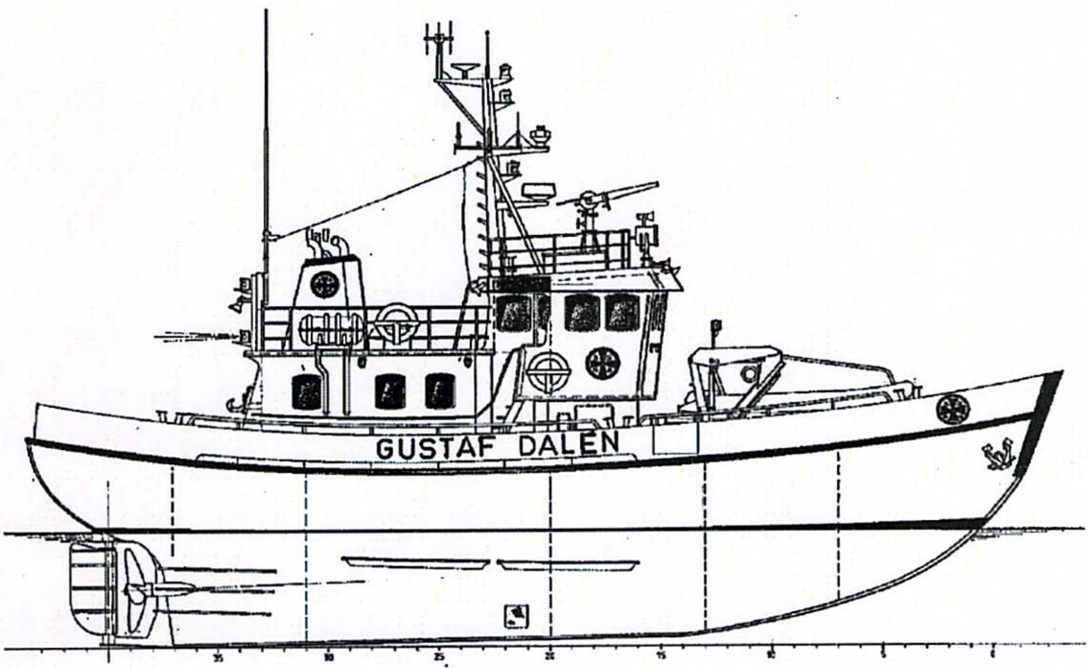
RS Gustaf Dalén

Ice class calculation: ICE-C / ICE-1C



TRANSPORT STYRELSEN
Gothenburg Maritime Inspectorate Office
INTE GODKÄND/NOT APPROVED
29/1-14 TSS 2013-413

REV:	DATE:	SIGN:	DESCRIPTION:
A	2013-01-29	UO	For approval

FKAB MARINE DESIGN

Fartygskonstruktioner AB
Uddevalla
PHONE: +46-(0)522-981 00
Göteborg
PHONE: +46-(0)31-744 56 50
E-mail: info@fkab.se
www.fkab.se

SIGN:	DATE:	CHECKED:	DATE:	DOCUMENT NO:	REV:
UO	2013-01-29	SJ	2013-01-30	13230-2-100-01	A

TABLE OF CONTENTS:

Page:

1. INTRODUCTION:

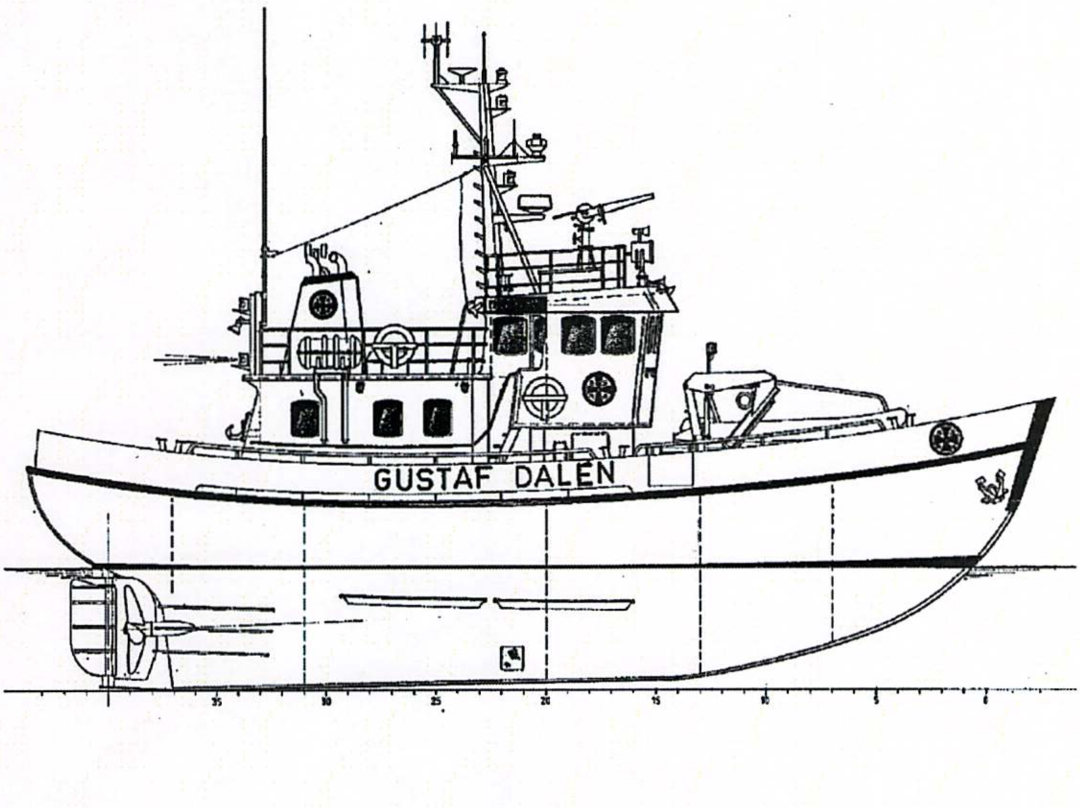
Ice class calculations for R/K Gustaf Dalén

The report includes calculations for
- Basic ice strengthening: ICE-C
- Ice strengthening for the Northern Baltic: ICE-1C

The calculations shows that R/K Gustaf Dalén fulfils the DnV requirement for a basic ice strengthening ICE-C (January 1990) but does not fulfil the requirements for ICE-1C

General arrangement according to: Djupviks varv AB Drawing 22746

DNV Rules for classification January 1990 is used as reference



MAIN DIMENSION:
- LENGHT OVER ALL: 18.,5 M
- LPP: 15.74 M
- EXTERNAL BREADTH: 5.75
- MOLDED DEPHT: 3.23 M

2. Basic ICE Strengthening ICE-C

2.1 Shell plating – B100:

DnV Rules for ships Pt5. Ch 1. Sec 2 – January 1990 gives:

From stem to a distance B abaft F.P and within a belt extending vertically from 0,5 m above LWL to 0,5 m below BWL, the shell plating thickness is not to be less than:

t = 6 + 0,11 * L + Δt (mm)

Term	Value	Definition
L	18,5	Rule lenght
Δt	-2,3	$\Delta t = 20 * (s_0 - s_s)$
Δt	0,0	Minimum
s_0	0,4	Spacing in m of ordinary main frames
s_s	0,5	0,48 + 0,002 * L
t	8,0	t=6 + 0,11 * L + Δt

Required minimum thickness for the shell plating is according to above 8,0 mm.
Existing thickness is 9-12 mm ➔ OK

2.2 Ordinary frames – B200:

DnV Rules for ships Pt5. Ch 1. Sec 2 – January 1990 gives:

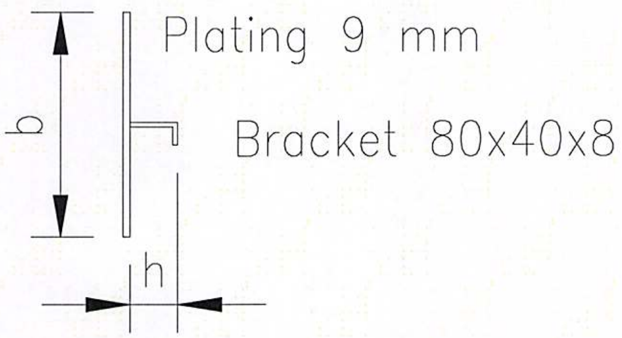
Ordinary frames in fore peak are to have a section modulus not less than:

$Z = 0{,}25 * L * T\ (cm^3)$

Term	Value	Definition
L	18,5	Rule lenght (m)
T	2,0	Rule draught (m)
Z	9,3	Z = 0,25 * L * T (cm3) - Section modulus

The distance between ordinary frames in fore peak is not to exceed 0,61 m (see s_0 in previous chapter =) ➔ OK

Existing section modulus



Calculation Z (section modulus mm3)

	b	h	Distance to CG	Area	S (A*CG)	I (A*CG^2)	I0= b*h^3/12
1	40	8	85	320	27200	2312000	1706,66667
2	8	72	45	576	25920	1166400	248832
3	400	9	4,5	3600	16200	72900	24300
Σ		89		4496	69320	3551300	274838,667

CG	15,42	
h_{Σ}-CG	73,58	
I	2757353	$I + I_0 - A*S^2$
Z	37473	I/biggest distance to Tp

Where plating is 12 mm, the section modulus is 39,3 cm3

Required section modulus is according to above 9,3 cm^3.
Existing section modulus is: 37,5 cm^3 ➔ OK

2.3 Ordinary frames- B202

DnV Rules for ships Pt5. Ch 1. Sec 2 – January 1990 gives:

From collision bulkhead to 1,5 B abaft F.P, the section modulus of ordinary main frames is not to be less than:

Z = 0,4 * L * s0 * T (cm3)

Term	Value	Definition
L	18,5	Rule lenght (m)
T	2,0	Rule draught (m)
S_0	0,4	Spacing in m of ordinary main frames
Z	5,9	Z = 0,4 * L * s0 * T (cm^3) - Section modulus

Required section modulus is according to above 5,9 cm^3.
Existing section modulus is: 37,5 cm^3 ➔ OK

2.4 Intermediate ice frames – B300

DnV Rules for ships Pt5. Ch 1. Sec 2 – January 1990 gives:

The intermediate ice frames are to have a section modulus not less than:

— forward of collision bulkhead

$Z = (L^2/160 + 10) * s_0/s_s$ (cm3)

Term	Value	Definition
L	18,5	Rule lenght (m)
T	2,0	Rule draught (m)
S_0	0,4	Spacing in m of ordinary main frames
S_s	0,5	$s_s = 0,48 + 0,002 * L$
	1,3	Proportion konstant (frame span 2,6 m instead of 2,0 m)
Z	12,2	$Z = (L^2/160+10) * s_0/s_s$ * prop.constant (cm^3) - Section modulus

Required section modulus is according to above 12,2 cm^3, but need in no case have a section modulus large that 75% of the ordinary frames:
0,75 * 9,3 = 7,0 cm^3

Existing section modulus is: 37,5 cm^3 ➔ OK

— abaft collision bulkhead

$Z = (L^2/100 + 20) * s_0/s_s$ (cm3)

Term	Value	Definition
L	18,5	Rule lenght (m)
T	2,0	Rule draught (m)
S_0	0,4	Spacing in m of ordinary main frames
S_s	0,5	$s_s = 0,48 + 0,002 * L$
	1,3	Proportion konstant (frame span 2,6 m instead of 2,0 m)
Z	23,6	$Z = (L^2/100+20) * s_0/s_s$ *prop.constant (cm^3) - Section modulus

Required section modulus is according to above 23,6 cm^3, but need in no case have a section modulus large that 75% of the ordinary frames:
0,75 * 9,3 = 7,0 cm^3

Existing section modulus is: 37,5 cm^3 ➔ OK

2.5 Output of propulsion machinery – C101

DnV Rules for ships Pt5. Ch 1. Sec 2 – January 1990 gives:

The maximum continous output is generally not to be less than:

Ps = 0,73 * L * B (kW)

Term	Value	Definition
L	18,5	Rule lenght (m)
B	5,8	Rule breadth (m)
P_s	77,7	Ps = 0,73 * L * B (kW) - output of propulsion machinery

Required continous output of propulsion machinery according to above 78 kW.
Existing output of propulsion machinery is 471 kW ➔ OK

3. ICE Strengthening for the northern Baltic ICE-1C

3.1 Design Loads – B100

DnV Rules for ships Pt5. Ch 1. Sec 3 – January 1990 gives:

An ice strengthened ship is assumed to operate in open sea conditions corresponding to a level ice thickness not exceeding h_0. The design height (h) of the area actually under ice pressure at any particular point of time is, however, assumed to be only a fraction of the ice thickness. The values for ho and h for ICE-1C is (according to DnV table B1):
h_0 = 0,4 m   h = 0,22 (m)

3.2 Ice pressure ICE-1C – B200

DnV Rules for ships Pt5. Ch 1. Sec 3 – January 1990 gives:

The design ice pressure (based on a nominal ice pressure of 5600 kN/m2) is determined by the formula:

p = 5600 * c_d *c_1 *c_a (kN/m2)

Term	Value	Definition
k	0,18	√(Δf*Ps)/1000
Δf	70,0	Displacement (t)
P_s	471,0	Machinery output (kW)
a	30,0	
b	230,0	
c_d	0,24	Probability factor (size and engine output) c_d = (a*k +b)/1000
c_1	1,0	Probability factor (ice pressure versus region of the hull)
c_a	1,0	Probability factor (fullenght of area under pressure at the same time)
p	1318,5	Ice pressure: p = 5600 * c_d * c_1 * c_a (kN/m^2)

3.3 Shell plating – Plate thickness in the ice belt - C200

DnV Rules for ships Pt5. Ch 1. Sec 3 – January 1990 gives:

$t = 21,1 * s * \sqrt{(x_1 * p_{PL}/\sigma_F)} + t_c$

Term	Value	Definition
x_1	0,80	$x_1 = 1,3 - 4,2/((h/s)+1,8)^2$, maximum 1,0
p_{PL}	988,9	$p_{PL} = 0,75 * p$
t_c	2,0	Increment for abrasion and corrosion
h	0,22	Design height of the area actually under ice pressure (m)
s	0,2	Stiffener spacing (m)
σ_F	235	Yield stress of the material
t	9,75	$t=21,1 * s * \sqrt{(x_1 * p_{PL}/\sigma_F)} + t_c$

Required shell plating according to above 9,75 mm.
Existing shell plating is 12 mm ➔ OK

3.4 Transverse frames - D200

DnV Rules for ships Pt5. Ch 1. Sec 3 – January 1990 gives:

$Z = p * s * h * l /(m_t */ \sigma_F) * 10^3$ (cm^3)

Term	Value	Definition
p	1318,5	Ice pressure as calculated in 3.2
s	0,2	Stiffener spacing (m)
h	0,2	Design height of the area actually under ice pressure (m)
l	2,6	Stiffener span (m)
m_0	6,0	Constant - boundary condition
m_t	6,4	$m_t = 7 * m_0 / (7 - 5 * h/l)$
σ_F	235	Yield stress of the material
Z	100,5	$Z = p * s * h * l /(m_t * \sigma_F) * 10^3$, section modulus (cm^3)

Required section modulus according to above is 100,5 cm^3.
Existing section modulus is 37 cm^3 (9 mm plate) and 39 cm^3 (12 mm plate)➔ NOK

3.5 Machinery – Engine output J102

DnV Rules for ships Pt5. Ch 1. Sec 3 – January 1990 gives:

The engine output is not to be, in any case, less than 740 kW for ice class ICE-1C. Existing engine output is 471 kW ➔ NOK

(According to DnV Januari 2012 the engine output for ICE-1C needs to be at least 1000kW)