (kW)
$K_Q$ = torque coefficient
$K_T$ = thrust coefficient
t = thrust deduction factor
$V_2$ = open water speed (m/s)
$\Delta$ = displacement (metric tons)
h = level ice thickness (m)
B = ship beam (m)
$\varphi$ = stem angle (degrees)
$C_{AB}$ = air-bubbling coefficient
$T_3$ = tow rope pull at 1.5 m/s speed of advance
$R_3$ = ice resistance at 1.5 m/s speed of advance

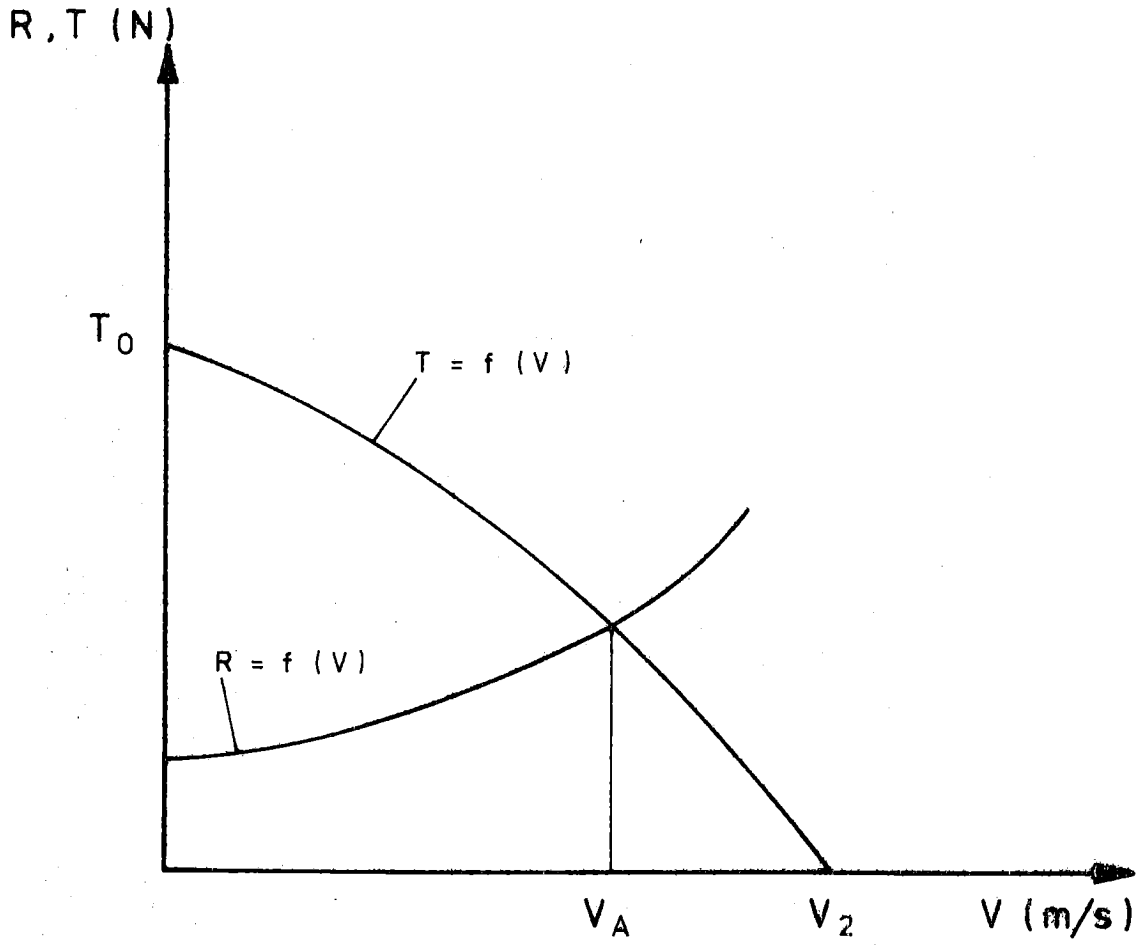


Fig. 1. Calculation of actual speed in ice, $V_A$.

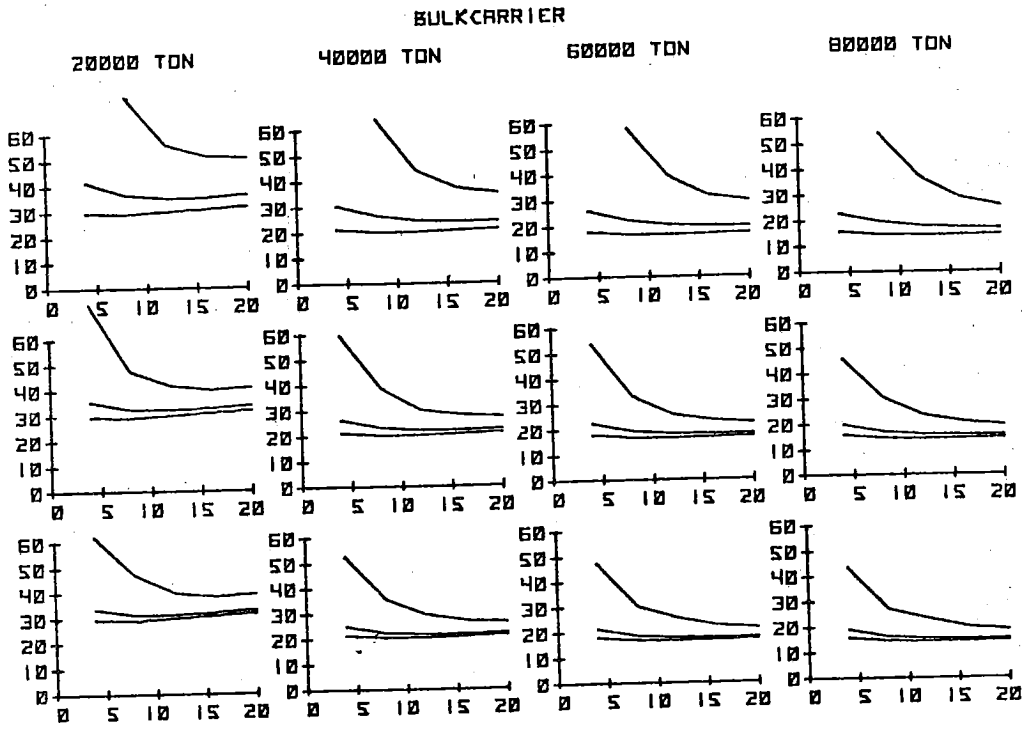


Fig. 2 Transportation costs for bulkcarriers from Luleå to a harbour at a distance of 1610 km. The number above each group of diagrams shows the amount of cargo transported in one direction (full load). It is assumed that the return voyage is made in ballast. In each of the twelve diagrams the vertical axis shows the transportation cost in Fmk/ton, and the horizontal axis the power used by the cargo ship in MW. It is assumed that max. 90% of the installed engine power is used. The lowest of the three curves shows the cost in open water, the uppermost curve the cost during the most difficult winter month, and the intermediate curve the costs evened out over the whole year. The uppermost row of diagrams corresponds to a hard winter, the lowest row to a mild winter, and the intermediate one to a normal winter

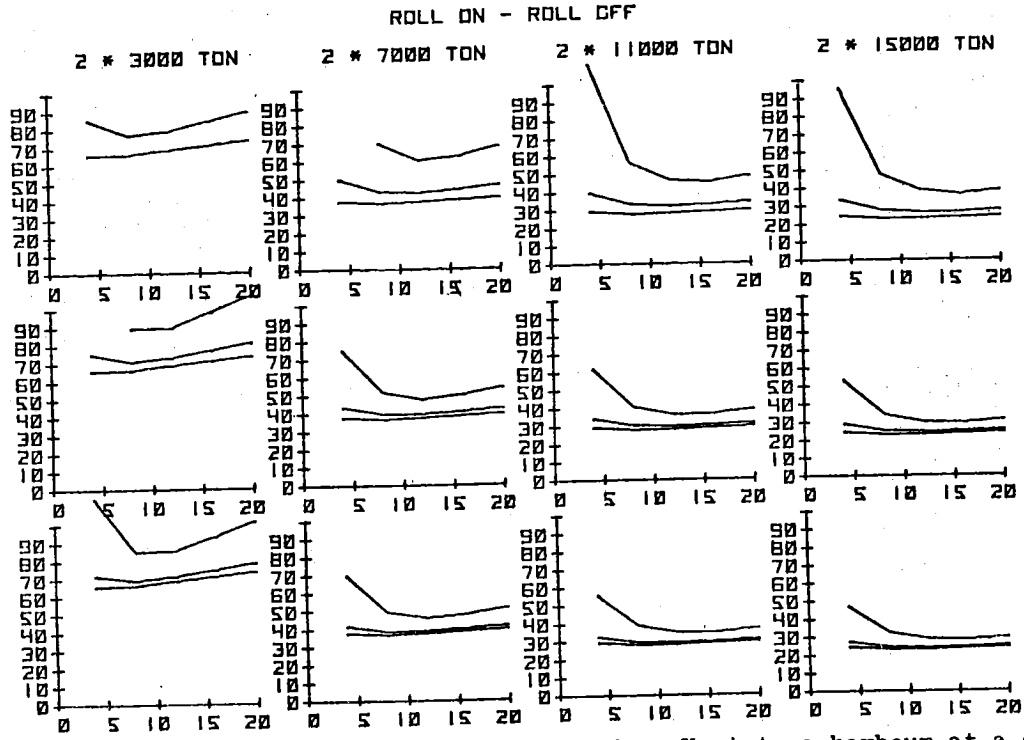


Fig. 3 Transportation costs for ro-ro ships from Kemi to a harbour at a distance of 1610 km. For explanation of the curves, see the text of Fig. 2. In Fig. 3 it is assumed that the ro-ro vessel has a full load in both directions

```
10 DIM D$[30],R$[25]
20 P1=0
30 DISP "NUMBER OF AUTOM. CALC.";
40 INPUT D[1]
50 IF D[1]<1 OR D[1]>170 THEN 30
60 DISP "SHAFT POWER, KW";
70 INPUT D[2]
80 IF D[2]<100 THEN 60
90 GOSUB 1280
100 DISP "PROP`DIAM, M , IF UNKNOWN = 0";
110 INPUT D[3]
120 IF D[3]<0 OR D[3]>15 THEN 100
130 GOSUB 1280
140 D[4]=1
150 IF D[3]=0 THEN 200
160 DISP "NUMBER OF PROPELLERS";
170 INPUT D[4]
180 IF D[4]<1 OR D[4]>4 THEN 160
190 GOSUB 1280
200 DISP "DISPLACEMENT, TONS";
210 INPUT D[5]
220 GOSUB 1280
230 DISP "MAX SPEED, M/S, IF UNKNOWN = 0";
240 INPUT D[6]
250 GOSUB 1280
260 DISP "BEAM, M";
270 INPUT D[7]
280 GOSUB 1280
290 DISP "STEM ANGLE, DEG";
300 INPUT D[8]
310 IF D[8]<15 OR D[8]>90 THEN 290
320 GOSUB 1280
330 DISP "ICE RES COEFF, IF UNKNOWN = 1";
340 INPUT D[9]
350 GOSUB 1280
360 DISP "CHANNEL RES RATIO"
370 WAIT 2000
380 DISP "IF UNKNOWN = 0.4";
390 INPUT D[10]
400 GOSUB 1280
410 DISP "RIDGE RES RATIO, IF UNKNOWN = 1";
420 INPUT D[11]
430 GOSUB 1280
440 DISP "AIR BUBBLING, 0.2=YES, 0=NO";
450 INPUT D[12]
460 GOSUB 1280
470 DISP "ICEBREAKER TYPE"
480 WAIT 2000
490 DISP " 6=URHO, 7=APU, 8=KARHU, 9=OWN";
500 INPUT D[13]
510 IF D[13]=6 OR D[13]=7 THEN 540
520 IF D[13]=8 OR D[13]=9 THEN 540
530 GOTO 470
540 GOSUB 1280
550 DISP "SHIP PRICE";
560 INPUT D[14]
570 GOSUB 1280
580 DISP "DEPRECIATION TIME, YEARS";
590 INPUT D[15]
600 GOSUB 1280
610 DISP "INTEREST RATE, % PER YEAR";
620 INPUT D[16]
630 GOSUB 1280
640 DISP "INSURANCE RATE, % OF PRICE";
650 INPUT D[17]
```

(CONT)

```
660 GOSUB 1280
670 DISP "REPAIR COSTS, % OF PRICE";
680 INPUT D[18]
690 GOSUB 1280
700 DISP "CREW COSTS PER MONTH";
710 INPUT D[19]
720 GOSUB 1280
730 DISP "LOAD AND UNLOAD TIME,HOURS";
740 INPUT D[20]
750 GOSUB 1280
760 DISP "LOAD BOTH WAYS, TONS";
770 INPUT D[21]
780 GOSUB 1280
790 DISP "LOST TIME PER ROUNDTRIP, HOURS";
800 INPUT D[22]
810 GOSUB 1280
820 DISP "FUEL COSTS /KW*H";
830 INPUT D[23]
840 GOSUB 1280
850 DISP "HARBOUR COSTS PER ROUNDTRIP";
860 INPUT D[24]
870 GOSUB 1280
880 DISP "MISC COSTS PER YEAR";
890 INPUT D[25]
900 GOSUB 1280
910 DISP "TOTAL ONE WAY DISTANCE, KM";
920 INPUT D[26]
930 IF D[26]<1000 THEN 910
940 GOSUB 1280
950 DISP "OFF TIME, DAYS PER YEAR";
960 INPUT D[27]
970 GOSUB 1280
980 DISP "HARBOUR,  10=KEMI, 13=RAAHE"
990 WAIT 3000
1000 DISP "16=KOKKOLA, 19=LULEA"
1010 WAIT 3000
1020 DISP "22=PITEA, 25=SKELLEFTEA";
1030 INPUT D[28]
1040 IF D[28]=10 OR D[28]=13 OR D[28]=16 THEN 1070
1050 IF D[28]=19 OR D[28]=22 OR D[28]=25 THEN 1070
1060 GOTO 980
1070 GOSUB 1280
1080 D[30]=28
1090 D[29]=0
1100 STORE  DATA 28,D
1110 P1=1
1120 IF D[1]<1.5 THEN 1270
1130 FOR N=29 TO 27+D[1]
1140 D[29]=1
1150 FOR M=1 TO 50
1160 DISP "INDEX OF NEW DATA,ALL GIVEN=1";
1170 INPUT X
1180 IF X<0.6 THEN 1240
1190 GOTO X OF 1250,60,100,140,200,230,260,290,330,360,410,440,470,550,580,
1200 GOTO X-16 OF 640,670,700,730,760,790,820,850,880,910,950,980,1240
1210 IF X<13.5 THEN 1230
1220 GOTO 1240
1230 D[29]=0
1240 NEXT M
1250 STORE  DATA N,D
1260 NEXT N
1270 LOAD 2
1280 IF P1>0.5 THEN 1210
1290 RETURN
1300 END
```

```
10 DIM D$[30],L$[24],C$[24],R$[25],S$[24],I[6,24]
20 P1=27
30 DISP "USING OWN ICEBREAKER? 1=YES,0=NO";
40 INPUT Y
50 IF Y<0.5 THEN 230
60 FOR N=1 TO 25
70 IF N<8.5 THEN 130
80 IF N<16.5 THEN 160
90 IF N<24.5 THEN 190
100 DISP "ICEB`BEAM";
110 INPUT R[N]
120 GOTO 210
130 DISP "LEVEL";0.1*N;"M";
140 INPUT R[N]
150 GOTO 210
160 DISP "CHANNEL";0.1*(N-8);"M";
170 INPUT R[N]
180 GOTO 210
190 DISP "RIDGE";N-12;"M";
200 INPUT R[N]
210 NEXT N
220 STORE  DATA 9,R
230 LOAD  DATA 28,D
240 LINK 3
250 END
```

```
10 P1=P1+1
20 IF P1-28=D[1] THEN 670
30 LOAD  DATA P1,D
40 IF D[29]>0.5 THEN 660
50 V3=1.994*D[2]↑0.3333/D[5]↑0.16667
60 IF D[6]>0.5 THEN 100
70 V2=V3
80 K7=1.994
90 GOTO 120
100 V2=D[6]
110 K7=1.994*V2/V3
120 IF D[3]<0.1 THEN 160
130 N=(D[2]/(D[4]*D[3]↑5*0.25447))↑0.3333
140 T0=D[4]*0.034*D[3]↑4*N↑2*0.94
150 GOTO 170
160 T0=0.012*D[2]
170 T3=T0*(1-1.5/(3*V2)-2*(1.5/V2)↑2/3)
180 M1=2-0.0325*D[8]+0.00275*D[8]↑2
190 V3=INT(V2*10)+1
200 C1=1.7*D[9]*D[7]*M1
210 FOR H=1 TO 8
220 C2=C1*(0.1*H)↑1.5
230 GOSUB 690
240 L[H]=B1
250 NEXT H
260 V3=INT(V2*10)+1
270 C1=1.7*D[10]*D[7]*M1
280 FOR H=1 TO 8
290 C2=C1*(0.1*H)↑1.5
300 GOSUB 690
310 L[H+8]=B1
320 NEXT H
330 V3=INT(V2*10)+1
340 C1=0.6*D[11]*D[7]*M1
350 FOR H=1 TO 8
360 C2=C1*(H+4)
370 GOSUB 690
380 L[H+16]=B1
390 NEXT H
400 LOAD  DATA D[13],R
410 V3=INT(V2*10)+1
420 C1=1.7*(D[9]*(D[7]-R[25])+D[10]*R[25])*M1
430 FOR H=1 TO 8
440 C2=C1*(0.1*H)↑1.5
450 GOSUB 690
460 IF B1<L[8+H] THEN 480
470 B1=L[8+H]
480 C[H]=B1
490 NEXT H
500 V3=INT(V2*10)+1
510 C1=0.6*M1*D[11]*D[10]*D[7]
520 FOR H=1 TO 8
530 C2=C1*(H+4)
540 GOSUB 690
550 C[H+16]=B1
560 NEXT H
570 V3=INT(V2*10)+1
580 C1=0.6*D[11]*(D[7]-R[25]+D[10]*R[25])*M1
590 FOR H=1 TO 8
600 C2=C1*(H+4)
610 GOSUB 690
620 IF B1<C[H+16] THEN 640
630 B1=C[H+16]
640 C[H+8]=B1
650 NEXT H
```

```
660 LINK 4
670 REWIND
680 END
690 FOR V=V3 TO 0 STEP -1
700 V1=0.1*V+0.00000001
710 T=T0*(1-V1/(3*V2)-2*(V1/V2)↑2/3)
720 R=C2*(1-D[12]+0.282*V1↑1.2)
730 IF R<T THEN 790
740 T9=T
750 R9=R
760 NEXT V
770 B1=0
780 GOTO 800
790 B1=0.1*V+0.1*ABS(T-R)/(ABS(T-R)+ABS(T9-R9))
800 R3=C2*(1-D[12]+0.282*1.5↑1.2)
810 B2=9*T3/(7*R3+5*T3)
820 IF B2>0.64 THEN 930
830 IF D[12]<0.001 THEN 870
840 B3=0.98*B2↑2+0.373*B2
850 B4=0.3*B2
860 GOTO 890
870 B3=1.96*B2↑2-0.255*B2
880 B4=0.1*B2
890 IF B3>B4 THEN 920
900 B2=B4
910 GOTO 930
920 B2=B3
930 IF B1>B2 THEN 950
940 B1=B2
950 V3=V+1
960 RETURN
```

```
10 FORMAT 80"-",/,/,"CALCULATION NUMBER",F4.0
20 PRINT
30 WRITE (15,10)P1-27
40 PRINT
50 FORMAT F7.0," KW",F7.0," KN",F7.2," M/S",F8.2," M",F8.2,F11.0," DEG"
60 FORMAT F7.0," TON",2F7.2,F6.2,F9.2,F10.0
70 PRINT "                                                    OPEN WATER"
80 PRINT "     POWER      THRUST  MAX SPEED     BEAM     SPEED COEFF    STEM ANGL
90 WRITE (15,50)D[2],10*T0,V2,D[7],K7,D[8]
100 PRINT
110 PRINT "                    ICE RES COEFF        AIR BUBBL"
120 PRINT "     DISPL        LEV    CH     RID       COEFF       ICEB"
130 WRITE (15,60)D[5],D[9],D[10],D[11],D[12],D[13]
140 PRINT
150 PRINT
160 PRINT "SPEED IN ICE (M/S)"
170 PRINT
180 PRINT "ICE THICKNESS       ICEBREAKER        SHIP ALONE ";
190 FORMAT "          ASSISTED BY ICEBREAKER"
200 WRITE (15,190)
210 PRINT "LEVEL   RIDGE      LEVEL  RIDGE      LEVEL  RIDGE";
220 FORMAT "          LEVEL              RIDGE"
230 WRITE (15,220)
240 PRINT "   M       M                                      ";
250 FORMAT "      1 IB    2 IB       1 IB    2 IB"
260 WRITE (15,250)
270 FORMAT F5.2,F7.1,F10.2,F7.2,F10.2,F7.2,F10.2,F7.2,F10.2,F7.2
280 FOR H=1 TO 8
290 WRITE (15,270)0.1*H,H+4,R[H],R[H+16],L[H],L[H+16],C[H],L[H+8],C[H+8],C[H
300 NEXT H
310 PRINT
320 FORMAT F12.0,F9.0," TON",F12.1," YEARS",F6.1," DAYS",F10.1," %"
330 FORMAT 2F12.0,F10.1," HOURS",F10.0,F10.1," %"
340 FORMAT F12.0,F9.0," KM",F9.1," HOURS",F9.1," %",F13.5
350 PRINT "       PRICE      LOAD BOTH WAYS    DEPR TIME    OFF TIME     INSUR RA
360 WRITE (15,320)D[14],D[21],D[15],D[27],D[17]
370 PRINT
380 PRINT "       CREW COST    HARB COSTS  LOAD TIME     HARBOUR NO    REPAIR CO
390 WRITE (15,330)D[19],D[24],D[20],D[28],D[18]
400 PRINT
410 PRINT "                     ONE WAY      LOST TIME"
420 PRINT "     MISC COSTS   DISTANCE    PER ROUNDTRIP   INTEREST   FUEL COST/KW
430 WRITE (15,340)D[25],D[26],D[22],D[16],D[23]
440 PRINT
450 PRINT
460 PRINT "         FULL SPEED              OPTIMUM SPEED"
470 PRINT "        TRANSP    COST           TRANSP    COST     ICE      ICEBR.    TOT
480 PRINT "        CARGO      PER           CARGO      PER     JOURNEY TOWING    JOU
490 PRINT "MONTH   TONS       TON           TONS       TON     HOURS    HOURS    HOU
500 PRINT
510 PRINT "MILD WINTER"
520 A1=0.01*D[16]
530 W5=D[14]*(A1*(1+A1)↑D[15]/((1+A1)↑D[15]-1)+0.01*D[17])/12
540 LINK 5
550 END
```

```
10 FORMAT F3.0,F9.0,F8.2,F13.0,F8.2,F9.1,F8.1,F9.1
20 FOR N=D[28] TO D[28]+2
30 IF N-D[28]=0 THEN 80
40 IF N-D[28]=2 THEN 70
50 PRINT "NORMAL WINTER"
60 GOTO 80
70 PRINT "HARD WINTER"
80 LOAD  DATA N,I
90 PRINT "SHIP ALONE"
100 FOR M=1 TO 24
110 S[M]=L[M]
120 NEXT M
130 GOSUB 580
140 PRINT "SHIP ASS BY 1 ICEB"
150 FOR M=1 TO 8
160 IF C[M]>R[M] THEN 220
170 IF C[M]>2.5 THEN 200
180 S[M]=100+0.5*(R[M]+C[M])
190 GOTO 230
200 S[M]=C[M]
210 GOTO 230
220 S[M]=R[M]
230 IF L[M+8]>R[M+8] THEN 260
240 S[M+8]=L[M+8]
250 GOTO 270
260 S[M+8]=R[M+8]
270 IF C[M+8]>R[M+16] THEN 330
280 IF C[M+8]>0.2 THEN 310
290 S[M+16]=100+0.5*(R[M+16]+C[M+8])
300 GOTO 340
310 S[M+16]=C[M+8]
320 GOTO 340
330 S[M+16]=R[M+16]
340 NEXT M
350 GOSUB 580
360 IF D[7]<R[25] THEN 550
370 PRINT "SHIP ASS BY 2 ICEB"
380 FOR M=1 TO 8
390 IF L[M+8]>R[M] THEN 450
400 IF L[M+8]>2.5 THEN 430
410 S[M]=100+0.5*(R[M]+L[M+8])
420 GOTO 460
430 S[M]=L[M+8]
440 GOTO 460
450 S[M]=R[M]
460 IF C[M+16]>R[M+16] THEN 520
470 IF C[M+16]>0.2 THEN 500
480 S[M+16]=100+0.5*(R[M+16]+C[M+16])
490 GOTO 530
500 S[M+16]=C[M+16]
510 GOTO 530
520 S[M+16]=R[M+16]
530 NEXT M
540 GOSUB 580
550 NEXT N
560 LINK 3
570 END
580 C1=C2=C3=C4=0
590 FOR M=0 TO 6
600 S3=V2
610 GOSUB 1000
620 D1=A6
630 D2=A7/A6
640 C1=C1+A6
650 C2=C2+A7
```

(CONT)

```
660 S3=V2-0.05
670 GOSUB 1130
680 IF D2>A7/A6 THEN 720
690 D3=D1
700 D4=D2
710 GOTO 870
720 C5=10
730 S3=V2
740 C6=1
750 D4=D2
760 C5=0.1*C5
770 C6=-1*C6
780 IF C5<0.02 THEN 870
790 S3=S3+C5*C6
800 GOSUB 1130
810 IF D4>A7/A6 THEN 840
820 D4=A7/A6
830 GOTO 760
840 D4=A7/A6
850 D3=A6
860 GOTO 790
870 C3=C3+D3
880 C4=C4+D3*D4
890 WRITE (15,10)M,D1,D2,D3,D4,A1,B1,A1+A9
900 NEXT M
910 PRINT "TOTAL"
920 A1=(155-D[27])/30
930 C1=C1+A1*D1
940 C2=C2+D1*D2*A1
950 C3=C3+A1*D3
960 C4=C4+D3*D4*A1
970 WRITE (15,10)12,C1,C2/C1,C3,C4/C3
980 PRINT
990 RETURN
1000 A1=M1=B1=0
1010 IF M=6 THEN 1110
1020 FOR Z=1 TO 24
1030 M1=M1+I[M+1,Z]
1040 IF S[Z]<100 THEN 1090
1050 R3=0.278*I[M+1,Z]/(S[Z]-100)
1060 A1=A1+R3
1070 B1=B1+R3
1080 GOTO 1100
1090 A1=A1+0.278*I[M+1,Z]/S[Z]
1100 NEXT Z
1110 GOSUB 1130
1120 RETURN
1130 A9=(D[26]-M1)*0.278/S3
1140 X3=D[23]*(A1*D[2]+A9*S3↑3*SQR(D[5])/(K7↑3))
1150 A5=2*(A1+A9)+D[20]+D[22]
1160 A7=D[19]+0.000833*D[18]*D[14]+0.0833*D[25]
1170 A6=720*D[21]/A5
1180 A8=2*X3+D[24]
1190 A7=A7+A8*720/A5+W5
1200 RETURN
```

APPENDIX B

| Data | Subject | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calculations | | | | | | | | | | |
| 2 | Power (kW) | | | | | | | | | | |
| 3 | Propeller diameter (m) (0) | | | | | | | | | | |
| 4 | Number of propellers | | | | | | | | | | |
| 5 | Displacement (tons) | | | | | | | | | | |
| 6 | Max. speed (m/s) (0) | | | | | | | | | | |
| 7 | Beam (m) | | | | | | | | | | |
| 8 | Stem angle (deg.) | | | | | | | | | | |
| 9 | Ice resistance coeff. (1) | | | | | | | | | | |
| 10 | Channel res. ratio (0.4) | | | | | | | | | | |
| 11 | Ridge res. coefficient (1) | | | | | | | | | | |
| 12 | Air bubbling (0 or 0.2) | | | | | | | | | | |
| 13 | Icebreaker | | | | | | | | | | |
| 14 | Ship price | | | | | | | | | | |
| 15 | Depr. time (years) | | | | | | | | | | |
| 16 | Interest % | | | | | | | | | | |
| 17 | Insurance % | | | | | | | | | | |
| 18 | Repair % | | | | | | | | | | |
| 19 | Crew cost/month | | | | | | | | | | |
| 20 | Load + unload time (h) | | | | | | | | | | |
| 21 | Load both ways (tons) | | | | | | | | | | |
| 22 | Lost time/roundtrip (h) | | | | | | | | | | |
| 23 | Fuel costs/kW · h | | | | | | | | | | |
| 24 | Harbour cost/roundtrip | | | | | | | | | | |
| 25 | Misc. cost/year | | | | | | | | | | |
| 26 | Total one way distance (km) | | | | | | | | | | |
| 27 | Off time days/year | | | | | | | | | | |
| 28 | Harbour | | | | | | | | | | |

LEVEL ICE

| THICKNESS (M) | URHO ATLE | APU NJORD | KARHU HANSE |
|---|---|---|---|
| 0.1 | 9.296 | 8.475 | 7.740 |
| 0.2 | 8.531 | 7.463 | 6.756 |
| 0.3 | 7.656 | 6.367 | 5.697 |
| 0.4 | 6.764 | 5.319 | 4.692 |
| 0.5 | 5.909 | 4.378 | 3.796 |
| 0.6 | 5.120 | 3.561 | 3.022 |
| 0.7 | 4.409 | 2.862 | 2.362 |
| 0.8 | 3.775 | 2.265 | 1.800 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | URHO ATLE | APU NJORD | KARHU HANSE |
|---|---|---|---|
| 0.1 | 9.565 | 8.843 | 8.099 |
| 0.2 | 9.238 | 8.397 | 7.664 |
| 0.3 | 8.835 | 7.859 | 7.140 |
| 0.4 | 8.386 | 7.276 | 6.575 |
| 0.5 | 7.911 | 6.679 | 5.998 |
| 0.6 | 7.426 | 6.089 | 5.430 |
| 0.7 | 6.941 | 5.521 | 4.885 |
| 0.8 | 6.465 | 4.983 | 4.371 |

ICE RIDGES

| THICKNESS (M) | URHO ATLE | APU NJORD | KARHU HANSE |
|---|---|---|---|
| 5.0 | 1.054 | 0.423 | 0.353 |
| 6.0 | 0.586 | 0.343 | 0.258 |
| 7.0 | 0.496 | 0.261 | 0.149 |
| 8.0 | 0.427 | 0.162 | 0.092 |
| 9.0 | 0.373 | 0.106 | 0.060 |
| 10.0 | 0.330 | 0.073 | 0.041 |
| 11.0 | 0.295 | 0.052 | 0.029 |
| 12.0 | 0.266 | 0.038 | 0.021 |

KEMI

MILD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 36 | 240 | 0 | 0 |
| 0.3 | 37 | 0 | 0 | 260 | 0 | 0 |
| 0.4 | 0 | 0 | 46 | 108 | 148 | 27 |
| 0.5 | 0 | 40 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 10 |
| 0.7 | 0 | 0 | 28 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 37 | 37 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 260 | 0 |
| 0.3 | 0 | 74 | 0 | 0 | 56 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 164 |
| 0.5 | 0 | 0 | 74 | 74 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 0 | 1 | 3 | 2 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 0 | 3 | 0 | 0 |

KEMI

NORMAL WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 56 | 28 | 130 | 0 | 0 | 0 |
| 0.4 | 0 | 44 | 319 | 296 | 0 | 0 |
| 0.5 | 0 | 8 | 0 | 37 | 0 | 0 |
| 0.6 | 0 | 8 | 0 | 77 | 73 | 0 |
| 0.7 | 0 | 0 | 74 | 78 | 37 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 111 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 111 | 0 | 74 | 111 |
| 0.3 | 0 | 83 | 0 | 111 | 278 | 0 |
| 0.4 | 0 | 0 | 0 | 112 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 83 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 7 | 4 | 1 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 3 | 2 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 4 | 0 | 0 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 3 | 0 | 0 | 0 | 0 |

KEMI

HARD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 40 | 74 | 0 | 0 | 0 | 0 |
| 0.2 | 56 | 0 | 150 | 0 | 0 | 0 |
| 0.3 | 18 | 56 | 150 | 0 | 37 | 0 |
| 0.4 | 0 | 560 | 93 | 148 | 56 | 186 |
| 0.5 | 0 | 0 | 560 | 0 | 408 | 56 |
| 0.6 | 0 | 0 | 0 | 620 | 74 | 56 |
| 0.7 | 0 | 0 | 0 | 56 | 111 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 93 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 11 | 0 | 0 | 20 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 0 | 0 | 3 | 6 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 7 | 0 | 5 | 0 |

RAAHE

MILD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 240 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 260 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 34 | 84 | 20 |
| 0.5 | 0 | 0 | 28 | 28 | 20 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 260 | 0 |
| 0.3 | 0 | 111 | 0 | 0 | 56 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 111 |
| 0.5 | 0 | 0 | 84 | 84 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 0 | 1 | 3 | 2 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 0 | 3 | 0 | 0 |

RAAHE

NORMAL WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 28 | 130 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 286 | 296 | 0 | 0 |
| 0.5 | 0 | 0 | 28 | 37 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 74 | 28 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 111 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 111 | 0 | 74 | 111 |
| 0.3 | 0 | 83 | 0 | 111 | 278 | 0 |
| 0.4 | 0 | 0 | 0 | 112 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 83 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 7 | 4 | 1 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 3 | 2 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 4 | 0 | 0 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 3 | 0 | 0 | 0 | 0 |

RAAHE

HARD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 20 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 74 | 150 | 0 | 0 | 0 |
| 0.3 | 0 | 56 | 150 | 0 | 37 | 0 |
| 0.4 | 0 | 509 | 93 | 148 | 56 | 223 |
| 0.5 | 0 | 0 | 481 | 0 | 408 | 0 |
| 0.6 | 0 | 0 | 37 | 658 | 74 | 0 |
| 0.7 | 0 | 0 | 0 | 10 | 20 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 93 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 11 | 0 | 0 | 20 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 0 | 0 | 3 | 6 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 7 | 0 | 5 | 0 |

KOKKOLA

MILD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 10 | 0 | 240 | 0 | 0 |
| 0.3 | 0 | 0 | 18 | 260 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 74 | 0 | 20 |
| 0.5 | 0 | 0 | 0 | 0 | 20 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 260 | 0 |
| 0.3 | 0 | 0 | 18 | 0 | 56 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 36 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 0 | 1 | 3 | 2 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 0 | 3 | 0 | 0 |

KOKKOLA

NORMAL WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 14 | 130 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 204 | 310 | 15 | 0 |
| 0.5 | 0 | 0 | 28 | 28 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 111 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 28 | 111 | 0 | 74 | 111 |
| 0.3 | 0 | 0 | 0 | 111 | 222 | 0 |
| 0.4 | 0 | 0 | 0 | 112 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 7 | 4 | 1 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 3 | 2 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 4 | 0 | 0 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 3 | 0 | 0 | 0 | 0 |

KOKKOLA

HARD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 74 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 150 | 0 | 0 | 0 |
| 0.3 | 0 | 56 | 150 | 37 | 37 | 0 |
| 0.4 | 0 | 435 | 93 | 0 | 56 | 149 |
| 0.5 | 0 | 0 | 424 | 0 | 425 | 0 |
| 0.6 | 0 | 0 | 20 | 537 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 20 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 93 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 11 | 0 | 0 | 20 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 0 | 0 | 3 | 6 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 7 | 0 | 5 | 0 |

LULEA

MILD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 20 | 0 | 0 | 0 |
| 0.2 | 14 | 17 | 37 | 240 | 0 | 0 |
| 0.3 | 0 | 0 | 37 | 297 | 37 | 37 |
| 0.4 | 0 | 0 | 74 | 37 | 0 | 0 |
| 0.5 | 0 | 20 | 19 | 74 | 74 | 0 |
| 0.6 | 0 | 0 | 18 | 18 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 19 | 37 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 111 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 297 | 74 |
| 0.3 | 0 | 0 | 0 | 37 | 74 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 0 | 1 | 3 | 2 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 0 | 3 | 0 | 0 |

LULEA

NORMAL WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 18 | 74 | 0 | 0 | 0 | 111 |
| 0.3 | 18 | 0 | 130 | 0 | 0 | 0 |
| 0.4 | 0 | 37 | 275 | 296 | 55 | 0 |
| 0.5 | 0 | 0 | 185 | 204 | 18 | 0 |
| 0.6 | 0 | 0 | 37 | 0 | 74 | 0 |
| 0.7 | 0 | 0 | 0 | 18 | 37 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 111 |
| 0.2 | 0 | 111 | 111 | 0 | 74 | 111 |
| 0.3 | 0 | 0 | 0 | 111 | 222 | 0 |
| 0.4 | 0 | 0 | 0 | 56 | 37 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 7 | 4 | 1 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 3 | 2 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 4 | 0 | 0 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 3 | 0 | 0 | 0 | 0 |

LULEA

HARD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 74 | 74 | 0 | 0 | 0 | 0 |
| 0.2 | 130 | 0 | 150 | 0 | 0 | 0 |
| 0.3 | 19 | 56 | 150 | 0 | 37 | 0 |
| 0.4 | 0 | 564 | 93 | 148 | 56 | 130 |
| 0.5 | 0 | 0 | 555 | 0 | 352 | 93 |
| 0.6 | 0 | 0 | 0 | 592 | 111 | 56 |
| 0.7 | 0 | 0 | 19 | 74 | 93 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 19 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 11 | 0 | 0 | 20 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 0 | 0 | 3 | 6 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 7 | 0 | 5 | 0 |

PITEA

MILD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 20 | 0 | 0 | 0 |
| 0.2 | 0 | 19 | 37 | 240 | 0 | 0 |
| 0.3 | 0 | 0 | 74 | 297 | 74 | 0 |
| 0.4 | 0 | 0 | 37 | 111 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 93 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 297 | 0 |
| 0.3 | 0 | 0 | 0 | 37 | 111 | 20 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 0 | 1 | 3 | 2 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 0 | 3 | 0 | 0 |

PITEA

NORMAL WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 20 | 46 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 130 | 0 | 0 | 56 |
| 0.4 | 0 | 0 | 275 | 296 | 148 | 0 |
| 0.5 | 0 | 0 | 148 | 111 | 0 | 0 |
| 0.6 | 0 | 0 | 37 | 74 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 130 |
| 0.2 | 0 | 139 | 111 | 0 | 74 | 111 |
| 0.3 | 0 | 0 | 0 | 111 | 222 | 0 |
| 0.4 | 0 | 0 | 0 | 56 | 37 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 7 | 4 | 1 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 3 | 2 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 4 | 0 | 0 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 3 | 0 | 0 | 0 | 0 |

PITEA

HARD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 74 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 111 | 74 | 150 | 0 | 0 | 0 |
| 0.3 | 0 | 56 | 150 | 0 | 37 | 0 |
| 0.4 | 0 | 527 | 93 | 148 | 56 | 130 |
| 0.5 | 0 | 0 | 518 | 0 | 352 | 111 |
| 0.6 | 0 | 0 | 19 | 611 | 167 | 0 |
| 0.7 | 0 | 0 | 0 | 19 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 19 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 11 | 0 | 0 | 20 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 0 | 0 | 3 | 6 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 7 | 0 | 5 | 0 |

SKELLEFTEA

MILD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 20 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 40 | 240 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 297 | 37 | 0 |
| 0.4 | 0 | 0 | 30 | 37 | 19 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 297 | 0 |
| 0.3 | 0 | 0 | 0 | 37 | 56 | 20 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 0 | 1 | 3 | 2 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 0 | 3 | 0 | 0 |

SKELLEFTEA

HARD WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 74 | 74 | 0 | 0 | 0 | 0 |
| 0.2 | 37 | 0 | 150 | 0 | 0 | 0 |
| 0.3 | 0 | 56 | 150 | 0 | 37 | 0 |
| 0.4 | 0 | 453 | 93 | 148 | 56 | 167 |
| 0.5 | 0 | 0 | 444 | 0 | 352 | 0 |
| 0.6 | 0 | 0 | 19 | 555 | 93 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 19 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 0 | 19 | 0 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 11 | 0 | 0 | 20 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 0 | 0 | 3 | 6 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 0 | 7 | 0 | 5 | 0 |

SKELLEFTEA

NORMAL WINTER

LEVEL ICE

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.3 | 0 | 0 | 130 | 0 | 0 | 0 |
| 0.4 | 0 | 0 | 275 | 296 | 74 | 0 |
| 0.5 | 0 | 0 | 111 | 111 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE CLOGGED CHANNEL

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 0.1 | 0 | 0 | 0 | 0 | 0 | 111 |
| 0.2 | 0 | 111 | 111 | 0 | 74 | 111 |
| 0.3 | 0 | 0 | 0 | 111 | 222 | 0 |
| 0.4 | 0 | 0 | 0 | 56 | 37 | 0 |
| 0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.8 | 0 | 0 | 0 | 0 | 0 | 0 |

ICE RIDGES

| THICKNESS (M) | DEC | JAN | FEB | MAR | APR | MAY |
|---|---|---|---|---|---|---|
| 5.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6.0 | 0 | 0 | 7 | 4 | 1 | 0 |
| 7.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.0 | 0 | 0 | 3 | 2 | 0 | 0 |
| 9.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10.0 | 0 | 2 | 4 | 0 | 0 | 0 |
| 11.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12.0 | 0 | 3 | 0 | 0 | 0 | 0 |

APPENDIX E 1

| Data | Subject | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calculations | 12 | | | | | | | | | |
| 2 | Power (kW) | 2 000 | | | | 3 000 | 4 000 | | | 5 000 | 6 000 |
| 3 | Propeller diameter (m) (0) | 0 | | | | | | | | | |
| 4 | Number of propellers | | | | | | | | | | |
| 5 | Displacement (tons) | 10 000 | | | | | | | | | |
| 6 | Max. speed (m/s) (0) | 0 | | | | | | | | | |
| 7 | Beam (m) | 20 | | | | | | | | | |
| 8 | Stem angle (deg.) | 60 | | | | | | | | | |
| 9 | Ice resistance coeff. (1) | 1 | | | | | | | | | |
| 10 | Channel res. ratio (0.4) | 0.4 | | | | | | | | | |
| 11 | Ridge res. coefficient (1) | 1 | | | | | | | | | |
| 12 | Air bubbling (0 or 0.2) | 0 | | | 0.2 | | | | | | |
| 13 | Icebreaker | 6 | 7 | 8 | 6 | | | 7 | 8 | 6 | |
| 14 | Ship price | 30 000 000 | | | | 31 000 000 | 32 000 000 | | | 33 000 000 | 34 000 000 |
| 15 | Depr. time (years) | 15 | | | | | | | | | |
| 16 | Interest % | 15 | | | | | | | | | |
| 17 | Insurance % | 1 | | | | | | | | | |
| 18 | Repair % | 1 | | | | | | | | | |
| 19 | Crew cost/month | 100 000 | | | | | | | | | |
| 20 | Load + unload time (h) | 48 | | | | | | | | | |
| 21 | Load both ways (tons) | 10 000 | | | | | | | | | |
| 22 | Lost time/roundtrip (h) | 6 | | | | | | | | | |
| 23 | Fuel costs/kW · h | 0.07 | | | | | | | | | |
| 24 | Harbour cost/roundtrip | 5 000 | | | | | | | | | |
| 25 | Misc. cost/year | 1 000 000 | | | | | | | | | |
| 26 | Total one way distance (km) | 1 600 | | | | | | | | | |
| 27 | Off time days/year | 20 | | | | | | | | | |
| 28 | Harbour | 10 | | | | | | | | | |

APPENDIX E 2

| Data | Subject | 11 | 12 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calculations | | | | | | | | | | |
| 2 | Power (kW) | | | | | | | | | | |
| 3 | Propeller diameter (m) (0) | | | | | | | | | | |
| 4 | Number of propellers | | | | | | | | | | |
| 5 | Displacement (tons) | | | | | | | | | | |
| 6 | Max. speed (m/s) (0) | | | | | | | | | | |
| 7 | Beam (m) | | | | | | | | | | |
| 8 | Stem angle (deg.) | | | | | | | | | | |
| 9 | Ice resistance coeff. (1) | | | | | | | | | | |
| 10 | Channel res. ratio (0.4) | | | | | | | | | | |
| | | | | | | | | | | | |
| 11 | Ridge res. coefficient (1) | | | | | | | | | | |
| 12 | Air bubbling (0 or 0.2) | | | | | | | | | | |
| 13 | Icebreaker | 7 | 8 | | | | | | | | |
| 14 | Ship price | | | | | | | | | | |
| 15 | Depr. time (years) | | | | | | | | | | |
| 16 | Interest % | | | | | | | | | | |
| 17 | Insurance % | | | | | | | | | | |
| 18 | Repair % | | | | | | | | | | |
| 19 | Crew cost/month | | | | | | | | | | |
| 20 | Load + unload time (h) | | | | | | | | | | |
| | | | | | | | | | | | |
| 21 | Load both ways (tons) | | | | | | | | | | |
| 22 | Lost time/roundtrip (h) | | | | | | | | | | |
| 23 | Fuel costs/kW · h | | | | | | | | | | |
| 24 | Harbour cost/roundtrip | | | | | | | | | | |
| 25 | Misc. cost/year | | | | | | | | | | |
| 26 | Total one way distance (km) | | | | | | | | | | |
| 27 | Off time days/year | | | | | | | | | | |
| 28 | Harbour | | | | | | | | | | |

CALCULATION NUMBER 1



| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 2000 KW | 240 KN | 5.41 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.00 | 6 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 9.30 | 1.05 | 2.15 | 0.00 | 3.83 | 3.83 | 0.01 | 0.01 |
| 0.20 | 6.0 | 8.53 | 0.59 | 0.28 | 0.00 | 1.87 | 1.87 | 0.01 | 0.01 |
| 0.30 | 7.0 | 7.66 | 0.50 | 0.08 | 0.00 | 0.47 | 0.47 | 0.01 | 0.01 |
| 0.40 | 8.0 | 6.76 | 0.43 | 0.02 | 0.00 | 0.22 | 0.22 | 0.00 | 0.00 |
| 0.50 | 9.0 | 5.91 | 0.37 | 0.01 | 0.00 | 0.11 | 0.11 | 0.00 | 0.00 |
| 0.60 | 10.0 | 5.12 | 0.33 | 0.01 | 0.00 | 0.06 | 0.06 | 0.00 | 0.00 |
| 0.70 | 11.0 | 4.41 | 0.30 | 0.01 | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 |
| 0.80 | 12.0 | 3.78 | 0.27 | 0.01 | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 30000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 15143 | 50.04 | 15143 | 50.04 | 130.4 | 0.0 | 211.5 |
| 1 | 3818 | 199.20 | 3818 | 199.20 | 839.4 | 0.0 | 916.5 |
| 2 | 1819 | 418.50 | 1819 | 418.50 | 1879.6 | 0.0 | 1953.0 |
| 3 | 664 | 1147.26 | 664 | 1147.26 | 5352.0 | 0.0 | 5397.4 |
| 4 | 941 | 809.09 | 941 | 809.09 | 3742.2 | 0.0 | 3799.0 |
| 5 | 3997 | 190.29 | 3997 | 190.29 | 801.8 | 0.0 | 874.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 207696 | 41.91 | 207696 | 41.91 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 32777 | 22.98 | 32777 | 22.98 | 2.5 | 2.5 | 83.6 |
| 1 | 23922 | 31.58 | 23922 | 31.58 | 47.1 | 3.7 | 124.2 |
| 2 | 12242 | 61.96 | 12242 | 61.96 | 194.4 | 10.8 | 267.8 |
| 3 | 11559 | 65.64 | 11559 | 65.64 | 239.5 | 55.9 | 284.9 |
| 4 | 20515 | 36.87 | 20515 | 36.87 | 92.1 | 20.6 | 149.0 |
| 5 | 11761 | 64.50 | 11761 | 64.50 | 207.2 | 3.2 | 279.8 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 294090 | 29.52 | 294090 | 29.52 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 11852 | 64.00 | 11852 | 64.00 | 197.4 | 0.0 | 277.5 |
| 1 | 1633 | 466.06 | 1633 | 466.06 | 2109.7 | 0.0 | 2177.8 |
| 2 | 404 | 1884.40 | 404 | 1884.40 | 8832.3 | 0.0 | 8881.7 |
| 3 | 361 | 2107.58 | 361 | 2107.58 | 9890.7 | 0.0 | 9936.5 |
| 4 | 992 | 767.53 | 992 | 767.53 | 3548.0 | 0.0 | 3602.6 |
| 5 | 29996 | 25.13 | 29996 | 25.13 | 16.5 | 0.0 | 93.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 226553 | 38.40 | 226553 | 38.40 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 32681 | 23.05 | 32681 | 23.05 | 3.8 | 3.8 | 83.9 |
| 1 | 21450 | 35.25 | 21450 | 35.25 | 73.4 | 16.6 | 141.5 |
| 2 | 23508 | 32.14 | 23508 | 32.14 | 77.2 | 60.7 | 126.6 |
| 3 | 10968 | 69.18 | 10968 | 69.18 | 255.8 | 51.4 | 301.6 |
| 4 | 7583 | 100.18 | 7583 | 100.18 | 393.6 | 13.4 | 448.2 |
| 5 | 29996 | 25.13 | 29996 | 25.13 | 16.5 | 0.0 | 93.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 307500 | 28.23 | 307500 | 28.23 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 15227 | 49.76 | 15227 | 49.76 | 137.8 | 0.0 | 210.1 |
| 1 | 385 | 1978.38 | 385 | 1978.38 | 9279.3 | 0.0 | 9325.8 |
| 2 | 246 | 3089.79 | 246 | 3089.79 | 14545.8 | 0.0 | 14579.0 |
| 3 | 165 | 4603.42 | 165 | 4603.42 | 21694.2 | 0.0 | 21733.5 |
| 4 | 188 | 4040.60 | 188 | 4040.60 | 19027.4 | 0.0 | 19073.3 |
| 5 | 590 | 1291.07 | 590 | 1291.07 | 6010.1 | 0.0 | 6077.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 198117 | 43.95 | 198117 | 43.95 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 30116 | 25.03 | 30116 | 25.03 | 21.0 | 4.2 | 93.2 |
| 1 | 24926 | 30.30 | 24926 | 30.30 | 71.3 | 66.0 | 117.9 |
| 2 | 23714 | 31.86 | 23714 | 31.86 | 91.9 | 91.9 | 125.1 |
| 3 | 21285 | 35.53 | 21285 | 35.53 | 103.2 | 103.2 | 142.5 |
| 4 | 19966 | 37.89 | 19966 | 37.89 | 107.8 | 107.8 | 153.7 |
| 5 | 27773 | 27.17 | 27773 | 27.17 | 36.0 | 36.0 | 103.2 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 329094 | 26.36 | 329094 | 26.36 | | | |

CALCULATION NUMBER 2

| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 2000 KW | 240 KN | 5.41 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.00 | 7 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 8.48 | 0.42 | 2.15 | 0.00 | 3.83 | 3.83 | 0.01 | 0.01 |
| 0.20 | 6.0 | 7.46 | 0.34 | 0.28 | 0.00 | 1.87 | 1.87 | 0.01 | 0.01 |
| 0.30 | 7.0 | 6.37 | 0.26 | 0.08 | 0.00 | 0.47 | 0.47 | 0.01 | 0.01 |
| 0.40 | 8.0 | 5.32 | 0.16 | 0.02 | 0.00 | 0.22 | 0.22 | 0.00 | 0.00 |
| 0.50 | 9.0 | 4.38 | 0.11 | 0.01 | 0.00 | 0.11 | 0.11 | 0.00 | 0.00 |
| 0.60 | 10.0 | 3.56 | 0.07 | 0.01 | 0.00 | 0.06 | 0.06 | 0.00 | 0.00 |
| 0.70 | 11.0 | 2.86 | 0.05 | 0.01 | 0.00 | 0.03 | 0.03 | 0.00 | 0.00 |
| 0.80 | 12.0 | 2.27 | 0.04 | 0.01 | 0.00 | 0.02 | 0.02 | 0.00 | 0.00 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 30000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | FULL SPEED COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | OPTIMUM SPEED COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 15143 | 50.04 | 15143 | 50.04 | 130.4 | 0.0 | 211.5 |
| 1 | 3818 | 199.20 | 3818 | 199.20 | 839.4 | 0.0 | 916.5 |
| 2 | 1819 | 418.50 | 1819 | 418.50 | 1879.6 | 0.0 | 1953.0 |
| 3 | 664 | 1147.26 | 664 | 1147.26 | 5352.0 | 0.0 | 5397.4 |
| 4 | 941 | 809.09 | 941 | 809.09 | 3742.2 | 0.0 | 3799.0 |
| 5 | 3997 | 190.29 | 3997 | 190.29 | 801.8 | 0.0 | 874.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 207696 | 41.91 | 207696 | 41.91 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 32635 | 23.08 | 32635 | 23.08 | 3.0 | 3.0 | 84.1 |
| 1 | 23724 | 31.85 | 23724 | 31.85 | 48.4 | 5.0 | 125.5 |
| 2 | 11890 | 63.80 | 11890 | 63.80 | 203.1 | 19.5 | 276.5 |
| 3 | 9613 | 78.97 | 9613 | 78.97 | 302.5 | 118.9 | 347.9 |
| 4 | 18612 | 40.66 | 18612 | 40.66 | 110.1 | 38.5 | 166.9 |
| 5 | 11722 | 64.72 | 11722 | 64.72 | 208.2 | 4.2 | 280.8 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 289510 | 30.00 | 289510 | 30.00 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 11852 | 64.00 | 11852 | 64.00 | 197.4 | 0.0 | 277.5 |
| 1 | 1633 | 466.06 | 1633 | 466.06 | 2109.7 | 0.0 | 2177.8 |
| 2 | 404 | 1884.40 | 404 | 1884.40 | 8832.3 | 0.0 | 8881.7 |
| 3 | 361 | 2107.58 | 361 | 2107.58 | 9890.7 | 0.0 | 9936.5 |
| 4 | 992 | 767.53 | 992 | 767.53 | 3548.0 | 0.0 | 3602.6 |
| 5 | 29996 | 25.13 | 29996 | 25.13 | 16.5 | 0.0 | 93.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 226553 | 38.40 | 226553 | 38.40 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 32468 | 23.20 | 32468 | 23.20 | 4.6 | 4.6 | 84.6 |
| 1 | 16629 | 45.54 | 16629 | 45.54 | 122.0 | 65.2 | 190.1 |
| 2 | 18024 | 42.00 | 18024 | 42.00 | 123.8 | 107.3 | 173.2 |
| 3 | 10255 | 74.01 | 10255 | 74.01 | 278.7 | 74.2 | 324.5 |
| 4 | 7480 | 101.56 | 7480 | 101.56 | 400.1 | 19.9 | 454.8 |
| 5 | 29996 | 25.13 | 29996 | 25.13 | 16.5 | 0.0 | 93.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 296167 | 29.32 | 296167 | 29.32 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 15227 | 49.76 | 15227 | 49.76 | 137.8 | 0.0 | 210.1 |
| 1 | 385 | 1978.38 | 385 | 1978.38 | 9279.3 | 0.0 | 9325.8 |
| 2 | 246 | 3089.79 | 246 | 3089.79 | 14545.8 | 0.0 | 14579.0 |
| 3 | 165 | 4603.42 | 165 | 4603.42 | 21694.2 | 0.0 | 21733.5 |
| 4 | 188 | 4040.60 | 188 | 4040.60 | 19027.4 | 0.0 | 19073.3 |
| 5 | 590 | 1291.07 | 590 | 1291.07 | 6010.1 | 0.0 | 6077.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 198117 | 43.95 | 198117 | 43.95 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 29972 | 25.15 | 29972 | 25.15 | 21.5 | 4.8 | 93.8 |
| 1 | 18881 | 40.08 | 18881 | 40.08 | 117.6 | 112.2 | 164.1 |
| 2 | 14008 | 54.11 | 14008 | 54.11 | 197.1 | 197.1 | 230.3 |
| 3 | 16578 | 45.68 | 16578 | 45.68 | 151.3 | 151.3 | 190.5 |
| 4 | 11151 | 68.04 | 11151 | 68.04 | 250.3 | 250.3 | 296.3 |
| 5 | 20969 | 36.06 | 20969 | 36.06 | 78.1 | 78.1 | 145.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 292875 | 29.65 | 292875 | 29.65 | | | |

CALCULATION NUMBER 3



| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 2000 KW | 240 KN | 5.41 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.00 | 8 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 7.74 | 0.35 | 2.15 | 0.00 | 3.50 | 3.83 | 0.01 | 0.01 |
| 0.20 | 6.0 | 6.76 | 0.26 | 0.28 | 0.00 | 1.33 | 1.87 | 0.00 | 0.01 |
| 0.30 | 7.0 | 5.70 | 0.15 | 0.08 | 0.00 | 0.33 | 0.47 | 0.00 | 0.01 |
| 0.40 | 8.0 | 4.69 | 0.09 | 0.02 | 0.00 | 0.14 | 0.22 | 0.00 | 0.00 |
| 0.50 | 9.0 | 3.80 | 0.06 | 0.01 | 0.00 | 0.07 | 0.11 | 0.00 | 0.00 |
| 0.60 | 10.0 | 3.02 | 0.04 | 0.01 | 0.00 | 0.03 | 0.06 | 0.00 | 0.00 |
| 0.70 | 11.0 | 2.36 | 0.03 | 0.01 | 0.00 | 0.02 | 0.03 | 0.00 | 0.00 |
| 0.80 | 12.0 | 1.80 | 0.02 | 0.01 | 0.00 | 0.01 | 0.02 | 0.00 | 0.00 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 30000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | FULL SPEED COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | OPTIMUM SPEED COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 15143 | 50.04 | 15143 | 50.04 | 130.4 | 0.0 | 211.5 |
| 1 | 3818 | 199.20 | 3818 | 199.20 | 839.4 | 0.0 | 916.5 |
| 2 | 1819 | 418.50 | 1819 | 418.50 | 1879.6 | 0.0 | 1953.0 |
| 3 | 664 | 1147.26 | 664 | 1147.26 | 5352.0 | 0.0 | 5397.4 |
| 4 | 941 | 809.09 | 941 | 809.09 | 3742.2 | 0.0 | 3799.0 |
| 5 | 3997 | 190.29 | 3997 | 190.29 | 801.8 | 0.0 | 874.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 207696 | 41.91 | 207696 | 41.91 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 32515 | 23.17 | 32515 | 23.17 | 3.4 | 3.4 | 84.5 |
| 1 | 23599 | 32.02 | 23599 | 32.02 | 49.2 | 5.8 | 126.3 |
| 2 | 11603 | 65.38 | 11603 | 65.38 | 210.6 | 27.0 | 283.9 |
| 3 | 8303 | 91.47 | 8303 | 91.47 | 361.6 | 178.0 | 407.0 |
| 4 | 17260 | 43.87 | 17260 | 43.87 | 125.2 | 53.6 | 182.1 |
| 5 | 11696 | 64.86 | 11696 | 64.86 | 208.9 | 4.9 | 281.5 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 286290 | 30.34 | 286290 | 30.34 | | | |

(cont)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SHIP ASS BY 2 ICEB | | | | | | | |
| 0 | 32539 | 23.15 | 32539 | 23.15 | 3.3 | 3.3 | 84.4 |
| 1 | 23609 | 32.00 | 23609 | 32.00 | 49.1 | 5.7 | 126.2 |
| 2 | 11613 | 65.32 | 11613 | 65.32 | 210.3 | 26.7 | 283.7 |
| 3 | 8462 | 89.75 | 8462 | 89.75 | 353.5 | 169.9 | 398.8 |
| 4 | 17285 | 43.81 | 17285 | 43.81 | 124.9 | 53.3 | 181.8 |
| 5 | 11698 | 64.85 | 11698 | 64.85 | 208.9 | 4.9 | 281.4 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 286521 | 30.31 | 286521 | 30.31 | | | |
| NORMAL WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 11852 | 64.00 | 11852 | 64.00 | 197.4 | 0.0 | 277.5 |
| 1 | 1633 | 466.06 | 1633 | 466.06 | 2109.7 | 0.0 | 2177.8 |
| 2 | 404 | 1884.40 | 404 | 1884.40 | 8832.3 | 0.0 | 8881.7 |
| 3 | 361 | 2107.58 | 361 | 2107.58 | 9890.7 | 0.0 | 9936.5 |
| 4 | 992 | 767.53 | 992 | 767.53 | 3548.0 | 0.0 | 3602.6 |
| 5 | 29996 | 25.13 | 29996 | 25.13 | 16.5 | 0.0 | 93.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 226553 | 38.40 | 226553 | 38.40 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 32289 | 23.33 | 32289 | 23.33 | 5.2 | 5.2 | 85.2 |
| 1 | 13710 | 55.30 | 13710 | 55.30 | 168.1 | 111.3 | 236.2 |
| 2 | 14903 | 50.85 | 14903 | 50.85 | 165.7 | 149.1 | 215.0 |
| 3 | 9761 | 77.77 | 9761 | 77.77 | 296.4 | 92.0 | 342.2 |
| 4 | 7417 | 102.44 | 7417 | 102.44 | 404.2 | 24.1 | 458.9 |
| 5 | 29996 | 25.13 | 29996 | 25.13 | 16.5 | 0.0 | 93.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 289389 | 30.01 | 289389 | 30.01 | | | |
| SHIP ASS BY 2 ICEB | | | | | | | |
| 0 | 32324 | 23.30 | 32324 | 23.30 | 5.0 | 5.0 | 85.1 |
| 1 | 14057 | 53.92 | 14057 | 53.92 | 161.6 | 104.9 | 229.7 |
| 2 | 14986 | 50.57 | 14986 | 50.57 | 164.3 | 147.8 | 213.7 |
| 3 | 9790 | 77.54 | 9790 | 77.54 | 295.4 | 90.9 | 341.2 |
| 4 | 7419 | 102.40 | 7419 | 102.40 | 404.1 | 23.9 | 450.7 |
| 5 | 29996 | 25.13 | 29996 | 25.13 | 16.5 | 0.0 | 93.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 289885 | 29.96 | 289885 | 29.96 | | | |
| HARD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 15227 | 49.76 | 15227 | 49.76 | 137.8 | 0.0 | 210.1 |
| 1 | 385 | 1978.38 | 385 | 1978.38 | 9279.3 | 0.0 | 9325.8 |
| 2 | 246 | 3089.79 | 246 | 3089.79 | 14545.8 | 0.0 | 14579.0 |
| 3 | 165 | 4603.42 | 165 | 4603.42 | 21694.2 | 0.0 | 21733.5 |
| 4 | 188 | 4040.60 | 188 | 4040.60 | 19027.4 | 0.0 | 19073.3 |
| 5 | 590 | 1291.07 | 590 | 1291.07 | 6010.1 | 0.0 | 6077.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 198117 | 43.95 | 198117 | 43.95 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 29729 | 25.36 | 29729 | 25.36 | 22.5 | 5.5 | 94.8 |
| 1 | 15071 | 50.28 | 15071 | 50.28 | 165.8 | 159.9 | 212.3 |
| 2 | 10219 | 74.27 | 10219 | 74.27 | 292.4 | 292.4 | 325.6 |
| 3 | 14442 | 52.48 | 14442 | 52.48 | 183.4 | 183.4 | 222.6 |
| 4 | 7773 | 97.72 | 7773 | 97.72 | 390.6 | 390.6 | 436.5 |
| 5 | 17220 | 43.97 | 17220 | 43.97 | 115.5 | 115.5 | 182.7 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 275768 | 31.50 | 275768 | 31.50 | | | |

(cont)

HIP ASS BY 2 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 29865 | 25.24 | 29865 | 25.24 | 22.0 | 5.2 | 94.2 |
| 1 | 15264 | 49.64 | 15264 | 49.64 | 162.8 | 157.4 | 209.3 |
| 2 | 10732 | 70.71 | 10732 | 70.71 | 275.5 | 275.5 | 308.7 |
| 3 | 14517 | 52.21 | 14517 | 52.21 | 182.1 | 182.1 | 221.3 |
| 4 | 8018 | 94.74 | 8018 | 94.74 | 376.5 | 376.5 | 422.4 |
| 5 | 17264 | 43.86 | 17264 | 43.86 | 114.9 | 114.9 | 182.2 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 276974 | 31.37 | 276974 | 31.37 | | | |

CALCULATION NUMBER 4

| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 2000 KW | 240 KN | 5.41 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 6 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 9.30 | 1.05 | 2.41 | 0.01 | 3.94 | 3.94 | 0.04 | 0.04 |
| 0.20 | 6.0 | 8.53 | 0.59 | 0.43 | 0.01 | 2.16 | 2.16 | 0.03 | 0.03 |
| 0.30 | 7.0 | 7.66 | 0.50 | 0.21 | 0.01 | 0.79 | 0.79 | 0.03 | 0.03 |
| 0.40 | 8.0 | 6.76 | 0.43 | 0.13 | 0.01 | 0.38 | 0.38 | 0.02 | 0.02 |
| 0.50 | 9.0 | 5.91 | 0.37 | 0.08 | 0.01 | 0.25 | 0.25 | 0.02 | 0.02 |
| 0.60 | 10.0 | 5.12 | 0.33 | 0.06 | 0.01 | 0.18 | 0.18 | 0.02 | 0.02 |
| 0.70 | 11.0 | 4.41 | 0.30 | 0.05 | 0.01 | 0.14 | 0.14 | 0.02 | 0.02 |
| 0.80 | 12.0 | 3.78 | 0.27 | 0.04 | 0.01 | 0.11 | 0.11 | 0.01 | 0.01 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 30000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | FULL SPEED COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | OPTIMUM SPEED COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 23101 | 32.71 | 23101 | 32.71 | 48.5 | 0.0 | 129.6 |
| 1 | 13807 | 54.90 | 13807 | 54.90 | 157.4 | 0.0 | 234.4 |
| 2 | 7040 | 107.93 | 7040 | 107.93 | 411.7 | 0.0 | 485.0 |
| 3 | 2516 | 302.51 | 2516 | 302.51 | 1359.1 | 0.0 | 1404.5 |
| 4 | 4399 | 172.87 | 4399 | 172.87 | 735.0 | 0.0 | 791.9 |
| 5 | 11079 | 68.48 | 11079 | 68.48 | 226.0 | 0.0 | 298.6 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 243257 | 35.75 | 243257 | 35.75 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 32805 | 22.96 | 32805 | 22.96 | 2.4 | 2.4 | 83.5 |
| 1 | 27051 | 27.90 | 27051 | 27.90 | 29.7 | 3.6 | 106.8 |
| 2 | 18817 | 40.22 | 18817 | 40.22 | 91.6 | 10.5 | 165.0 |
| 3 | 17376 | 43.58 | 17376 | 43.58 | 135.2 | 54.1 | 180.6 |
| 4 | 22976 | 32.89 | 22976 | 32.89 | 73.3 | 20.0 | 130.2 |
| 5 | 16115 | 47.01 | 16115 | 47.01 | 124.5 | 3.2 | 197.1 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 316454 | 27.42 | 316454 | 27.42 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 20024 | 37.78 | 20024 | 37.78 | 73.5 | 0.0 | 153.5 |
| 1 | 6455 | 117.73 | 6455 | 117.73 | 463.3 | 0.0 | 531.3 |
| 2 | 1968 | 386.75 | 1968 | 386.75 | 1753.3 | 0.0 | 1802.7 |
| 3 | 1859 | 409.55 | 1859 | 409.55 | 1864.7 | 0.0 | 1910.5 |
| 4 | 4225 | 180.00 | 4225 | 180.00 | 770.9 | 0.0 | 825.5 |
| 5 | 30558 | 24.67 | 30558 | 24.67 | 14.3 | 0.0 | 91.5 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 246403 | 35.29 | 246403 | 35.29 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 32723 | 23.02 | 32723 | 23.02 | 3.7 | 3.7 | 83.8 |
| 1 | 24391 | 30.97 | 24391 | 30.97 | 53.1 | 16.0 | 121.2 |
| 2 | 24137 | 31.30 | 24137 | 31.30 | 73.2 | 58.9 | 122.6 |
| 3 | 14721 | 51.48 | 14721 | 51.48 | 172.2 | 50.1 | 218.0 |
| 4 | 12290 | 61.71 | 12290 | 61.71 | 211.8 | 13.1 | 266.4 |
| 5 | 30558 | 24.67 | 30558 | 24.67 | 14.3 | 0.0 | 91.5 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 320136 | 27.10 | 320136 | 27.10 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 20599 | 36.72 | 20599 | 36.72 | 76.2 | 0.0 | 148.4 |
| 1 | 1970 | 386.44 | 1970 | 386.44 | 1754.7 | 0.0 | 1801.2 |
| 2 | 1313 | 579.72 | 1313 | 579.72 | 2681.5 | 0.0 | 2714.7 |
| 3 | 904 | 841.99 | 904 | 841.99 | 3915.2 | 0.0 | 3954.4 |
| 4 | 1002 | 759.60 | 1002 | 759.60 | 3519.1 | 0.0 | 3565.0 |
| 5 | 3036 | 250.62 | 3036 | 250.62 | 1092.2 | 0.0 | 1159.4 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 210139 | 41.42 | 210139 | 41.42 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 30645 | 24.60 | 30645 | 24.60 | 18.9 | 4.1 | 91.1 |
| 1 | 25267 | 29.89 | 25267 | 29.89 | 69.4 | 64.2 | 115.9 |
| 2 | 24123 | 31.32 | 24123 | 31.32 | 89.4 | 89.4 | 122.5 |
| 3 | 21630 | 34.95 | 21630 | 34.95 | 100.5 | 100.5 | 139.8 |
| 4 | 20334 | 37.20 | 20334 | 37.20 | 104.5 | 104.5 | 150.5 |
| 5 | 27985 | 26.96 | 27985 | 26.96 | 35.1 | 35.1 | 102.3 |
| 6 | 32966 | 22.85 | 32966 | 22.85 | 0.0 | 0.0 | 83.0 |
| TOTAL | | | | | | | |
| 12 | 331298 | 26.18 | 331298 | 26.18 | | | |

CALCULATION NUMBER 5

| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 3000 KW | 360 KN | 6.19 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 6 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 9.30 | 1.05 | 3.45 | 0.02 | 4.89 | 4.89 | 0.06 | 0.06 |
| 0.20 | 6.0 | 8.53 | 0.59 | 1.05 | 0.02 | 3.19 | 3.19 | 0.05 | 0.05 |
| 0.30 | 7.0 | 7.66 | 0.50 | 0.35 | 0.02 | 1.80 | 1.80 | 0.04 | 0.04 |
| 0.40 | 8.0 | 6.76 | 0.43 | 0.21 | 0.01 | 0.75 | 0.75 | 0.04 | 0.04 |
| 0.50 | 9.0 | 5.91 | 0.37 | 0.14 | 0.01 | 0.42 | 0.42 | 0.03 | 0.03 |
| 0.60 | 10.0 | 5.12 | 0.33 | 0.10 | 0.01 | 0.31 | 0.31 | 0.03 | 0.03 |
| 0.70 | 11.0 | 4.41 | 0.30 | 0.08 | 0.01 | 0.23 | 0.23 | 0.03 | 0.03 |
| 0.80 | 12.0 | 3.78 | 0.27 | 0.06 | 0.01 | 0.18 | 0.18 | 0.02 | 0.02 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 31000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 28520 | 28.39 | 28520 | 28.39 | 29.1 | 0.0 | 99.8 |
| 1 | 19624 | 41.55 | 19624 | 41.55 | 89.8 | 0.0 | 157.0 |
| 2 | 10737 | 76.47 | 10737 | 76.47 | 244.8 | 0.0 | 308.8 |
| 3 | 4165 | 198.14 | 4165 | 198.14 | 798.0 | 0.0 | 837.6 |
| 4 | 6917 | 119.06 | 6917 | 119.06 | 444.2 | 0.0 | 493.9 |
| 5 | 16878 | 48.42 | 16878 | 48.42 | 123.5 | 0.0 | 186.8 |
| 6 | 36433 | 22.09 | 36433 | 22.09 | 0.0 | 0.0 | 72.4 |
| TOTAL | | | | | | | |
| 12 | 287223 | 32.51 | 287223 | 32.51 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 36244 | 22.21 | 36244 | 22.21 | 2.2 | 2.2 | 72.9 |
| 1 | 33138 | 24.35 | 33138 | 24.35 | 14.9 | 3.5 | 82.2 |
| 2 | 23857 | 34.07 | 23857 | 34.07 | 60.4 | 8.3 | 124.4 |
| 3 | 20567 | 39.62 | 20567 | 39.62 | 108.8 | 38.9 | 148.4 |
| 4 | 28396 | 28.52 | 28396 | 28.52 | 50.5 | 19.3 | 100.2 |
| 5 | 23408 | 34.73 | 23408 | 34.73 | 64.0 | 3.0 | 127.3 |
| 6 | 36433 | 22.09 | 36433 | 22.09 | 0.0 | 0.0 | 72.4 |
| TOTAL | | | | | | | |
| 12 | 365991 | 25.38 | 365991 | 25.38 | | | |

( cont )

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 25658 | 31.63 | 25658 | 31.63 | 44.0 | 0.0 | 113.9 |
| 1 | 9759 | 84.21 | 9759 | 84.21 | 283.0 | 0.0 | 342.4 |
| 2 | 3170 | 260.59 | 3170 | 260.59 | 1066.1 | 0.0 | 1109.2 |
| 3 | 3064 | 269.61 | 3064 | 269.61 | 1108.4 | 0.0 | 1148.4 |
| 4 | 6868 | 119.91 | 6868 | 119.91 | 449.9 | 0.0 | 497.5 |
| 5 | 34785 | 23.17 | 34785 | 23.17 | 9.7 | 0.0 | 77.0 |
| 6 | 36433 | 22.09 | 36433 | 22.09 | 0.0 | 0.0 | 72.4 |
| TOTAL | | | | | | | |
| 12 | 283685 | 32.93 | 283685 | 32.93 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 36148 | 22.27 | 36148 | 22.27 | 3.3 | 3.3 | 73.2 |
| 1 | 29906 | 27.05 | 29906 | 27.05 | 34.4 | 15.3 | 93.9 |
| 2 | 26576 | 30.52 | 26576 | 30.52 | 65.7 | 56.1 | 108.8 |
| 3 | 20723 | 39.32 | 20723 | 39.32 | 107.1 | 48.3 | 147.0 |
| 4 | 18813 | 43.37 | 18813 | 43.37 | 117.1 | 12.8 | 164.7 |
| 5 | 34785 | 23.17 | 34785 | 23.17 | 9.7 | 0.0 | 77.0 |
| 6 | 36433 | 22.09 | 36433 | 22.09 | 0.0 | 0.0 | 72.4 |
| TOTAL | | | | | | | |
| 12 | 367331 | 25.28 | 367331 | 25.28 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 27736 | 29.21 | 27736 | 29.21 | 40.3 | 0.0 | 103.3 |
| 1 | 3187 | 259.13 | 3187 | 259.13 | 1062.2 | 0.0 | 1102.8 |
| 2 | 2178 | 379.42 | 2178 | 379.42 | 1596.8 | 0.0 | 1625.8 |
| 3 | 1483 | 557.51 | 1483 | 557.51 | 2365.9 | 0.0 | 2400.2 |
| 4 | 1626 | 508.49 | 1626 | 508.49 | 2147.0 | 0.0 | 2187.1 |
| 5 | 4819 | 171.16 | 4819 | 171.16 | 661.8 | 0.0 | 720.5 |
| 6 | 36433 | 22.09 | 36433 | 22.09 | 0.0 | 0.0 | 72.4 |
| TOTAL | | | | | | | |
| 12 | 241412 | 38.80 | 241412 | 38.80 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 34019 | 23.70 | 34019 | 23.70 | 16.3 | 1.1 | 79.3 |
| 1 | 27158 | 29.85 | 27158 | 29.85 | 65.3 | 61.1 | 105.9 |
| 2 | 24456 | 33.22 | 24456 | 33.22 | 91.5 | 78.4 | 120.4 |
| 3 | 22672 | 35.88 | 22672 | 35.88 | 97.8 | 97.8 | 132.1 |
| 4 | 21403 | 38.05 | 21403 | 38.05 | 101.4 | 101.4 | 141.5 |
| 5 | 30274 | 26.71 | 30274 | 26.71 | 33.7 | 33.7 | 92.4 |
| 6 | 36433 | 22.09 | 36433 | 22.09 | 0.0 | 0.0 | 72.4 |
| TOTAL | | | | | | | |
| 12 | 360363 | 25.79 | 360363 | 25.79 | | | |

CALCULATION NUMBER 6

| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 4000 KW | 480 KN | 6.82 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 6 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 9.30 | 1.05 | 4.24 | 0.03 | 5.62 | 5.62 | 0.09 | 0.09 |
| 0.20 | 6.0 | 8.53 | 0.59 | 1.80 | 0.03 | 3.99 | 3.99 | 0.07 | 0.07 |
| 0.30 | 7.0 | 7.66 | 0.50 | 0.50 | 0.02 | 2.58 | 2.58 | 0.06 | 0.06 |
| 0.40 | 8.0 | 6.76 | 0.43 | 0.30 | 0.02 | 1.49 | 1.49 | 0.05 | 0.05 |
| 0.50 | 9.0 | 5.91 | 0.37 | 0.20 | 0.02 | 0.64 | 0.64 | 0.05 | 0.05 |
| 0.60 | 10.0 | 5.12 | 0.33 | 0.15 | 0.01 | 0.43 | 0.43 | 0.04 | 0.04 |
| 0.70 | 11.0 | 4.41 | 0.30 | 0.11 | 0.01 | 0.33 | 0.33 | 0.04 | 0.04 |
| 0.80 | 12.0 | 3.78 | 0.27 | 0.09 | 0.01 | 0.26 | 0.26 | 0.03 | 0.03 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 32000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 32335 | 26.64 | 32335 | 26.64 | 20.6 | 0.0 | 84.8 |
| 1 | 24010 | 36.23 | 24010 | 36.23 | 62.3 | 0.0 | 123.4 |
| 2 | 14232 | 61.82 | 14232 | 61.82 | 168.2 | 0.0 | 226.4 |
| 3 | 5829 | 152.40 | 5829 | 152.40 | 554.9 | 0.0 | 590.8 |
| 4 | 9333 | 94.80 | 9333 | 94.80 | 314.0 | 0.0 | 359.1 |
| 5 | 22762 | 38.27 | 22762 | 38.27 | 74.1 | 0.0 | 131.6 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 323145 | 30.81 | 323145 | 30.81 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 38006 | 22.51 | 38006 | 22.51 | 4.0 | 0.0 | 68.2 |
| 1 | 36377 | 23.57 | 36377 | 23.57 | 11.4 | 3.4 | 72.4 |
| 2 | 28317 | 30.57 | 28317 | 30.57 | 42.4 | 7.9 | 100.6 |
| 3 | 22234 | 39.21 | 22234 | 39.21 | 99.2 | 22.5 | 135.2 |
| 4 | 31596 | 27.29 | 31596 | 27.29 | 42.2 | 18.1 | 87.3 |
| 5 | 30649 | 28.16 | 30649 | 28.16 | 33.4 | 2.8 | 90.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 401823 | 24.58 | 401823 | 24.58 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 29719 | 29.08 | 29719 | 29.08 | 31.2 | 0.0 | 94.6 |
| 1 | 12704 | 69.38 | 12704 | 69.38 | 202.8 | 0.0 | 256.8 |
| 2 | 4401 | 202.19 | 4401 | 202.19 | 752.2 | 0.0 | 791.3 |
| 3 | 4341 | 205.00 | 4341 | 205.00 | 766.3 | 0.0 | 802.6 |
| 4 | 9426 | 93.86 | 9426 | 93.86 | 312.0 | 0.0 | 355.3 |
| 5 | 37717 | 22.70 | 37717 | 22.70 | 7.7 | 0.0 | 68.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 312950 | 31.85 | 312950 | 31.85 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 37502 | 22.83 | 37502 | 22.83 | 6.0 | 0.0 | 69.5 |
| 1 | 32424 | 26.57 | 32424 | 26.57 | 30.5 | 13.0 | 84.4 |
| 2 | 27041 | 32.06 | 27041 | 32.06 | 67.3 | 45.6 | 106.4 |
| 3 | 25443 | 34.13 | 25443 | 34.13 | 78.5 | 45.6 | 114.8 |
| 4 | 23452 | 37.12 | 23452 | 37.12 | 83.5 | 12.5 | 126.8 |
| 5 | 37717 | 22.70 | 37717 | 22.70 | 7.7 | 0.0 | 68.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 398222 | 24.81 | 398222 | 24.81 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 32272 | 26.70 | 32272 | 26.70 | 27.7 | 0.0 | 85.0 |
| 1 | 4432 | 200.77 | 4432 | 200.77 | 748.7 | 0.0 | 785.6 |
| 2 | 3086 | 288.73 | 3086 | 288.73 | 1113.3 | 0.0 | 1139.6 |
| 3 | 2105 | 423.82 | 2105 | 423.82 | 1652.4 | 0.0 | 1683.5 |
| 4 | 2286 | 390.26 | 2286 | 390.26 | 1512.0 | 0.0 | 1548.4 |
| 5 | 6606 | 134.36 | 6606 | 134.36 | 465.1 | 0.0 | 518.3 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 265430 | 37.73 | 265430 | 37.73 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 36699 | 23.35 | 36699 | 23.35 | 14.3 | 0.0 | 71.5 |
| 1 | 28393 | 30.48 | 28393 | 30.48 | 63.2 | 53.5 | 100.1 |
| 2 | 24563 | 35.39 | 24563 | 35.39 | 93.5 | 66.9 | 119.8 |
| 3 | 23602 | 36.88 | 23602 | 36.88 | 94.7 | 94.7 | 125.8 |
| 4 | 22080 | 39.49 | 22080 | 39.49 | 99.9 | 95.9 | 136.3 |
| 5 | 32214 | 26.75 | 32214 | 26.75 | 31.9 | 31.9 | 85.1 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 382195 | 25.89 | 382195 | 25.89 | | | |

CALCULATION NUMBER 7

| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 4000 KW | 480 KN | 6.82 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 7 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | 2 IB | RIDGE 1 IB | 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 8.48 | 0.42 | 4.24 | 0.03 | 5.62 | 5.62 | 0.09 | 0.09 |
| 0.20 | 6.0 | 7.46 | 0.34 | 1.80 | 0.03 | 3.99 | 3.99 | 0.07 | 0.07 |
| 0.30 | 7.0 | 6.37 | 0.26 | 0.50 | 0.02 | 2.58 | 2.58 | 0.06 | 0.06 |
| 0.40 | 8.0 | 5.32 | 0.16 | 0.30 | 0.02 | 1.49 | 1.49 | 0.05 | 0.05 |
| 0.50 | 9.0 | 4.38 | 0.11 | 0.20 | 0.02 | 0.64 | 0.64 | 0.05 | 0.05 |
| 0.60 | 10.0 | 3.56 | 0.07 | 0.15 | 0.01 | 0.43 | 0.43 | 0.04 | 0.04 |
| 0.70 | 11.0 | 2.86 | 0.05 | 0.11 | 0.01 | 0.33 | 0.33 | 0.04 | 0.04 |
| 0.80 | 12.0 | 2.27 | 0.04 | 0.09 | 0.01 | 0.26 | 0.26 | 0.03 | 0.03 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 32000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 32335 | 26.64 | 32335 | 26.64 | 20.6 | 0.0 | 84.8 |
| 1 | 24010 | 36.23 | 24010 | 36.23 | 62.3 | 0.0 | 123.4 |
| 2 | 14232 | 61.82 | 14232 | 61.82 | 168.2 | 0.0 | 226.4 |
| 3 | 5829 | 152.40 | 5829 | 152.40 | 554.9 | 0.0 | 590.8 |
| 4 | 9333 | 94.80 | 9333 | 94.80 | 314.0 | 0.0 | 359.1 |
| 5 | 22762 | 38.27 | 22762 | 38.27 | 74.1 | 0.0 | 131.6 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 323145 | 30.81 | 323145 | 30.81 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 38006 | 22.51 | 38006 | 22.51 | 4.0 | 0.0 | 68.2 |
| 1 | 36001 | 23.83 | 36001 | 23.83 | 12.4 | 4.4 | 73.4 |
| 2 | 27099 | 31.98 | 27099 | 31.98 | 48.1 | 13.6 | 106.3 |
| 3 | 18450 | 47.45 | 18450 | 47.45 | 132.4 | 55.7 | 168.4 |
| 4 | 28566 | 30.29 | 28566 | 30.29 | 54.3 | 30.2 | 99.4 |
| 5 | 30448 | 28.36 | 30448 | 28.36 | 34.2 | 3.6 | 91.7 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 393214 | 25.14 | 393214 | 25.14 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 29719 | 29.08 | 29719 | 29.08 | 31.2 | 0.0 | 94.6 |
| 1 | 12704 | 69.38 | 12704 | 69.38 | 202.8 | 0.0 | 256.8 |
| 2 | 4401 | 202.19 | 4401 | 202.19 | 752.2 | 0.0 | 791.3 |
| 3 | 4341 | 205.00 | 4341 | 205.00 | 766.3 | 0.0 | 802.6 |
| 4 | 9426 | 93.86 | 9426 | 93.86 | 312.0 | 0.0 | 355.3 |
| 5 | 37717 | 22.70 | 37717 | 22.70 | 7.7 | 0.0 | 68.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 312950 | 31.85 | 312950 | 31.85 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 37502 | 22.83 | 37502 | 22.83 | 6.0 | 0.0 | 69.5 |
| 1 | 26214 | 33.10 | 26214 | 33.10 | 56.8 | 39.3 | 110.7 |
| 2 | 22003 | 39.63 | 22003 | 39.63 | 97.8 | 76.1 | 136.9 |
| 3 | 22637 | 38.49 | 22637 | 38.49 | 96.0 | 63.2 | 132.3 |
| 4 | 22648 | 38.47 | 22648 | 38.47 | 89.0 | 17.9 | 132.3 |
| 5 | 37717 | 22.70 | 37717 | 22.70 | 7.7 | 0.0 | 68.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 383364 | 25.81 | 383364 | 25.81 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 32272 | 26.70 | 32272 | 26.70 | 27.7 | 0.0 | 85.0 |
| 1 | 4432 | 200.77 | 4432 | 200.77 | 748.7 | 0.0 | 785.6 |
| 2 | 3086 | 288.73 | 3086 | 288.73 | 1113.3 | 0.0 | 1139.6 |
| 3 | 2105 | 423.82 | 2105 | 423.82 | 1652.4 | 0.0 | 1683.5 |
| 4 | 2286 | 390.26 | 2286 | 390.26 | 1512.0 | 0.0 | 1548.4 |
| 5 | 6606 | 134.36 | 6606 | 134.36 | 465.1 | 0.0 | 518.3 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 265430 | 37.73 | 265430 | 37.73 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 36699 | 23.35 | 36699 | 23.35 | 14.3 | 0.0 | 71.5 |
| 1 | 22817 | 38.18 | 22817 | 38.18 | 94.2 | 84.5 | 131.0 |
| 2 | 17568 | 49.89 | 17568 | 49.89 | 151.8 | 125.2 | 178.1 |
| 3 | 18800 | 46.55 | 18800 | 46.55 | 133.6 | 133.6 | 164.7 |
| 4 | 14198 | 61.97 | 14198 | 61.97 | 190.4 | 186.4 | 226.8 |
| 5 | 25933 | 33.47 | 25933 | 33.47 | 59.0 | 59.0 | 112.2 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 350658 | 28.31 | 350658 | 28.31 | | | |

CALCULATION NUMBER 8

| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 4000 KW | 480 KN | 6.82 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 8 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 7.74 | 0.35 | 4.24 | 0.03 | 5.37 | 5.62 | 0.07 | 0.09 |
| 0.20 | 6.0 | 6.76 | 0.26 | 1.80 | 0.03 | 3.51 | 3.99 | 0.06 | 0.07 |
| 0.30 | 7.0 | 5.70 | 0.15 | 0.50 | 0.02 | 2.02 | 2.58 | 0.05 | 0.06 |
| 0.40 | 8.0 | 4.69 | 0.09 | 0.30 | 0.02 | 0.93 | 1.49 | 0.04 | 0.05 |
| 0.50 | 9.0 | 3.80 | 0.06 | 0.20 | 0.02 | 0.46 | 0.64 | 0.04 | 0.05 |
| 0.60 | 10.0 | 3.02 | 0.04 | 0.15 | 0.01 | 0.34 | 0.43 | 0.03 | 0.04 |
| 0.70 | 11.0 | 2.36 | 0.03 | 0.11 | 0.01 | 0.26 | 0.33 | 0.03 | 0.04 |
| 0.80 | 12.0 | 1.80 | 0.02 | 0.09 | 0.01 | 0.20 | 0.26 | 0.03 | 0.03 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 32000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 32335 | 26.64 | 32335 | 26.64 | 20.6 | 0.0 | 84.8 |
| 1 | 24010 | 36.23 | 24010 | 36.23 | 62.3 | 0.0 | 123.4 |
| 2 | 14232 | 61.82 | 14232 | 61.82 | 168.2 | 0.0 | 226.4 |
| 3 | 5829 | 152.40 | 5829 | 152.40 | 554.9 | 0.0 | 590.8 |
| 4 | 9333 | 94.80 | 9333 | 94.80 | 314.0 | 0.0 | 359.1 |
| 5 | 22762 | 38.27 | 22762 | 38.27 | 74.1 | 0.0 | 131.6 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 323145 | 30.81 | 323145 | 30.81 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 38543 | 22.19 | 38543 | 22.19 | 2.7 | 2.7 | 66.9 |
| 1 | 35717 | 24.02 | 35717 | 24.02 | 13.2 | 5.2 | 74.2 |
| 2 | 26122 | 33.22 | 26122 | 33.22 | 53.1 | 18.2 | 111.2 |
| 3 | 16693 | 52.56 | 16693 | 52.56 | 153.0 | 62.8 | 188.9 |
| 4 | 26426 | 32.83 | 26426 | 32.83 | 64.5 | 40.4 | 109.6 |
| 5 | 30261 | 28.54 | 30261 | 28.54 | 34.9 | 4.3 | 92.4 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 388407 | 25.46 | 388407 | 25.46 | | | |

( cont )

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SHIP ASS BY 2 ICEB. | | | | | | | |
| 0 | 38006 | 22.51 | 38006 | 22.51 | 4.0 | 0.0 | 68.2 |
| 1 | 35793 | 23.97 | 35793 | 23.97 | 13.0 | 5.0 | 74.0 |
| 2 | 26448 | 32.80 | 26448 | 32.80 | 51.4 | 16.9 | 109.5 |
| 3 | 16435 | 53.40 | 16435 | 53.40 | 156.4 | 40.5 | 192.3 |
| 4 | 27056 | 32.04 | 27056 | 32.04 | 61.3 | 37.2 | 106.4 |
| 5 | 30335 | 28.47 | 30335 | 28.47 | 34.6 | 4.0 | 92.1 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 388716 | 25.44 | 388716 | 25.44 | | | |
| NORMAL WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 29719 | 29.08 | 29719 | 29.08 | 31.2 | 0.0 | 94.6 |
| 1 | 12704 | 69.38 | 12704 | 69.38 | 202.8 | 0.0 | 256.8 |
| 2 | 4401 | 202.19 | 4401 | 202.19 | 752.2 | 0.0 | 791.3 |
| 3 | 4341 | 205.00 | 4341 | 205.00 | 766.3 | 0.0 | 802.6 |
| 4 | 9426 | 93.86 | 9426 | 93.86 | 312.0 | 0.0 | 355.3 |
| 5 | 37717 | 22.70 | 37717 | 22.70 | 7.7 | 0.0 | 68.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 312950 | 31.85 | 312950 | 31.85 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 38300 | 22.33 | 38300 | 22.33 | 4.0 | 4.0 | 67.5 |
| 1 | 22753 | 38.29 | 22753 | 38.29 | 77.7 | 24.2 | 131.6 |
| 2 | 19336 | 45.23 | 19336 | 45.23 | 120.4 | 112.6 | 159.5 |
| 3 | 20592 | 42.41 | 20592 | 42.41 | 111.8 | 79.0 | 148.1 |
| 4 | 22121 | 39.41 | 22121 | 39.41 | 92.8 | 21.7 | 136.1 |
| 5 | 37717 | 22.70 | 37717 | 22.70 | 7.7 | 0.0 | 68.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 375462 | 26.38 | 375462 | 26.38 | | | |
| SHIP ASS BY 2 ICEB | | | | | | | |
| 0 | 37502 | 22.83 | 37502 | 22.83 | 6.0 | 0.0 | 69.5 |
| 1 | 22900 | 38.04 | 22900 | 38.04 | 76.7 | 20.1 | 130.6 |
| 2 | 19680 | 44.43 | 19680 | 44.43 | 117.1 | 95.4 | 156.2 |
| 3 | 21151 | 41.27 | 21151 | 41.27 | 107.2 | 74.4 | 143.5 |
| 4 | 22210 | 39.25 | 22210 | 39.25 | 92.1 | 21.1 | 135.4 |
| 5 | 37717 | 22.70 | 37717 | 22.70 | 7.7 | 0.0 | 68.9 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 375804 | 26.35 | 375804 | 26.35 | | | |
| HARD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 32272 | 26.70 | 32272 | 26.70 | 27.7 | 0.0 | 85.0 |
| 1 | 4432 | 200.77 | 4432 | 200.77 | 748.7 | 0.0 | 785.6 |
| 2 | 3086 | 288.73 | 3086 | 288.73 | 1113.3 | 0.0 | 1139.6 |
| 3 | 2105 | 423.82 | 2105 | 423.82 | 1652.4 | 0.0 | 1683.5 |
| 4 | 2286 | 390.26 | 2286 | 390.26 | 1512.0 | 0.0 | 1548.4 |
| 5 | 6606 | 134.36 | 6606 | 134.36 | 465.1 | 0.0 | 518.3 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 265430 | 37.73 | 265430 | 37.73 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 36703 | 23.35 | 36703 | 23.35 | 14.3 | 1.3 | 71.5 |
| 1 | 19087 | 45.84 | 19087 | 45.84 | 125.0 | 121.2 | 161.9 |
| 2 | 14440 | 60.92 | 14440 | 60.92 | 196.2 | 93.2 | 222.5 |
| 3 | 16296 | 53.86 | 16296 | 53.86 | 163.0 | 163.0 | 194.1 |
| 4 | 10811 | 81.70 | 10811 | 81.70 | 269.9 | 204.7 | 306.3 |
| 5 | 22337 | 39.02 | 22337 | 39.02 | 81.3 | 81.3 | 134.6 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 334318 | 29.75 | 334318 | 29.75 | | | |

(cont)

| SHIP | ASS BY 2 | ICEB | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 36699 | 23.35 | 36699 | 23.35 | 14.3 | 0.0 | 71.5 |
| 1 | 19933 | 43.85 | 19933 | 43.85 | 117.0 | 107.3 | 153.9 |
| 2 | 14435 | 60.94 | 14435 | 60.94 | 196.3 | 78.5 | 222.6 |
| 3 | 16768 | 52.32 | 16768 | 52.32 | 156.8 | 156.8 | 187.9 |
| 4 | 11168 | 79.06 | 11168 | 79.06 | 259.2 | 190.1 | 295.6 |
| 5 | 23331 | 37.32 | 23331 | 37.32 | 74.5 | 74.5 | 127.7 |
| 6 | 39026 | 21.90 | 39026 | 21.90 | 0.0 | 0.0 | 65.7 |
| TOTAL | | | | | | | |
| 12 | 336978 | 29.50 | 336978 | 29.50 | | | |

CALCULATION NUMBER 9



| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 5000 KW | 600 KN | 7.34 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 6 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 9.30 | 1.05 | 4.90 | 0.04 | 6.23 | 6.23 | 0.12 | 0.12 |
| 0.20 | 6.0 | 8.53 | 0.59 | 2.43 | 0.03 | 4.65 | 4.65 | 0.10 | 0.10 |
| 0.30 | 7.0 | 7.66 | 0.50 | 0.84 | 0.03 | 3.23 | 3.23 | 0.08 | 0.08 |
| 0.40 | 8.0 | 6.76 | 0.43 | 0.40 | 0.02 | 2.11 | 2.11 | 0.07 | 0.07 |
| 0.50 | 9.0 | 5.91 | 0.37 | 0.27 | 0.02 | 1.23 | 1.23 | 0.06 | 0.06 |
| 0.60 | 10.0 | 5.12 | 0.33 | 0.20 | 0.02 | 0.56 | 0.56 | 0.05 | 0.05 |
| 0.70 | 11.0 | 4.41 | 0.30 | 0.15 | 0.02 | 0.44 | 0.44 | 0.05 | 0.05 |
| 0.80 | 12.0 | 3.78 | 0.27 | 0.12 | 0.02 | 0.35 | 0.35 | 0.04 | 0.04 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 33000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 36579 | 24.87 | 36579 | 24.87 | 12.2 | 0.0 | 71.8 |
| 1 | 27538 | 33.49 | 27538 | 33.49 | 47.5 | 0.0 | 104.1 |
| 2 | 17924 | 52.20 | 17924 | 52.20 | 120.3 | 0.0 | 174.2 |
| 3 | 7966 | 119.20 | 7966 | 119.20 | 391.8 | 0.0 | 425.2 |
| 4 | 11621 | 81.27 | 11621 | 81.27 | 241.3 | 0.0 | 283.1 |
| 5 | 26738 | 34.53 | 26738 | 34.53 | 54.7 | 0.0 | 108.0 |
| 6 | 41110 | 21.97 | 41110 | 21.97 | 0.0 | 0.0 | 61.0 |
| TOTAL | | | | | | | |
| 12 | 354471 | 29.77 | 354471 | 29.77 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 40291 | 22.45 | 40291 | 22.45 | 3.2 | 0.0 | 62.8 |
| 1 | 38822 | 23.35 | 38822 | 23.35 | 9.5 | 3.1 | 66.1 |
| 2 | 33637 | 27.16 | 33637 | 27.16 | 26.5 | 7.6 | 80.4 |
| 3 | 26643 | 34.66 | 26643 | 34.66 | 75.0 | 21.5 | 108.3 |
| 4 | 33942 | 26.91 | 33942 | 26.91 | 37.5 | 17.2 | 79.3 |
| 5 | 34521 | 26.43 | 34521 | 26.43 | 24.3 | 2.7 | 77.6 |
| 6 | 41110 | 21.97 | 41110 | 21.97 | 0.0 | 0.0 | 61.0 |
| TOTAL | | | | | | | |
| 12 | 433963 | 24.06 | 433963 | 24.06 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 34619 | 26.35 | 34619 | 26.35 | 18.5 | 0.0 | 77.4 |
| 1 | 15554 | 60.36 | 15554 | 60.36 | 154.7 | 0.0 | 204.8 |
| 2 | 5748 | 165.71 | 5748 | 165.71 | 563.2 | 0.0 | 599.5 |
| 3 | 5608 | 169.89 | 5608 | 169.89 | 581.5 | 0.0 | 615.2 |
| 4 | 12158 | 77.62 | 12158 | 77.62 | 229.2 | 0.0 | 269.4 |
| 5 | 40000 | 22.62 | 40000 | 22.62 | 6.6 | 0.0 | 63.4 |
| 6 | 41110 | 21.97 | 41110 | 21.97 | 0.0 | 0.0 | 61.0 |
| TOTAL | | | | | | | |
| 12 | 339794 | 31.12 | 339794 | 31.12 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 39883 | 22.69 | 39883 | 22.69 | 4.8 | 0.0 | 63.7 |
| 1 | 34718 | 26.27 | 34718 | 26.27 | 27.0 | 12.5 | 77.0 |
| 2 | 28971 | 31.76 | 28971 | 31.76 | 61.2 | 43.4 | 97.5 |
| 3 | 28080 | 32.82 | 28080 | 32.82 | 67.8 | 43.5 | 101.4 |
| 4 | 28522 | 32.29 | 28522 | 32.29 | 59.3 | 12.2 | 99.5 |
| 5 | 40000 | 22.62 | 40000 | 22.62 | 6.6 | 0.0 | 63.4 |
| 6 | 41110 | 21.97 | 41110 | 21.97 | 0.0 | 0.0 | 61.0 |
| TOTAL | | | | | | | |
| 12 | 426280 | 24.52 | 426280 | 24.52 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 36028 | 25.27 | 36028 | 25.27 | 20.2 | 0.0 | 73.3 |
| 1 | 5717 | 166.62 | 5717 | 166.62 | 568.7 | 0.0 | 602.9 |
| 2 | 4074 | 234.40 | 4074 | 234.40 | 832.4 | 0.0 | 856.8 |
| 3 | 2753 | 347.48 | 2753 | 347.48 | 1251.8 | 0.0 | 1280.7 |
| 4 | 2974 | 321.56 | 2974 | 321.56 | 1149.8 | 0.0 | 1183.6 |
| 5 | 8350 | 113.64 | 8350 | 113.64 | 355.1 | 0.0 | 404.5 |
| 6 | 41110 | 21.97 | 41110 | 21.97 | 0.0 | 0.0 | 61.0 |
| TOTAL | | | | | | | |
| 12 | 286004 | 37.23 | 286004 | 37.23 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 39143 | 23.15 | 39143 | 23.15 | 12.2 | 0.0 | 65.3 |
| 1 | 30132 | 30.49 | 30132 | 30.49 | 58.5 | 50.4 | 92.7 |
| 2 | 26630 | 34.68 | 26630 | 34.68 | 84.0 | 62.1 | 108.4 |
| 3 | 24396 | 37.98 | 24396 | 37.98 | 91.9 | 91.9 | 120.8 |
| 4 | 23240 | 39.94 | 23240 | 39.94 | 94.4 | 91.2 | 128.1 |
| 5 | 33867 | 26.97 | 33867 | 26.97 | 30.2 | 30.2 | 79.6 |
| 6 | 41110 | 21.97 | 41110 | 21.97 | 0.0 | 0.0 | 61.0 |
| TOTAL | | | | | | | |
| 12 | 403514 | 25.98 | 403514 | 25.98 | | | |

CALCULATION NUMBER 10

| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 6000 KW | 720 KN | 7.80 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 6 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 9.30 | 1.05 | 5.46 | 0.05 | 6.75 | 6.75 | 0.15 | 0.15 |
| 0.20 | 6.0 | 8.53 | 0.59 | 2.98 | 0.04 | 5.22 | 5.22 | 0.12 | 0.12 |
| 0.30 | 7.0 | 7.66 | 0.50 | 1.33 | 0.03 | 3.80 | 3.80 | 0.10 | 0.10 |
| 0.40 | 8.0 | 6.76 | 0.43 | 0.50 | 0.03 | 2.64 | 2.64 | 0.08 | 0.08 |
| 0.50 | 9.0 | 5.91 | 0.37 | 0.34 | 0.03 | 1.73 | 1.73 | 0.07 | 0.07 |
| 0.60 | 10.0 | 5.12 | 0.33 | 0.24 | 0.02 | 1.00 | 1.00 | 0.07 | 0.07 |
| 0.70 | 11.0 | 4.41 | 0.30 | 0.19 | 0.02 | 0.54 | 0.54 | 0.06 | 0.06 |
| 0.80 | 12.0 | 3.78 | 0.27 | 0.15 | 0.02 | 0.43 | 0.43 | 0.05 | 0.05 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 34000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 39813 | 24.02 | 39813 | 24.02 | 7.7 | 0.0 | 63.8 |
| 1 | 30453 | 31.95 | 30453 | 31.95 | 38.3 | 0.0 | 91.6 |
| 2 | 20885 | 47.40 | 20885 | 47.40 | 95.0 | 0.0 | 145.7 |
| 3 | 10065 | 100.26 | 10065 | 100.26 | 299.5 | 0.0 | 330.9 |
| 4 | 13765 | 72.83 | 13765 | 72.83 | 195.4 | 0.0 | 234.8 |
| 5 | 29852 | 32.63 | 29852 | 32.63 | 43.8 | 0.0 | 93.9 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 380552 | 29.26 | 380552 | 29.26 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 42161 | 22.58 | 42161 | 22.58 | 2.7 | 0.0 | 58.7 |
| 1 | 40788 | 23.40 | 40788 | 23.40 | 8.3 | 2.9 | 61.6 |
| 2 | 35780 | 26.93 | 35780 | 26.93 | 23.2 | 4.6 | 73.9 |
| 3 | 28215 | 34.63 | 28215 | 34.63 | 69.4 | 14.4 | 100.8 |
| 4 | 33548 | 28.84 | 33548 | 28.84 | 41.2 | 7.7 | 80.6 |
| 5 | 36794 | 26.14 | 36794 | 26.14 | 21.0 | 0.9 | 71.2 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 453006 | 24.30 | 453006 | 24.30 | | | |

( cont )

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 38412 | 24.96 | 38412 | 24.96 | 11.7 | 0.0 | 67.1 |
| 1 | 18147 | 54.82 | 18147 | 54.82 | 124.6 | 0.0 | 171.7 |
| 2 | 7094 | 142.98 | 7094 | 142.98 | 446.5 | 0.0 | 480.7 |
| 3 | 6858 | 147.98 | 6858 | 147.98 | 466.5 | 0.0 | 498.2 |
| 4 | 14563 | 68.74 | 14563 | 68.74 | 182.7 | 0.0 | 220.4 |
| 5 | 41882 | 22.75 | 41882 | 22.75 | 5.9 | 0.0 | 59.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 362676 | 30.79 | 362676 | 30.79 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 41812 | 22.79 | 41812 | 22.79 | 4.1 | 0.0 | 59.5 |
| 1 | 35831 | 26.89 | 35831 | 26.89 | 26.7 | 9.4 | 73.8 |
| 2 | 27137 | 36.07 | 27137 | 36.07 | 71.7 | 22.8 | 105.9 |
| 3 | 27008 | 36.25 | 27008 | 36.25 | 74.8 | 23.8 | 106.5 |
| 4 | 31652 | 30.67 | 31652 | 30.67 | 49.2 | 11.6 | 87.0 |
| 5 | 41882 | 22.75 | 41882 | 22.75 | 5.9 | 0.0 | 59.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 441042 | 25.00 | 441042 | 25.00 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 38875 | 24.64 | 38875 | 24.64 | 16.0 | 0.0 | 65.9 |
| 1 | 6980 | 145.36 | 6980 | 145.36 | 456.8 | 0.0 | 489.0 |
| 2 | 5073 | 200.67 | 5073 | 200.67 | 659.9 | 0.0 | 682.9 |
| 3 | 3417 | 298.77 | 3417 | 298.77 | 999.6 | 0.0 | 1026.8 |
| 4 | 3675 | 277.65 | 3675 | 277.65 | 921.0 | 0.0 | 952.8 |
| 5 | 10028 | 100.63 | 10028 | 100.63 | 285.8 | 0.0 | 332.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 303766 | 37.10 | 303766 | 37.10 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 41131 | 23.19 | 41131 | 23.19 | 10.9 | 0.0 | 60.8 |
| 1 | 25745 | 38.12 | 25745 | 38.12 | 80.9 | 14.8 | 113.0 |
| 2 | 27367 | 35.75 | 27367 | 35.75 | 81.7 | 53.0 | 104.7 |
| 3 | 24465 | 40.20 | 24465 | 40.20 | 93.2 | 77.6 | 120.3 |
| 4 | 23867 | 41.26 | 23867 | 41.26 | 92.3 | 83.7 | 124.0 |
| 5 | 32618 | 29.71 | 32618 | 29.71 | 37.2 | 17.6 | 83.7 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 410913 | 26.97 | 410913 | 26.97 | | | |

CALCULATION NUMBER 11



| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 6000 KW | 720 KN | 7.80 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 7 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 8.48 | 0.42 | 5.46 | 0.05 | 6.75 | 6.75 | 0.15 | 0.15 |
| 0.20 | 6.0 | 7.46 | 0.34 | 2.98 | 0.04 | 5.22 | 5.22 | 0.12 | 0.12 |
| 0.30 | 7.0 | 6.37 | 0.26 | 1.33 | 0.03 | 3.80 | 3.80 | 0.10 | 0.10 |
| 0.40 | 8.0 | 5.32 | 0.16 | 0.50 | 0.03 | 2.64 | 2.64 | 0.08 | 0.08 |
| 0.50 | 9.0 | 4.38 | 0.11 | 0.34 | 0.03 | 1.73 | 1.73 | 0.07 | 0.07 |
| 0.60 | 10.0 | 3.56 | 0.07 | 0.24 | 0.02 | 1.00 | 1.00 | 0.07 | 0.07 |
| 0.70 | 11.0 | 2.86 | 0.05 | 0.19 | 0.02 | 0.54 | 0.54 | 0.06 | 0.06 |
| 0.80 | 12.0 | 2.27 | 0.04 | 0.15 | 0.02 | 0.43 | 0.43 | 0.05 | 0.05 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 34000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | FULL SPEED COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | OPTIMUM SPEED COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 39813 | 24.02 | 39813 | 24.02 | 7.7 | 0.0 | 63.8 |
| 1 | 30453 | 31.95 | 30453 | 31.95 | 38.3 | 0.0 | 91.6 |
| 2 | 20885 | 47.40 | 20885 | 47.40 | 95.0 | 0.0 | 145.7 |
| 3 | 10065 | 100.26 | 10065 | 100.26 | 299.5 | 0.0 | 330.9 |
| 4 | 13765 | 72.83 | 13765 | 72.83 | 195.4 | 0.0 | 234.8 |
| 5 | 29852 | 32.63 | 29852 | 32.63 | 43.8 | 0.0 | 93.9 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 380552 | 29.26 | 380552 | 29.26 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 42161 | 22.58 | 42161 | 22.58 | 2.7 | 0.0 | 58.7 |
| 1 | 40453 | 23.61 | 40453 | 23.61 | 9.1 | 3.6 | 62.3 |
| 2 | 34376 | 28.10 | 34376 | 28.10 | 27.3 | 8.7 | 78.0 |
| 3 | 23185 | 42.52 | 23185 | 42.52 | 97.1 | 19.9 | 128.5 |
| 4 | 31195 | 31.15 | 31195 | 31.15 | 49.3 | 15.8 | 88.7 |
| 5 | 36678 | 26.23 | 36678 | 26.23 | 21.3 | 1.2 | 71.5 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 443768 | 24.84 | 443768 | 24.84 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 38412 | 24.96 | 38412 | 24.96 | 11.7 | 0.0 | 67.1 |
| 1 | 18147 | 54.82 | 18147 | 54.82 | 124.6 | 0.0 | 171.7 |
| 2 | 7094 | 142.98 | 7094 | 142.98 | 446.5 | 0.0 | 480.7 |
| 3 | 6858 | 147.98 | 6858 | 147.98 | 466.5 | 0.0 | 498.2 |
| 4 | 14563 | 68.74 | 14563 | 68.74 | 182.7 | 0.0 | 220.4 |
| 5 | 41882 | 22.75 | 41882 | 22.75 | 5.9 | 0.0 | 59.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 362676 | 30.79 | 362676 | 30.79 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 41812 | 22.79 | 41812 | 22.79 | 4.1 | 0.0 | 59.5 |
| 1 | 29238 | 33.35 | 29238 | 33.35 | 49.4 | 9.9 | 96.4 |
| 2 | 23444 | 42.03 | 23444 | 42.03 | 92.6 | 43.7 | 126.8 |
| 3 | 24941 | 39.40 | 24941 | 39.40 | 85.9 | 34.8 | 117.5 |
| 4 | 30430 | 31.98 | 30430 | 31.98 | 53.8 | 16.1 | 91.5 |
| 5 | 41882 | 22.75 | 41882 | 22.75 | 5.9 | 0.0 | 59.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 427467 | 25.85 | 427467 | 25.85 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 38875 | 24.64 | 38875 | 24.64 | 16.0 | 0.0 | 65.9 |
| 1 | 6980 | 145.36 | 6980 | 145.36 | 456.8 | 0.0 | 489.0 |
| 2 | 5073 | 200.67 | 5073 | 200.67 | 659.9 | 0.0 | 682.9 |
| 3 | 3417 | 298.77 | 3417 | 298.77 | 999.6 | 0.0 | 1026.8 |
| 4 | 3675 | 277.65 | 3675 | 277.65 | 921.0 | 0.0 | 952.8 |
| 5 | 10028 | 100.63 | 10028 | 100.63 | 285.8 | 0.0 | 332.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 303766 | 37.10 | 303766 | 37.10 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 41131 | 23.19 | 41131 | 23.19 | 10.9 | 0.0 | 60.8 |
| 1 | 22777 | 43.31 | 22777 | 43.31 | 99.1 | 33.0 | 131.3 |
| 2 | 19864 | 49.93 | 19864 | 49.93 | 131.4 | 51.0 | 154.4 |
| 3 | 20328 | 48.75 | 20328 | 48.75 | 123.1 | 107.6 | 150.3 |
| 4 | 15938 | 62.66 | 15938 | 62.66 | 167.3 | 121.8 | 199.1 |
| 5 | 27866 | 35.08 | 27866 | 35.08 | 56.0 | 36.5 | 102.5 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 383625 | 29.01 | 383625 | 29.01 | | | |

CALCULATION NUMBER 12



| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 6000 KW | 720 KN | 7.80 M/S | 20.00 M | 1.99 | 60 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 8 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 7.74 | 0.35 | 5.46 | 0.05 | 6.51 | 6.75 | 0.11 | 0.15 |
| 0.20 | 6.0 | 6.76 | 0.26 | 2.98 | 0.04 | 4.74 | 5.22 | 0.09 | 0.12 |
| 0.30 | 7.0 | 5.70 | 0.15 | 1.33 | 0.03 | 3.22 | 3.80 | 0.08 | 0.10 |
| 0.40 | 8.0 | 4.69 | 0.09 | 0.50 | 0.03 | 2.04 | 2.64 | 0.07 | 0.08 |
| 0.50 | 9.0 | 3.80 | 0.06 | 0.34 | 0.03 | 1.14 | 1.73 | 0.06 | 0.07 |
| 0.60 | 10.0 | 3.02 | 0.04 | 0.24 | 0.02 | 0.54 | 1.00 | 0.05 | 0.07 |
| 0.70 | 11.0 | 2.36 | 0.03 | 0.19 | 0.02 | 0.42 | 0.54 | 0.05 | 0.06 |
| 0.80 | 12.0 | 1.80 | 0.02 | 0.15 | 0.02 | 0.33 | 0.43 | 0.04 | 0.05 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 34000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | FULL SPEED COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | OPTIMUM SPEED COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 39813 | 24.02 | 39813 | 24.02 | 7.7 | 0.0 | 63.8 |
| 1 | 30453 | 31.95 | 30453 | 31.95 | 38.3 | 0.0 | 91.6 |
| 2 | 20885 | 47.40 | 20885 | 47.40 | 95.0 | 0.0 | 145.7 |
| 3 | 10065 | 100.26 | 10065 | 100.26 | 299.5 | 0.0 | 330.9 |
| 4 | 13765 | 72.83 | 13765 | 72.83 | 195.4 | 0.0 | 234.8 |
| 5 | 29852 | 32.63 | 29852 | 32.63 | 43.8 | 0.0 | 93.9 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 380552 | 29.26 | 380552 | 29.26 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 41919 | 22.72 | 41919 | 22.72 | 3.2 | 0.0 | 59.2 |
| 1 | 40065 | 23.86 | 40065 | 23.86 | 9.9 | 4.5 | 63.2 |
| 2 | 33470 | 28.91 | 33470 | 28.91 | 30.2 | 9.4 | 80.9 |
| 3 | 19512 | 50.86 | 19512 | 50.86 | 126.3 | 18.6 | 157.7 |
| 4 | 30151 | 32.29 | 30151 | 32.29 | 53.3 | 21.9 | 92.7 |
| 5 | 36779 | 26.15 | 36779 | 26.15 | 21.0 | 3.8 | 71.2 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 437614 | 25.21 | 437614 | 25.21 | | | |

(cont)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SHIP ASS BY 2 ICEB | | | | | | | |
| 0 | 42161 | 22.58 | 42161 | 22.58 | 2.7 | 0.0 | 58.7 |
| 1 | 40280 | 23.72 | 40280 | 23.72 | 9.4 | 4.0 | 62.7 |
| 2 | 33278 | 29.09 | 33278 | 29.09 | 30.8 | 5.4 | 81.5 |
| 3 | 19804 | 50.08 | 19804 | 50.08 | 123.6 | 9.2 | 155.0 |
| 4 | 29429 | 33.12 | 29429 | 33.12 | 56.2 | 9.2 | 95.6 |
| 5 | 36617 | 26.27 | 36617 | 26.27 | 21.5 | 1.4 | 71.6 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 437290 | 25.23 | 437290 | 25.23 | | | |
| | | | | | | | |
| NORMAL WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 38412 | 24.96 | 38412 | 24.96 | 11.7 | 0.0 | 67.1 |
| 1 | 18147 | 54.82 | 18147 | 54.82 | 124.6 | 0.0 | 171.7 |
| 2 | 7094 | 142.98 | 7094 | 142.98 | 446.5 | 0.0 | 480.7 |
| 3 | 6858 | 147.98 | 6858 | 147.98 | 466.5 | 0.0 | 498.2 |
| 4 | 14563 | 68.74 | 14563 | 68.74 | 182.7 | 0.0 | 220.4 |
| 5 | 41882 | 22.75 | 41882 | 22.75 | 5.9 | 0.0 | 59.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 362676 | 30.79 | 362676 | 30.79 | | | |
| | | | | | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 41453 | 23.00 | 41453 | 23.00 | 4.8 | 0.0 | 60.2 |
| 1 | 24793 | 39.65 | 24793 | 39.65 | 71.4 | 5.8 | 118.5 |
| 2 | 21415 | 46.18 | 21415 | 46.18 | 107.2 | 63.0 | 141.3 |
| 3 | 24308 | 40.48 | 24308 | 40.48 | 89.6 | 69.7 | 121.3 |
| 4 | 29380 | 33.18 | 29380 | 33.18 | 58.0 | 20.4 | 95.8 |
| 5 | 41882 | 22.75 | 41882 | 22.75 | 5.9 | 0.0 | 59.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 418950 | 26.42 | 418950 | 26.42 | | | |
| | | | | | | | |
| SHIP ASS BY 2 ICEB | | | | | | | |
| 0 | 41812 | 22.79 | 41812 | 22.79 | 4.1 | 0.0 | 59.5 |
| 1 | 24728 | 39.76 | 24728 | 39.76 | 71.8 | 1.9 | 118.9 |
| 2 | 21062 | 46.99 | 21062 | 46.99 | 110.0 | 34.0 | 144.1 |
| 3 | 23833 | 41.32 | 23833 | 41.32 | 92.6 | 41.5 | 124.3 |
| 4 | 29797 | 32.69 | 29797 | 32.69 | 56.3 | 18.7 | 94.1 |
| 5 | 41882 | 22.75 | 41882 | 22.75 | 5.9 | 0.0 | 59.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 418833 | 26.42 | 418833 | 26.42 | | | |
| | | | | | | | |
| HARD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 38875 | 24.64 | 38875 | 24.64 | 16.0 | 0.0 | 65.9 |
| 1 | 6980 | 145.36 | 6980 | 145.36 | 456.8 | 0.0 | 489.0 |
| 2 | 5073 | 200.67 | 5073 | 200.67 | 659.9 | 0.0 | 682.9 |
| 3 | 3417 | 298.77 | 3417 | 298.77 | 999.6 | 0.0 | 1026.8 |
| 4 | 3675 | 277.65 | 3675 | 277.65 | 921.0 | 0.0 | 952.8 |
| 5 | 10028 | 100.63 | 10028 | 100.63 | 285.8 | 0.0 | 332.3 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 303766 | 37.10 | 303766 | 37.10 | | | |
| | | | | | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 40852 | 23.36 | 40852 | 23.36 | 11.5 | 0.0 | 61.4 |
| 1 | 21694 | 45.57 | 21694 | 45.57 | 107.0 | 85.5 | 139.2 |
| 2 | 15418 | 64.83 | 15418 | 64.83 | 183.7 | 70.8 | 206.6 |
| 3 | 17611 | 56.54 | 17611 | 56.54 | 150.4 | 150.4 | 177.6 |
| 4 | 11892 | 84.58 | 11892 | 84.58 | 244.2 | 155.6 | 275.9 |
| 5 | 24983 | 39.33 | 24983 | 39.33 | 70.9 | 30.4 | 117.4 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 368169 | 30.30 | 368169 | 30.30 | | | |

( cont )

SHIP ASS BY 2 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 41131 | 23.19 | 41131 | 23.19 | 10.9 | 0.0 | 60.8 |
| 1 | 20776 | 47.66 | 20776 | 47.66 | 114.3 | 34.8 | 146.5 |
| 2 | 15925 | 62.71 | 15925 | 62.71 | 176.3 | 56.3 | 199.2 |
| 3 | 18553 | 53.58 | 18553 | 53.58 | 140.1 | 124.5 | 167.2 |
| 4 | 12488 | 80.46 | 12488 | 80.46 | 229.7 | 135.7 | 261.5 |
| 5 | 24552 | 40.05 | 24552 | 40.05 | 73.5 | 13.4 | 119.9 |
| 6 | 42858 | 22.19 | 42858 | 22.19 | 0.0 | 0.0 | 57.4 |
| TOTAL | | | | | | | |
| 12 | 369145 | 30.22 | 369145 | 30.22 | | | |

APPENDIX G

| Data | Subject | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Number of calculations | 2 | | | | | | | | | |
| 2 | Power (kW) | 12 000 | | | | | | | | | |
| 3 | Propeller diameter (m) (0) | 0 | | | | | | | | | |
| 4 | Number of propellers | | | | | | | | | | |
| 5 | Displacement (tons) | 10 000 | | | | | | | | | |
| 6 | Max. speed (m/s) (0) | 0 | | | | | | | | | |
| 7 | Beam (m) | 20 | | | | | | | | | |
| 8 | Stem angle (deg.) | 20 | | | | | | | | | |
| 9 | Ice resistance coeff. (1) | 1 | | | | | | | | | |
| 10 | Channel res. ratio (0.4) | 0.4 | | | | | | | | | |
| 11 | Ridge res. coefficient (1) | 1 | | | | | | | | | |
| 12 | Air bubbling (0 or 0.2) | 0.2 | | | | | | | | | |
| 13 | Icebreaker | 6 | 8 | | | | | | | | |
| 14 | Ship price | 40 000 000 | | | | | | | | | |
| 15 | Depr. time (years) | 15 | | | | | | | | | |
| 16 | Interest % | 15 | | | | | | | | | |
| 17 | Insurance % | 1 | | | | | | | | | |
| 18 | Repair % | 1 | | | | | | | | | |
| 19 | Crew cost/month | 100 000 | | | | | | | | | |
| 20 | Load + unload time (h) | 48 | | | | | | | | | |
| 21 | Load both ways (tons) | 10 000 | | | | | | | | | |
| 22 | Lost time/roundtrip (h) | 6 | | | | | | | | | |
| 23 | Fuel costs/kW · h | 0.07 | | | | | | | | | |
| 24 | Harbour cost/roundtrip | 5 000 | | | | | | | | | |
| 25 | Misc. cost/year | 1 000 000 | | | | | | | | | |
| 26 | Total one way distance (km) | 1 600 | | | | | | | | | |
| 27 | Off time days/year | 20 | | | | | | | | | |
| 28 | Harbour | 10 | | | | | | | | | |

CALCULATION NUMBER 1



| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 12000 KW | 1440 KN | 9.83 M/S | 20.00 M | 1.99 | 20 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 6 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 9.30 | 1.05 | 9.29 | 0.61 | 9.61 | 9.61 | 3.32 | 3.32 |
| 0.20 | 6.0 | 8.53 | 0.59 | 8.40 | 0.49 | 9.22 | 9.22 | 2.74 | 2.74 |
| 0.30 | 7.0 | 7.66 | 0.50 | 7.40 | 0.41 | 8.75 | 8.75 | 2.27 | 2.27 |
| 0.40 | 8.0 | 6.76 | 0.43 | 6.40 | 0.35 | 8.23 | 8.23 | 1.87 | 1.87 |
| 0.50 | 9.0 | 5.91 | 0.37 | 5.48 | 0.31 | 7.69 | 7.69 | 1.53 | 1.53 |
| 0.60 | 10.0 | 5.12 | 0.33 | 4.64 | 0.27 | 7.14 | 7.14 | 1.23 | 1.23 |
| 0.70 | 11.0 | 4.41 | 0.30 | 3.91 | 0.24 | 6.60 | 6.60 | 0.96 | 0.96 |
| 0.80 | 12.0 | 3.78 | 0.27 | 3.27 | 0.22 | 6.08 | 6.08 | 0.72 | 0.72 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 40000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 49597 | 24.68 | 45727 | 24.39 | 1.4 | 0.0 | 51.2 |
| 1 | 49047 | 25.01 | 45432 | 24.72 | 4.4 | 0.0 | 51.7 |
| 2 | 47441 | 25.99 | 44201 | 25.72 | 8.9 | 0.0 | 53.9 |
| 3 | 41467 | 30.32 | 39887 | 30.15 | 35.1 | 0.0 | 62.9 |
| 4 | 45432 | 27.32 | 43088 | 27.11 | 21.2 | 0.0 | 56.1 |
| 5 | 48735 | 25.19 | 45359 | 24.93 | 7.3 | 0.0 | 51.9 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 555804 | 25.44 | 515826 | 25.18 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 49629 | 24.67 | 45754 | 24.37 | 1.3 | 0.0 | 51.1 |
| 1 | 49147 | 24.95 | 45517 | 24.66 | 4.2 | 0.0 | 51.5 |
| 2 | 47772 | 25.78 | 44488 | 25.51 | 8.3 | 0.0 | 53.4 |
| 3 | 42602 | 29.40 | 40936 | 29.24 | 32.8 | 0.0 | 60.6 |
| 4 | 46080 | 26.88 | 43669 | 26.67 | 20.1 | 0.0 | 55.0 |
| 5 | 48814 | 25.15 | 45426 | 24.88 | 7.2 | 0.0 | 51.7 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 558127 | 25.31 | 517924 | 25.05 | | | |

(cont)

NORMAL WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 49476 | 24.75 | 45667 | 24.46 | 2.1 | 0.0 | 51.3 |
| 1 | 45197 | 27.48 | 42446 | 27.23 | 15.5 | 0.0 | 57.3 |
| 2 | 39286 | 32.23 | 37745 | 32.04 | 37.7 | 0.0 | 68.0 |
| 3 | 40916 | 30.78 | 39363 | 30.61 | 36.0 | 0.0 | 64.1 |
| 4 | 45900 | 27.00 | 43597 | 26.80 | 21.6 | 0.0 | 55.2 |
| 5 | 49691 | 24.63 | 45977 | 24.35 | 3.3 | 0.0 | 50.8 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 544551 | 26.05 | 506928 | 25.82 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 49525 | 24.73 | 45709 | 24.43 | 2.0 | 0.0 | 51.2 |
| 1 | 45893 | 27.00 | 43060 | 26.75 | 14.3 | 0.0 | 56.1 |
| 2 | 40722 | 30.95 | 39068 | 30.77 | 34.5 | 0.0 | 64.8 |
| 3 | 42114 | 29.79 | 40471 | 29.62 | 33.5 | 0.0 | 61.6 |
| 4 | 46369 | 26.69 | 44020 | 26.48 | 20.8 | 0.0 | 54.4 |
| 5 | 49691 | 24.63 | 45977 | 24.35 | 3.3 | 0.0 | 50.8 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 548399 | 25.84 | 510438 | 25.60 | | | |

HARD WINTER
SHIP ALONE

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 49371 | 24.82 | 45922 | 24.55 | 6.5 | 0.0 | 50.9 |
| 1 | 39281 | 32.23 | 37826 | 32.06 | 39.3 | 0.0 | 67.8 |
| 2 | 37106 | 34.36 | 36168 | 34.24 | 51.9 | 0.0 | 72.3 |
| 3 | 33753 | 38.17 | 32837 | 38.03 | 58.3 | 0.0 | 82.4 |
| 4 | 31593 | 41.06 | 30656 | 40.89 | 61.9 | 0.0 | 90.1 |
| 5 | 42846 | 29.21 | 40396 | 28.96 | 20.4 | 0.0 | 61.6 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 508035 | 28.21 | 475940 | 28.08 | | | |

SHIP ASS BY 1 ICEB

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 49406 | 24.80 | 45953 | 24.53 | 6.5 | 0.0 | 50.8 |
| 1 | 40689 | 30.98 | 39130 | 30.81 | 36.1 | 0.0 | 64.7 |
| 2 | 38748 | 32.73 | 37726 | 32.61 | 47.8 | 0.0 | 68.2 |
| 3 | 35753 | 35.81 | 34727 | 35.67 | 52.3 | 0.0 | 76.4 |
| 4 | 33743 | 38.18 | 32677 | 38.02 | 54.6 | 0.0 | 82.8 |
| 5 | 43892 | 28.42 | 41325 | 28.17 | 18.4 | 0.0 | 59.6 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 516316 | 27.69 | 483671 | 27.54 | | | |

CALCULATION NUMBER 2



| POWER | THRUST | MAX SPEED | BEAM | OPEN WATER SPEED COEFF | STEM ANGLE |
|---|---|---|---|---|---|
| 12000 KW | 1440 KN | 9.83 M/S | 20.00 M | 1.99 | 20 DEG |

| DISPL | ICE RES COEFF LEV | CH | RID | AIR BUBBL COEFF | ICEB |
|---|---|---|---|---|---|
| 10000 TON | 1.00 | 0.40 | 1.00 | 0.20 | 8 |

SPEED IN ICE (M/S)

| ICE THICKNESS LEVEL M | RIDGE M | ICEBREAKER LEVEL | RIDGE | SHIP ALONE LEVEL | RIDGE | ASSISTED BY ICEBREAKER LEVEL 1 IB | LEVEL 2 IB | RIDGE 1 IB | RIDGE 2 IB |
|---|---|---|---|---|---|---|---|---|---|
| 0.10 | 5.0 | 7.74 | 0.35 | 9.29 | 0.61 | 9.56 | 9.61 | 2.62 | 3.32 |
| 0.20 | 6.0 | 6.76 | 0.26 | 8.40 | 0.49 | 9.08 | 9.22 | 2.06 | 2.74 |
| 0.30 | 7.0 | 5.70 | 0.15 | 7.40 | 0.41 | 8.51 | 8.75 | 1.61 | 2.27 |
| 0.40 | 8.0 | 4.69 | 0.09 | 6.40 | 0.35 | 7.89 | 8.23 | 1.23 | 1.87 |
| 0.50 | 9.0 | 3.80 | 0.06 | 5.48 | 0.31 | 7.25 | 7.69 | 0.91 | 1.53 |
| 0.60 | 10.0 | 3.02 | 0.04 | 4.64 | 0.27 | 6.62 | 7.14 | 0.62 | 1.23 |
| 0.70 | 11.0 | 2.36 | 0.03 | 3.91 | 0.24 | 6.02 | 6.60 | 0.54 | 0.96 |
| 0.80 | 12.0 | 1.80 | 0.02 | 3.27 | 0.22 | 5.45 | 6.08 | 0.49 | 0.72 |

| PRICE | LOAD BOTH WAYS | DEPR TIME | OFF TIME | INSUR RATE |
|---|---|---|---|---|
| 40000000 | 10000 TON | 15.0 YEARS | 20.0 DAYS | 1.0 % |

| CREW COST | HARB COSTS | LOAD TIME | HARBOUR NO | REPAIR COST |
|---|---|---|---|---|
| 100000 | 5000 | 48.0 HOURS | 10 | 1.0 % |

| MISC COSTS | ONE WAY DISTANCE | LOST TIME PER ROUNDTRIP | INTEREST | FUEL COST/KW*H |
|---|---|---|---|---|
| 1000000 | 1600 KM | 6.0 HOURS | 15.0 % | 0.07000 |

| MONTH | FULL SPEED TRANSP CARGO TONS | COST PER TON | OPTIMUM SPEED TRANSP CARGO TONS | COST PER TON | ICE JOURNEY HOURS | ICEBR. TOWING HOURS | TOTAL JOURN HOURS |
|---|---|---|---|---|---|---|---|
| MILD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 49597 | 24.68 | 45727 | 24.39 | 1.4 | 0.0 | 51.2 |
| 1 | 49047 | 25.01 | 45432 | 24.72 | 4.4 | 0.0 | 51.7 |
| 2 | 47441 | 25.99 | 44201 | 25.72 | 8.9 | 0.0 | 53.9 |
| 3 | 41467 | 30.32 | 39887 | 30.15 | 35.1 | 0.0 | 62.9 |
| 4 | 45432 | 27.32 | 43088 | 27.11 | 21.2 | 0.0 | 56.1 |
| 5 | 48735 | 25.19 | 45359 | 24.93 | 7.3 | 0.0 | 51.9 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 555804 | 25.44 | 515826 | 25.18 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 49315 | 24.85 | 45487 | 24.55 | 1.8 | 0.0 | 51.6 |
| 1 | 48111 | 25.57 | 44627 | 25.29 | 5.8 | 0.0 | 53.1 |
| 2 | 42506 | 29.48 | 39886 | 29.21 | 17.7 | 0.0 | 62.7 |
| 3 | 24132 | 55.00 | 23588 | 54.83 | 97.4 | 0.0 | 125.3 |
| 4 | 36878 | 34.59 | 35318 | 34.38 | 39.6 | 0.0 | 74.5 |
| 5 | 47362 | 26.04 | 44166 | 25.77 | 9.5 | 0.0 | 54.0 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 522388 | 27.32 | 485206 | 27.14 | | | |

(cont)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SHIP ASS BY 2 ICEB | | | | | | | |
| 0 | 49315 | 24.85 | 45487 | 24.55 | 1.8 | 0.0 | 51.6 |
| 1 | 48111 | 25.57 | 44627 | 25.29 | 5.8 | 0.0 | 53.1 |
| 2 | 42506 | 29.48 | 39886 | 29.21 | 17.7 | 0.0 | 62.7 |
| 3 | 24132 | 55.00 | 23588 | 54.83 | 97.4 | 0.0 | 125.3 |
| 4 | 36878 | 34.59 | 35318 | 34.38 | 39.6 | 0.0 | 74.5 |
| 5 | 47362 | 26.04 | 44166 | 25.77 | 9.5 | 0.0 | 54.0 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 522388 | 27.32 | 485206 | 27.14 | | | |
| NORMAL WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 49476 | 24.75 | 45667 | 24.46 | 2.1 | 0.0 | 51.3 |
| 1 | 45197 | 27.48 | 42446 | 27.23 | 15.5 | 0.0 | 57.3 |
| 2 | 39286 | 32.23 | 37745 | 32.04 | 37.7 | 0.0 | 68.0 |
| 3 | 40916 | 30.78 | 39363 | 30.61 | 36.0 | 0.0 | 64.1 |
| 4 | 45900 | 27.00 | 43597 | 26.80 | 21.6 | 0.0 | 55.2 |
| 5 | 49691 | 24.63 | 45977 | 24.35 | 3.3 | 0.0 | 50.8 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 544551 | 26.05 | 506928 | 25.82 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 49053 | 25.00 | 45306 | 24.71 | 2.7 | 0.0 | 51.9 |
| 1 | 27898 | 47.03 | 26825 | 46.78 | 64.9 | 0.0 | 106.7 |
| 2 | 26565 | 49.60 | 25851 | 49.41 | 81.6 | 0.0 | 111.9 |
| 3 | 33368 | 38.66 | 32328 | 38.49 | 55.9 | 0.0 | 84.0 |
| 4 | 41713 | 30.12 | 39802 | 29.91 | 29.5 | 0.0 | 63.1 |
| 5 | 49228 | 24.90 | 45580 | 24.62 | 4.0 | 0.0 | 51.4 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 501910 | 28.60 | 467826 | 28.47 | | | |
| SHIP ASS BY 2 ICEB | | | | | | | |
| 0 | 49053 | 25.00 | 45306 | 24.71 | 2.7 | 0.0 | 51.9 |
| 1 | 27898 | 47.03 | 26825 | 46.78 | 64.9 | 0.0 | 106.7 |
| 2 | 26565 | 49.60 | 25851 | 49.41 | 81.6 | 0.0 | 111.9 |
| 3 | 33368 | 38.66 | 32328 | 38.49 | 55.9 | 0.0 | 84.0 |
| 4 | 41713 | 30.12 | 39802 | 29.91 | 29.5 | 0.0 | 63.1 |
| 5 | 49228 | 24.90 | 45580 | 24.62 | 4.0 | 0.0 | 51.4 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 501910 | 28.60 | 467826 | 28.47 | | | |
| HARD WINTER | | | | | | | |
| SHIP ALONE | | | | | | | |
| 0 | 49371 | 24.82 | 45922 | 24.55 | 6.5 | 0.0 | 50.9 |
| 1 | 39281 | 32.23 | 37826 | 32.06 | 39.3 | 0.0 | 67.8 |
| 2 | 37106 | 34.36 | 36168 | 34.24 | 51.9 | 0.0 | 72.3 |
| 3 | 33753 | 38.17 | 32837 | 38.03 | 58.3 | 0.0 | 82.4 |
| 4 | 31593 | 41.06 | 30656 | 40.89 | 61.9 | 0.0 | 90.1 |
| 5 | 42846 | 29.21 | 40396 | 28.96 | 20.4 | 0.0 | 61.6 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 508035 | 28.21 | 475940 | 28.08 | | | |
| SHIP ASS BY 1 ICEB | | | | | | | |
| 0 | 48400 | 25.40 | 45081 | 25.13 | 8.0 | 0.0 | 52.3 |
| 1 | 26152 | 50.44 | 25499 | 50.27 | 85.3 | 0.0 | 113.9 |
| 2 | 18342 | 73.64 | 18109 | 73.52 | 151.2 | 0.0 | 171.6 |
| 3 | 25480 | 51.88 | 24955 | 51.73 | 92.9 | 0.0 | 117.0 |
| 4 | 14246 | 95.97 | 14052 | 95.81 | 200.7 | 0.0 | 228.9 |
| 5 | 28930 | 45.21 | 27792 | 44.96 | 60.8 | 0.0 | 102.1 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 435634 | 33.57 | 407622 | 33.72 | | | |

(cont)

| SHIP | ASS BY 2 | ICEB | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 48400 | 25.40 | 45081 | 25.13 | 8.0 | 0.0 | 52.3 |
| 1 | 26152 | 50.44 | 25499 | 50.27 | 85.3 | 0.0 | 113.9 |
| 2 | 18342 | 73.64 | 18109 | 73.52 | 151.2 | 0.0 | 171.6 |
| 3 | 25480 | 51.88 | 24955 | 51.73 | 92.9 | 0.0 | 117.0 |
| 4 | 14246 | 95.97 | 14052 | 95.81 | 200.7 | 0.0 | 228.9 |
| 5 | 28930 | 45.21 | 27792 | 44.96 | 60.8 | 0.0 | 102.1 |
| 6 | 49833 | 24.55 | 45842 | 24.24 | 0.0 | 0.0 | 50.9 |
| TOTAL | | | | | | | |
| 12 | 435634 | 33.57 | 407622 | 33.72 | | | |

ISBN 951-46-3172-2