Samsung Heavy Industries CO.

Technical issues on EEDI Application

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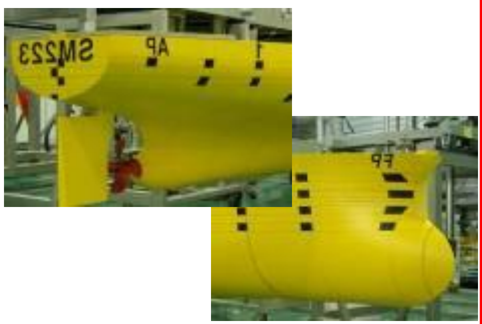
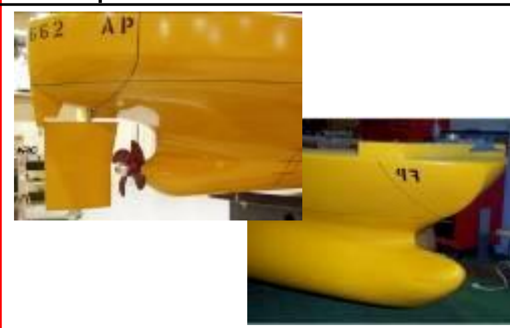
Correction for Ice Classed Ship

❖ What is Ice Classed Ship ?

	Conventional	Ice-strengthening	Ice-breaking
Navigation	 Open Sea	 Open Sea, Baltic, Arctic	 Arctic
Hull Form			
Design Target	Open Sea Performance	Mainly Open Sea	Ice Performance
Propulsion Power	Base	High (⇧)	Much High (⇧⇧)
DWT	Base	Low (⇩)	Much Low (⇩⇩)

Correction for Ice Classed Ship

❖ Introduced formula for Ice class correction (MEPC 62/5/4, Circ.681)

Power correction factor fj

"The power correction factor, f_j, for ice-classed ships shall be taken as the greater value of f_{j0} and $f_{j,min}$ as tabulated below, but not greater than $f_{j,max}$ = 1.0.

Ship Type	f_{j0}	$f_{j,min}$ Depending on Ice Class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.516L_{PP}^{1.87}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.72L_{PP}^{0.06}$	$0.61L_{PP}^{0.08}$	$0.50L_{PP}^{0.10}$	$0.40L_{PP}^{0.12}$
Dry Cargo Carrier	$\frac{2.150L_{PP}^{1.58}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.89L_{PP}^{0.02}$	$0.78L_{PP}^{0.04}$	$0.68L_{PP}^{0.06}$	$0.58L_{PP}^{0.08}$
General Cargo Ship	$\frac{0.045L_{PP}^{2.37}}{\sum_{i=1}^{nME} MCR_{ME(i)}}$	$0.85L_{PP}^{0.03}$	$0.70L_{PP}^{0.06}$	$0.54L_{PP}^{0.10}$	$0.39L_{PP}^{0.15}$

MCR, Length

For other ship types, f_j shall be taken as 1.0."

Capacity correction factor fi

"The capacity correction factor, f_i, for ice-classed ships shall be taken as the lesser value of f_{i0} and $f_{i,max}$ as tabulated below, but not less than $f_{i,min}$ = 1.0.

Ship Type	f_{i0}	$f_{i,max}$ Depending on Ice Class			
		IC	IB	IA	IA Super
Tanker	$\frac{0.00115L_{PP}^{3.36}}{Capacity}$	$1.31L_{PP}^{-0.05}$	$1.54L_{PP}^{-0.07}$	$1.80L_{PP}^{-0.09}$	$2.10L_{PP}^{-0.11}$
Dry Cargo Carrier	$\frac{0.000665L_{PP}^{3.44}}{Capacity}$	$1.31L_{PP}^{-0.05}$	$1.54L_{PP}^{-0.07}$	$1.80L_{PP}^{-0.09}$	$2.10L_{PP}^{-0.11}$
General Cargo Carrier	$\frac{0.000676L_{PP}^{3.44}}{Capacity}$	1.0	1.08	1.12	1.25
Container Ship	$\frac{0.1137L_{PP}^{2.29}}{Capacity}$	1.0	$1.25L_{PP}^{-0.04}$	$1.60L_{PP}^{-0.08}$	$2.10L_{PP}^{-0.12}$
Gas Tanker	$\frac{0.1749L_{PP}^{2.33}}{Capacity}$	$1.25L_{PP}^{-0.04}$	$1.60L_{PP}^{-0.08}$	$2.10L_{PP}^{-0.12}$	1.0

DWT, Length

For other ship types, f_i shall be taken as 1.0."

Power correction factor fj

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\prod_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE} *\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$

Capacity correction factor fi

❖ Investigation for 104 ice classed tankers constructed in Korean shipyards

Ice	LBP	Power Correction (fj)			Capacity Correction (fi)		
		Guideline [A] *	Required [B] **	Difference [B]-[A]	Guideline [C] *	Required [D] **	Difference [D]-[C]
1C	219	0.5%	0.0%	-0.5%	0.1%	7.0%	7.0%
1C	234	0.1%	27.3%	27.2%	0.0%	1.3%	1.3%
1C	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.4%
1C	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.9%
1C	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0%
1C	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.7%
1B	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.1%
1B	2[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
1B	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.1%
1A	17[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.8%
1A	17[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
1A	17[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.9%
1A	17[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
1A	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.6%
1A	2[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.0%
1A	2[illegible]	13.7%	46.8%	33.1%			
1A	234	2.6%	26.1%	23.4%	0.0%	0.6%	0.6%
1A	239	0.0%	0.2%	0.2%	0.6%	0.4%	-0.2%
1A	239	13.0%	16.5%	3.4%			
1A	239	8.5%	10.7%	2.2%			
1A	242	6.3%	10.5%	4.2%			
1A	264	6.5%	0.0%	-6.5%	0.0%	1.5%	1.5%
1A	264	6.5%	0.0%	-6.5%	0.0%	0.1%	0.1%
1A	275	0.0%	0.0%	0.0%			
1A	264	6.5%	0.0%	-6.5%			
1A	270	12.5%	16.4%	4.0%			
Average		5.9%	12.2%	6.2%	0.0%	1.1%	1.1%

Guideline [A] *	Required [B] **
8.5%	16.7%
0.0%	5.6%
13.7%	46.8%
2.6%	26.1%
0.0%	0.2%
13.0%	16.5%
8.5%	10.7%
6.3%	10.5%

Guideline [C] *
0.1%
0.0%
0.0%
0.0%
0.0%
0.0%
0.0%

*** Guideline: compensation according to the current guideline**

**** Required: MCR or DWT of ice class / MCR or DWT of non-ice tanker, based on same ship yard**

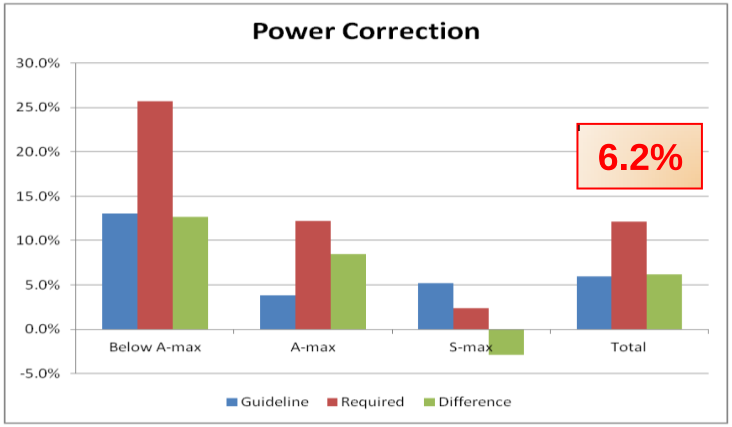
Correction for Ice Classed Ship

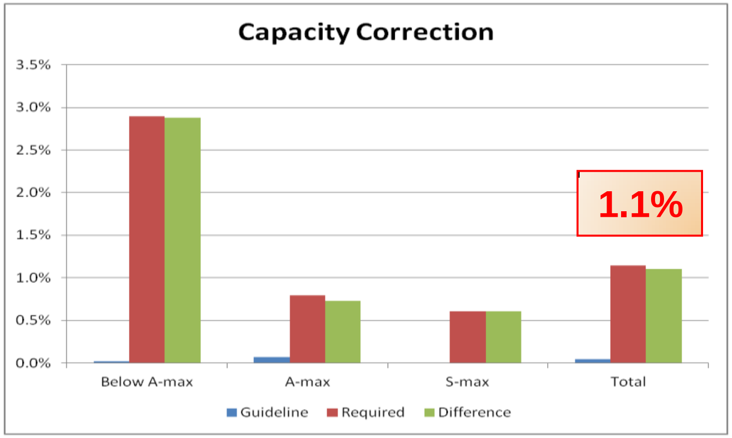
❖ Power correction factor fj

- ✓ Less or zero compensations are given in many cases
- ✓ Additional correction is needed for A-max tankers, while additional consideration is not necessary for S-max tankers
- ✓ Assessment suggests additional correction of abt. 6.2% on the basis of average value

❖ Capacity correction factor fi

- ✓ Zero compensations are given in the majority cases
- ✓ Assessment suggests additional correction of abt. 1.1% on the basis of average value

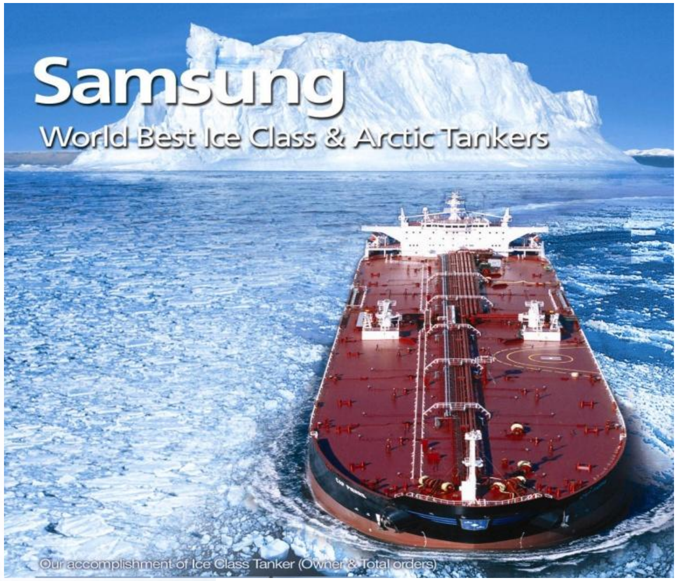




Correction for Ice Classed Ship

❖ Remarks

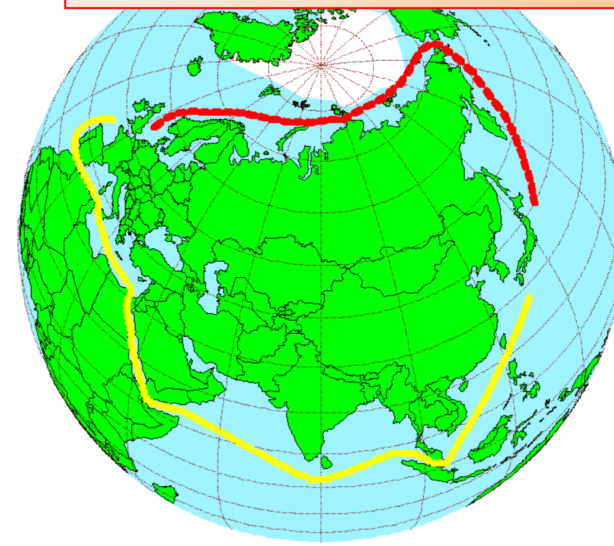
- ✓ We agree in principle on the idea of correction factors for ice class vessels
- ✓ **More consideration** to be taken to fulfill the purpose of these formulas through further investigation on ice class vessels



Correction for Ice Classed Ship

❖ What draw our attention into Ice Breaking Ship ?

NSR (Northern Sea Route)



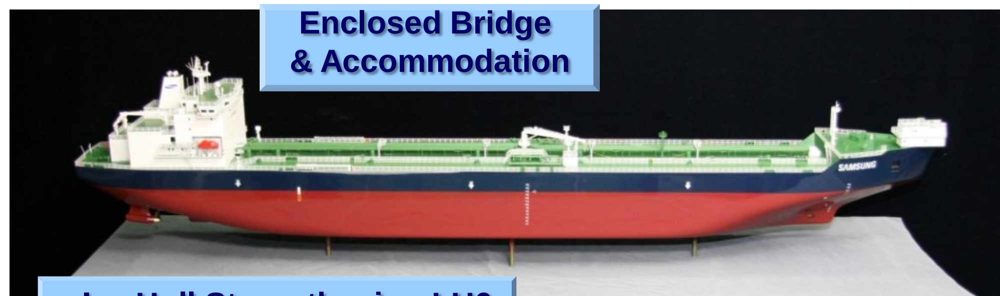
- ✓ **25% of world wide undiscovered hydrocarbon reserves in Arctic region**
- ✓ **Arctic Oil & Gas reserves will improve global energy supply**
- ✓ **NSR is supposed to be attractive transportation measure**

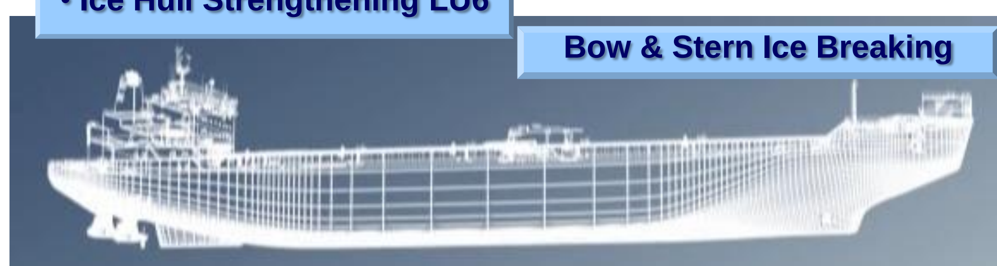
Ice Breaking Merchant Ships

Correction for Ice Classed Ship

❖ Ice breaking arctic tanker

Vessel Particulars	
L x B x D	257 x 34 x 21m
Deadweight	70,000 MT
Speed	15.7 knots (Open water) 2.8 knots (1.6 m Ice)
Ice Class	Arc 6 (Air Temp. -45ºC)
Propulsion	10 MW POD x 2 sets
Engine Power	27MW / 4sets





Correction for Ice Classed Ship

❖ Investigation for ice breaking tanker built in SHI

Category	Environment Condition	Level Ice	IACS Polar	DNV	RMRS	ABS	Fin-Swedish
Ice Breaking (Arctic)	Severe	> 3.0 m	PC1~PC2*	Polar 30	Arc 9	A5	-
		> 2.0 m	PC2~PC3	Polar 20 Polar 10	Arc 8	A4	-
		> 1.5 m	PC4	ICE-15 ICE-10	Arc 7	A4-3	-
		> 1.0 m	PC5	ICE-10	Arc 6	A2-1	-
		< 1.0 m	PC6	ICE-05	Arc 5	IAA	IAS

	Power Correction (fj)		
	Guideline (1AS) *	Required **	Difference
Ice Breaking Tanker	Abt. 23%	Abt. 40%	Abt. 17%

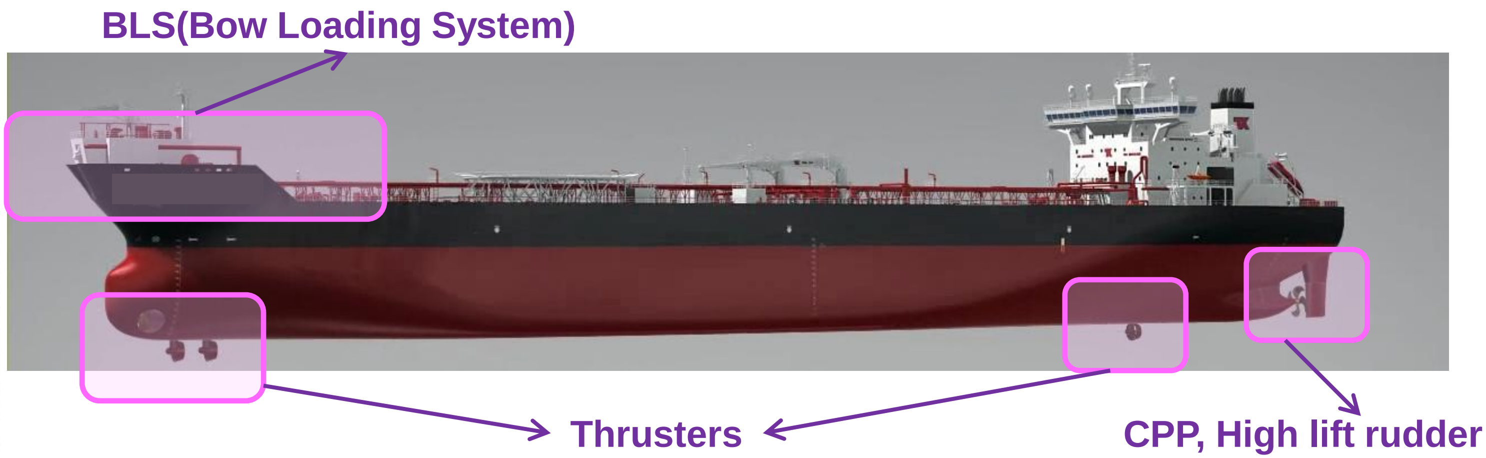
*** Compensation for 1AS according to the current guideline**

**** Propulsion power of 70K ice-breaking Tanker / propulsion power of 70K conventional Tanker**

More consideration to be taken for Ice Breaking Ship

Correction for Shuttle Tanker

❖ What are different from the conventional tanker?



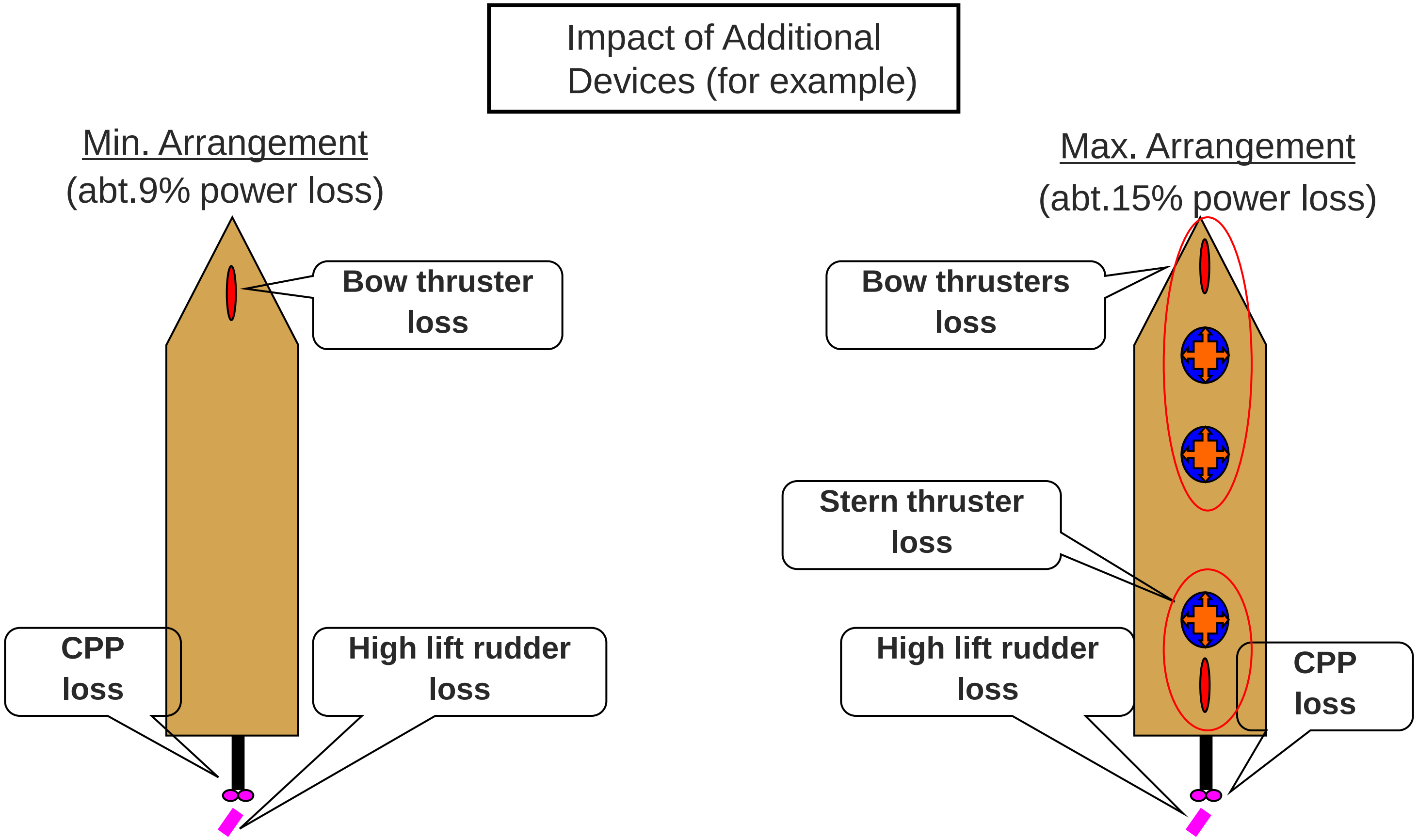
- ✓ **Careful maneuvering and dynamic positioning are necessary for loading from offshore plant or FPSO**
- ✓ **Thrusters, CPP and high lift rudder are equipped accordingly**

Significant disadvantage in the hydro dynamic aspect

Correction for Shuttle Tanker

❖ The disadvantage of shuttle tanker in view of EEDI

- ✓ **In point of power : abt. 9%~15% of power loss is necessary for maneuvering & DP**
- ✓ **In point of DWT : less than 1% of deadweight loss (negligible)**



Correction for Shuttle Tanker

❖ Remarks

- ✓ **Shuttle tanker is treated as a conventional tanker in EEDI (using the same reference line)**
- ✓ **However, current guideline provides the compensation for only shuttle tankers equipping dual engine & twin propeller (i.e. fj = 0.77)**
- ✓ **Suitable compensation should be given for shuttle tanker for fair comparison in EEDI**

Closing Remarks

Thank you !