



UNIVERSIDADE DA CORUÑA



Escola Politécnica Superior

**Trabajo Fin de Máster**

**CURSO 2016/2017**

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*BUQUE LNG DE MEMBRANA DE 145.000 m<sup>3</sup>*

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**Máster en Ingeniería Naval y Oceánica**

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**FECHA**

SEPTIEMBRE DE 2017

## CUADERNO 4

En el presente cuaderno realizaremos el compartimentado del buque, argumentando las decisiones tomadas, el cálculo de los tanques, las hidrostáticas y las curvas de KN.



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*BUQUE LNG DE MEMBRANA DE 145.000 m<sup>3</sup>*

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**Máster en Ingeniería Naval y Oceánica**

**CUADERNO 4**

**CÁLCULOS DE ARQUITECTURA NAVAL**

DEPARTAMENTO DE INGENIERÍA NAVAL Y OCEÁNICA  
TRABAJO FIN DE MÁSTER  
CURSO 2016-2017

**PROYECTO NÚMERO: 17-32 P**

**TIPO DE BUQUE:** Buque tanque LNG de membrana

**CLASIFICACIÓN, COTA Y REGLAMENTOS DE APLICACIÓN:** DNV, SOLAS, MARPOL, CIG.

**CARACTERÍSTICAS DE LA CARGA:** gas natural licuado con capacidad para 145.000 m<sup>3</sup>.

**VELOCIDAD Y AUTONOMÍA:** 19,5 nudos a la velocidad de servicio, 85% MCR + 15% MM. 12.000 millas a la velocidad de servicio.

**SISTEMAS Y EQUIPOS DE CARGA / DESCARGA:** los habituales en este tipo de buque.

**PROPULSIÓN:** Propulsión Diesel eléctrico. Dos líneas de ejes

**TRIPULACIÓN Y PASAJE:** 35 tripulantes en camarotes individuales.

**OTROS EQUIPOS E INSTALACIONES:** Las habituales en este tipo de buque.

Ferrol, Abril de 2017

ALUMNO: D. Ismael Grandal Mouriz

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## 1-INTRODUCCIÓN

En el presente cuaderno vamos a realizar el compartimentado del buque, al mismo tiempo que obtendremos:

- Curvas hidrostáticas
- Curvas KN
- Capacidades y centros de gravedad de los tanques principales.

Las características principales de nuestro buque son las siguientes:

<b>L</b>	269,7
<b>B</b>	43,2
<b>D</b>	26,3
<b>T</b>	11,5
<b>Volumen</b>	145.000
<b><math>\Delta</math></b>	105.379
<b>V</b>	19,5
<b>Fn</b>	0,1950
<b>Cb</b>	0,7673
<b>Cm</b>	0,9971
<b>Cp</b>	0,7905

Para realizar los cálculos del buque vamos a utilizar el Código Internacional para la construcción y el equipo de buques que transporten Gases licuados a granel (Código CIG).

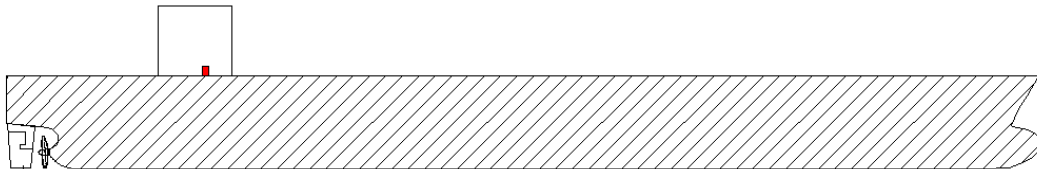
En relación al tipo de carga que transportamos (gas metano), nuestro buque está dentro de la categoría 2G.

a	b	c	d	e	f	g	h	i
Product name	UN number	Ship type	Independent tank type C required	Control of vapour space within cargo tanks	Vapour detection	Gauging	MFAG table no.	Special requirements
Isoprene*	1218	2G/ 2PG	-	-	F	R	310	14.4.3, 17.8, 17.10, 17.12
Isopropylamine*	1221	2G/ 2PG	-	-	F+T	C	320	14.4.2, 14.4.3, 17.2.4, 17.10, 17.11, 17.12, 17.17
<b>Methane (LNG)</b>	1972	2G	-	-	F	C	620	
Methyl acetylene-propadiene mixtures	1060	2G/ 2PG	-	-	F	R	310	17.18
Methyl bromide	1062	1G	Yes	-	F+T	C	345	14.4, 17.2.3, 17.3.2, 17.4.1, 17.5, 17.9
Methyl chloride	1063	2G/ 2PG	-	-	F+T	C	340	17.2.3
Monoethylamine*	1036	2G/ 2PG	-	-	F+T	C	320	14.4.2, 14.4.3, 14.4.4, 17.2.1, 17.3.1, 17.10, 17.11, 17.12, 17.17
Nitrogen	2040	3G	-	-	O	C	620	17.19

## 2-ZONA ESTANCA

Definiremos zona estanca como aquella que no dispone de aberturas o, en caso de tenerlas, están protegidas con cierres estancos a la intemperie.

Nuestra zona estanca abarcará desde la línea base hasta la cubierta de francobordo, situada a 26,3 metros, así como lo que sobresalgan por encima de esta cubierta los tanques de carga. En la figura puede verse claramente la zona que estamos describiendo.



## 3-PUNTOS DE INUNDACIÓN PROGRESIVA

El punto de inundación progresiva será aquel punto de la estructura del barco que en el caso de estar sumergido en una condición de equilibrio pueda dar lugar a una inundación no restringida.

Los puntos de inundación progresiva son aberturas no estancas a la intemperie. Esto quiere decir, podrá soportar sin filtrar agua una situación de inmersión transitoria como un golpe de mar,... pero no una situación de inmersión permanente. Son puntos que provocarán una inundación progresiva si están sumergidos en el equilibrio y además limitarán el rango de la curva de estabilidad a su ángulo de inundación.

En nuestro caso se trata de las puertas en la cubierta 1 de habilitación. En la figura del apartado uno se puede ver claramente la localización de una de las puertas marcada en rojo. Hay una a cada banda.

Su localización exacta se muestra en la siguiente tabla:

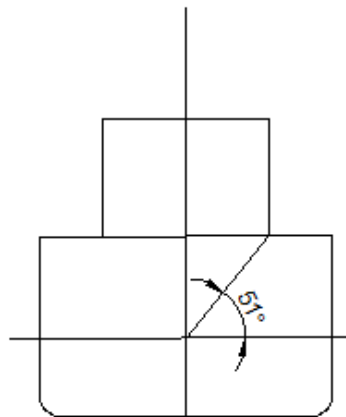
<b>TIPO</b>	<b>X (m)</b>	<b>Y (m)</b>	<b>Z (m)</b>
<b>Puerta</b>	48,96	-12	29,3
<b>Puerta</b>	48,96	12	29,3

#### Ángulo de inundación progresiva

El ángulo de inundación progresiva es la inclinación respecto de la horizontal (flotación en aguas tranquilas) que debe alcanzar el buque para que la superficie del agua alcance la parte más baja de la abertura más baja que pueda producir una inundación progresiva de los espacios bajo la cubierta de francobordo.

En el caso de nuestro buque, y teniendo en cuenta la situación de los puntos de inundación progresiva, el ángulo de inundación progresiva será:

$$\alpha_{ip} = 51^{\circ}$$



#### **4-DISPOSICIÓN INTERNA**

La disposición de nuestro buque se detalla más en profundidad en el cuaderno 8. Pero a modo podemos decir que:

-Longitudinalmente: situaremos mamparos intentando hacerlos coincidir con los anillos resistentes del casco.

-Transversalmente: situaremos mamparos de acuerdo a la normativa vigente (doble casco).

-Verticalmente: situaremos una cubierta de doble fondo a instancias de la normativa.



## 5-DOBLE FONDO, DOBLE CASCO Y COFERDAMS

### Doble fondo

Utilizando las normas de nuestra Sociedad de Clasificación (DNV Pt.3 Ch.1 Sec.6 D101) aplicamos la expresión siguiente para calcular la altura mínima de doble fondo que debemos tener:

$$250 + 20 \cdot B + 50 \cdot T = 1.689 \text{ mm}$$

### D. Arrangement of Double Bottom

#### D 100 General

101 The height of centre girder and floors at centre line is not to be less than:

$$250 + 20 B + 50 T \text{ (mm), minimum 650 mm}$$

The height is to be sufficient to give good access to all parts of the double bottom. For ships with a great rise of floors, the minimum height may have to be increased after special consideration.

La norma dice que como mínimo debemos tener una altura de doble fondo de 650 mm.

Para este tipo de buques y utilizando como referencia un buque base, vamos a proyectar un doble fondo de 2.500 mm, es decir, 2,5 m. Con ello cumplimos también las exigencias del CIG, que exige un valor superior a 2 m.

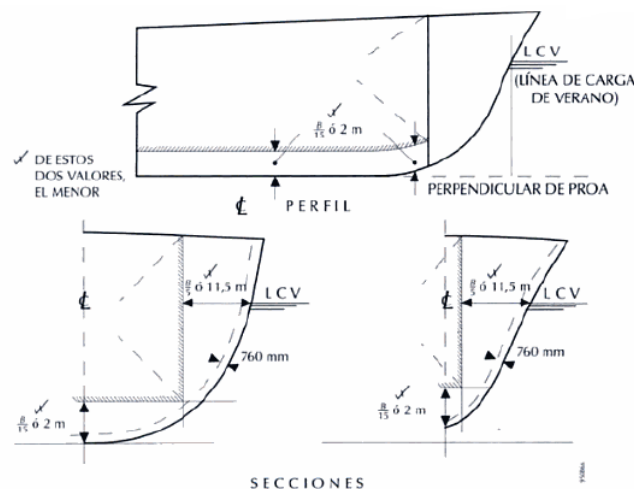
Definiremos doble fondo en toda la zona de carga, en cámara de máquinas y en la zona del tanque almacén de fuel oil.

### Doble casco

Según el código CIG, en el capítulo "2.6 Ubicación de los tanques de carga":

2.6.1 Los tanques de carga estarán situados a las siguientes distancias, medidas hacia el interior del buque desde el forro:

- 2 Buques tipo 2G/2PG y 3G: desde la línea de trazado de la chapa del forro del fondo, en el eje longitudinal, una distancia no menor que la extensión vertical de la avería especificada en 2.5.1.2.3; en ningún punto será de menos de 760 mm desde la chapa del forro



En la figura anterior podemos ver las prescripciones relativas a la ubicación de los tanques.

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Debido a las características de este buque y a modo de protección hemos puesto un doble casco de 2,5 metros. Tendremos doble casco en toda la zona de carga y en la zona de los tanques almacén de fuel oil. Así también podemos facilitar el mantenimiento y la exploración de los tanques de carga de una forma cómoda. Con ello cumplimos las exigencias del CIG que establece que la manga del doble casco de nuestro buque no ha de ser inferior a 760 mm:

### **Coferdams**

Se proyectan coferdams a ambos lados de los tanques. Estos espacios no solo nos proporcionan protección y pueden ser utilizados como tanques de lastre sino que además nos permiten supervisar las zonas adyacentes a los tanques a fin de realizar un correcto mantenimiento de los mismos. A la hora de realizar la distribución tenemos en cuenta el CIG:

*3.1.1 Los espacios de bodega estarán separados de los espacios de máquinas y de calderas, de alojamiento y de servicio, puestos de control, cajas de cadenas, tanques de agua potable y de agua destinada a usos domésticos, y pañoles. Los espacios de bodega estarán situados a proa de los espacios de categoría A para máquinas, excepto de aquellos que la Administración juzgue necesarios para la seguridad o la navegación del buque.*

*3.1.2 Cuando se transporte carga en un sistema de contención que no necesite barrera secundaria, para separar los espacios de bodega de los espacios de los espacios a que se hace referencia en 3.1.1. o de los situados debajo de dichos espacios de bodega o fuera de estos y hacia el costado, en los que haya una fuente de ignición o riesgo de incendio, se utilizarán coferdanes o tanques de combustible líquido. Si en el espacio adyacente no hay riesgo de ignición ni de incendio se podrá utilizar una sola división de clase A-0 hermética.*

*3.1.4 Cuando se transporte carga en un sistema de contención que necesite una barrera secundaria:*

*.1 (...)*

*.2 a temperaturas inferiores a -55-C, el buque llevará también un mamparo longitudinal que forme tanques laterales.*

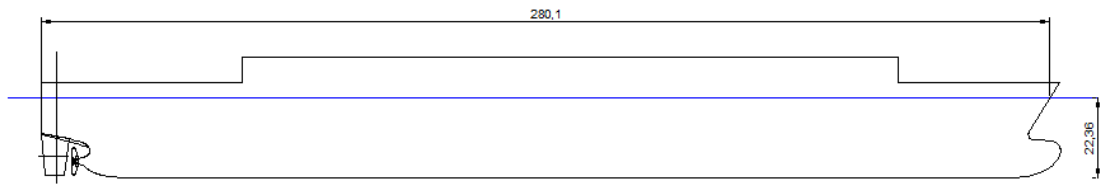
## **6-MAMPARO DE COLISIÓN**

### **Mamparo de colisión de proa**

Para situar el mamparo de colisión deberemos seguir lo dispuesto por el SOLAS en el capítulo II.

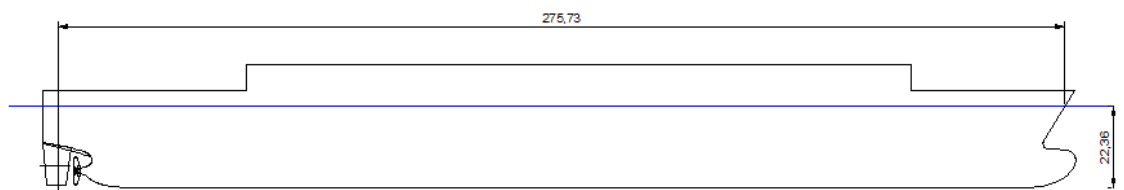
Primeramente debemos definir la eslora que utilizaremos en los cálculos sucesivos que nos llevarán al posicionamiento del mamparo de colisión. Tomaremos el mayor valor de L entre:

- 96 % de la eslora total desde el extremo de la roda hasta el extremo del codaste en una flotación al 85 % del puntal mínimo de trazado:



$$T_{85\%D} = 0,85 \cdot 26,3 = 22,36 \text{ m.}$$
$$L = 0,96 \cdot 280,1 = 268,896 \text{ m.}$$

- Eslora desde el extremo de la roda hasta el eje de la mecha del timón en la misma flotación:



$$L = 275,73 \text{ m.}$$

Por tanto tomaremos  $L = 275,73 \text{ m.}$

Según lo dispuesto por el SOLAS en el Capítulo II-1-Regla 11, la situación del mamparo de colisión deberá cumplir:

- *Se instalará un mamparo de colisión que será estanco hasta la cubierta de francobordo. Dicho mamparo estará situado a una distancia de la perpendicular de proa no inferior al 5% de la eslora o a 10 metros si esta segunda magnitud es menor y salvo cuando la Administración permita otra cosa, dicha distancia no será superior al 8% de la eslora.*

$$5\% L = 0,05 \cdot 275,8 = 13,79 \text{ m.}$$

En nuestro caso 10 metros es la menor

- *Cuando cualquier parte del buque que quede por debajo de la flotación se prolongue delante de la perpendicular de proa, como por ejemplo ocurre con una proa de bulbo, las distancias estipuladas en el párrafo anterior se medirán desde un punto situado:*
  - *A 1,5 % L a partir de la Ppr.*
  - *A mitad de dicha prolongación*
  - *A una distancia de 3 metros por delante de la Ppr*

*De estas medidas se tomará la menor*

$$1,5\% L = 4,14 \text{ m.}$$

$$\text{Protuberancia del bulbo } 8,76/2 = 4,38 \text{ m.}$$

Luego tomaremos 3 metros, por ser el menor de estos valores.

Luego al valor obtenido anteriormente de 10 metros de distancia mínima, teniendo en cuenta que tiene bulbo, hemos de restarle 3:

$$10 - 3 = 7 \text{ m.}$$

A nuestra eslora le restamos el valor antes calculado como distancia mínima para situar nuestro mamparo de proa:

$$275,8 - 7 = 268,8 \text{ m. como mínimo.}$$

Además, calcularemos el 8 % de L:

$$0,08 \cdot 275,8 = 22,06 \text{ m.}$$

Como nuestro buque tiene bulbo deberemos restarle también los 3 metros calculados anteriormente:

$$22,06 - 3 = 19,06 \text{ m.}$$

Luego  $275,8 - 19,04 = 256,74 \text{ m. como máximo}$

Por tanto, deberemos situar el mamparo de proa en el intervalo entre 256,74 y 268,8 metros.

Escogemos 264,685 metros, coincidiendo con la cuaderna 311.

### **Mamparo de colisión de popa**

El mamparo de colisión de popa se suele tomar, como mínimo un 4 % de L, en nuestro caso, esto es, aproximadamente: 11,03 m.

Tomando como referencia nuestro buque base, estableceremos la longitud del pique de popa en 16 m. (11,36 desde la perpendicular de popa), coincidiendo con la cuaderna 20.

### **Cámara de máquinas**

Tomando como referencia nuestro buque base estableceremos una eslora de cámara de máquinas de 40 m., yendo ésta de la cuaderna 20 a la 70 (de 11,36 m. a 51,36 m.).

## **7-CLARA DE CUADERNAS**

La separación entre cuadernas en las distintas zonas del buque la hemos hecho analizando los buques de referencia, nuestro buque base y las limitaciones establecidas por la Sociedad de Clasificación, que establece que la separación en nuestro caso no puede ser mayor que:

$$S = 2,08 \cdot L + 438 = 998 \text{ mm.}$$

Donde:

L: eslora de escantillonado (aproximadamente el 96 % de L al 85 % de D). Este valor es 269,22 m.

Podemos distinguir tres zonas:

-Zona de cámara de máquinas: con una separación entre cuadernas de 800 mm.

-Zona de carga: con una separación entre cuadernas de 925 mm.

-Zona de proa: con una separación entre cuadernas de 800 mm.

## **8-HIPÓTESIS DE AVERÍA**

A la hora de situar nuestros tanques hemos de tener en cuenta los requerimientos del CIG en cuanto a averías.

Según el CIG, las dimensiones máximas de averías supuestas serán las siguientes:

1-En el costado

1.1-Extensión longitudinal:  $1/3 L^{2/3}$  o bien 14,5 metros, si este valor es menor.

1.2-Extensión transversal medida hacia el interior del buque, desde el costado, perpendicularmente al eje longitudinal, al nivel de la línea de carga de verano:  $B/5$  o bien 11,5 metros, si este valor es menor.

1.3-Extensión vertical: hacia arriba, sin límite desde la línea de trazado de la chapa del forro del fondo en el eje longitudinal.

2-En el fondo

- a) A 0,3 L de la perpendicular de proa del buque
- b) En cualquier otra parte del buque

**2.1-Extensión longitudinal:**

- $1/3 L^{2/3}$  o bien 14,5 metros, si este valor es menor (a)
- $1/3 L^{2/3}$  o bien 5 metros, si este valor es menor (b)

**2.2-Extensión transversal:**

- B/6 o bien 10 metros, si este valor es menor (a).
- B/6 o bien 5 metros, si este valor es menor (b).

**2.3-Extensión vertical:**

- B/15 o bien 2 metros, si este valor es menor, midiendo desde la línea de trazado de la chapa del forro del fondo en el eje longitudinal (a).
- B/15 o bien 2 metros, si este valor es menor, midiendo desde la línea de trazado de la chapa del forro del fondo en el eje longitudinal (b).

**9-COMPARTIMENTADO DE LOS TANQUES DE CARGA**

Para diseñar la disposición interna de nuestro buque debemos tener en cuenta varios factores, tres de ellos fundamentales:

- La capacidad de los tanques de carga ha de ser de 145.000 m<sup>3</sup>.
- Cumplimiento del Código CIG.
- Las características geométricas de nuestros tanques (membrana).

A la hora de diseñar nuestros tanques de carga hemos de tener en cuenta que el volumen neto que necesitamos transportar no se corresponde con el volumen neto para el que debemos diseñar.

Primeramente hemos de tener en cuenta la permeabilidad ( $\mu$ ) de los tanques. Según el CIG tenemos:

ESPACIOS	PERMEABILIDAD
Asignados a pertrechos	0,6
Ocupados como alojamientos	0,95
Ocupados por maquinaria	0,85
Espacios perdidos	0,95
Destinados a líquidos consumibles	0 a 0,95
Destinados a otros líquidos	0 a 0,95

Puesto que nuestros tanques no tienen mucho espacio perdido de su volumen real, tomamos un valor de 0,97. Lo que nos puede quitar volumen de carga son las bombas, el trípode y algún que otro equipo instalado.

Debemos dividir nuestro volumen de las RPA entre la permeabilidad en tanto por ciento:

$$Volumen\ carga = \frac{145.000}{0,97} \approx 149.500m^3$$

Pero además el CIG en su capítulo 15 establece que dichos tanques deberán ir cargados como máximo al 98 % de su capacidad:

15.1.1. Ningún tanque de carga se llenará tanto que el líquido ocupe más del 98% de su capacidad, a la temperatura de referencia.

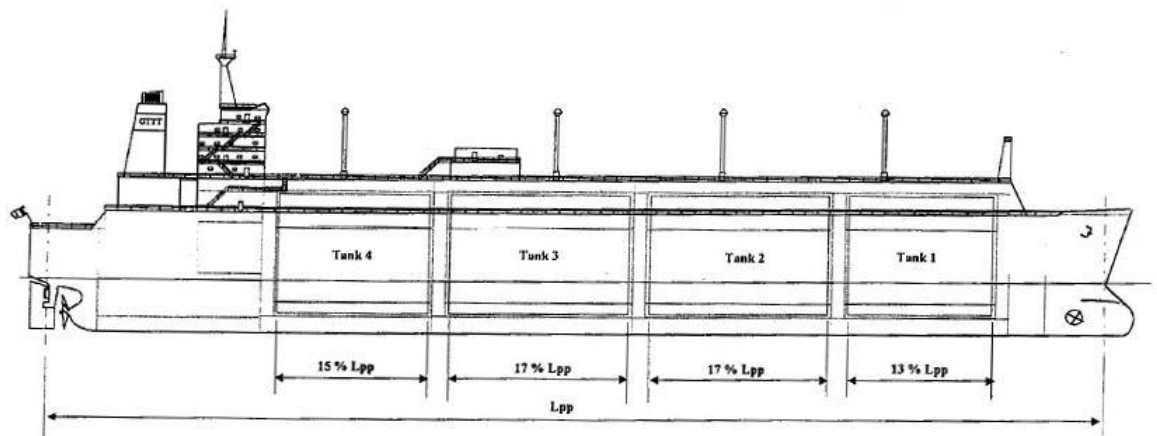
Por lo tanto dividiremos el volumen anteriormente calculado por 0,98.

$$\text{Volumen carga}_{FINAL} = \frac{149.500}{0,98} \approx 152.550 \text{ m}^3$$

Sin tener en cuenta la permeabilidad necesitamos 147.960 m<sup>3</sup>.

Tomaremos una densidad del gas natural licuado de 0,43 t/m<sup>3</sup>.

Cada uno de los tanques de carga debe representar aproximadamente el siguiente porcentaje de la eslora:



Teniendo en cuenta también la estructura de nuestro buque base tenemos que:

Lpp = 269,7 m.	L(tanque)	≈ % de Lpp
Tanque 4	40,7	15
Tanque 3	46,25	17
Tanque 2	46,25	17
Tanque 1	35,15	13

El porcentaje es aproximado, puesto que tenemos que hacer coincidir el inicio y el final de los tanques con una cuaderna.

Por tanto, finalmente tenemos una distribución como sigue:

	Cuaderna inicial	Cuaderna final	Lcompartimentado (m)	Pos. Long. (m)
Cofferdam 5	70	73	2,775	51,36-54,135
Tanque 4	73	117	40,7	54,135-94,835
Cofferdam 4	117	120	2,775	94,835-97,610
Tanque 3	120	170	46,25	97,610-143,86
Cofferdam 3	170	173	2,775	143,86-146,635

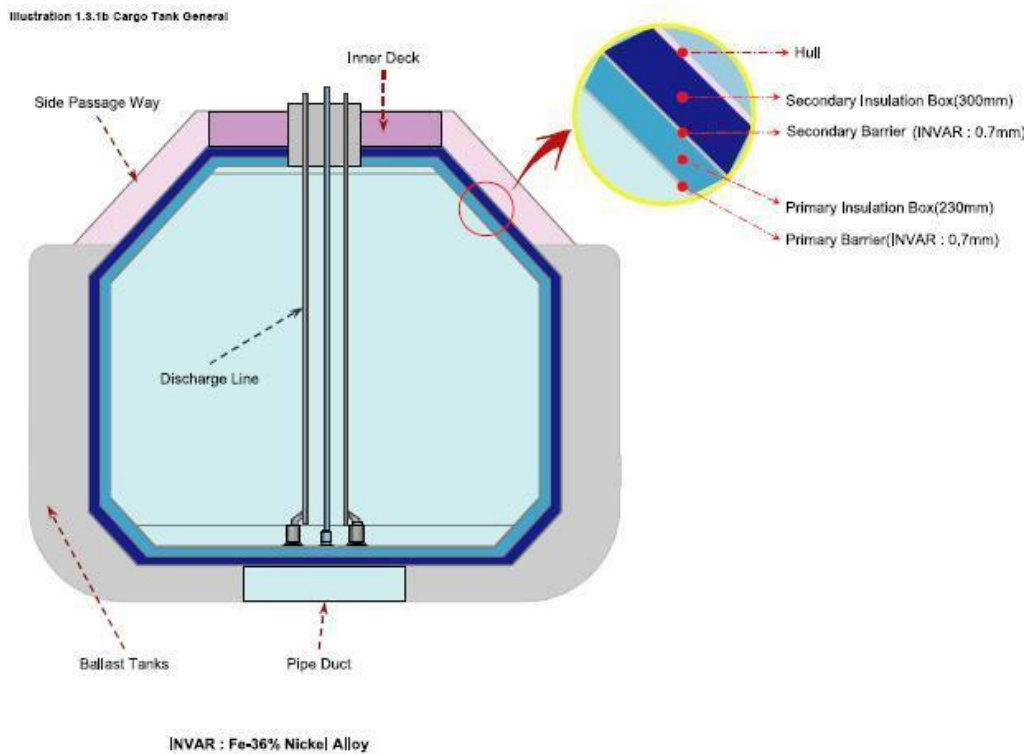
<b>Tanque 2</b>	173	223	46,25	146,635- 192,885
<b>Cofferdam 2</b>	223	226	2,775	192,886-195,66
<b>Tanque 1</b>	226	264	35,15	195,66-230,809
<b>Cofferdam 1</b>	264	267	2,775	230,810- 233,585

Una vez definida la geometría tenemos que definir la membrana de nuestros tanques. Debemos tener en cuenta los espesores de cada barrera y de cada aislante térmico:

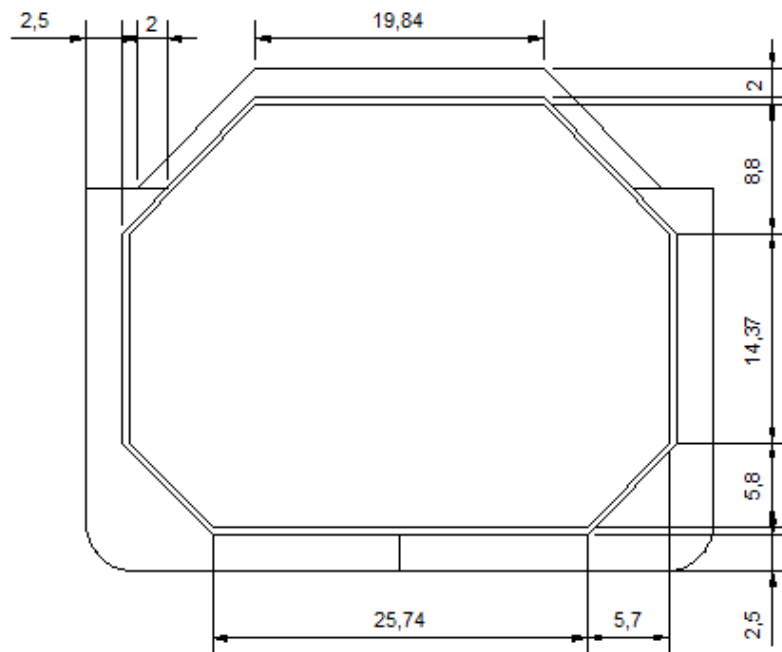
- Barrera primaria invar: 0,7 mm.
- Primera capa de aislante térmico: 230 mm.
- Barrera secundaria invar: 0,7 mm.
- Segunda capa de aislante térmico: 300 mm.

Por tanto, tendremos un espesor de 531,4 mm. Esto debemos sumárselo al doble casco y al doble fondo.

En la siguiente imagen podemos ver un esquema de un tanque de membrana.



Una vista de la estructura transversal en la cuaderna maestra de los tanques:



En la imagen anterior podemos ver las dimensiones.

### 10-DOMOS

El CIG nos obliga a colocar nos obliga a poner domos en la parte superior de los tanques como medida de protección. Pueden llenarse de agua de lastre. En nuestro buque irán vacíos, puesto que añadir pesos a tanta altura puede perjudicarnos la estabilidad. Fijamos un espacio de 2 metros entre la parte superior de los tanques y la del domo.

Los podemos ver en el esquema anterior de la sección transversal del buque

### 11-CONSUMOS Y JUSTIFICACIÓN DE LA AUTONOMÍA. FUEL, DIESEL, ACEITE, AGUA DULCE, LODOS Y LASTRE.

#### Autonomía

Según las RPA debemos tener 12.000 millas de autonomía a 19,5 knot. Señalar que un nudo (knot) es igual a una milla marina (mn) por hora.

$$t_{navegación} = \frac{Autonomía}{Velocidad} = 615,38 \approx 25 \text{ días}$$

#### Fuel Oil

El buque lleva instalados cuatro motores dual-fuel como generadores para suministrar energía a toda la planta eléctrica del buque. En ninguna condición de carga eléctrica funcionan los cuatro motores de manera simultánea, uno siempre estará en stand-by.



El dimensionamiento de los tanques de combustible lo realizaremos teniendo en cuenta la situación de mayor consumo, es decir estando parado uno de los motores 16V50.

Los consumos del fuel oil se pueden determinar de la forma:

$$\text{Consumo}_{FO} = c_e \cdot PS \cdot t_{nav} \cdot 10^{-6}$$

Donde:

$c_e$ : consumo específico del motor (189 g/kWh), sacado del catálogo que adjuntamos como anexo.

PS: potencia del motor en kW

La potencia del motor en condiciones de servicio será:

$$PS = MCR \cdot Margen = 17.700 \cdot 0,85 = 14.535 \text{ kW}$$

$$PS = MCR \cdot Margen = 15.200 \cdot 0,85 = 12.920 \text{ kW}$$

$T_{nav}$ : tiempo de navegación ininterrumpida (615,38 h.)

Por lo que el consumo de fuel será:

$$\text{Consumo}_{FO} 18V50 = 1.690,52 \text{ t}$$

$$\text{Consumo}_{FO} 16V50 = 1.502,68 \text{ t}$$

Por lo tanto, teniendo en cuenta que de manera simultánea trabajan dos motores 18V50 y un motor 16V50, el consumo de fuel oil de los motores principales es:

$$\text{Consumo}_{FO} = 2 \cdot 1.690,52 + 1 \cdot 1.502,68 = 4.883,72 \text{ t}$$

Y por consiguiente el volumen necesario de los tanques de combustible será:

$$\text{Volumen}_{FO} = \frac{\text{Consumo total}}{\rho_{FO}} = 5.034,76 \text{ m}^3$$

Donde:

$\rho_{FO}$ : densidad del fuel oil (0,97 t/m<sup>3</sup>).

#### Volumen de los tanques almacén

Se instalarán dos tanques almacén en la parte de proa del buque que tendrán una capacidad conjunta igual al volumen total de combustible necesario menos tres días y medio de consumo.

$$\begin{aligned} \text{Volumen}_{TA} &= V_{TOTAL} - 84 \text{ h} = \\ \text{Volumen}_{TA} &= 5.034,76 - \left( \frac{189 \cdot (2 \cdot 14.535 + 1 \cdot 12.920) \cdot 84 \cdot 10^{-6}}{0,97} \right) \approx 4.347,51 \text{ m}^3 \end{aligned}$$

Teniendo en cuenta la permeabilidad:

$$\text{Volumen}_{TA} = \frac{4347,51}{0,97} = 4.481,96 \text{ m}^3$$

#### Volumen del tanque de sedimentación

Instalaremos dos tanques de sedimentación a cada banda en cámara de máquinas.

$$Volumen_{TS} = \frac{189 \cdot (2 \cdot 14.535 + 1 \cdot 12.920) \cdot 36 \cdot 10^{-6}}{0,97} = 294,53 \text{ m}^3$$

Teniendo en cuenta la permeabilidad:

$$Volumen_{TS} = \frac{294,53}{0,97} = 303,64 \text{ m}^3$$

#### Volumen de los tanques de uso diario

Se instalarán dos tanques de uso diario a cada banda en cámara de máquinas. En cada tanque debe haber volumen suficiente para propulsar el buque un día entero.

$$Volumen_{TUD} = \frac{189 \cdot (2 \cdot 14.535 + 1 \cdot 12.920) \cdot 24 \cdot 10^{-6}}{0,97} = 196,35 \text{ m}^3$$

Teniendo en cuenta la permeabilidad:

$$Volumen_{UD} = \frac{196,35}{0,97} = 202,42 \text{ m}^3$$

#### **Diesel Oil**

En nuestro buque debemos llevar también diesel oil necesario para la propulsión del buque al navegar cerca de puerto, la costa o zonas protegidas (ECA). Estimaremos que será suficiente llevar combustible en los tanques para 4 días de navegación

$$Volumen_{T.DO} = \frac{189 \cdot (2 \cdot 14.535 + 1 \cdot 12.920) \cdot 96 \cdot 10^{-6}}{0,9} = 846,51 \text{ m}^3$$

Donde la densidad del diesel oil es igual a 0,9 t/m<sup>3</sup>.

Con la permeabilidad:

$$Volumen_{TDO} = \frac{847}{0,97} = 873 \text{ m}^3$$

Instalaremos dos tanques de diesel oil a cada banda en cámara de máquinas.

#### **Aceite**

Del catálogo de los motores Wärtsilä, vemos que el consumo específico de aceite lubricante por parte del motor es de 0,5 g/kWh

Por tanto, y teniendo en cuenta las potencias calculadas anteriormente:

$$Consumo_{AC} = c_e \cdot PS \cdot t_{nav} \cdot 10^{-6}$$

$$Consumo_{AC18V50} = 2 \cdot 0,5 \cdot 14.535 \cdot 615,38 \cdot 10^{-6} = 8,94 \text{ t}$$

$$Consumo_{AC16V50} = 1 \cdot 0,5 \cdot 12.920 \cdot 615,38 \cdot 10^{-6} = 3,97 \text{ t}$$

Volumen de los tanques de aceite de lubricación:

$$Volumen_{AC} = \frac{\text{Consumo total}}{\rho_{Ac.Lub.}} = 14,34 \text{ m}^3$$

Donde:

$\rho_{ac.lub.}$ : densidad del aceite de lubricación (0,9 t/m<sup>3</sup>)

Del catálogo del fabricante obtenemos que cada motor 18V50 necesita un volumen de 25 m<sup>3</sup> de aceite, y cada motor 16V50 un volumen de 22 m<sup>3</sup>. Necesitaremos, por tanto un volumen total de aceite de:

$$Volumen\ total_{AC} = 108,34m^3$$

Teniendo en cuenta la permeabilidad:

$$Volumen\ total_{AC} = \frac{109}{0,97} = 113\ m^3$$

Instalaremos dos tanques de aceite a cada banda en cámara de máquinas.

### Agua dulce

Para los cálculos de capacidad de agua dulce recurrimos a la norma UNE EN ISO 15748, Embarcaciones y tecnología marina. Suministror de agua potable en buques y estructuras marinas.

**Tabla A.1**  
Valores guía para el consumo de agua potable en litros por persona/cama y día

Tipo de buque		Grupo de personas embarcado	Consumo de agua cuando esté equipado con	
			sistema de aseos de gravedad	sistema de aseos de vacío
Buque de alta mar	Carguero	Tripulante/cama	220 l	175 l

Se considera un consumo diario de 175 l. por persona y día. Por lo tanto, el consumo de agua dulce del buque es:

$$Consumo_{AD} = 175 \cdot 35 \cdot 25 = 153.125\ l.$$

Teniendo en cuenta una permeabilidad del tanque de 0,97, la capacidad del tanque de agua dulce debe ser:

$$Volumen_{AD} = \frac{153.125}{1000} \cdot 1,03 = 157,72 \approx 158\ m^3.$$

Instalaremos dos tanques de agua dulce en el pique de popa centrados en cruzía.

### Aguas negras y grises

Para los cálculos de capacidad de aguas negras y grises recurriremos a la norma UNE EN ISO 15749, Embarcaciones y tecnología marina. Sistemas de desagüe en barcos y estructuras marinas.

**Tabla 2**  
Cantidad mínima de agua de desecho

Tipo de buque	Cantidad mínima de agua de desecho por persona y día en litros			
	Planta sin vacío		Planta con vacío	
	Aguas negras	Aguas negras y grises	Aguas negras	Aguas negras y grises
Buques de pasaje	70	230	25	185
Buques de alta mar exceptuando los de pasaje	70	180	25	135
Los buques costeros pueden conservar los valores recomendados por las autoridades responsables.				
NOTA - Estos valores son los recomendados. Hay que considerar las posibles variaciones debidas a los reglamentos nacionales o a las recomendaciones de las sociedades de clasificación.				

Se considera una cantidad mínima de aguas negras y grises es de 180 l. por persona y día. Por tanto, el volumen total de agua de aguas negras es:

$$\text{Consumo}_{ANG} = 180 \cdot 35 \cdot 25 = 157.500 \text{ l.}$$

Teniendo en cuenta una permeabilidad del tanque del 0,98, la capacidad del tanque de aguas negras y grises del buque será:

$$\text{Volumen}_{ANG} = \frac{157.500}{1000} \cdot 1,03 = 162,225 \approx 163 \text{ m}^3.$$

Instalaremos un tanque de aguas negras y grises en el doble fondo de la cámara de máquinas.

### Lodos

El tanque de lodos lo dimensionaremos de acuerdo con el convenio MARPOL. En el Anexo I, Regla 17 se indica, a modo de orientación la capacidad adecuada del tanque de lodos. De todas formas, la capacidad del tanque de lodos podrá calcularse en función de cualquier otra hipótesis.

Para construidos con posterioridad al 31 de diciembre de 1990, y que no lleven agua de lastre en los tanques de Fuel Oil, la capacidad mínima de los tanques de lodos se calcula mediante la siguiente expresión.

$$V_{LODOS} = K_1 \cdot C \cdot D \approx 72 \text{ m}^3$$

Donde:

$K_1$ : 0,015 para los buques en los que se purifique el fueloil pesado destinado a la máquina principal.

C: consumo diario de Fuel Oil en  $\text{m}^3$  (191,09)

D: duración máxima, en días, del viaje entre puertos en el que los fangos pueden descargarse en tierra. (25 días).

Teniendo en cuenta una permeabilidad del 0,97 en el tanque, nuestro tanque de lodos deberá tener una capacidad de:

$$V_{LODOS} = \frac{72}{0,97} \approx 75 \text{ m}^3$$

Instalaremos un tanque de lodos en el doble fondo de la cámara de máquinas.

### Tanques de lastre

Tomando como referencia nuestro buque base, definiremos como tanques de lastre el pique de popa, el pique de proa, los cofferdams entre tanques de carga y el doble fondo y doble casco a lo largo de la eslora de carga, cuyos tanques tendrán forma de "L".

## 12-RESUMEN DE VOLÚMENES DE TANQUES

En la siguiente tabla podemos ver un resumen de las capacidades requeridas en los tanques de nuestro buque. Comprobamos que cumplimos con todos los volúmenes. Es conveniente señalar que extraemos los datos de Maxsurf, donde ya hemos supuesto una permeabilidad del 0,97, por tanto, en nuestros volúmenes requeridos no debemos tenerla en cuenta.

Tanques	Volumen requerido (m <sup>3</sup> )	Volumen real (m <sup>3</sup> )
Carga	147.960	149.647,760
FO Almacén	4.347,51	3.428,012 x 2 = 6.856,024
Diesel	846,51	426,439 x 2 = 852,878
FO Sed.	294,53	151,427 x 2 = 302,854
FO UD	196,35	99,380 x 2 = 198,76
Aceite	108,34	54,908 x 2 = 109,816
Agua dulce	153,125	77,236 x 2 = 154,472
Aguas grises	157,5	164,884
Lodos	72	73,905

En concreto, para nuestras RPA, y lo que más nos interesa en nuestro buque, cumplimos con la capacidad de carga. Debemos llevar 147.960 m<sup>3</sup> para cumplir con los requerimientos, y llevamos 149.648 m<sup>3</sup>. Tenemos un volumen a mayores de 1.688 m<sup>3</sup>.

En los anexos adjuntamos las tablas de capacidades así como las gráficas de todos los tanques del buque, incluidos los de lastre y cofferdams.

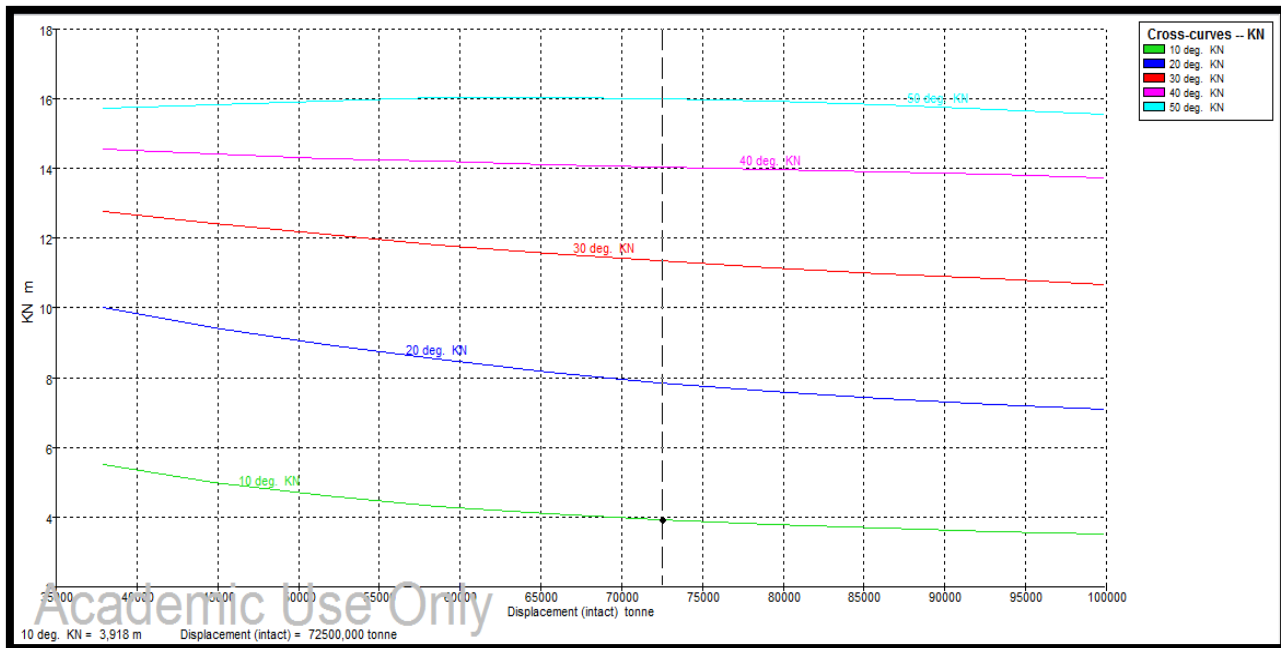
## 13-CURVAS DE KN (BRAZOS ADRIZANTES)

Vamos a calcular nuestras curvas de KN o curvas de brazos de adrizamiento desde nuestro desplazamiento inicial (rosca) hasta nuestro desplazamiento final con un incremento en intervalos de 10 desplazamientos y para ángulos de escora de 10° a 50°.

Haremos el cálculo para distintos asientos (aproantes y apopantes), desde asiento 0 hasta un 1,5 % de Lpp (4,05) con incrementos de 0,5.

A continuación se muestran tanto la tabla de valores como la gráfica de curvas hidrostáticas para asiento 0. El resto de cálculos los adjuntamos en el anexo.

	Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
1	37887	4,996	0,000 (fixed)	136,995	0,000	0,000	5,500	10,010	12,765	14,553	15,719
2	44777	5,772	0,000 (fixed)	136,717	0,000	0,000	4,990	9,437	12,412	14,415	15,837
3	51667	6,530	0,000 (fixed)	136,387	0,000	0,000	4,611	8,946	12,100	14,298	15,937
4	58557	7,274	0,000 (fixed)	136,008	0,000	0,000	4,322	8,524	11,822	14,199	16,022
5	65447	8,005	0,000 (fixed)	135,602	0,000	0,000	4,098	8,161	11,576	14,114	16,051
6	72338	8,723	0,000 (fixed)	135,161	0,000	0,000	3,922	7,856	11,358	14,038	16,021
7	79228	9,431	0,000 (fixed)	134,697	0,000	0,000	3,781	7,605	11,163	13,969	15,947
8	86118	10,130	0,000 (fixed)	134,214	0,000	0,000	3,670	7,400	10,986	13,906	15,840
9	93008	10,819	0,000 (fixed)	133,714	0,000	0,000	3,582	7,233	10,826	13,839	15,706
10	99898	11,500	0,000 (fixed)	133,199	0,000	0,000	3,513	7,097	10,681	13,744	15,552



#### 14-CURVAS HIDROSTÁTICAS

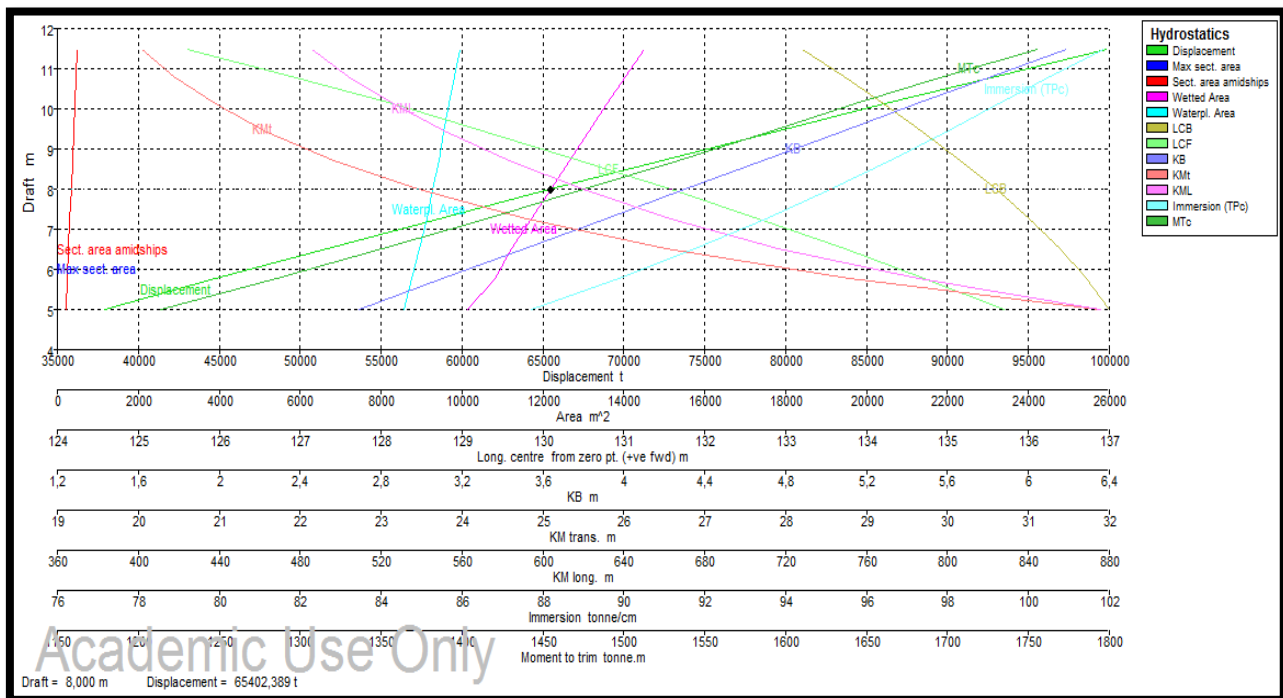
Las curvas hidrostáticas o curvas de carenas rectas son las curvas que reflejan el compartimiento de la carena del buque para distintos calados.

Vamos a calcular nuestras curvas hidrostáticas desde nuestro desplazamiento inicial (rosca) hasta nuestro desplazamiento final con un incremento en intervalos de 10 desplazamientos.

Haremos el cálculo para distintos asientos (aproantes y apopantes), desde asiento 0 hasta un 1,5 % de Lpp (4,05) con incrementos de 0,5.

A continuación se muestran tanto la tabla de valores como la gráfica de curvas hidrostáticas para asiento 0. El resto de cálculos los juntamos en el anexo.

	Draft Amidships m	4,996	5,772	6,531	7,274	8,005	8,723	9,431	10,130	10,819	11,500
1	Displacement t	37887	44777	51667	58557	65447	72337	79228	86118	93008	99898
2	Heel deg	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
3	Draft at FP m	4,996	5,772	6,531	7,274	8,005	8,723	9,431	10,130	10,819	11,500
4	Draft at AP m	4,996	5,772	6,531	7,274	8,005	8,723	9,431	10,130	10,819	11,500
5	Draft at LCF m	4,996	5,772	6,531	7,274	8,005	8,723	9,431	10,130	10,819	11,500
6	Trim (+ve by stern) m	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
7	WL Length m	257,197	258,412	260,778	263,388	266,348	269,362	271,869	273,542	274,294	275,945
8	Beam max extents on	43,082	43,118	43,144	43,159	43,170	43,177	43,183	43,187	43,190	43,193
9	Wetted Area m²	10137,8	10813,0	11233,8	11701,0	12191,1	12655,5	13116,3	13573,4	14035,9	14499,7
10	Waterpl. Area m²	8557,96	8768,90	8952,25	9123,26	9278,12	9422,26	9556,42	9683,77	9809,35	9937,33
11	Prismatic coeff. (Cp)	0,685	0,695	0,701	0,704	0,706	0,707	0,709	0,712	0,718	0,720
12	Block coeff. (Cb)	0,668	0,679	0,686	0,691	0,694	0,696	0,698	0,702	0,708	0,711
13	Max Sect. area coeff. (	0,983	0,984	0,986	0,987	0,988	0,989	0,989	0,990	0,991	0,991
14	Waterpl. area coeff. (C	0,772	0,787	0,796	0,803	0,807	0,810	0,814	0,820	0,828	0,834
15	LCB from zero pt. (+ve	136,995	136,717	136,387	136,008	135,602	135,161	134,697	134,214	133,714	133,199
16	LCF from zero pt. (+ve	135,694	134,708	133,731	132,656	131,572	130,454	129,306	128,143	126,893	125,596
17	KB m	2,689	3,104	3,510	3,909	4,302	4,689	5,071	5,448	5,820	6,188
18	KG m	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
19	BMT m	29,193	25,688	23,017	20,890	19,162	17,730	16,525	15,500	14,618	13,854
20	BML m	872,922	782,730	712,884	659,224	615,167	578,572	547,371	520,575	498,007	479,460
21	GMT m	20,381	17,291	15,027	13,300	11,964	10,919	10,095	9,448	8,938	8,542
22	GML m	864,111	774,333	704,894	651,634	607,969	571,761	540,942	514,522	492,327	474,148
23	KMt m	31,881	28,791	26,527	24,800	23,464	22,419	21,595	20,948	20,438	20,042
24	KML m	875,611	785,833	716,394	663,134	619,469	583,261	552,442	526,022	503,827	485,648
25	Immersion (TPc) tonne/	87,719	89,881	91,761	93,514	95,101	96,578	97,953	99,259	100,546	101,858
26	MTC tonne.m	1213,89	1285,59	1350,38	1414,82	1475,34	1533,54	1589,08	1642,91	1697,82	1756,26
27	RM at 1deg = GMT Disp.	13476,5	13512,5	13550,1	13591,8	13665,2	13784,9	13958,8	14199,8	14507,9	14892,9
28	Max deck inclination de	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
29	Trim angle (+ve by ster	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000



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-CIG

-Diverso material web



# ANEXO I

Catálogo del motor

### 3.6 Wärtsilä 16V50DF

Wärtsilä 16V50DF		DE IMO Tier 2		DE IMO Tier 2		ME IMO Tier 2	
		Gas mode	Diesel mode	Gas mode	Diesel mode	Gas mode	Diesel mode
Cylinder output	kW	950		975		975	
Engine speed	rpm	500		514		514	
Engine output	kW	15200		15600		15600	
Mean effective pressure	MPa	2.0		2.0		2.0	
<b>Combustion air system (Note 1)</b>							
Flow at 100% load	kg/s	24.5	30.1	24.4	30.0	24.4	29.1
Temperature at turbocharger intake, max.	°C	45		45		45	
Temperature after air cooler, nom. (TE 601)	°C	45	50	45	50	45	50
<b>Exhaust gas system</b>							
Flow at 100% load	kg/s	25.1	30.9	25.1	30.9	25.1	30.0
Flow at 75% load	kg/s	18.9	23.9	18.9	23.9	19.2	22.3
Flow at 50% load	kg/s	14.4	16.9	14.4	16.9	14.1	16.2
Temperature after turbocharger at 100% load (TE 517)	°C	373	343	373	343	369	350
Temperature after turbocharger at 75% load (TE 517)	°C	424	351	424	351	388	380
Temperature after turbocharger at 50% load (TE 517)	°C	426	385	426	385	390	370
Backpressure, max.	kPa	4		4		4	
Calculated exhaust diameter for 35 m/s	mm	1289	1397	1289	1397	1285	1384
<b>Heat balance at 100% load (Note 2)</b>							
Jacket water, HT-circuit	kW	1760	2723	1760	2723	1707	2880
Charge air, HT-circuit	kW	2240	3360	2240	3360	2293	3307
Charge air, LT-circuit	kW	1333	1680	1333	1680	1333	1627
Lubricating oil, LT-circuit	kW	1253	2080	1253	2080	1253	2187
Radiation	kW	427	480	427	480	560	613
<b>Fuel consumption (Note 3)</b>							
Total energy consumption at 100% load	kJ/kWh	7300	-	7300	-	7300	-
Total energy consumption at 75% load	kJ/kWh	7620	-	7620	-	7490	-
Total energy consumption at 50% load	kJ/kWh	8260	-	8260	-	7830	-
Fuel gas consumption at 100% load	kJ/kWh	7258	-	7258	-	7258	-
Fuel gas consumption at 75% load	kJ/kWh	7562	-	7562	-	7429	-
Fuel gas consumption at 50% load	kJ/kWh	8153	-	8153	-	7734	-
Fuel oil consumption at 100% load	g/kWh	1.0	189	1.0	189	1.0	190
Fuel oil consumption at 75% load	g/kWh	1.5	192	1.5	192	1.5	196
Fuel oil consumption 50% load	g/kWh	2.4	204	2.4	204	2.3	200
<b>Fuel gas system (Note 4)</b>							
Gas pressure at engine inlet, min (PT901)	kPa (a)	472	-	472	-	472	-
Gas pressure to Gas Valve unit, min	kPa (a)	592	-	592	-	592	-
Gas temperature before Gas Valve Unit	°C	0...60	-	0...60	-	0...60	-
<b>Fuel oil system</b>							
Pressure before injection pumps (PT 101)	kPa	800±50		800±50		800±50	
Fuel oil flow to engine, approx	m³/h	16.2		16.6		16.7	
HFO viscosity before the engine	cSt	-	16...24	-	16...24	-	16...24
Max. HFO temperature before engine (TE 101)	°C	-	140	-	140	-	140
MDF viscosity, min.	cSt	2.0		2.0		2.0	
Max. MDF temperature before engine (TE 101)	°C	45		45		45	
Leak fuel quantity (HFO), clean fuel at 100% load	kg/h	-	12.1	-	12.1	-	12.4
Leak fuel quantity (MDF), clean fuel at 100% load	kg/h	32.1	60.3	32.1	60.3	31.1	62.2
Pilot fuel (MDF) viscosity before the engine	cSt	2...11		2...11		2...11	
Pilot fuel pressure at engine inlet (PT 112)	kPa	400...800		400...800		400...800	
Pilot fuel pressure drop after engine, max	kPa	150		150		150	
Pilot fuel return flow at 100% load	kg/h	317		317		317	
<b>Lubricating oil system (Note 5)</b>							
Pressure before bearings, nom. (PT 201)	kPa	400		400		400	
Pressure after pump, max.	kPa	800		800		800	
Suction ability, including pipe loss, max.	kPa	40		40		40	
Priming pressure, nom. (PT 201)	kPa	80		80		80	
Temperature before bearings, nom. (TE 201)	°C	63		63		63	
Temperature after engine, approx.	°C	78		78		78	
Pump capacity (main), engine driven	m³/h	263		272		279	

Wärtsilä 16V50DF		DE		DE		ME	
		IMO Tier 2		IMO Tier 2		IMO Tier 2	
		Gas mode	Diesel mode	Gas mode	Diesel mode	Gas mode	Diesel mode
<b>Cylinder output</b>	<b>kW</b>	<b>950</b>		<b>975</b>		<b>975</b>	
<b>Engine speed</b>	<b>rpm</b>	<b>500</b>		<b>514</b>		<b>514</b>	
Pump capacity (main), electrically driven	m <sup>3</sup> /h	260		260		260	
Oil flow through engine	m <sup>3</sup> /h	230		230		230	
Priming pump capacity (50/60Hz)	m <sup>3</sup> /h	85.0 / 85.0		85.0 / 85.0		85.0 / 85.0	
Oil volume in separate system oil tank	m <sup>3</sup>	22		22		22	
Oil consumption at 100% load, approx.	g/kWh	0.5		0.5		0.5	
Crankcase ventilation flow rate at full load	l/min	3600		3600		3600	
Crankcase volume	m <sup>3</sup>	39.4		39.4		39.4	
Crankcase ventilation backpressure, max.	Pa	500		500		500	
Oil volume in turning device	l	68.0...70.0		68.0...70.0		68.0...70.0	
Oil volume in speed governor	l	6.2		6.2		6.2	
<b>HT cooling water system</b>							
Pressure at engine, after pump, nom. (PT 401)	kPa	250 + static		250 + static		250 + static	
Pressure at engine, after pump, max. (PT 401)	kPa	480		480		480	
Temperature before cylinders, approx. (TE 401)	°C	74		74		74	
Temperature after charge air cooler, nom.	°C	91		91		91	
Capacity of engine driven pump, nom.	m <sup>3</sup> /h	355		355		355	
Pressure drop over engine, total	kPa	50		50		50	
Pressure drop in external system, max.	kPa	150		150		150	
Pressure from expansion tank	kPa	70...150		70...150		70...150	
Water volume in engine	m <sup>3</sup>	2.1		2.1		2.1	
<b>LT cooling water system</b>							
Pressure at engine, after pump, nom. (PT 471)	kPa	250+ static		250+ static		250+ static	
Pressure at engine, after pump, max. (PT 471)	kPa	440		440		440	
Temperature before engine, max. (TE 471)	°C	38		38		38	
Temperature before engine, min. (TE 471)	°C	25		25		25	
Capacity of engine driven pump, nom.	m <sup>3</sup> /h	355		355		355	
Pressure drop over charge air cooler	kPa	30		30		30	
Pressure drop in external system, max.	kPa	200		200		200	
Pressure from expansion tank	kPa	70...150		70...150		70...150	
<b>Starting air system (Note 6)</b>							
Pressure, nom. (PT 301)	kPa	3000		3000		3000	
Pressure at engine during start, min. (20 °C)	kPa	1000		1000		1000	
Pressure, max. (PT 301)	kPa	3000		3000		3000	
Low pressure limit in starting air vessel	kPa	1800		1800		1800	
Consumption per start at 20 °C (successful start)	Nm <sup>3</sup>	7.8		7.8		7.8	
Consumption per start at 20 °C (with slowturn)	Nm <sup>3</sup>	9.4		9.4		9.4	

**Notes:**

- Note 1 At Gas LHV 49620kJ/kg
- Note 2 At 100% output and nominal speed. The figures are valid for ambient conditions according to ISO 15550, except for LT-water temperature, which is 35°C in gas operation and 45°C in back-up fuel operation. And with engine driven water, lube oil and pilot fuel pumps.
- Note 3 According to ISO 15550, lower calorific value 42700 kJ/kg, with engine driven pumps (two cooling water + one lubricating oil pumps). Tolerance 5%. Gas Lower heating value >28 MJ/m<sup>3</sup>N and Methane Number High (>80). The fuel consumption BSEC and SFOC are guaranteed at 100% load and the values at other loads are given for indication only.
- Note 4 Fuel gas pressure given at LHV ≥ 36MJ/m<sup>3</sup>N. Required fuel gas pressure depends on fuel gas LHV and need to be increased for lower LHV's. Pressure drop in external fuel gas system to be considered. See chapter Fuel system for further information.
- Note 5 Lubricating oil treatment losses and oil changes are not included in oil consumption. The lubricating oil volume of the governor is depending of the governor type.
- Note 6 At manual starting the consumption may be 2...3 times lower.

ME = Engine driving propeller, variable speed

DE = Diesel-Electric engine driving generator

Subject to revision without notice.



## 3.7 Wärtsilä 18V50DF

Wärtsilä 18V50DF		DE IMO Tier 2		DE IMO Tier 2	
		Gas mode	Diesel mode	Gas mode	Diesel mode
Cylinder output	kW	950		975	
Engine speed	rpm	500		514	
Engine output	kW	17100		17550	
Mean effective pressure	MPa	2.0		2.0	
<b>Combustion air system (Note 1)</b>					
Flow at 100% load	kg/s	27.5	33.8	27.5	33.7
Temperature at turbocharger intake, max.	°C	45		45	
Temperature after air cooler, nom. (TE 601)	°C	45	50	45	50
<b>Exhaust gas system</b>					
Flow at 100% load	kg/s	28.2	34.7	28.2	34.7
Flow at 75% load	kg/s	21.3	26.9	21.3	26.9
Flow at 50% load	kg/s	16.2	19.0	16.2	19.0
Temperature after turbocharger at 100% load (TE 517)	°C	373	343	373	343
Temperature after turbocharger at 75% load (TE 517)	°C	424	351	424	351
Temperature after turbocharger at 50% load (TE 517)	°C	426	385	426	385
Backpressure, max.	kPa	4		4	
Calculated exhaust diameter for 35 m/s	mm	1366	1480	1366	1480
<b>Heat balance at 100% load (Note 2)</b>					
Jacket water, HT-circuit	kW	1980	3120	1980	3120
Charge air, HT-circuit	kW	2520	3780	2520	3780
Charge air, LT-circuit	kW	1500	1890	1500	1890
Lubricating oil, LT-circuit	kW	1410	2340	1410	2340
Radiation	kW	480	540	480	540
<b>Fuel consumption (Note 3)</b>					
Total energy consumption at 100% load	kJ/kWh	7300	-	7300	-
Total energy consumption at 75% load	kJ/kWh	7620	-	7620	-
Total energy consumption at 50% load	kJ/kWh	8260	-	8260	-
Fuel gas consumption at 100% load	kJ/kWh	7258	-	7258	-
Fuel gas consumption at 75% load	kJ/kWh	7562	-	7562	-
Fuel gas consumption at 50% load	kJ/kWh	8153	-	8153	-
Fuel oil consumption at 100% load	g/kWh	1.0	189	1.0	189
Fuel oil consumption at 75% load	g/kWh	1.5	192	1.5	192
Fuel oil consumption 50% load	g/kWh	2.4	204	2.4	204
<b>Fuel gas system (Note 4)</b>					
Gas pressure at engine inlet, min (PT901)	kPa (a)	472	-	472	-
Gas pressure to Gas Valve unit, min	kPa (a)	592	-	592	-
Gas temperature before Gas Valve Unit	°C	0...60	-	0...60	-
<b>Fuel oil system</b>					
Pressure before injection pumps (PT 101)	kPa	800±50		800±50	
Fuel oil flow to engine, approx	m³/h	18.2		18.7	
HFO viscosity before the engine	cSt	-	16...24	-	16...24
Max. HFO temperature before engine (TE 101)	°C	-	140	-	140
MDF viscosity, min.	cSt	2.0		2.0	
Max. MDF temperature before engine (TE 101)	°C	45		45	
Leak fuel quantity (HFO), clean fuel at 100% load	kg/h	-	13.6	-	13.6
Leak fuel quantity (MDF), clean fuel at 100% load	kg/h	36.1	68.0	36.1	68.0
Pilot fuel (MDF) viscosity before the engine	cSt	2...11		2...11	
Pilot fuel pressure at engine inlet (PT 112)	kPa	400...800		400...800	
Pilot fuel pressure drop after engine, max	kPa	150		150	
Pilot fuel return flow at 100% load	kg/h	325		325	
<b>Lubricating oil system (Note 5)</b>					
Pressure before bearings, nom. (PT 201)	kPa	400		400	
Pressure after pump, max.	kPa	800		800	
Suction ability, including pipe loss, max.	kPa	40		40	
Priming pressure, nom. (PT 201)	kPa	80		80	
Temperature before bearings, nom. (TE 201)	°C	63		63	
Temperature after engine, approx.	°C	78		78	
Pump capacity (main), engine-driven	m³/h	335		345	

Wärtsilä 18V50DF		DE IMO Tier 2		DE IMO Tier 2	
		Gas mode	Diesel mode	Gas mode	Diesel mode
<b>Cylinder output</b>	<b>kW</b>	<b>950</b>		<b>975</b>	
<b>Engine speed</b>	<b>rpm</b>	<b>500</b>		<b>514</b>	
Pump capacity (main), electrically driven	m <sup>3</sup> /h	335		335	
Oil flow through engine	m <sup>3</sup> /h	260		260	
Priming pump capacity (50/60Hz)	m <sup>3</sup> /h	100.0 / 100.0		100.0 / 100.0	
Oil volume in separate system oil tank	m <sup>3</sup>	25		25	
Oil consumption at 100% load, approx.	g/kWh	0.5		0.5	
Crankcase ventilation flow rate at full load	l/min	4200		4200	
Crankcase volume	m <sup>3</sup>	44.3		44.3	
Crankcase ventilation backpressure, max.	Pa	500		500	
Oil volume in turning device	l	68.0...70.0		68.0...70.0	
Oil volume in speed governor	l	6.2		6.2	
<b>HT cooling water system</b>					
Pressure at engine, after pump, nom. (PT 401)	kPa	250 + static		250 + static	
Pressure at engine, after pump, max. (PT 401)	kPa	480		480	
Temperature before cylinders, approx. (TE 401)	°C	74		74	
Temperature after charge air cooler, nom.	°C	91		91	
Capacity of engine driven pump, nom.	m <sup>3</sup> /h	400		400	
Pressure drop over engine, total	kPa	50		50	
Pressure drop in external system, max.	kPa	150		150	
Pressure from expansion tank	kPa	70...150		70...150	
Water volume in engine	m <sup>3</sup>	2.6		2.6	
<b>LT cooling water system</b>					
Pressure at engine, after pump, nom. (PT 471)	kPa	250+ static		250+ static	
Pressure at engine, after pump, max. (PT 471)	kPa	440		440	
Temperature before engine, max. (TE 471)	°C	45		45	
Temperature before engine, min. (TE 471)	°C	25		25	
Capacity of engine driven pump, nom.	m <sup>3</sup> /h	400		200	
Pressure drop over charge air cooler	kPa	30		30	
Pressure drop in external system, max.	kPa	200		200	
Pressure from expansion tank	kPa	70...150		70...150	
<b>Starting air system (Note 6)</b>					
Pressure, nom. (PT 301)	kPa	3000		3000	
Pressure at engine during start, min. (20 °C)	kPa	1000		1000	
Pressure, max. (PT 301)	kPa	3000		3000	
Low pressure limit in starting air vessel	kPa	1800		1800	
Consumption per start at 20 °C (successful start)	Nm <sup>3</sup>	9.0		9.0	
Consumption per start at 20 °C (with slowturn)	Nm <sup>3</sup>	10.8		10.8	

**Notes:**

- Note 1 At Gas LHV 49620kJ/kg
- Note 2 At 100% output and nominal speed. The figures are valid for ambient conditions according to ISO 15550, except for LT-water temperature, which is 35°C in gas operation and 45°C in back-up fuel operation. And with engine driven water, lube oil and pilot fuel pumps.
- Note 3 According to ISO 15550, lower calorific value 42700 kJ/kg, with engine driven pumps (two cooling water + one lubricating oil pumps). Tolerance 5%. Gas Lower heating value >28 MJ/m<sup>3</sup>N and Methane Number High (>80). The fuel consumption BSEC and SFOC are guaranteed at 100% load and the values at other loads are given for indication only.
- Note 4 Fuel gas pressure given at LHV ≥ 36MJ/m<sup>3</sup>N. Required fuel gas pressure depends on fuel gas LHV and need to be increased for lower LHV's. Pressure drop in external fuel gas system to be considered. See chapter Fuel system for further information.
- Note 5 Lubricating oil treatment losses and oil changes are not included in oil consumption. The lubricating oil volume of the governor is depending of the governor type.
- Note 6 At manual starting the consumption may be 2...3 times lower.

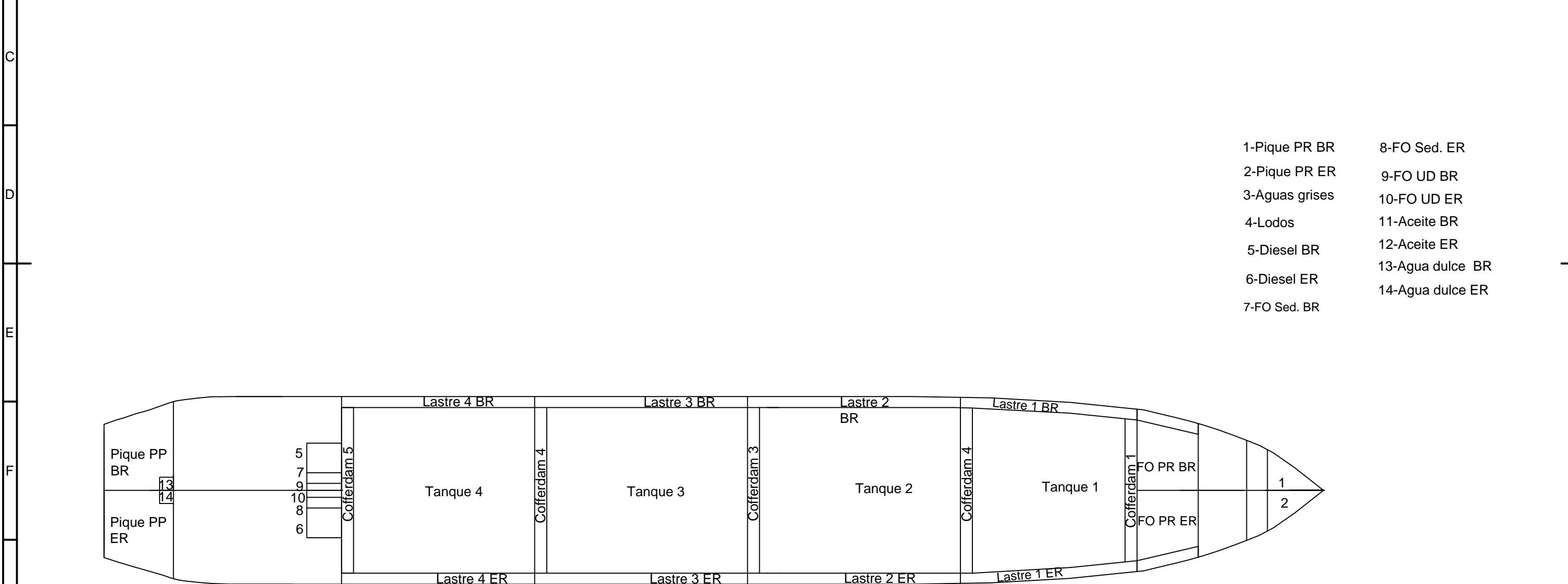
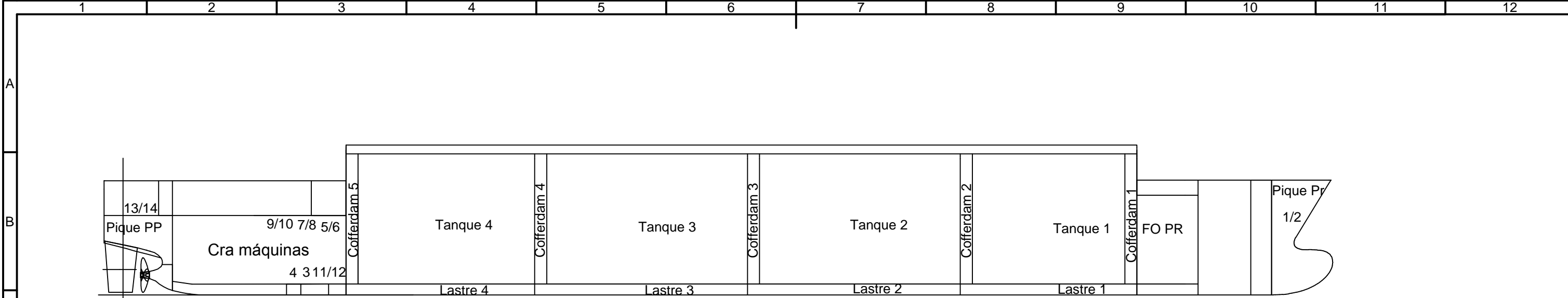
ME = Engine driving propeller, variable speed

DE = Diesel-Electric engine driving generator

Subject to revision without notice.

# ANEXO II

Plano de compartimentado



- 1-Pique PR BR
- 2-Pique PR ER
- 3-Aguas grises
- 4-Lodos
- 5-Diesel BR
- 6-Diesel ER
- 7-FO Sed. BR
- 8-FO Sed. ER
- 9-FO UD BR
- 10-FO UD ER
- 11-Aceite BR
- 12-Aceite ER
- 13-Agua dulce BR
- 14-Agua dulce ER

 UNIVERSIDADE DA CORUÑA ESCOLA POLITÉCNICA SUPERIOR	PROYECTO: 17-32 P
	PLANO DE COMPARTIMENTADO
AUTOR: ISMAEL GRANDAL MOURIZ	ESCALA 1:900

# ANEXO III

Tablas de capacidades tanques



## Tank Calibrations - Tanques final - copia (2)

Stability 20.00.04.9, build: 9

### Tank Calibrations - Pique PP BR

Fluid Type = Water Ballast      Specific gravity = 1,025

Permeability = 97 %

Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Pique PP BR	10,271	0,000	100,000	1686,821	1728,991	4,740	-7,841	14,783	0,000
	10,145	0,126	98,000	1653,084	1694,411	4,754	-7,809	14,713	8351,014
	10,139	0,132	97,900	1651,398	1692,683	4,754	-7,807	14,709	8349,840
	10,000	0,271	95,692	1614,146	1654,500	4,770	-7,771	14,631	8324,062
	9,500	0,771	87,766	1480,447	1517,458	4,833	-7,627	14,347	8200,802
	9,000	1,271	79,896	1347,706	1381,399	4,905	-7,463	14,058	8012,569
	8,500	1,771	72,104	1216,273	1246,680	4,988	-7,274	13,764	7779,193
	8,000	2,271	64,422	1086,686	1113,853	5,083	-7,057	13,464	7412,996
	7,500	2,771	56,915	960,060	984,061	5,192	-6,814	13,158	6913,726
	7,000	3,271	49,638	837,304	858,236	5,320	-6,545	12,847	6304,634
	6,500	3,771	42,664	719,666	737,658	5,472	-6,257	12,531	5535,844
	6,000	4,271	36,052	608,138	623,342	5,659	-5,955	12,210	4750,641
	5,500	4,771	29,843	503,396	515,981	5,892	-5,641	11,883	4008,369
	5,000	5,271	24,083	406,237	416,393	6,185	-5,320	11,548	3320,103
	4,500	5,771	18,835	317,716	325,659	6,552	-4,996	11,204	2693,541
	4,000	6,271	14,177	239,146	245,124	7,008	-4,681	10,849	2128,597
	3,500	6,771	10,209	172,209	176,515	7,539	-4,378	10,485	1582,490
	3,000	7,271	7,032	118,616	121,581	8,042	-4,055	10,122	1080,688
	2,500	7,771	4,577	77,201	79,131	8,495	-3,696	9,763	690,767
	2,000	8,271	2,734	46,111	47,264	8,951	-3,326	9,404	380,884
	1,500	8,771	1,420	23,954	24,553	9,423	-2,942	9,045	216,880
	1,280	8,991	1,000	16,868	17,290	9,659	-2,796	8,886	134,164
	1,000	9,271	0,622	10,497	10,760	9,743	-2,450	8,711	75,508
	0,500	9,771	0,128	2,155	2,209	10,354	-1,918	8,362	22,466
	0,000	10,271	0,000	0,000	0,000	10,794	-1,532	8,029	0,000

## Tank Calibrations - Pique PP ER

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Pique PP ER	10,271	0,000	100,000	1686,821	1728,991	4,740	7,841	14,783	0,000
	10,145	0,126	98,000	1653,084	1694,411	4,754	7,809	14,713	8351,014
	10,139	0,132	97,900	1651,398	1692,683	4,754	7,807	14,709	8349,840
	10,000	0,271	95,692	1614,146	1654,500	4,770	7,771	14,631	8324,062
	9,500	0,771	87,766	1480,447	1517,458	4,833	7,627	14,347	8200,802
	9,000	1,271	79,896	1347,706	1381,399	4,905	7,463	14,058	8012,569
	8,500	1,771	72,104	1216,273	1246,680	4,988	7,274	13,764	7779,193
	8,000	2,271	64,422	1086,686	1113,853	5,083	7,057	13,464	7412,996
	7,500	2,771	56,915	960,060	984,061	5,192	6,814	13,158	6913,726
	7,000	3,271	49,638	837,304	858,236	5,320	6,545	12,847	6304,634
	6,500	3,771	42,664	719,666	737,658	5,472	6,257	12,531	5535,844
	6,000	4,271	36,052	608,138	623,342	5,659	5,955	12,210	4750,641
	5,500	4,771	29,843	503,396	515,981	5,892	5,641	11,883	4008,369
	5,000	5,271	24,083	406,237	416,393	6,185	5,320	11,548	3320,103
	4,500	5,771	18,835	317,716	325,659	6,552	4,996	11,204	2693,541
	4,000	6,271	14,177	239,146	245,124	7,008	4,681	10,849	2128,597
	3,500	6,771	10,209	172,209	176,515	7,539	4,378	10,485	1582,490
	3,000	7,271	7,032	118,616	121,581	8,042	4,055	10,122	1080,688
	2,500	7,771	4,577	77,201	79,131	8,495	3,696	9,763	690,767
	2,000	8,271	2,734	46,111	47,264	8,951	3,326	9,404	380,884
	1,500	8,771	1,420	23,954	24,553	9,423	2,942	9,045	216,880
	1,280	8,991	1,000	16,868	17,290	9,659	2,796	8,886	134,164
	1,000	9,271	0,622	10,497	10,760	9,743	2,450	8,711	75,508
	0,500	9,771	0,128	2,155	2,209	10,354	1,918	8,362	22,466
	0,000	10,271	0,000	0,000	0,000	10,794	1,532	8,029	0,000

## Tank Calibrations - Agua dulce BR

Fluid Type = Fresh Water                      Specific gravity = 1  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Agua dulce BR	6,500	0,000	100,000	77,236	77,236	9,610	-1,750	21,550	0,000
	6,370	0,130	98,000	75,692	75,692	9,610	-1,750	21,485	12,505
	6,364	0,136	97,900	75,614	75,614	9,610	-1,750	21,482	12,505
	6,250	0,250	96,154	74,266	74,266	9,610	-1,750	21,425	12,505
	6,000	0,500	92,308	71,295	71,295	9,610	-1,750	21,300	12,505
	5,750	0,750	88,462	68,324	68,324	9,610	-1,750	21,175	12,505
	5,500	1,000	84,615	65,354	65,354	9,610	-1,750	21,050	12,505
	5,250	1,250	80,769	62,383	62,383	9,610	-1,750	20,925	12,505
	5,000	1,500	76,923	59,413	59,413	9,610	-1,750	20,800	12,505
	4,750	1,750	73,077	56,442	56,442	9,610	-1,750	20,675	12,505
	4,500	2,000	69,231	53,471	53,471	9,610	-1,750	20,550	12,505
	4,250	2,250	65,385	50,501	50,501	9,610	-1,750	20,425	12,505
	4,000	2,500	61,538	47,530	47,530	9,610	-1,750	20,300	12,505
	3,750	2,750	57,692	44,559	44,559	9,610	-1,750	20,175	12,505
	3,500	3,000	53,846	41,589	41,589	9,610	-1,750	20,050	12,505
	3,250	3,250	50,000	38,618	38,618	9,610	-1,750	19,925	12,505
	3,000	3,500	46,154	35,648	35,648	9,610	-1,750	19,800	12,505
	2,750	3,750	42,308	32,677	32,677	9,610	-1,750	19,675	12,505
	2,500	4,000	38,462	29,706	29,706	9,610	-1,750	19,550	12,505
	2,250	4,250	34,615	26,736	26,736	9,610	-1,750	19,425	12,505
	2,000	4,500	30,769	23,765	23,765	9,610	-1,750	19,300	12,505
	1,750	4,750	26,923	20,794	20,794	9,610	-1,750	19,175	12,505
	1,500	5,000	23,077	17,824	17,824	9,610	-1,750	19,050	12,505
	1,250	5,250	19,231	14,853	14,853	9,610	-1,750	18,925	12,505
	1,000	5,500	15,385	11,883	11,883	9,610	-1,750	18,800	12,505
	0,750	5,750	11,538	8,912	8,912	9,610	-1,750	18,675	12,505
	0,500	6,000	7,692	5,941	5,941	9,610	-1,750	18,550	12,505
	0,250	6,250	3,846	2,971	2,971	9,610	-1,750	18,425	12,505
	0,065	6,435	1,000	0,772	0,772	9,610	-1,750	18,332	12,505
	0,000	6,500	0,000	0,000	0,000	9,610	-1,750	18,300	0,000

## Tank Calibrations - Agua dulce ER

Fluid Type = Fresh Water                      Specific gravity = 1  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Agua dulce ER	6,500	0,000	100,000	77,236	77,236	9,610	1,750	21,550	0,000
	6,370	0,130	98,000	75,692	75,692	9,610	1,750	21,485	12,505
	6,364	0,136	97,900	75,614	75,614	9,610	1,750	21,482	12,505
	6,250	0,250	96,154	74,266	74,266	9,610	1,750	21,425	12,505
	6,000	0,500	92,308	71,295	71,295	9,610	1,750	21,300	12,505
	5,750	0,750	88,462	68,324	68,324	9,610	1,750	21,175	12,505
	5,500	1,000	84,615	65,354	65,354	9,610	1,750	21,050	12,505
	5,250	1,250	80,769	62,383	62,383	9,610	1,750	20,925	12,505
	5,000	1,500	76,923	59,413	59,413	9,610	1,750	20,800	12,505
	4,750	1,750	73,077	56,442	56,442	9,610	1,750	20,675	12,505
	4,500	2,000	69,231	53,471	53,471	9,610	1,750	20,550	12,505
	4,250	2,250	65,385	50,501	50,501	9,610	1,750	20,425	12,505
	4,000	2,500	61,538	47,530	47,530	9,610	1,750	20,300	12,505
	3,750	2,750	57,692	44,559	44,559	9,610	1,750	20,175	12,505
	3,500	3,000	53,846	41,589	41,589	9,610	1,750	20,050	12,505
	3,250	3,250	50,000	38,618	38,618	9,610	1,750	19,925	12,505
	3,000	3,500	46,154	35,648	35,648	9,610	1,750	19,800	12,505
	2,750	3,750	42,308	32,677	32,677	9,610	1,750	19,675	12,505
	2,500	4,000	38,462	29,706	29,706	9,610	1,750	19,550	12,505
	2,250	4,250	34,615	26,736	26,736	9,610	1,750	19,425	12,505
	2,000	4,500	30,769	23,765	23,765	9,610	1,750	19,300	12,505
	1,750	4,750	26,923	20,794	20,794	9,610	1,750	19,175	12,505
	1,500	5,000	23,077	17,824	17,824	9,610	1,750	19,050	12,505
	1,250	5,250	19,231	14,853	14,853	9,610	1,750	18,925	12,505
	1,000	5,500	15,385	11,883	11,883	9,610	1,750	18,800	12,505
	0,750	5,750	11,538	8,912	8,912	9,610	1,750	18,675	12,505
	0,500	6,000	7,692	5,941	5,941	9,610	1,750	18,550	12,505
	0,250	6,250	3,846	2,971	2,971	9,610	1,750	18,425	12,505
	0,065	6,435	1,000	0,772	0,772	9,610	1,750	18,332	12,505
	0,000	6,500	0,000	0,000	0,000	9,610	1,750	18,300	0,000

## Tank Calibrations - Aceite BR

Fluid Type =                      Specific gravity = 0,9  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Aceite BR	3,800	0,000	100,000	54,908	49,417	32,095	-17,140	20,200	0,000
	3,800	0,000	100,000	54,908	49,417	32,095	-17,140	20,200	0,000
	3,724	0,076	98,000	53,810	48,429	32,095	-17,140	20,162	17,168
	3,720	0,080	97,900	53,755	48,380	32,095	-17,140	20,160	17,168
	3,600	0,200	94,737	52,018	46,816	32,095	-17,140	20,100	17,168
	3,400	0,400	89,474	49,128	44,215	32,095	-17,140	20,000	17,168
	3,200	0,600	84,211	46,238	41,615	32,095	-17,140	19,900	17,168
	3,000	0,800	78,947	43,348	39,014	32,095	-17,140	19,800	17,168
	2,800	1,000	73,684	40,459	36,413	32,095	-17,140	19,700	17,168
	2,600	1,200	68,421	37,569	33,812	32,095	-17,140	19,600	17,168
	2,400	1,400	63,158	34,679	31,211	32,095	-17,140	19,500	17,168
	2,200	1,600	57,895	31,789	28,610	32,095	-17,140	19,400	17,168
	2,000	1,800	52,632	28,899	26,009	32,095	-17,140	19,300	17,168
	1,800	2,000	47,368	26,009	23,408	32,095	-17,140	19,200	17,168
	1,600	2,200	42,105	23,119	20,807	32,095	-17,140	19,100	17,168
	1,400	2,400	36,842	20,229	18,206	32,095	-17,140	19,000	17,168
	1,200	2,600	31,579	17,339	15,605	32,095	-17,140	18,900	17,168
	1,000	2,800	26,316	14,449	13,005	32,095	-17,140	18,800	17,168
	0,800	3,000	21,053	11,560	10,404	32,095	-17,140	18,700	17,168
	0,600	3,200	15,789	8,670	7,803	32,095	-17,140	18,600	17,168
	0,400	3,400	10,526	5,780	5,202	32,095	-17,140	18,500	17,168
	0,200	3,600	5,263	2,890	2,601	32,095	-17,140	18,400	17,168
	0,038	3,762	1,000	0,549	0,494	32,095	-17,140	18,319	17,168
	0,000	3,800	0,000	0,000	0,000	32,095	-17,140	18,300	0,000

## Tank Calibrations - Aceite ER

Fluid Type = Specific gravity = 0,9  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Aceite ER	3,800	0,000	100,000	54,908	49,417	32,095	17,140	20,200	0,000
	3,800	0,000	100,000	54,908	49,417	32,095	17,140	20,200	0,000
	3,724	0,076	98,000	53,810	48,429	32,095	17,140	20,162	17,168
	3,720	0,080	97,900	53,755	48,380	32,095	17,140	20,160	17,168
	3,600	0,200	94,737	52,018	46,816	32,095	17,140	20,100	17,168
	3,400	0,400	89,474	49,128	44,215	32,095	17,140	20,000	17,168
	3,200	0,600	84,211	46,238	41,615	32,095	17,140	19,900	17,168
	3,000	0,800	78,947	43,348	39,014	32,095	17,140	19,800	17,168
	2,800	1,000	73,684	40,459	36,413	32,095	17,140	19,700	17,168
	2,600	1,200	68,421	37,569	33,812	32,095	17,140	19,600	17,168
	2,400	1,400	63,158	34,679	31,211	32,095	17,140	19,500	17,168
	2,200	1,600	57,895	31,789	28,610	32,095	17,140	19,400	17,168
	2,000	1,800	52,632	28,899	26,009	32,095	17,140	19,300	17,168
	1,800	2,000	47,368	26,009	23,408	32,095	17,140	19,200	17,168
	1,600	2,200	42,105	23,119	20,807	32,095	17,140	19,100	17,168
	1,400	2,400	36,842	20,229	18,206	32,095	17,140	19,000	17,168
	1,200	2,600	31,579	17,339	15,605	32,095	17,140	18,900	17,168
	1,000	2,800	26,316	14,449	13,005	32,095	17,140	18,800	17,168
	0,800	3,000	21,053	11,560	10,404	32,095	17,140	18,700	17,168
	0,600	3,200	15,789	8,670	7,803	32,095	17,140	18,600	17,168
	0,400	3,400	10,526	5,780	5,202	32,095	17,140	18,500	17,168
	0,200	3,600	5,263	2,890	2,601	32,095	17,140	18,400	17,168
	0,038	3,762	1,000	0,549	0,494	32,095	17,140	18,319	17,168
	0,000	3,800	0,000	0,000	0,000	32,095	17,140	18,300	0,000

## Tank Calibrations - FO UD BR

Fluid Type = Specific gravity = 0,97  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
FO UD BR	4,620	0,000	100,000	99,380	96,398	36,305	-16,700	20,610	0,000
	4,600	0,020	99,567	98,949	95,981	36,305	-16,700	20,600	41,301
	4,528	0,092	98,000	97,392	94,470	36,305	-16,700	20,564	41,301
	4,523	0,097	97,900	97,293	94,374	36,305	-16,700	20,561	41,301
	4,400	0,220	95,238	94,647	91,808	36,305	-16,700	20,500	41,301
	4,200	0,420	90,909	90,345	87,635	36,305	-16,700	20,400	41,301
	4,000	0,620	86,580	86,043	83,462	36,305	-16,700	20,300	41,301
	3,800	0,820	82,251	81,741	79,289	36,305	-16,700	20,200	41,301
	3,600	1,020	77,922	77,439	75,115	36,305	-16,700	20,100	41,301
	3,400	1,220	73,593	73,136	70,942	36,305	-16,700	20,000	41,301
	3,200	1,420	69,264	68,834	66,769	36,305	-16,700	19,900	41,301
	3,000	1,620	64,935	64,532	62,596	36,305	-16,700	19,800	41,301
	2,800	1,820	60,606	60,230	58,423	36,305	-16,700	19,700	41,301
	2,600	2,020	56,277	55,928	54,250	36,305	-16,700	19,600	41,301
	2,400	2,220	51,948	51,626	50,077	36,305	-16,700	19,500	41,301
	2,200	2,420	47,619	47,324	45,904	36,305	-16,700	19,400	41,301
	2,000	2,620	43,290	43,021	41,731	36,305	-16,700	19,300	41,301
	1,800	2,820	38,961	38,719	37,558	36,305	-16,700	19,200	41,301
	1,600	3,020	34,632	34,417	33,385	36,305	-16,700	19,100	41,301
	1,400	3,220	30,303	30,115	29,212	36,305	-16,700	19,000	41,301
	1,200	3,420	25,974	25,813	25,038	36,305	-16,700	18,900	41,301
	1,000	3,620	21,645	21,511	20,865	36,305	-16,700	18,800	41,301
	0,800	3,820	17,316	17,209	16,692	36,305	-16,700	18,700	41,301
	0,600	4,020	12,987	12,906	12,519	36,305	-16,700	18,600	41,301
	0,400	4,220	8,658	8,604	8,346	36,305	-16,700	18,500	41,301
	0,200	4,420	4,329	4,302	4,173	36,305	-16,700	18,400	41,301
	0,046	4,574	1,000	0,994	0,964	36,305	-16,700	18,323	41,301
	0,000	4,620	0,000	0,000	0,000	36,305	-16,700	18,300	0,000

## Tank Calibrations - FO UD ER

Fluid Type =                      Specific gravity = 0,97  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
FO UD ER	4,620	0,000	100,000	99,380	96,398	36,305	16,700	20,610	0,000
	4,600	0,020	99,567	98,949	95,981	36,305	16,700	20,600	41,301
	4,528	0,092	98,000	97,392	94,470	36,305	16,700	20,564	41,301
	4,523	0,097	97,900	97,293	94,374	36,305	16,700	20,561	41,301
	4,400	0,220	95,238	94,647	91,808	36,305	16,700	20,500	41,301
	4,200	0,420	90,909	90,345	87,635	36,305	16,700	20,400	41,301
	4,000	0,620	86,580	86,043	83,462	36,305	16,700	20,300	41,301
	3,800	0,820	82,251	81,741	79,289	36,305	16,700	20,200	41,301
	3,600	1,020	77,922	77,439	75,115	36,305	16,700	20,100	41,301
	3,400	1,220	73,593	73,136	70,942	36,305	16,700	20,000	41,301
	3,200	1,420	69,264	68,834	66,769	36,305	16,700	19,900	41,301
	3,000	1,620	64,935	64,532	62,596	36,305	16,700	19,800	41,301
	2,800	1,820	60,606	60,230	58,423	36,305	16,700	19,700	41,301
	2,600	2,020	56,277	55,928	54,250	36,305	16,700	19,600	41,301
	2,400	2,220	51,948	51,626	50,077	36,305	16,700	19,500	41,301
	2,200	2,420	47,619	47,324	45,904	36,305	16,700	19,400	41,301
	2,000	2,620	43,290	43,021	41,731	36,305	16,700	19,300	41,301
	1,800	2,820	38,961	38,719	37,558	36,305	16,700	19,200	41,301
	1,600	3,020	34,632	34,417	33,385	36,305	16,700	19,100	41,301
	1,400	3,220	30,303	30,115	29,212	36,305	16,700	19,000	41,301
	1,200	3,420	25,974	25,813	25,038	36,305	16,700	18,900	41,301
	1,000	3,620	21,645	21,511	20,865	36,305	16,700	18,800	41,301
	0,800	3,820	17,316	17,209	16,692	36,305	16,700	18,700	41,301
	0,600	4,020	12,987	12,906	12,519	36,305	16,700	18,600	41,301
	0,400	4,220	8,658	8,604	8,346	36,305	16,700	18,500	41,301
	0,200	4,420	4,329	4,302	4,173	36,305	16,700	18,400	41,301
	0,046	4,574	1,000	0,994	0,964	36,305	16,700	18,323	41,301
	0,000	4,620	0,000	0,000	0,000	36,305	16,700	18,300	0,000



## Tank Calibrations - FO Sed. BR

Fluid Type =                      Specific gravity = 0,97  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
FO Sed. BR	5,320	0,000	100,000	151,427	146,884	41,235	-16,300	20,960	0,000
	5,250	0,070	98,684	149,434	144,951	41,235	-16,300	20,925	74,385
	5,214	0,106	98,000	148,398	143,946	41,235	-16,300	20,907	74,385
	5,208	0,112	97,900	148,247	143,799	41,235	-16,300	20,904	74,385
	5,000	0,320	93,985	142,318	138,049	41,235	-16,300	20,800	74,385
	4,750	0,570	89,286	135,202	131,146	41,235	-16,300	20,675	74,385
	4,500	0,820	84,586	128,087	124,244	41,235	-16,300	20,550	74,385
	4,250	1,070	79,887	120,971	117,341	41,235	-16,300	20,425	74,385
	4,000	1,320	75,188	113,855	110,439	41,235	-16,300	20,300	74,385
	3,750	1,570	70,489	106,739	103,537	41,235	-16,300	20,175	74,385
	3,500	1,820	65,789	99,623	96,634	41,235	-16,300	20,050	74,385
	3,250	2,070	61,090	92,507	89,732	41,235	-16,300	19,925	74,385
	3,000	2,320	56,391	85,391	82,829	41,235	-16,300	19,800	74,385
	2,750	2,570	51,692	78,275	75,927	41,235	-16,300	19,675	74,385
	2,500	2,820	46,992	71,159	69,024	41,235	-16,300	19,550	74,385
	2,250	3,070	42,293	64,043	62,122	41,235	-16,300	19,425	74,385
	2,000	3,320	37,594	56,927	55,220	41,235	-16,300	19,300	74,385
	1,750	3,570	32,895	49,811	48,317	41,235	-16,300	19,175	74,385
	1,500	3,820	28,195	42,696	41,415	41,235	-16,300	19,050	74,385
	1,250	4,070	23,496	35,580	34,512	41,235	-16,300	18,925	74,385
	1,000	4,320	18,797	28,464	27,610	41,235	-16,300	18,800	74,385
	0,750	4,570	14,098	21,348	20,707	41,235	-16,300	18,675	74,385
	0,500	4,820	9,398	14,232	13,805	41,235	-16,300	18,550	74,385
	0,250	5,070	4,699	7,116	6,902	41,235	-16,300	18,425	74,385
	0,053	5,267	1,000	1,514	1,469	41,235	-16,300	18,327	74,385
	0,000	5,320	0,000	0,000	0,000	41,235	-16,300	18,300	0,000

## Tank Calibrations - FO Sed. ER

Fluid Type =                      Specific gravity = 0,97  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
FO Sed. ER	5,320	0,000	100,000	151,427	146,884	41,235	16,300	20,960	0,000
	5,250	0,070	98,684	149,434	144,951	41,235	16,300	20,925	74,385
	5,214	0,106	98,000	148,398	143,946	41,235	16,300	20,907	74,385
	5,208	0,112	97,900	148,247	143,799	41,235	16,300	20,904	74,385
	5,000	0,320	93,985	142,318	138,049	41,235	16,300	20,800	74,385
	4,750	0,570	89,286	135,202	131,146	41,235	16,300	20,675	74,385
	4,500	0,820	84,586	128,087	124,244	41,235	16,300	20,550	74,385
	4,250	1,070	79,887	120,971	117,341	41,235	16,300	20,425	74,385
	4,000	1,320	75,188	113,855	110,439	41,235	16,300	20,300	74,385
	3,750	1,570	70,489	106,739	103,537	41,235	16,300	20,175	74,385
	3,500	1,820	65,789	99,623	96,634	41,235	16,300	20,050	74,385
	3,250	2,070	61,090	92,507	89,732	41,235	16,300	19,925	74,385
	3,000	2,320	56,391	85,391	82,829	41,235	16,300	19,800	74,385
	2,750	2,570	51,692	78,275	75,927	41,235	16,300	19,675	74,385
	2,500	2,820	46,992	71,159	69,024	41,235	16,300	19,550	74,385
	2,250	3,070	42,293	64,043	62,122	41,235	16,300	19,425	74,385
	2,000	3,320	37,594	56,927	55,220	41,235	16,300	19,300	74,385
	1,750	3,570	32,895	49,811	48,317	41,235	16,300	19,175	74,385
	1,500	3,820	28,195	42,696	41,415	41,235	16,300	19,050	74,385
	1,250	4,070	23,496	35,580	34,512	41,235	16,300	18,925	74,385
	1,000	4,320	18,797	28,464	27,610	41,235	16,300	18,800	74,385
	0,750	4,570	14,098	21,348	20,707	41,235	16,300	18,675	74,385
	0,500	4,820	9,398	14,232	13,805	41,235	16,300	18,550	74,385
	0,250	5,070	4,699	7,116	6,902	41,235	16,300	18,425	74,385
	0,053	5,267	1,000	1,514	1,469	41,235	16,300	18,327	74,385
	0,000	5,320	0,000	0,000	0,000	41,235	16,300	18,300	0,000

## Tank Calibrations - Diesel BR

Fluid Type =                      Specific gravity = 0,9  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Diesel BR	7,510	0,000	100,000	426,439	383,795	47,608	-15,200	22,055	0,000
	7,500	0,010	99,867	425,871	383,284	47,608	-15,200	22,050	267,114
	7,360	0,150	98,000	417,910	376,119	47,608	-15,200	21,980	267,114
	7,352	0,158	97,900	417,484	375,736	47,608	-15,200	21,976	267,114
	7,000	0,510	93,209	397,480	357,732	47,608	-15,200	21,800	267,114
	6,500	1,010	86,551	369,088	332,180	47,608	-15,200	21,550	267,114
	6,000	1,510	79,893	340,697	306,627	47,608	-15,200	21,300	267,114
	5,500	2,010	73,236	312,306	281,075	47,608	-15,200	21,050	267,114
	5,000	2,510	66,578	283,914	255,523	47,608	-15,200	20,800	267,114
	4,500	3,010	59,920	255,523	229,970	47,608	-15,200	20,550	267,114
	4,000	3,510	53,262	227,131	204,418	47,608	-15,200	20,300	267,114
	3,500	4,010	46,605	198,740	178,866	47,608	-15,200	20,050	267,114
	3,000	4,510	39,947	170,349	153,314	47,608	-15,200	19,800	267,114
	2,500	5,010	33,289	141,957	127,761	47,608	-15,200	19,550	267,114
	2,000	5,510	26,631	113,566	102,209	47,608	-15,200	19,300	267,114
	1,500	6,010	19,973	85,174	76,657	47,608	-15,200	19,050	267,114
	1,000	6,510	13,316	56,783	51,105	47,608	-15,200	18,800	267,114
	0,500	7,010	6,658	28,391	25,552	47,608	-15,200	18,550	267,114
	0,075	7,435	1,000	4,264	3,838	47,608	-15,200	18,338	267,114
	0,000	7,510	0,000	0,000	0,000	47,608	-15,200	18,300	0,000

## Tank Calibrations - Diesel ER

Fluid Type =                      Specific gravity = 0,9  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Diesel ER	7,510	0,000	100,000	426,439	383,795	47,608	15,200	22,055	0,000
	7,500	0,010	99,867	425,871	383,284	47,608	15,200	22,050	267,114
	7,360	0,150	98,000	417,910	376,119	47,608	15,200	21,980	267,114
	7,352	0,158	97,900	417,484	375,736	47,608	15,200	21,976	267,114
	7,000	0,510	93,209	397,480	357,732	47,608	15,200	21,800	267,114
	6,500	1,010	86,551	369,088	332,180	47,608	15,200	21,550	267,114
	6,000	1,510	79,893	340,697	306,627	47,608	15,200	21,300	267,114
	5,500	2,010	73,236	312,306	281,075	47,608	15,200	21,050	267,114
	5,000	2,510	66,578	283,914	255,523	47,608	15,200	20,800	267,114
	4,500	3,010	59,920	255,523	229,970	47,608	15,200	20,550	267,114
	4,000	3,510	53,262	227,131	204,418	47,608	15,200	20,300	267,114
	3,500	4,010	46,605	198,740	178,866	47,608	15,200	20,050	267,114
	3,000	4,510	39,947	170,349	153,314	47,608	15,200	19,800	267,114
	2,500	5,010	33,289	141,957	127,761	47,608	15,200	19,550	267,114
	2,000	5,510	26,631	113,566	102,209	47,608	15,200	19,300	267,114
	1,500	6,010	19,973	85,174	76,657	47,608	15,200	19,050	267,114
	1,000	6,510	13,316	56,783	51,105	47,608	15,200	18,800	267,114
	0,500	7,010	6,658	28,391	25,552	47,608	15,200	18,550	267,114
	0,075	7,435	1,000	4,264	3,838	47,608	15,200	18,338	267,114
	0,000	7,510	0,000	0,000	0,000	47,608	15,200	18,300	0,000

## Tank Calibrations - Aguas grises

Fluid Type =                      Specific gravity = 1,5  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Aguas grises	2,459	0,000	100,000	164,884	247,326	46,898	0,000	1,435	0,000
	2,417	0,042	98,000	161,586	242,380	46,902	0,000	1,413	744,186
	2,415	0,044	97,900	161,422	242,132	46,902	0,000	1,412	744,186
	2,400	0,059	97,210	160,284	240,426	46,904	0,000	1,405	744,186
	2,300	0,159	92,474	152,476	228,714	46,915	0,000	1,354	744,186
	2,200	0,259	87,739	144,668	217,001	46,928	0,000	1,304	744,186
	2,100	0,359	83,003	136,859	205,289	46,942	0,000	1,253	744,186
	2,000	0,459	78,268	129,051	193,577	46,958	0,000	1,202	744,186
	1,900	0,559	73,532	121,243	181,865	46,976	0,000	1,152	744,186
	1,800	0,659	68,797	113,435	170,153	46,996	0,000	1,101	744,186
	1,700	0,759	64,061	105,627	158,440	47,020	0,000	1,050	744,186
	1,600	0,859	59,326	97,819	146,728	47,047	0,000	0,999	744,186
	1,500	0,959	54,590	90,011	135,016	47,079	0,000	0,947	744,186
	1,400	1,059	49,855	82,203	123,304	47,117	0,000	0,895	744,186
	1,300	1,159	45,119	74,395	111,592	47,162	0,000	0,843	744,186
	1,200	1,259	40,384	66,586	99,880	47,219	0,000	0,791	744,186
	1,100	1,359	35,648	58,778	88,167	47,291	0,000	0,738	744,186
	1,000	1,459	30,913	50,970	76,455	47,384	0,000	0,684	744,186
	0,900	1,559	26,189	43,181	64,772	47,509	0,000	0,628	729,789
	0,800	1,659	21,531	35,501	53,252	47,673	0,000	0,571	695,793
	0,700	1,759	17,013	28,051	42,077	47,886	0,000	0,513	645,830
	0,600	1,859	12,717	20,968	31,451	48,164	0,000	0,452	579,804
	0,500	1,959	8,782	14,479	21,719	48,521	0,000	0,390	488,618
	0,400	2,059	5,397	8,898	13,347	48,952	0,000	0,325	369,114
	0,300	2,159	2,728	4,499	6,748	49,469	0,000	0,258	237,910
	0,204	2,255	1,000	1,649	2,473	50,036	0,000	0,191	110,480
	0,200	2,259	0,946	1,560	2,340	50,061	0,000	0,188	104,424
	0,100	2,359	0,135	0,223	0,335	50,654	0,000	0,115	10,498
	0,000	2,459	0,000	0,000	0,000	51,307	0,000	0,041	0,000

## Tank Calibrations - Lodos

Fluid Type =                      Specific gravity = 1,5  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lodos	1,990	0,000	100,000	73,905	110,858	38,565	0,000	1,804	0,000
	1,964	0,026	98,000	72,427	108,641	38,576	0,000	1,791	405,224
	1,963	0,027	97,900	72,353	108,530	38,577	0,000	1,790	405,224
	1,900	0,090	92,993	68,727	103,090	38,607	0,000	1,755	405,224
	1,800	0,190	85,223	62,984	94,477	38,662	0,000	1,700	405,224
	1,700	0,290	77,453	57,242	85,863	38,729	0,000	1,644	405,224
	1,600	0,390	69,696	51,509	77,264	38,809	0,000	1,587	400,606
	1,500	0,490	62,010	45,829	68,743	38,905	0,000	1,528	387,307
	1,400	0,590	54,460	40,248	60,373	39,016	0,000	1,468	367,133
	1,300	0,690	47,116	34,821	52,232	39,144	0,000	1,407	346,456
	1,200	0,790	40,064	29,610	44,414	39,289	0,000	1,345	318,938
	1,100	0,890	33,359	24,654	36,981	39,452	0,000	1,282	293,558
	1,000	0,990	27,105	20,032	30,048	39,629	0,000	1,218	265,481
	0,900	1,090	21,374	15,796	23,695	39,817	0,000	1,152	231,764
	0,800	1,190	16,231	11,996	17,994	40,010	0,000	1,086	197,285
	0,700	1,290	11,727	8,667	13,000	40,211	0,000	1,019	161,272
	0,600	1,390	7,910	5,846	8,769	40,419	0,000	0,951	121,184
	0,500	1,490	4,826	3,567	5,350	40,647	0,000	0,880	78,484
	0,400	1,590	2,570	1,899	2,849	40,883	0,000	0,807	38,191
	0,300	1,690	1,123	0,830	1,245	41,137	0,000	0,733	13,162
	0,288	1,702	1,000	0,739	1,109	41,169	0,000	0,724	11,319
	0,200	1,790	0,347	0,257	0,385	41,401	0,000	0,658	2,828
	0,100	1,890	0,047	0,035	0,052	41,672	0,000	0,584	0,203
	0,000	1,990	0,000	0,000	0,000	41,955	0,000	0,510	0,000

## Tank Calibrations - FO Almacén BR

Fluid Type =                      Specific gravity = 0,97  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
FO Almacén BR	20,300	0,000	100,000	3325,172	3225,417	240,191	-6,240	13,648	0,000
	20,000	0,300	98,186	3264,852	3166,906	240,187	-6,219	13,482	3697,534
	19,969	0,331	98,000	3258,669	3160,909	240,187	-6,217	13,464	3697,534
	19,953	0,347	97,900	3255,343	3157,683	240,186	-6,216	13,455	3697,534
	19,000	1,300	92,139	3063,785	2971,872	240,173	-6,143	12,923	3696,815
	18,000	2,300	86,103	2863,074	2777,182	240,159	-6,057	12,356	3666,397
	17,000	3,300	80,114	2663,925	2584,008	240,145	-5,963	11,785	3585,599
	16,000	4,300	74,209	2467,561	2393,535	240,134	-5,862	11,210	3458,140
	15,000	5,300	68,423	2275,191	2206,935	240,126	-5,756	10,636	3248,300
	14,000	6,300	62,799	2088,160	2025,515	240,120	-5,652	10,066	2996,791
	13,000	7,300	57,338	1906,584	1849,386	240,115	-5,550	9,501	2762,270
	12,000	8,300	52,036	1730,293	1678,384	240,111	-5,449	8,940	2546,531
	11,000	9,300	46,886	1559,048	1512,276	240,110	-5,349	8,384	2349,861
	10,000	10,300	41,880	1392,579	1350,801	240,109	-5,248	7,832	2170,312
	9,000	11,300	37,011	1230,669	1193,749	240,110	-5,146	7,283	2004,133
	8,000	12,300	32,275	1073,200	1041,004	240,112	-5,041	6,738	1846,265
	7,000	13,300	27,673	920,165	892,560	240,116	-4,932	6,195	1692,856
	6,000	14,300	23,207	771,668	748,518	240,121	-4,818	5,654	1540,905
	5,000	15,300	18,884	627,934	609,096	240,127	-4,696	5,117	1388,111
	4,000	16,300	14,716	489,318	474,638	240,134	-4,565	4,582	1232,161
	3,000	17,300	10,716	356,331	345,641	240,141	-4,423	4,052	1071,992
	2,000	18,300	6,907	229,672	222,782	240,147	-4,269	3,526	908,129
	1,000	19,300	3,318	110,343	107,033	240,148	-4,096	3,008	739,528
	0,311	19,989	1,000	33,252	32,254	240,142	-3,962	2,657	618,354
	0,000	20,300	0,000	0,000	0,000	240,135	-3,897	2,500	0,000

## Tank Calibrations - FO Almacén ER

Fluid Type =                      Specific gravity = 0,97  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
FO Almacén ER	20,300	0,000	100,000	3325,172	3225,417	240,191	6,240	13,648	0,000
	20,000	0,300	98,186	3264,852	3166,906	240,187	6,219	13,482	3697,534
	19,969	0,331	98,000	3258,669	3160,909	240,187	6,217	13,464	3697,534
	19,953	0,347	97,900	3255,343	3157,683	240,186	6,216	13,455	3697,534
	19,000	1,300	92,139	3063,785	2971,872	240,173	6,143	12,923	3696,815
	18,000	2,300	86,103	2863,074	2777,182	240,159	6,057	12,356	3666,397
	17,000	3,300	80,114	2663,925	2584,008	240,145	5,963	11,785	3585,599
	16,000	4,300	74,209	2467,561	2393,535	240,134	5,862	11,210	3458,140
	15,000	5,300	68,423	2275,191	2206,935	240,126	5,756	10,636	3248,300
	14,000	6,300	62,799	2088,160	2025,515	240,120	5,652	10,066	2996,791
	13,000	7,300	57,338	1906,584	1849,386	240,115	5,550	9,501	2762,270
	12,000	8,300	52,036	1730,293	1678,384	240,111	5,449	8,940	2546,531
	11,000	9,300	46,886	1559,048	1512,276	240,110	5,349	8,384	2349,861
	10,000	10,300	41,880	1392,579	1350,801	240,109	5,248	7,832	2170,312
	9,000	11,300	37,011	1230,669	1193,749	240,110	5,146	7,283	2004,133
	8,000	12,300	32,275	1073,200	1041,004	240,112	5,041	6,738	1846,265
	7,000	13,300	27,673	920,165	892,560	240,116	4,932	6,195	1692,856
	6,000	14,300	23,207	771,668	748,518	240,121	4,818	5,654	1540,905
	5,000	15,300	18,884	627,934	609,096	240,127	4,696	5,117	1388,111
	4,000	16,300	14,716	489,318	474,638	240,134	4,565	4,582	1232,161
	3,000	17,300	10,716	356,331	345,641	240,141	4,423	4,052	1071,992
	2,000	18,300	6,907	229,672	222,782	240,147	4,269	3,526	908,129
	1,000	19,300	3,318	110,343	107,033	240,148	4,096	3,008	739,528
	0,311	19,989	1,000	33,252	32,254	240,142	3,962	2,657	618,354
	0,000	20,300	0,000	0,000	0,000	240,135	3,897	2,500	0,000



## Tank Calibrations - Tanque 4

Fluid Type = Specific gravity = 0,43  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Tanque 4	28,968	0,000	100,000	38159,440	16408,559	74,485	0,000	17,036	0,000
	28,036	0,932	98,000	37396,250	16080,388	74,485	0,000	16,740	14835,435
	28,000	0,968	97,918	37365,032	16066,964	74,485	0,000	16,728	14983,053
	27,992	0,976	97,900	37358,090	16063,979	74,485	0,000	16,725	15015,945
	26,000	2,968	93,013	35493,340	15262,136	74,485	0,000	16,028	24671,797
	24,000	4,968	87,295	33311,199	14323,816	74,485	0,000	15,243	37833,180
	22,000	6,968	80,763	30818,610	13252,002	74,485	0,000	14,372	54999,080
	20,000	8,968	73,420	28016,667	12047,167	74,485	0,000	13,408	74690,784
	18,000	10,968	65,736	25084,483	10786,328	74,485	0,000	12,400	74690,784
	16,000	12,968	58,052	22152,298	9525,488	74,485	0,000	11,389	74690,784
	14,000	14,968	50,368	19220,114	8264,649	74,485	0,000	10,376	74690,784
	12,000	16,968	42,684	16287,930	7003,810	74,485	0,000	9,358	74690,784
	10,000	18,968	35,000	13355,746	5742,971	74,485	0,000	8,332	74690,784
	8,000	20,968	27,316	10423,561	4482,131	74,485	0,000	7,291	74690,784
	6,000	22,968	19,632	7491,377	3221,292	74,485	0,000	6,218	74690,784
	4,000	24,968	12,277	4684,899	2014,507	74,485	0,000	5,120	55312,668
	2,000	26,968	5,732	2187,256	940,520	74,485	0,000	4,056	38080,622
	0,370	28,598	1,000	381,595	164,086	74,485	0,000	3,218	27029,831
	0,000	28,968	0,000	0,000	0,000	74,485	0,000	3,032	0,000

### Tank Calibrations - Tanque 3

Fluid Type =                      Specific gravity = 0,43  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Tanque 3	28,968	0,000	100,000	43363,003	18646,092	120,735	0,000	17,036	0,000
	28,036	0,932	98,000	42495,742	18273,170	120,735	0,000	16,740	16858,450
	28,000	0,968	97,918	42460,267	18257,915	120,735	0,000	16,728	17026,198
	27,992	0,976	97,900	42452,378	18254,523	120,735	0,000	16,725	17063,575
	26,000	2,968	93,013	40333,343	17343,338	120,735	0,000	16,028	28036,135
	24,000	4,968	87,295	37853,638	16277,065	120,735	0,000	15,243	42992,253
	22,000	6,968	80,763	35021,150	15059,095	120,735	0,000	14,372	62498,960
	20,000	8,968	73,420	31837,124	13689,964	120,735	0,000	13,408	84875,897
	18,000	10,968	65,736	28505,096	12257,192	120,735	0,000	12,400	84875,897
	16,000	12,968	58,052	25173,068	10824,420	120,735	0,000	11,389	84875,897
	14,000	14,968	50,368	21841,040	9391,648	120,735	0,000	10,376	84875,897
	12,000	16,968	42,684	18509,013	7958,876	120,735	0,000	9,358	84875,897
	10,000	18,968	35,000	15176,985	6526,104	120,735	0,000	8,332	84875,897
	8,000	20,968	27,316	11844,957	5093,332	120,735	0,000	7,291	84875,897
	6,000	22,968	19,632	8512,929	3660,560	120,735	0,000	6,218	84875,897
	4,000	24,968	12,277	5323,750	2289,212	120,735	0,000	5,120	62855,309
	2,000	26,968	5,732	2485,519	1068,773	120,735	0,000	4,056	43273,438
	0,370	28,598	1,000	433,631	186,461	120,735	0,000	3,218	30715,719
	0,000	28,968	0,000	0,000	0,000	120,735	0,000	3,032	0,000

## Tank Calibrations - Tanque 2

Fluid Type =                      Specific gravity = 0,43  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Tanque 2	28,968	0,000	100,000	43363,003	18646,092	169,760	0,000	17,036	0,000
	28,036	0,932	98,000	42495,742	18273,170	169,760	0,000	16,740	16858,450
	28,000	0,968	97,918	42460,267	18257,915	169,760	0,000	16,728	17026,198
	27,992	0,976	97,900	42452,378	18254,523	169,760	0,000	16,725	17063,575
	26,000	2,968	93,013	40333,343	17343,338	169,760	0,000	16,028	28036,135
	24,000	4,968	87,295	37853,638	16277,065	169,760	0,000	15,243	42992,253
	22,000	6,968	80,763	35021,150	15059,095	169,760	0,000	14,372	62498,960
	20,000	8,968	73,420	31837,124	13689,964	169,760	0,000	13,408	84875,897
	18,000	10,968	65,736	28505,096	12257,192	169,760	0,000	12,400	84875,897
	16,000	12,968	58,052	25173,068	10824,420	169,760	0,000	11,389	84875,897
	14,000	14,968	50,368	21841,040	9391,648	169,760	0,000	10,376	84875,897
	12,000	16,968	42,684	18509,013	7958,876	169,760	0,000	9,358	84875,897
	10,000	18,968	35,000	15176,985	6526,104	169,760	0,000	8,332	84875,897
	8,000	20,968	27,316	11844,957	5093,332	169,760	0,000	7,291	84875,897
	6,000	22,968	19,632	8512,929	3660,560	169,760	0,000	6,218	84875,897
	4,000	24,968	12,277	5323,750	2289,212	169,760	0,000	5,120	62855,309
	2,000	26,968	5,732	2485,519	1068,773	169,760	0,000	4,056	43273,438
	0,370	28,598	1,000	433,631	186,461	169,760	0,000	3,218	30715,719
	0,000	28,968	0,000	0,000	0,000	169,760	0,000	3,032	0,000

## Tank Calibrations - Tanque 1

Fluid Type =                      Specific gravity = 0,43  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Tanque 1	28,968	0,000	100,000	27816,349	11961,030	212,045	0,000	16,981	0,000
	28,000	0,968	98,100	27287,765	11733,739	212,055	0,000	16,699	6642,805
	27,952	1,016	98,000	27260,023	11721,810	212,056	0,000	16,685	6746,411
	27,904	1,064	97,900	27232,207	11709,849	212,056	0,000	16,670	6850,819
	26,000	2,968	93,481	26002,968	11181,276	212,073	0,000	16,042	11959,636
	24,000	4,968	87,928	24458,491	10517,151	212,084	0,000	15,287	19586,785
	22,000	6,968	81,443	22654,336	9741,365	212,090	0,000	14,433	29945,685
	20,000	8,968	74,026	20591,417	8854,309	212,088	0,000	13,474	42191,085
	18,000	10,968	66,218	18419,555	7920,409	212,080	0,000	12,464	42191,085
	16,000	12,968	58,411	16247,694	6986,509	212,072	0,000	11,453	42191,085
	14,000	14,968	50,603	14075,833	6052,608	212,060	0,000	10,438	42191,085
	12,000	16,968	42,795	11903,971	5118,708	212,044	0,000	9,417	42191,085
	10,000	18,968	34,987	9732,110	4184,807	212,021	0,000	8,387	42191,085
	8,000	20,968	27,179	7560,248	3250,907	211,985	0,000	7,340	42191,085
	6,000	22,968	19,371	5388,387	2317,006	211,919	0,000	6,255	42191,085
	4,000	24,968	11,954	3325,090	1429,789	211,814	0,000	5,139	29911,882
	2,000	26,968	5,495	1528,515	657,261	211,689	0,000	4,061	19394,784
	0,392	28,576	1,000	278,161	119,609	211,572	0,000	3,229	13024,171
	0,000	28,968	0,000	0,000	0,000	211,541	0,000	3,032	0,000

## Tank Calibrations - Cofferdam 5

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Cofferdam 5	28,968	0,000	100,000	2563,809	2627,904	52,768	0,000	17,036	0,000
	28,036	0,932	98,000	2512,533	2575,346	52,768	0,000	16,740	2375,961
	28,000	0,968	97,918	2510,435	2573,196	52,768	0,000	16,728	2399,603
	27,992	0,976	97,900	2509,969	2572,718	52,768	0,000	16,725	2404,871
	26,000	2,968	93,013	2384,682	2444,299	52,768	0,000	16,028	3951,299
	24,000	4,968	87,295	2238,071	2294,023	52,768	0,000	15,243	6059,153
	22,000	6,968	80,763	2070,602	2122,367	52,768	0,000	14,372	8808,349
	20,000	8,968	73,420	1882,349	1929,408	52,768	0,000	13,408	11962,064
	18,000	10,968	65,736	1685,345	1727,479	52,768	0,000	12,400	11962,064
	16,000	12,968	58,052	1488,341	1525,550	52,768	0,000	11,389	11962,064
	14,000	14,968	50,368	1291,337	1323,621	52,768	0,000	10,376	11962,064
	12,000	16,968	42,684	1094,333	1121,692	52,768	0,000	9,358	11962,064
	10,000	18,968	35,000	897,329	919,762	52,768	0,000	8,332	11962,064
	8,000	20,968	27,316	700,325	717,833	52,768	0,000	7,291	11962,064
	6,000	22,968	19,632	503,321	515,904	52,768	0,000	6,218	11962,064
	4,000	24,968	12,277	314,763	322,632	52,768	0,000	5,120	8858,572
	2,000	26,968	5,732	146,955	150,629	52,768	0,000	4,056	6098,782
	0,370	28,598	1,000	25,638	26,279	52,768	0,000	3,218	4328,949
	0,000	28,968	0,000	0,000	0,000	52,768	0,000	3,032	0,000

### Tank Calibrations - Cofferdam 4

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Cofferdam 4	28,968	0,000	100,000	2601,782	2666,826	96,222	0,000	17,036	0,000
	28,036	0,932	98,000	2549,746	2613,490	96,222	0,000	16,740	2411,152
	28,000	0,968	97,918	2547,617	2611,308	96,222	0,000	16,728	2435,144
	27,992	0,976	97,900	2547,144	2610,823	96,222	0,000	16,725	2440,489
	26,000	2,968	93,013	2420,002	2480,502	96,222	0,000	16,028	4009,821
	24,000	4,968	87,295	2271,219	2328,000	96,222	0,000	15,243	6148,895
	22,000	6,968	80,763	2101,270	2153,802	96,222	0,000	14,372	8938,809
	20,000	8,968	73,420	1910,228	1957,984	96,222	0,000	13,408	12139,234
	18,000	10,968	65,736	1710,307	1753,064	96,222	0,000	12,400	12139,234
	16,000	12,968	58,052	1510,385	1548,145	96,222	0,000	11,389	12139,234
	14,000	14,968	50,368	1310,463	1343,225	96,222	0,000	10,376	12139,234
	12,000	16,968	42,684	1110,541	1138,305	96,222	0,000	9,358	12139,234
	10,000	18,968	35,000	910,620	933,385	96,222	0,000	8,332	12139,234
	8,000	20,968	27,316	710,698	728,465	96,222	0,000	7,291	12139,234
	6,000	22,968	19,632	510,776	523,545	96,222	0,000	6,218	12139,234
	4,000	24,968	12,277	319,425	327,411	96,222	0,000	5,120	8989,776
	2,000	26,968	5,732	149,131	152,859	96,222	0,000	4,056	6189,111
	0,370	28,598	1,000	26,018	26,668	96,222	0,000	3,218	4393,064
	0,000	28,968	0,000	0,000	0,000	96,222	0,000	3,032	0,000

### Tank Calibrations - Cofferdam 3

Fluid Type = Water Ballast                      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Cofferdam 3	28,968	0,000	100,000	2601,774	2666,819	145,247	0,000	17,036	0,000
	28,036	0,932	98,000	2549,739	2613,482	145,247	0,000	16,740	2411,145
	28,000	0,968	97,918	2547,610	2611,301	145,247	0,000	16,728	2435,137
	27,992	0,976	97,900	2547,137	2610,815	145,247	0,000	16,725	2440,483
	26,000	2,968	93,013	2419,995	2480,495	145,247	0,000	16,028	4009,810
	24,000	4,968	87,295	2271,213	2327,994	145,247	0,000	15,243	6148,878
	22,000	6,968	80,763	2101,264	2153,796	145,247	0,000	14,372	8938,785
	20,000	8,968	73,420	1910,223	1957,979	145,247	0,000	13,408	12139,200
	18,000	10,968	65,736	1710,302	1753,060	145,247	0,000	12,400	12139,200
	16,000	12,968	58,052	1510,381	1548,140	145,247	0,000	11,389	12139,200
	14,000	14,968	50,368	1310,460	1343,221	145,247	0,000	10,376	12139,200
	12,000	16,968	42,684	1110,538	1138,302	145,247	0,000	9,358	12139,200
	10,000	18,968	35,000	910,617	933,382	145,247	0,000	8,332	12139,200
	8,000	20,968	27,316	710,696	728,463	145,247	0,000	7,291	12139,200
	6,000	22,968	19,632	510,775	523,544	145,247	0,000	6,218	12139,200
	4,000	24,968	12,277	319,424	327,410	145,247	0,000	5,120	8989,751
	2,000	26,968	5,732	149,131	152,859	145,247	0,000	4,056	6189,094
	0,370	28,598	1,000	26,018	26,668	145,247	0,000	3,218	4393,052
	0,000	28,968	0,000	0,000	0,000	145,247	0,000	3,032	0,000

## Tank Calibrations - Cofferdam 2

Fluid Type = Water Ballast                      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Cofferdam 2	28,968	0,000	100,000	2601,789	2666,833	194,272	0,000	17,036	0,000
	28,036	0,932	98,000	2549,753	2613,497	194,272	0,000	16,740	2411,158
	28,000	0,968	97,918	2547,624	2611,315	194,272	0,000	16,728	2435,150
	27,992	0,976	97,900	2547,151	2610,830	194,272	0,000	16,725	2440,496
	26,000	2,968	93,013	2420,009	2480,509	194,272	0,000	16,028	4009,833
	24,000	4,968	87,295	2271,226	2328,006	194,272	0,000	15,243	6148,912
	22,000	6,968	80,763	2101,276	2153,808	194,272	0,000	14,372	8938,834
	20,000	8,968	73,420	1910,234	1957,990	194,272	0,000	13,408	12139,267
	18,000	10,968	65,736	1710,311	1753,069	194,272	0,000	12,400	12139,267
	16,000	12,968	58,052	1510,389	1548,149	194,272	0,000	11,389	12139,267
	14,000	14,968	50,368	1310,467	1343,228	194,272	0,000	10,376	12139,267
	12,000	16,968	42,684	1110,544	1138,308	194,272	0,000	9,358	12139,267
	10,000	18,968	35,000	910,622	933,388	194,272	0,000	8,332	12139,267
	8,000	20,968	27,316	710,700	728,467	194,272	0,000	7,291	12139,267
	6,000	22,968	19,632	510,777	523,547	194,272	0,000	6,218	12139,267
	4,000	24,968	12,277	319,426	327,412	194,272	0,000	5,120	8989,800
	2,000	26,968	5,732	149,132	152,860	194,272	0,000	4,056	6189,128
	0,370	28,598	1,000	26,018	26,668	194,272	0,000	3,218	4393,077
	0,000	28,968	0,000	0,000	0,000	194,272	0,000	3,032	0,000



## Tank Calibrations - Cofferdam 1

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Cofferdam 1	28,968	0,000	100,000	1535,325	1573,708	232,175	0,000	17,045	0,000
	28,000	0,968	98,275	1508,844	1546,565	232,176	0,000	16,791	308,265
	27,857	1,111	98,000	1504,618	1542,233	232,176	0,000	16,751	327,106
	27,806	1,162	97,900	1503,083	1540,660	232,176	0,000	16,737	334,042
	26,000	2,968	93,916	1441,920	1477,968	232,176	0,000	16,178	646,731
	24,000	4,968	88,485	1358,539	1392,503	232,176	0,000	15,453	1171,085
	22,000	6,968	81,983	1258,700	1290,167	232,176	0,000	14,616	1922,017
	20,000	8,968	74,412	1142,461	1171,023	232,176	0,000	13,660	2843,409
	18,000	10,968	66,391	1019,318	1044,801	232,175	0,000	12,649	2843,409
	16,000	12,968	58,370	896,174	918,579	232,175	0,000	11,634	2843,409
	14,000	14,968	50,350	773,031	792,357	232,175	0,000	10,615	2843,409
	12,000	16,968	42,329	649,887	666,135	232,174	0,000	9,589	2843,409
	10,000	18,968	34,308	526,744	539,913	232,174	0,000	8,550	2843,409
	8,000	20,968	26,288	403,601	413,691	232,173	0,000	7,488	2843,409
	6,000	22,968	18,267	280,457	287,469	232,171	0,000	6,370	2843,409
	4,000	24,968	10,804	165,883	170,030	232,167	0,000	5,202	1719,082
	2,000	26,968	4,713	72,362	74,171	232,163	0,000	4,081	870,817
	0,477	28,491	1,000	15,353	15,737	232,159	0,000	3,274	456,665
	0,000	28,968	0,000	0,000	0,000	232,157	0,000	3,032	0,000

## Tank Calibrations - Pique PR BR

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Pique PR BR	23,800	0,000	100,000	566,859	581,031	268,686	-1,906	16,155	0,000
	23,603	0,197	98,000	555,522	569,410	268,676	-1,879	15,950	283,410
	23,593	0,207	97,900	554,955	568,829	268,676	-1,878	15,940	282,666
	23,000	0,800	92,145	522,333	535,391	268,650	-1,802	15,324	240,774
	22,000	1,800	83,256	471,944	483,742	268,611	-1,685	14,290	184,199
	21,000	2,800	75,359	427,180	437,860	268,584	-1,582	13,271	138,644
	20,000	3,800	68,431	387,906	397,603	268,573	-1,493	12,285	101,438
	19,000	4,800	62,428	353,880	362,727	268,581	-1,420	11,349	71,725
	18,000	5,800	57,308	324,855	332,976	268,606	-1,365	10,486	48,259
	17,000	6,800	53,009	300,487	307,999	268,645	-1,328	9,713	30,848
	16,000	7,800	49,486	280,517	287,530	268,697	-1,310	9,051	18,642
	15,000	8,800	46,639	264,380	270,989	268,754	-1,306	8,503	10,696
	14,000	9,800	44,407	251,726	258,019	268,813	-1,314	8,075	5,717
	13,000	10,800	42,664	241,843	247,889	268,870	-1,329	7,750	3,112
	12,000	11,800	41,321	234,231	240,087	268,922	-1,346	7,514	1,733
	11,000	12,800	40,275	228,302	234,010	268,973	-1,362	7,345	1,278
	10,000	13,800	39,199	222,202	227,757	269,027	-1,380	7,191	1,711
	9,000	14,800	37,599	213,135	218,464	269,089	-1,402	6,988	4,303
	8,000	15,800	34,917	197,929	202,878	269,148	-1,424	6,683	12,864
	7,000	16,800	31,026	175,875	180,271	269,184	-1,435	6,269	25,043
	6,000	17,800	26,355	149,397	153,132	269,216	-1,417	5,787	34,143
	5,000	18,800	21,290	120,682	123,699	269,243	-1,368	5,262	36,453
	4,000	19,800	16,172	91,670	93,961	269,263	-1,290	4,711	32,883
	3,000	20,800	11,270	63,884	65,481	269,273	-1,190	4,148	25,890
	2,000	21,800	6,807	38,584	39,548	269,269	-1,069	3,582	17,673
	1,000	22,800	2,982	16,902	17,325	269,246	-0,930	3,027	9,948
	0,373	23,427	1,000	5,669	5,810	269,225	-0,834	2,691	5,955
	0,000	23,800	0,000	0,000	0,000	269,203	-0,776	2,500	0,000

## Tank Calibrations - Pique PR ER

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Pique PR ER	23,800	0,000	100,000	566,859	581,031	268,686	1,906	16,155	0,000
	23,603	0,197	98,000	555,522	569,410	268,676	1,879	15,950	283,410
	23,593	0,207	97,900	554,955	568,829	268,676	1,878	15,940	282,666
	23,000	0,800	92,145	522,333	535,391	268,650	1,802	15,324	240,774
	22,000	1,800	83,256	471,944	483,742	268,611	1,685	14,290	184,199
	21,000	2,800	75,359	427,180	437,860	268,584	1,582	13,271	138,644
	20,000	3,800	68,431	387,906	397,603	268,573	1,493	12,285	101,438
	19,000	4,800	62,428	353,880	362,727	268,581	1,420	11,349	71,725
	18,000	5,800	57,308	324,855	332,976	268,606	1,365	10,486	48,259
	17,000	6,800	53,009	300,487	307,999	268,645	1,328	9,713	30,848
	16,000	7,800	49,486	280,517	287,530	268,697	1,310	9,051	18,642
	15,000	8,800	46,639	264,380	270,989	268,754	1,306	8,503	10,696
	14,000	9,800	44,407	251,726	258,019	268,813	1,314	8,075	5,717
	13,000	10,800	42,664	241,843	247,889	268,870	1,329	7,750	3,112
	12,000	11,800	41,321	234,231	240,087	268,922	1,346	7,514	1,733
	11,000	12,800	40,275	228,302	234,010	268,973	1,362	7,345	1,278
	10,000	13,800	39,199	222,202	227,757	269,027	1,380	7,191	1,711
	9,000	14,800	37,599	213,135	218,464	269,089	1,402	6,988	4,303
	8,000	15,800	34,917	197,929	202,878	269,148	1,424	6,683	12,864
	7,000	16,800	31,026	175,875	180,271	269,184	1,435	6,269	25,043
	6,000	17,800	26,355	149,397	153,132	269,216	1,417	5,787	34,143
	5,000	18,800	21,290	120,682	123,699	269,243	1,368	5,262	36,453
	4,000	19,800	16,172	91,670	93,961	269,263	1,290	4,711	32,883
	3,000	20,800	11,270	63,884	65,481	269,273	1,190	4,148	25,890
	2,000	21,800	6,807	38,584	39,548	269,269	1,069	3,582	17,673
	1,000	22,800	2,982	16,902	17,325	269,246	0,930	3,027	9,948
	0,373	23,427	1,000	5,669	5,810	269,225	0,834	2,691	5,955
	0,000	23,800	0,000	0,000	0,000	269,203	0,776	2,500	0,000

## Tank Calibrations - Lastre 4 BR

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 4 BR	26,300	0,000	100,000	4891,953	5014,251	73,863	-15,611	9,342	0,000
	26,000	0,300	98,605	4823,721	4944,314	73,873	-15,564	9,104	536,685
	25,864	0,436	98,000	4794,114	4913,967	73,878	-15,543	9,000	496,455
	25,842	0,458	97,900	4789,221	4908,952	73,879	-15,539	8,983	489,908
	24,000	2,300	91,273	4465,014	4576,640	73,933	-15,254	7,821	129,146
	22,000	4,300	86,742	4243,355	4349,438	73,975	-14,993	7,026	55,906
	20,000	6,300	82,485	4035,105	4135,983	74,017	-14,718	6,305	56,367
	18,000	8,300	78,202	3825,622	3921,263	74,065	-14,410	5,610	57,535
	16,000	10,300	73,908	3615,540	3705,929	74,119	-14,065	4,948	57,161
	14,000	12,300	69,643	3406,904	3492,077	74,178	-13,681	4,332	55,286
	12,000	14,300	65,442	3201,373	3281,408	74,241	-13,254	3,775	52,260
	10,000	16,300	61,339	3000,686	3075,704	74,309	-12,784	3,292	47,886
	8,000	18,300	57,096	2793,085	2862,912	74,389	-12,236	2,871	105,895
	6,000	20,300	50,323	2461,768	2523,313	74,540	-11,296	2,325	404,672
	4,000	22,300	41,065	2008,872	2059,094	74,686	-9,781	1,729	800,926
	2,000	24,300	25,462	1245,581	1276,720	74,776	-7,870	1,109	22665,476
	0,165	26,135	1,000	48,919	50,142	76,738	-4,503	0,100	5157,176
	0,000	26,300	0,000	0,000	0,000	66,028	-0,013	0,000	0,000

## Tank Calibrations - Lastre 4 ER

Fluid Type = Water Ballast      Specific gravity = 1,025

Permeability = 97 %

Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 4 ER	26,300	0,000	100,000	4891,953	5014,251	73,863	15,611	9,342	0,000
	26,000	0,300	98,605	4823,721	4944,314	73,873	15,564	9,104	536,685
	25,864	0,436	98,000	4794,114	4913,967	73,878	15,543	9,000	496,455
	25,842	0,458	97,900	4789,221	4908,952	73,879	15,539	8,983	489,908
	24,000	2,300	91,273	4465,014	4576,640	73,933	15,254	7,821	129,146
	22,000	4,300	86,742	4243,355	4349,438	73,975	14,993	7,026	55,906
	20,000	6,300	82,485	4035,105	4135,983	74,017	14,718	6,305	56,367
	18,000	8,300	78,202	3825,622	3921,263	74,065	14,410	5,610	57,535
	16,000	10,300	73,908	3615,540	3705,929	74,119	14,065	4,948	57,161
	14,000	12,300	69,643	3406,904	3492,077	74,178	13,681	4,332	55,286
	12,000	14,300	65,442	3201,373	3281,408	74,241	13,254	3,775	52,260
	10,000	16,300	61,339	3000,686	3075,704	74,309	12,784	3,292	47,886
	8,000	18,300	57,096	2793,085	2862,912	74,389	12,236	2,871	105,895
	6,000	20,300	50,323	2461,768	2523,313	74,540	11,296	2,325	404,672
	4,000	22,300	41,065	2008,872	2059,094	74,686	9,781	1,729	800,926
	2,000	24,300	25,462	1245,581	1276,720	74,776	7,870	1,109	22665,476
	0,165	26,135	1,000	48,919	50,142	76,738	4,503	0,100	5157,176
	0,000	26,300	0,000	0,000	0,000	66,028	0,013	0,000	0,000

### Tank Calibrations - Lastre 3 BR

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 3 BR	26,271	0,000	100,000	6300,128	6457,632	119,611	-15,946	8,500	0,000
	26,000	0,271	98,894	6230,445	6386,206	119,614	-15,913	8,303	616,806
	25,771	0,500	98,000	6174,126	6328,479	119,616	-15,884	8,142	541,205
	25,745	0,526	97,900	6167,826	6322,021	119,617	-15,881	8,124	532,955
	24,000	2,271	92,405	5821,651	5967,192	119,633	-15,667	7,123	152,581
	22,000	4,271	88,376	5567,803	5706,998	119,646	-15,458	6,396	65,431
	20,000	6,271	84,602	5330,032	5463,283	119,659	-15,239	5,743	65,431
	18,000	8,271	80,828	5092,261	5219,567	119,673	-15,001	5,122	65,430
	16,000	10,271	77,054	4854,502	4975,864	119,689	-14,739	4,539	65,396
	14,000	12,271	73,282	4616,880	4732,302	119,706	-14,450	3,999	65,166
	12,000	14,271	69,519	4379,779	4489,273	119,724	-14,131	3,510	64,510
	10,000	16,271	65,774	4143,864	4247,460	119,739	-13,777	3,082	63,249
	8,000	18,271	61,825	3895,040	3992,416	119,751	-13,365	2,705	141,588
	6,000	20,271	55,498	3496,476	3583,888	119,771	-12,679	2,221	571,002
	4,000	22,271	46,328	2918,730	2991,699	119,800	-11,552	1,675	1435,994
	2,000	24,271	30,002	1890,146	1937,400	119,896	-10,070	1,066	39018,174
	0,099	26,172	1,000	63,001	64,576	120,768	-7,879	0,087	22315,857
	0,000	26,271	0,000	0,000	0,000	95,113	-0,048	0,029	0,000

### Tank Calibrations - Lastre 3 ER

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 3 ER	26,271	0,000	100,000	6300,128	6457,632	119,611	15,946	8,500	0,000
	26,000	0,271	98,894	6230,445	6386,206	119,614	15,913	8,303	616,806
	25,771	0,500	98,000	6174,126	6328,479	119,616	15,884	8,142	541,205
	25,745	0,526	97,900	6167,826	6322,021	119,617	15,881	8,124	532,955
	24,000	2,271	92,405	5821,651	5967,192	119,633	15,667	7,123	152,581
	22,000	4,271	88,376	5567,803	5706,998	119,646	15,458	6,396	65,431
	20,000	6,271	84,602	5330,032	5463,283	119,659	15,239	5,743	65,431
	18,000	8,271	80,828	5092,261	5219,567	119,673	15,001	5,122	65,430
	16,000	10,271	77,054	4854,502	4975,864	119,689	14,739	4,539	65,396
	14,000	12,271	73,282	4616,880	4732,302	119,706	14,450	3,999	65,166
	12,000	14,271	69,519	4379,779	4489,273	119,724	14,131	3,510	64,510
	10,000	16,271	65,774	4143,864	4247,460	119,739	13,777	3,082	63,249
	8,000	18,271	61,825	3895,040	3992,416	119,751	13,365	2,705	141,588
	6,000	20,271	55,498	3496,476	3583,888	119,771	12,679	2,221	571,002
	4,000	22,271	46,328	2918,730	2991,699	119,800	11,552	1,675	1435,994
	2,000	24,271	30,002	1890,146	1937,400	119,896	10,070	1,066	39018,174
	0,099	26,172	1,000	63,001	64,576	120,768	7,879	0,087	22315,857
	0,000	26,271	0,000	0,000	0,000	95,113	0,048	0,029	0,000

## Tank Calibrations - Lastre 2 BR

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 2 BR	26,254	0,000	100,000	5996,937	6146,861	167,618	-15,733	8,698	0,000
	26,000	0,254	98,910	5931,590	6079,880	167,610	-15,698	8,505	615,238
	25,778	0,477	98,000	5876,999	6023,924	167,604	-15,667	8,344	541,840
	25,753	0,502	97,900	5871,001	6017,776	167,603	-15,664	8,326	533,968
	24,000	2,254	92,104	5523,425	5661,511	167,560	-15,425	7,278	151,519
	22,000	4,254	87,902	5271,415	5403,200	167,529	-15,195	6,521	63,374
	20,000	6,254	83,983	5036,419	5162,329	167,499	-14,955	5,844	63,154
	18,000	8,254	80,070	4801,723	4921,766	167,467	-14,692	5,198	62,933
	16,000	10,254	76,162	4567,365	4681,549	167,433	-14,403	4,591	62,627
	14,000	12,254	72,266	4333,748	4442,092	167,398	-14,083	4,027	61,712
	12,000	14,254	68,406	4102,239	4204,795	167,365	-13,731	3,518	59,472
	10,000	16,254	64,624	3875,440	3972,326	167,343	-13,347	3,077	55,359
	8,000	18,254	60,745	3642,850	3733,922	167,341	-12,912	2,698	117,313
	6,000	20,254	54,563	3272,086	3353,888	167,338	-12,192	2,214	470,761
	4,000	22,254	45,675	2739,073	2807,550	167,350	-11,030	1,673	1145,976
	2,000	24,254	29,906	1793,415	1838,251	167,332	-9,524	1,077	34226,357
	0,083	26,172	1,000	59,969	61,469	166,112	-7,874	0,088	20070,921
	0,000	26,254	0,000	0,000	0,000	144,542	-3,597	0,046	0,000



## Tank Calibrations - Lastre 2 ER

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 2 ER	26,254	0,000	100,000	5996,937	6146,861	167,618	15,733	8,698	0,000
	26,000	0,254	98,910	5931,590	6079,880	167,610	15,698	8,505	615,238
	25,778	0,477	98,000	5876,999	6023,924	167,604	15,667	8,344	541,840
	25,753	0,502	97,900	5871,001	6017,776	167,603	15,664	8,326	533,968
	24,000	2,254	92,104	5523,425	5661,511	167,560	15,425	7,278	151,519
	22,000	4,254	87,902	5271,415	5403,200	167,529	15,195	6,521	63,374
	20,000	6,254	83,983	5036,419	5162,329	167,499	14,955	5,844	63,154
	18,000	8,254	80,070	4801,723	4921,766	167,467	14,692	5,198	62,933
	16,000	10,254	76,162	4567,365	4681,549	167,433	14,403	4,591	62,627
	14,000	12,254	72,266	4333,748	4442,092	167,398	14,083	4,027	61,712
	12,000	14,254	68,406	4102,239	4204,795	167,365	13,731	3,518	59,472
	10,000	16,254	64,624	3875,440	3972,326	167,343	13,347	3,077	55,359
	8,000	18,254	60,745	3642,850	3733,922	167,341	12,912	2,698	117,313
	6,000	20,254	54,563	3272,086	3353,888	167,338	12,192	2,214	470,761
	4,000	22,254	45,675	2739,073	2807,550	167,350	11,030	1,673	1145,976
	2,000	24,254	29,906	1793,415	1838,251	167,332	9,524	1,077	34226,357
	0,083	26,172	1,000	59,969	61,469	166,112	7,874	0,088	20070,921
	0,000	26,254	0,000	0,000	0,000	144,542	3,597	0,046	0,000

## Tank Calibrations - Lastre 1 BR

Fluid Type = Water Ballast      Specific gravity = 1,025  
 Permeability = 97 %  
 Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 1 BR	26,254	0,000	100,000	4149,818	4253,564	213,247	-13,942	11,812	0,000
	26,000	0,254	98,337	4080,800	4182,820	213,216	-13,895	11,569	1732,793
	25,947	0,307	98,000	4066,822	4168,493	213,209	-13,885	11,519	1704,160
	25,932	0,323	97,900	4062,672	4164,239	213,207	-13,882	11,504	1695,689
	24,000	2,254	87,534	3632,519	3723,332	212,941	-13,497	9,898	895,068
	22,000	4,254	80,155	3326,283	3409,440	212,636	-13,114	8,684	644,564
	20,000	6,254	73,508	3050,431	3126,691	212,322	-12,705	7,565	617,562
	18,000	8,254	67,278	2791,921	2861,719	212,006	-12,255	6,501	591,460
	16,000	10,254	61,496	2551,966	2615,765	211,697	-11,761	5,508	562,455
	14,000	12,254	56,218	2332,953	2391,277	211,411	-11,228	4,611	523,445
	12,000	14,254	51,542	2138,895	2192,368	211,166	-10,669	3,844	466,527
	10,000	16,254	47,608	1975,661	2025,053	210,984	-10,119	3,246	383,490
	8,000	18,254	44,344	1840,176	1886,181	210,885	-9,600	2,819	448,586
	6,000	20,254	39,374	1633,967	1674,816	210,752	-8,781	2,295	822,815
	4,000	22,254	32,606	1353,079	1386,906	210,560	-7,546	1,731	1175,274
	2,000	24,254	20,878	866,418	888,079	210,291	-6,049	1,150	10751,774
	0,174	26,080	1,000	41,498	42,536	208,177	-3,797	0,144	2745,833
	0,000	26,254	0,000	0,000	0,000	200,429	-0,099	0,046	0,000

## Tank Calibrations - Lastre 1 ER

Fluid Type = Water Ballast      Specific gravity = 1,025

Permeability = 97 %

Trim = 0 m (+ve by stern); Heel = 0 deg to starboard

Tank Name	Sounding m	Ullage m	% Full	Capacity m <sup>3</sup>	Capacity tonne	LCG m	TCG m	VCG m	FSM tonne.m
Lastre 1 ER	26,254	0,000	100,000	4149,818	4253,564	213,247	13,942	11,812	0,000
	26,000	0,254	98,337	4080,800	4182,820	213,216	13,895	11,569	1732,793
	25,947	0,307	98,000	4066,822	4168,493	213,209	13,885	11,519	1704,160
	25,932	0,323	97,900	4062,672	4164,239	213,207	13,882	11,504	1695,689
	24,000	2,254	87,534	3632,519	3723,332	212,941	13,497	9,898	895,068
	22,000	4,254	80,155	3326,283	3409,440	212,636	13,114	8,684	644,564
	20,000	6,254	73,508	3050,431	3126,691	212,322	12,705	7,565	617,562
	18,000	8,254	67,278	2791,921	2861,719	212,006	12,255	6,501	591,460
	16,000	10,254	61,496	2551,966	2615,765	211,697	11,761	5,508	562,455
	14,000	12,254	56,218	2332,953	2391,277	211,411	11,228	4,611	523,445
	12,000	14,254	51,542	2138,895	2192,368	211,166	10,669	3,844	466,527
	10,000	16,254	47,608	1975,661	2025,053	210,984	10,119	3,246	383,490
	8,000	18,254	44,344	1840,176	1886,181	210,885	9,600	2,819	448,586
	6,000	20,254	39,374	1633,967	1674,816	210,752	8,781	2,295	822,815
	4,000	22,254	32,606	1353,079	1386,906	210,560	7,546	1,731	1175,274
	2,000	24,254	20,878	866,418	888,079	210,291	6,049	1,150	10751,774
	0,174	26,080	1,000	41,498	42,536	208,177	3,797	0,144	2745,833
	0,000	26,254	0,000	0,000	0,000	200,429	0,099	0,046	0,000

# ANEXO IV

Tablas de KN

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

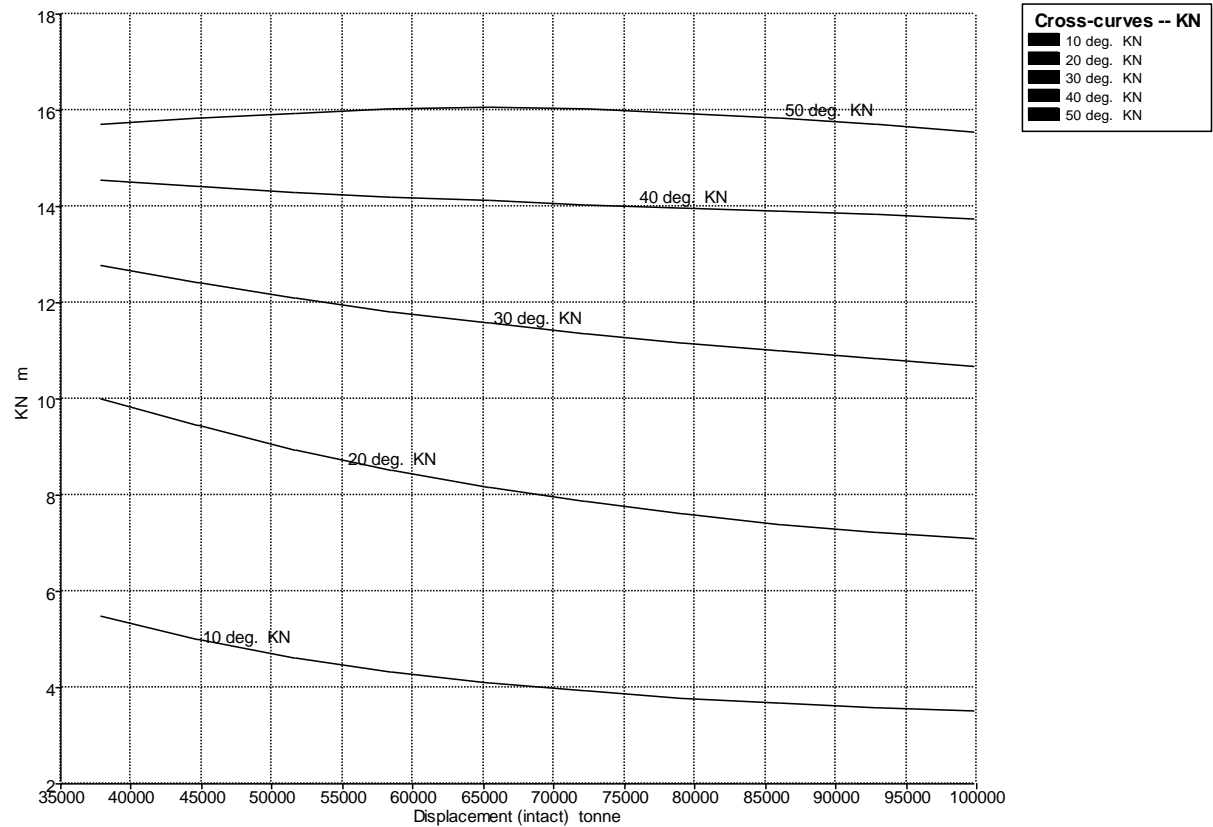
Model file: F:\TFM\CONTENIDO\TFG\CUADERNO 3\MÁSTER\Modelo casco final (Medium precision, 67 sections, Trimming on, Skin thickness not applied). Long. datum: AP; Vert. datum: Baseline. Analysis tolerance - ideal(worst case): Disp.%, 0,01000(0,100); Trim%(LCG-TCG): 0,01000(0,100); Heel%(LCG-TCG): 0,01000(0,100)

### Damage Case - Intact

Fixed Trim = 0 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,996	0,000 (fixed)	136,995	0,000	0,000	5,500	10,010	12,765	14,553	15,719
44777	5,772	0,000 (fixed)	136,717	0,000	0,000	4,990	9,437	12,412	14,415	15,837
51667	6,530	0,000 (fixed)	136,387	0,000	0,000	4,611	8,946	12,100	14,298	15,937
58557	7,274	0,000 (fixed)	136,008	0,000	0,000	4,322	8,524	11,822	14,199	16,022
65447	8,005	0,000 (fixed)	135,602	0,000	0,000	4,098	8,161	11,576	14,114	16,051
72338	8,723	0,000 (fixed)	135,161	0,000	0,000	3,922	7,856	11,358	14,038	16,021
79228	9,431	0,000 (fixed)	134,697	0,000	0,000	3,781	7,605	11,163	13,969	15,947
86118	10,130	0,000 (fixed)	134,214	0,000	0,000	3,670	7,400	10,986	13,906	15,840
93008	10,819	0,000 (fixed)	133,714	0,000	0,000	3,582	7,233	10,826	13,839	15,706
99898	11,500	0,000 (fixed)	133,199	0,000	0,000	3,513	7,097	10,681	13,744	15,552

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

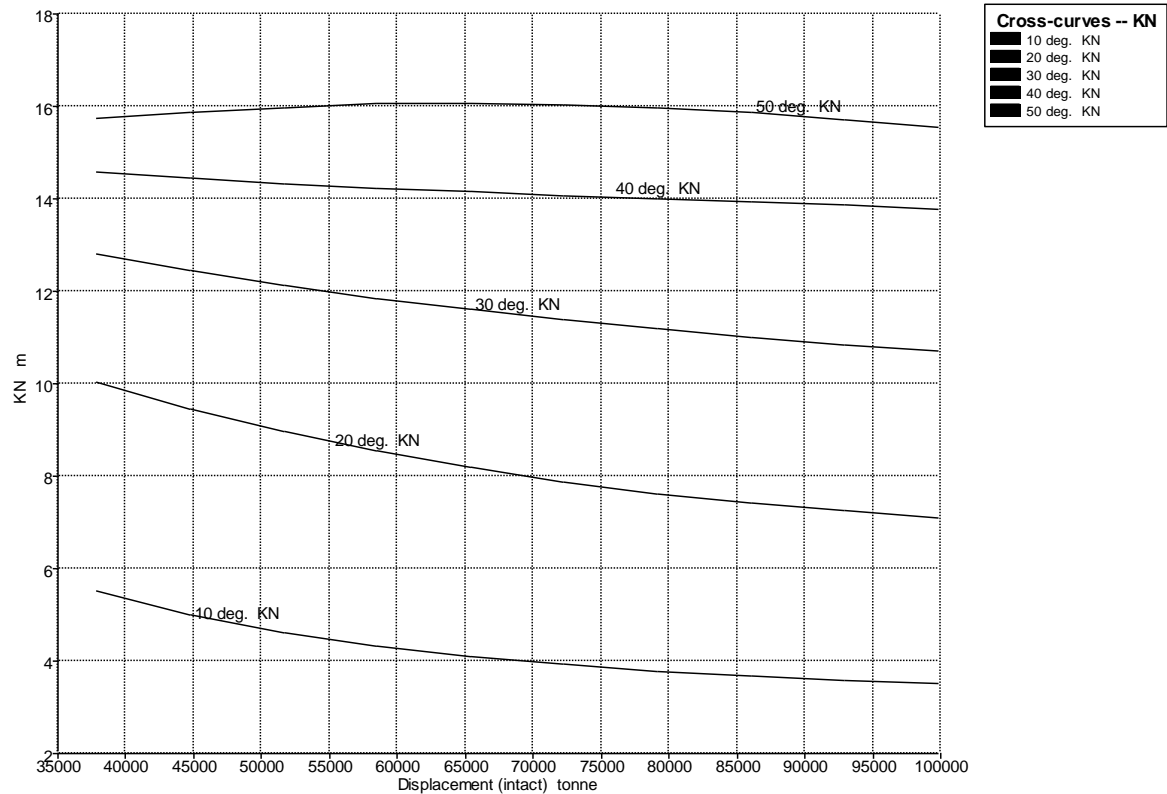
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### Damage Case - Intact

Fixed Trim = 0,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,997	0,500 (fixed)	135,368	0,000	0,000	5,513	10,034	12,800	14,588	15,750
44777	5,771	0,500 (fixed)	135,254	0,000	0,000	5,002	9,460	12,445	14,453	15,870
51667	6,528	0,500 (fixed)	135,055	0,000	0,000	4,622	8,968	12,131	14,335	15,971
58557	7,269	0,500 (fixed)	134,775	0,000	0,000	4,332	8,545	11,851	14,235	16,055
65447	7,998	0,500 (fixed)	134,447	0,000	0,000	4,107	8,181	11,604	14,148	16,081
72338	8,715	0,500 (fixed)	134,075	0,000	0,000	3,930	7,875	11,384	14,068	16,047
79228	9,421	0,500 (fixed)	133,668	0,000	0,000	3,789	7,623	11,187	13,996	15,969
86118	10,117	0,500 (fixed)	133,234	0,000	0,000	3,678	7,418	11,008	13,930	15,857
93008	10,804	0,500 (fixed)	132,775	0,000	0,000	3,590	7,249	10,846	13,858	15,721
99898	11,482	0,500 (fixed)	132,293	0,000	0,000	3,520	7,110	10,699	13,760	15,563



## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

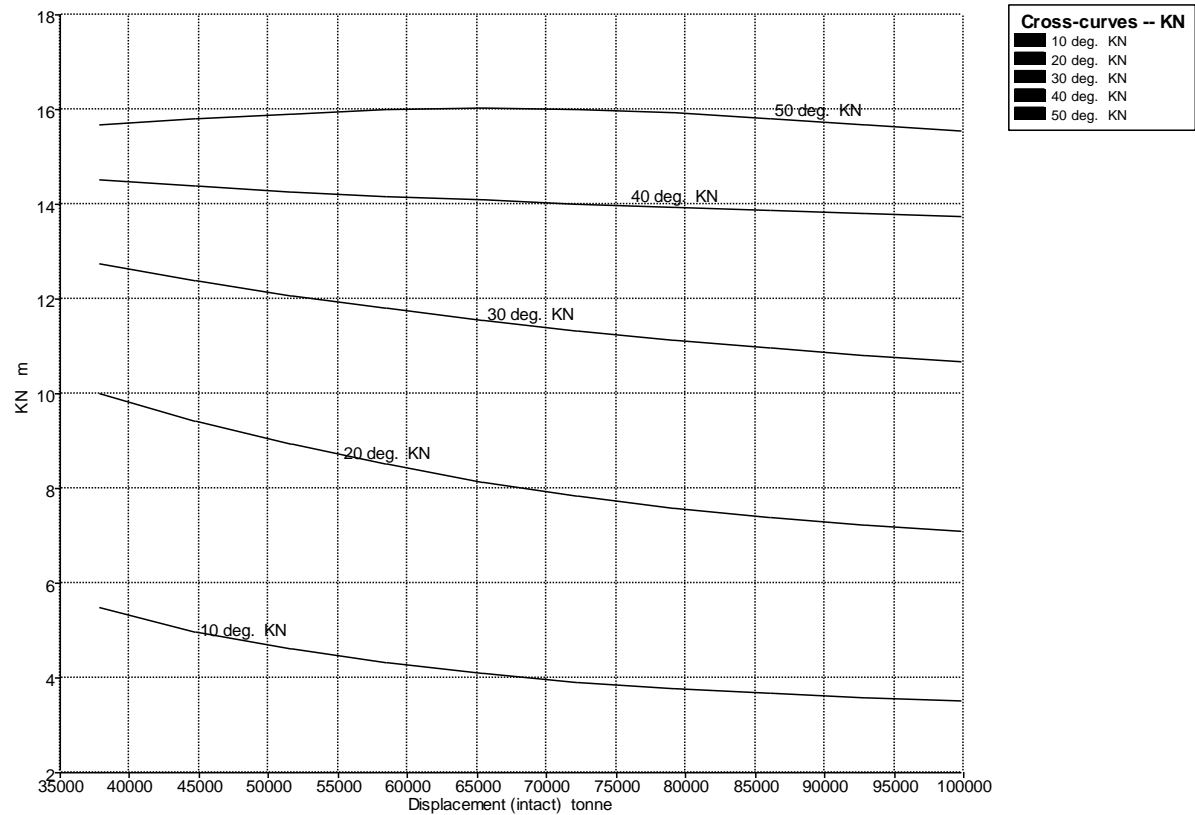
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### Damage Case - Intact

Fixed Trim = -0,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,994	-0,500 (fixed)	138,613	0,000	0,000	5,487	9,985	12,729	14,516	15,689
44777	5,772	-0,500 (fixed)	138,169	0,000	0,000	4,978	9,415	12,377	14,377	15,804
51667	6,532	-0,500 (fixed)	137,708	0,000	0,000	4,600	8,925	12,069	14,260	15,903
58557	7,278	-0,500 (fixed)	137,233	0,000	0,000	4,313	8,503	11,794	14,164	15,986
65447	8,010	-0,500 (fixed)	136,744	0,000	0,000	4,089	8,141	11,549	14,081	16,020
72338	8,731	-0,500 (fixed)	136,236	0,000	0,000	3,913	7,837	11,333	14,008	15,995
79228	9,441	-0,500 (fixed)	135,716	0,000	0,000	3,774	7,587	11,139	13,942	15,925
86118	10,142	-0,500 (fixed)	135,186	0,000	0,000	3,663	7,383	10,964	13,882	15,821
93008	10,834	-0,500 (fixed)	134,644	0,000	0,000	3,575	7,218	10,806	13,819	15,690
99898	11,517	-0,500 (fixed)	134,093	0,000	0,000	3,506	7,083	10,663	13,728	15,539

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

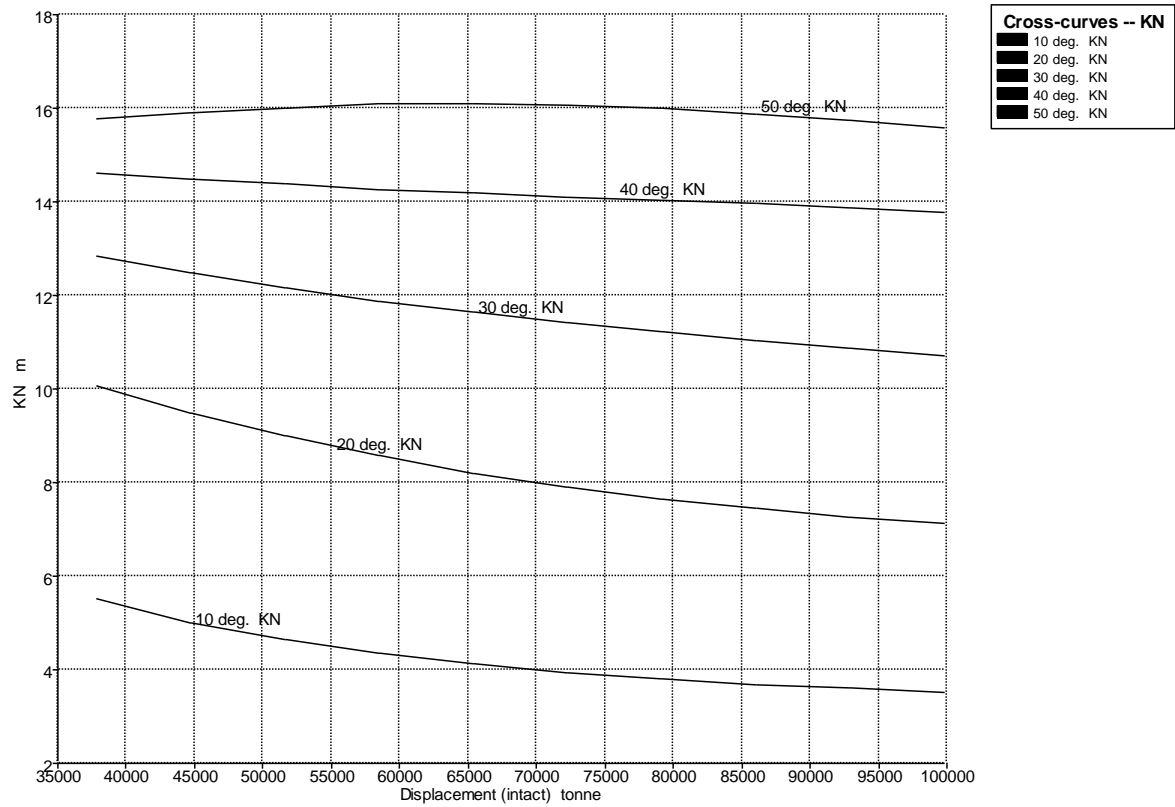
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### Damage Case - Intact

Fixed Trim = 1 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,997	1,000 (fixed)	133,732	0,000	0,000	5,527	10,057	12,835	14,623	15,782
44777	5,769	1,000 (fixed)	133,789	0,000	0,000	5,014	9,482	12,478	14,490	15,903
51667	6,524	1,000 (fixed)	133,711	0,000	0,000	4,633	8,991	12,161	14,373	16,004
58557	7,264	1,000 (fixed)	133,535	0,000	0,000	4,343	8,567	11,880	14,271	16,087
65447	7,991	1,000 (fixed)	133,282	0,000	0,000	4,117	8,202	11,632	14,181	16,109
72338	8,705	1,000 (fixed)	132,977	0,000	0,000	3,939	7,895	11,411	14,098	16,071
79228	9,409	1,000 (fixed)	132,628	0,000	0,000	3,798	7,643	11,211	14,023	15,989
86118	10,103	1,000 (fixed)	132,242	0,000	0,000	3,686	7,436	11,031	13,954	15,874
93008	10,788	1,000 (fixed)	131,826	0,000	0,000	3,598	7,265	10,867	13,877	15,735
99898	11,464	1,000 (fixed)	131,377	0,000	0,000	3,528	7,125	10,718	13,774	15,574

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

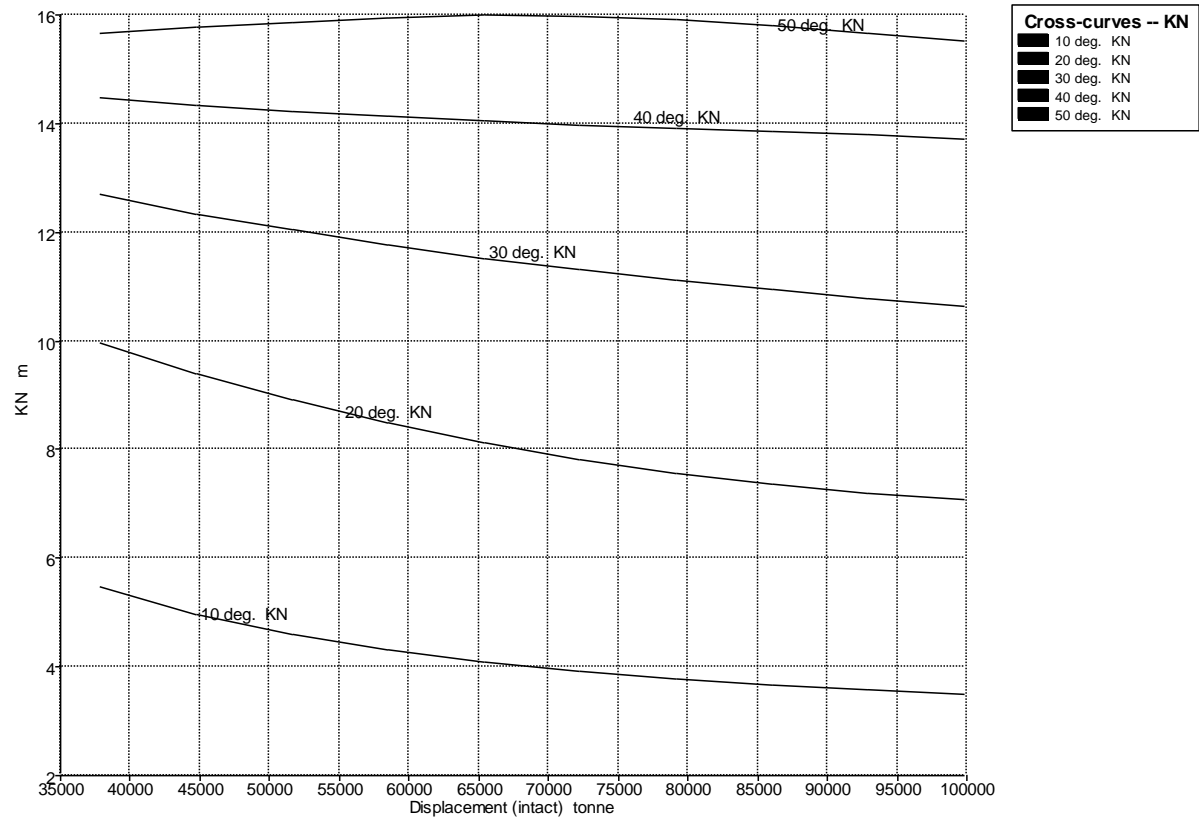
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### Damage Case - Intact

Fixed Trim = -1 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,991	-1,000 (fixed)	140,221	0,000	0,000	5,473	9,959	12,692	14,478	15,658
44777	5,771	-1,000 (fixed)	139,608	0,000	0,000	4,967	9,392	12,342	14,339	15,771
51667	6,533	-1,000 (fixed)	139,017	0,000	0,000	4,590	8,903	12,038	14,223	15,868
58557	7,281	-1,000 (fixed)	138,446	0,000	0,000	4,303	8,482	11,765	14,128	15,950
65447	8,015	-1,000 (fixed)	137,874	0,000	0,000	4,081	8,121	11,523	14,048	15,987
72338	8,738	-1,000 (fixed)	137,303	0,000	0,000	3,906	7,818	11,308	13,978	15,967
79228	9,451	-1,000 (fixed)	136,727	0,000	0,000	3,766	7,569	11,116	13,915	15,901
86118	10,154	-1,000 (fixed)	136,147	0,000	0,000	3,656	7,367	10,943	13,859	15,801
93008	10,847	-1,000 (fixed)	135,564	0,000	0,000	3,568	7,203	10,786	13,798	15,674
99898	11,533	-1,000 (fixed)	134,979	0,000	0,000	3,500	7,070	10,645	13,711	15,526

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

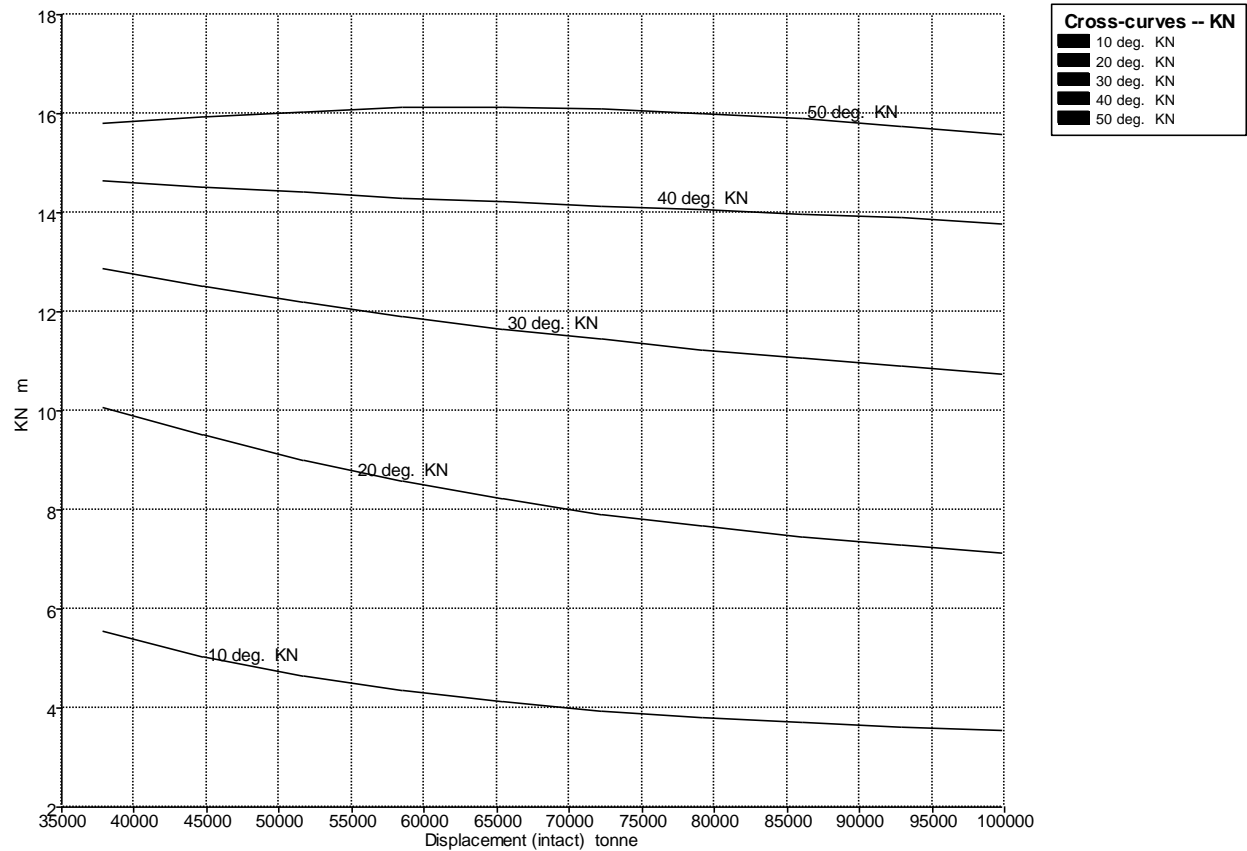
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### Damage Case - Intact

Fixed Trim = 1,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,996	1,500 (fixed)	132,085	0,000	0,000	5,540	10,079	12,869	14,656	15,814
44777	5,767	1,500 (fixed)	132,312	0,000	0,000	5,026	9,504	12,510	14,527	15,935
51667	6,520	1,500 (fixed)	132,357	0,000	0,000	4,644	9,013	12,191	14,410	16,037
58557	7,258	1,500 (fixed)	132,282	0,000	0,000	4,353	8,589	11,909	14,306	16,116
65447	7,982	1,500 (fixed)	132,111	0,000	0,000	4,126	8,224	11,660	14,214	16,136
72338	8,695	1,500 (fixed)	131,870	0,000	0,000	3,948	7,916	11,437	14,128	16,094
79228	9,397	1,500 (fixed)	131,577	0,000	0,000	3,807	7,663	11,236	14,050	16,008
86118	10,089	1,500 (fixed)	131,240	0,000	0,000	3,695	7,454	11,054	13,978	15,890
93008	10,771	1,500 (fixed)	130,865	0,000	0,000	3,606	7,282	10,888	13,895	15,748
99898	11,445	1,500 (fixed)	130,452	0,000	0,000	3,536	7,139	10,737	13,788	15,584



## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

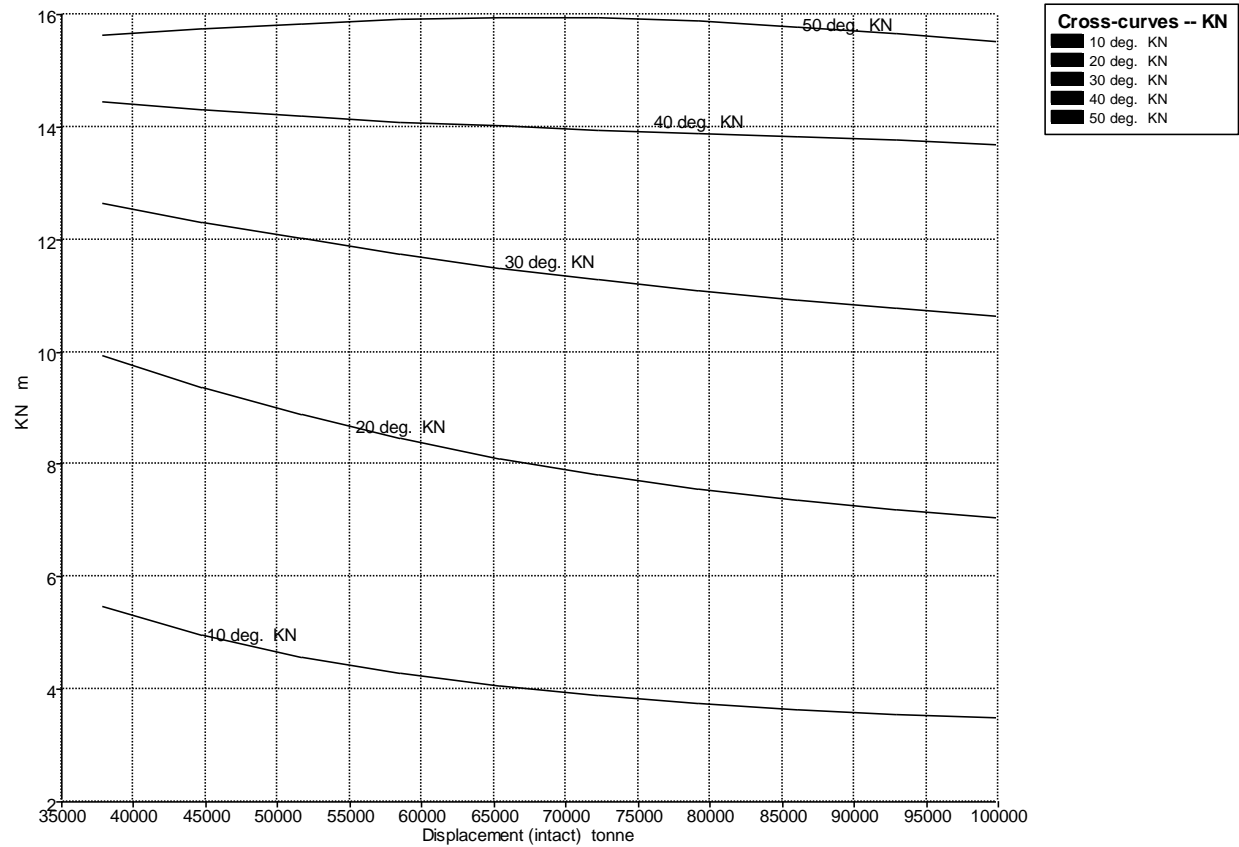
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### Damage Case - Intact

Fixed Trim = -1,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,988	-1,500 (fixed)	141,821	0,000	0,000	5,460	9,932	12,655	14,440	15,628
44777	5,769	-1,500 (fixed)	141,036	0,000	0,000	4,955	9,369	12,307	14,301	15,737
51667	6,533	-1,500 (fixed)	140,318	0,000	0,000	4,580	8,882	12,006	14,186	15,833
58557	7,283	-1,500 (fixed)	139,648	0,000	0,000	4,294	8,462	11,737	14,093	15,914
65447	8,019	-1,500 (fixed)	138,993	0,000	0,000	4,072	8,102	11,497	14,015	15,954
72338	8,745	-1,500 (fixed)	138,359	0,000	0,000	3,898	7,801	11,283	13,948	15,938
79228	9,459	-1,500 (fixed)	137,727	0,000	0,000	3,759	7,553	11,093	13,889	15,877
86118	10,164	-1,500 (fixed)	137,098	0,000	0,000	3,649	7,351	10,922	13,836	15,780
93008	10,860	-1,500 (fixed)	136,473	0,000	0,000	3,562	7,188	10,767	13,777	15,656
99898	11,548	-1,500 (fixed)	135,855	0,000	0,000	3,494	7,057	10,628	13,693	15,511

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

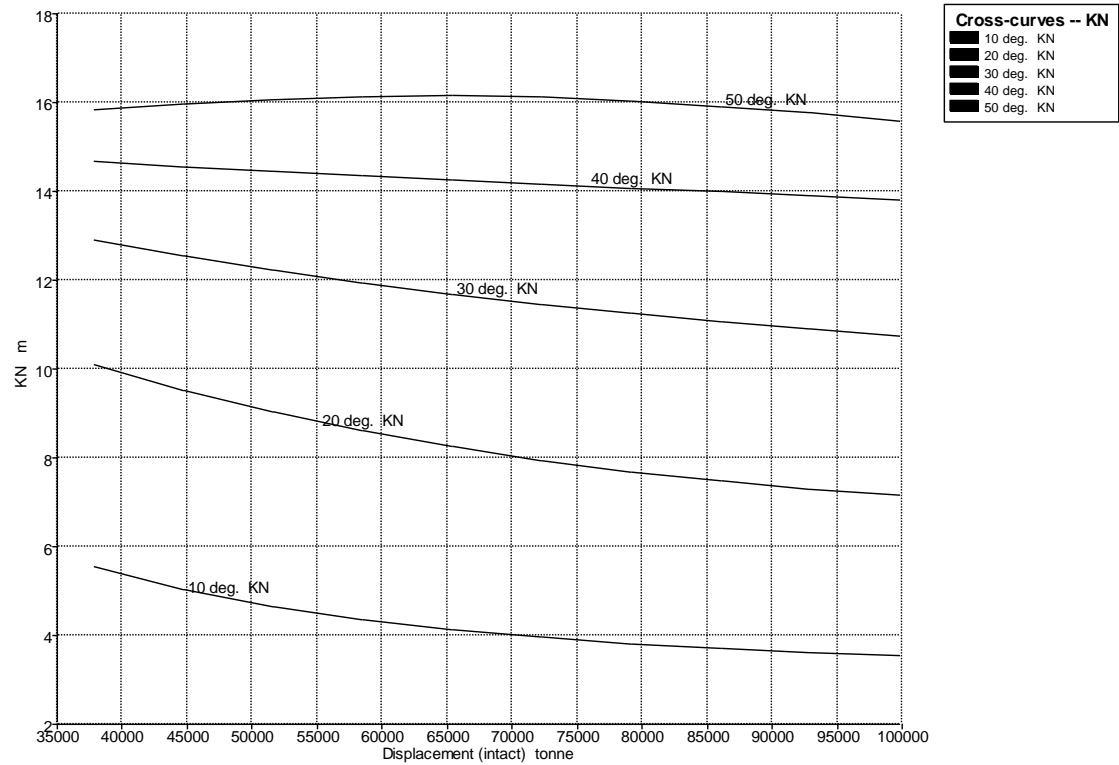
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### Damage Case - Intact

Fixed Trim = 2 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,994	2,000 (fixed)	130,428	0,000	0,000	5,553	10,101	12,902	14,688	15,845
44777	5,763	2,000 (fixed)	130,824	0,000	0,000	5,039	9,526	12,541	14,563	15,967
51667	6,514	2,000 (fixed)	130,992	0,000	0,000	4,656	9,035	12,222	14,447	16,070
58557	7,251	2,000 (fixed)	131,018	0,000	0,000	4,364	8,612	11,939	14,342	16,145
65447	7,973	2,000 (fixed)	130,928	0,000	0,000	4,137	8,246	11,688	14,247	16,161
72338	8,684	2,000 (fixed)	130,754	0,000	0,000	3,958	7,938	11,463	14,158	16,115
79228	9,384	2,000 (fixed)	130,518	0,000	0,000	3,816	7,683	11,261	14,077	16,026
86118	10,073	2,000 (fixed)	130,229	0,000	0,000	3,703	7,473	11,077	14,001	15,905
93008	10,754	2,000 (fixed)	129,893	0,000	0,000	3,615	7,298	10,909	13,913	15,759
99898	11,425	2,000 (fixed)	129,517	0,000	0,000	3,545	7,154	10,756	13,800	15,592

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

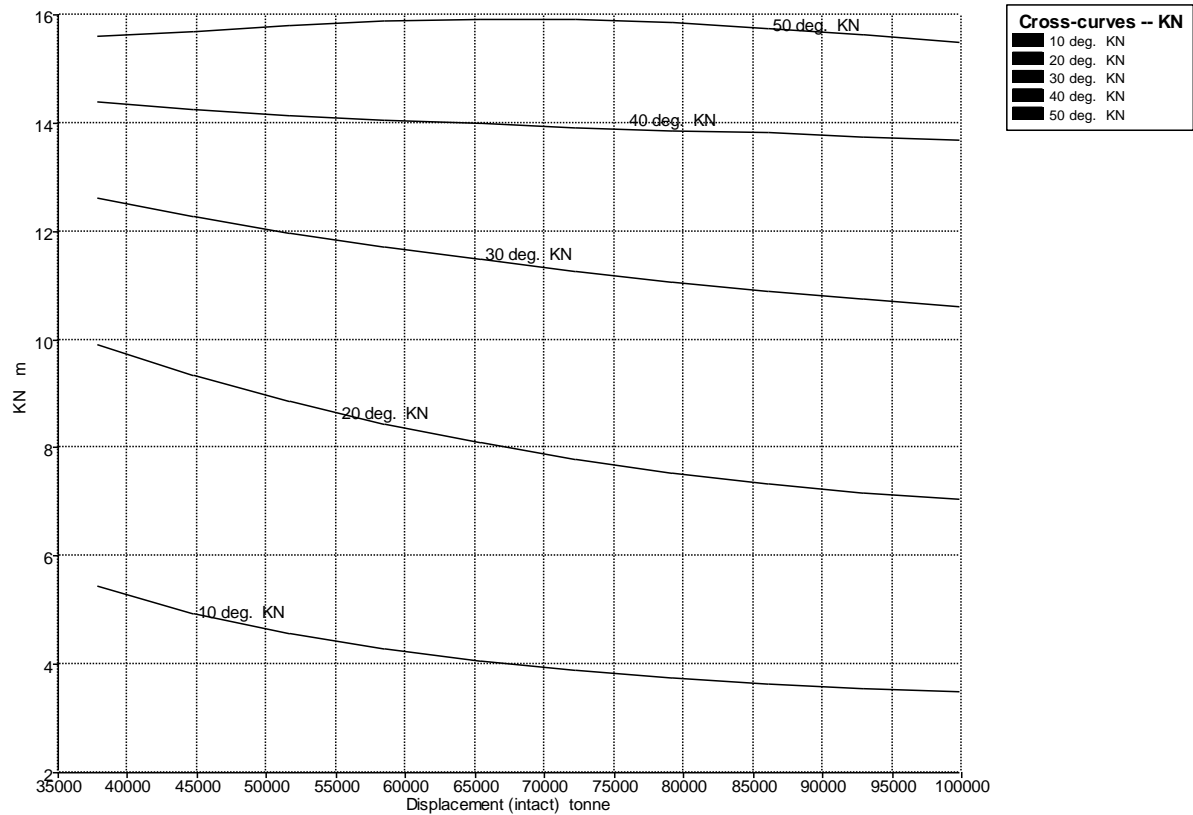
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### Damage Case - Intact

Fixed Trim = -2 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,966	-2,000 (fixed)	142,990	0,000	0,000	5,452	9,904	12,618	14,401	15,598
44777	5,766	-2,000 (fixed)	142,452	0,000	0,000	4,944	9,345	12,272	14,262	15,703
51667	6,532	-2,000 (fixed)	141,612	0,000	0,000	4,570	8,861	11,975	14,150	15,797
58557	7,284	-2,000 (fixed)	140,839	0,000	0,000	4,285	8,443	11,709	14,058	15,878
65447	8,023	-2,000 (fixed)	140,106	0,000	0,000	4,064	8,084	11,471	13,982	15,920
72338	8,750	-2,000 (fixed)	139,404	0,000	0,000	3,891	7,784	11,259	13,919	15,908
79228	9,467	-2,000 (fixed)	138,715	0,000	0,000	3,753	7,537	11,070	13,863	15,851
86118	10,174	-2,000 (fixed)	138,039	0,000	0,000	3,643	7,336	10,901	13,813	15,758
93008	10,873	-2,000 (fixed)	137,375	0,000	0,000	3,556	7,174	10,749	13,755	15,638
99898	11,562	-2,000 (fixed)	136,725	0,000	0,000	3,488	7,044	10,612	13,675	15,496

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

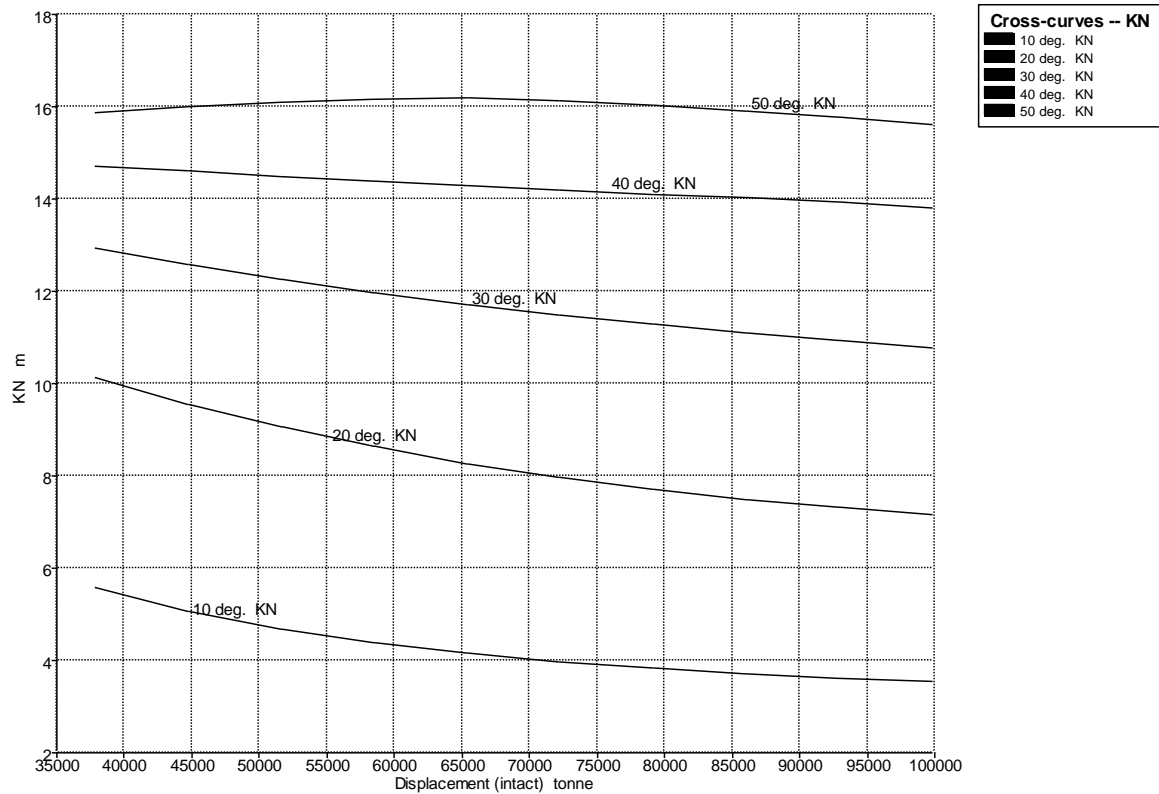
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### Damage Case - Intact

Fixed Trim = 2,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,991	2,500 (fixed)	128,764	0,000	0,000	5,567	10,121	12,934	14,720	15,877
44777	5,758	2,500 (fixed)	129,326	0,000	0,000	5,051	9,548	12,572	14,598	15,999
51667	6,508	2,500 (fixed)	129,624	0,000	0,000	4,668	9,058	12,251	14,483	16,101
58557	7,242	2,500 (fixed)	129,741	0,000	0,000	4,375	8,635	11,968	14,377	16,172
65447	7,963	2,500 (fixed)	129,733	0,000	0,000	4,147	8,269	11,716	14,279	16,184
72338	8,672	2,500 (fixed)	129,628	0,000	0,000	3,968	7,960	11,490	14,188	16,135
79228	9,370	2,500 (fixed)	129,448	0,000	0,000	3,825	7,704	11,286	14,105	16,042
86118	10,057	2,500 (fixed)	129,207	0,000	0,000	3,713	7,492	11,100	14,024	15,919
93008	10,735	2,500 (fixed)	128,910	0,000	0,000	3,624	7,315	10,930	13,929	15,770
99898	11,404	2,500 (fixed)	128,573	0,000	0,000	3,553	7,168	10,776	13,812	15,600



## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

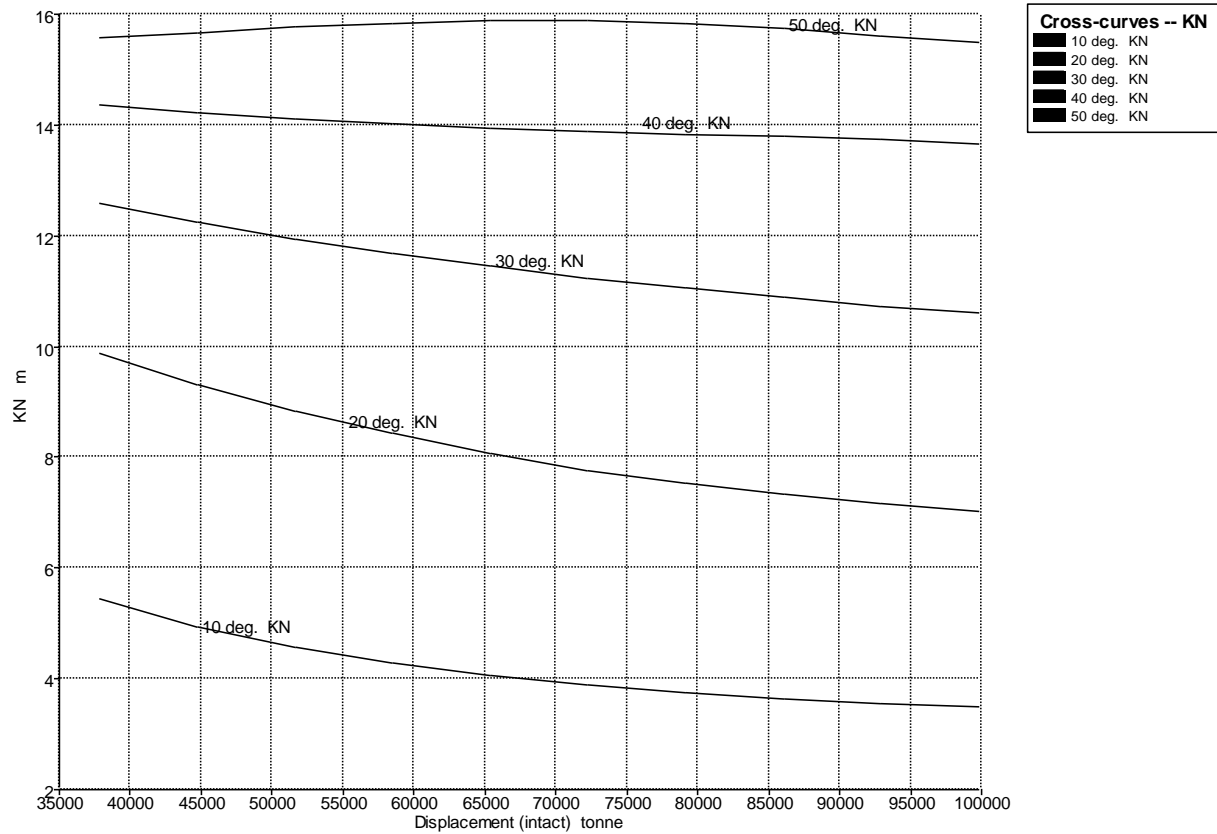
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### Damage Case - Intact

Fixed Trim = -2,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,964	-2,500 (fixed)	144,652	0,000	0,000	5,439	9,875	12,580	14,362	15,568
44777	5,762	-2,500 (fixed)	143,859	0,000	0,000	4,933	9,322	12,238	14,225	15,670
51667	6,530	-2,500 (fixed)	142,894	0,000	0,000	4,561	8,840	11,943	14,114	15,760
58557	7,284	-2,500 (fixed)	142,018	0,000	0,000	4,277	8,423	11,681	14,023	15,842
65447	8,025	-2,500 (fixed)	141,208	0,000	0,000	4,057	8,067	11,446	13,950	15,885
72338	8,755	-2,500 (fixed)	140,437	0,000	0,000	3,884	7,767	11,236	13,889	15,877
79228	9,474	-2,500 (fixed)	139,694	0,000	0,000	3,746	7,522	11,048	13,837	15,824
86118	10,184	-2,500 (fixed)	138,972	0,000	0,000	3,637	7,322	10,881	13,790	15,735
93008	10,884	-2,500 (fixed)	138,268	0,000	0,000	3,551	7,161	10,730	13,734	15,618
99898	11,576	-2,500 (fixed)	137,587	0,000	0,000	3,483	7,032	10,595	13,656	15,480

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

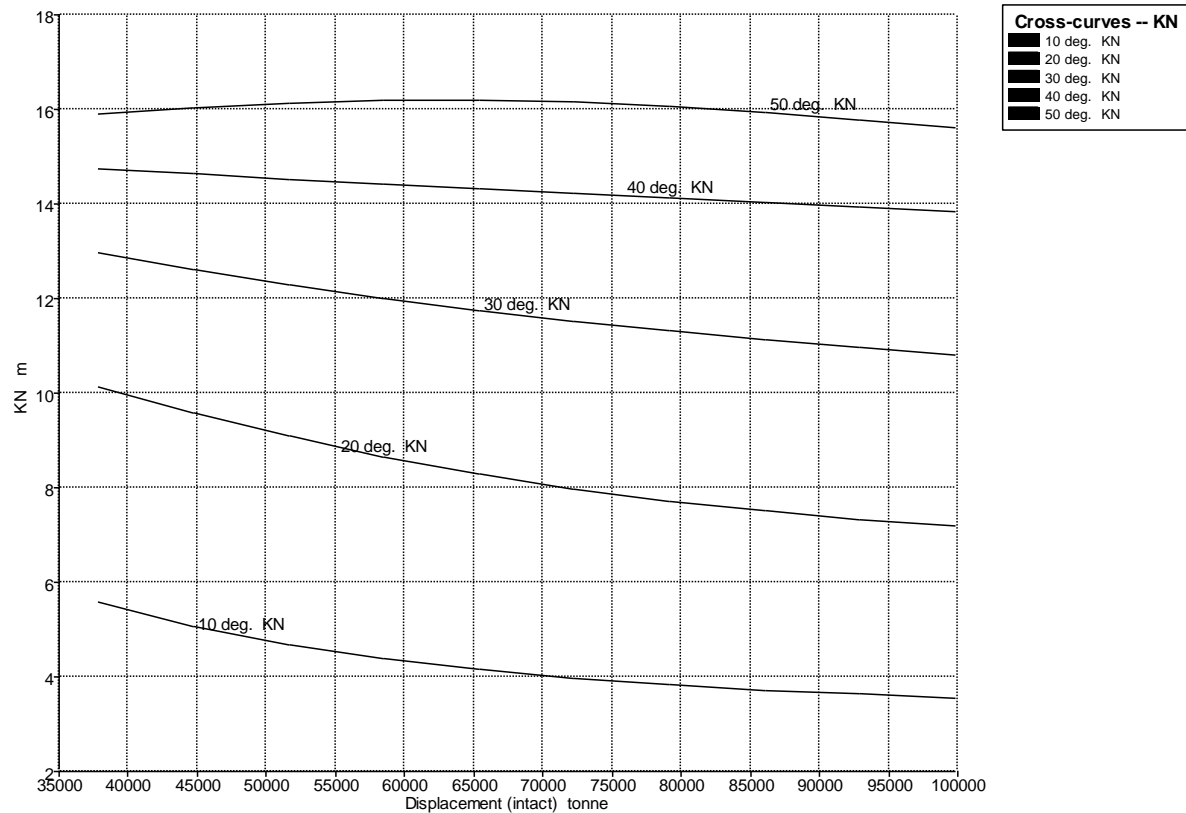
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### Damage Case - Intact

Fixed Trim = 3 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,986	3,000 (fixed)	127,099	0,000	0,000	5,580	10,141	12,965	14,750	15,909
44777	5,753	3,000 (fixed)	127,818	0,000	0,000	5,064	9,570	12,602	14,632	16,031
51667	6,501	3,000 (fixed)	128,243	0,000	0,000	4,680	9,081	12,281	14,519	16,132
58557	7,233	3,000 (fixed)	128,459	0,000	0,000	4,386	8,659	11,998	14,412	16,197
65447	7,952	3,000 (fixed)	128,528	0,000	0,000	4,157	8,292	11,744	14,311	16,205
72338	8,659	3,000 (fixed)	128,490	0,000	0,000	3,978	7,983	11,517	14,218	16,154
79228	9,355	3,000 (fixed)	128,367	0,000	0,000	3,835	7,726	11,311	14,132	16,058
86118	10,040	3,000 (fixed)	128,174	0,000	0,000	3,723	7,511	11,123	14,045	15,931
93008	10,716	3,000 (fixed)	127,917	0,000	0,000	3,634	7,332	10,952	13,945	15,779
99898	11,383	3,000 (fixed)	127,622	0,000	0,000	3,562	7,183	10,796	13,824	15,607

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

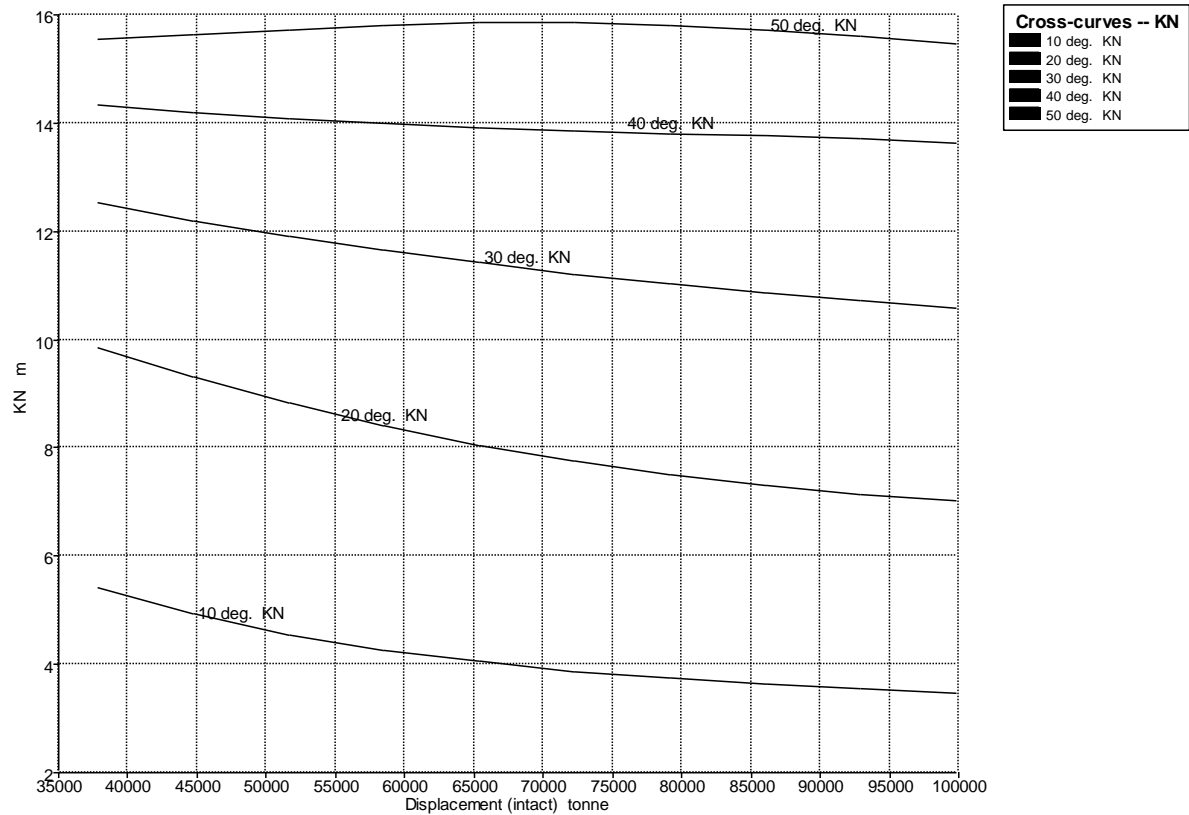
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### Damage Case - Intact

Fixed Trim = -3 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,961	-3,000 (fixed)	146,304	0,000	0,000	5,425	9,845	12,542	14,322	15,538
44777	5,757	-3,000 (fixed)	145,256	0,000	0,000	4,922	9,297	12,202	14,187	15,636
51667	6,528	-3,000 (fixed)	144,163	0,000	0,000	4,551	8,819	11,911	14,078	15,724
58557	7,284	-3,000 (fixed)	143,185	0,000	0,000	4,269	8,405	11,653	13,990	15,805
65447	8,027	-3,000 (fixed)	142,299	0,000	0,000	4,049	8,049	11,421	13,918	15,850
72338	8,759	-3,000 (fixed)	141,458	0,000	0,000	3,877	7,752	11,213	13,860	15,845
79228	9,481	-3,000 (fixed)	140,664	0,000	0,000	3,741	7,507	11,027	13,812	15,796
86118	10,193	-3,000 (fixed)	139,894	0,000	0,000	3,632	7,309	10,861	13,767	15,711
93008	10,895	-3,000 (fixed)	139,152	0,000	0,000	3,545	7,149	10,713	13,712	15,598
99898	11,588	-3,000 (fixed)	138,440	0,000	0,000	3,478	7,020	10,580	13,637	15,463

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

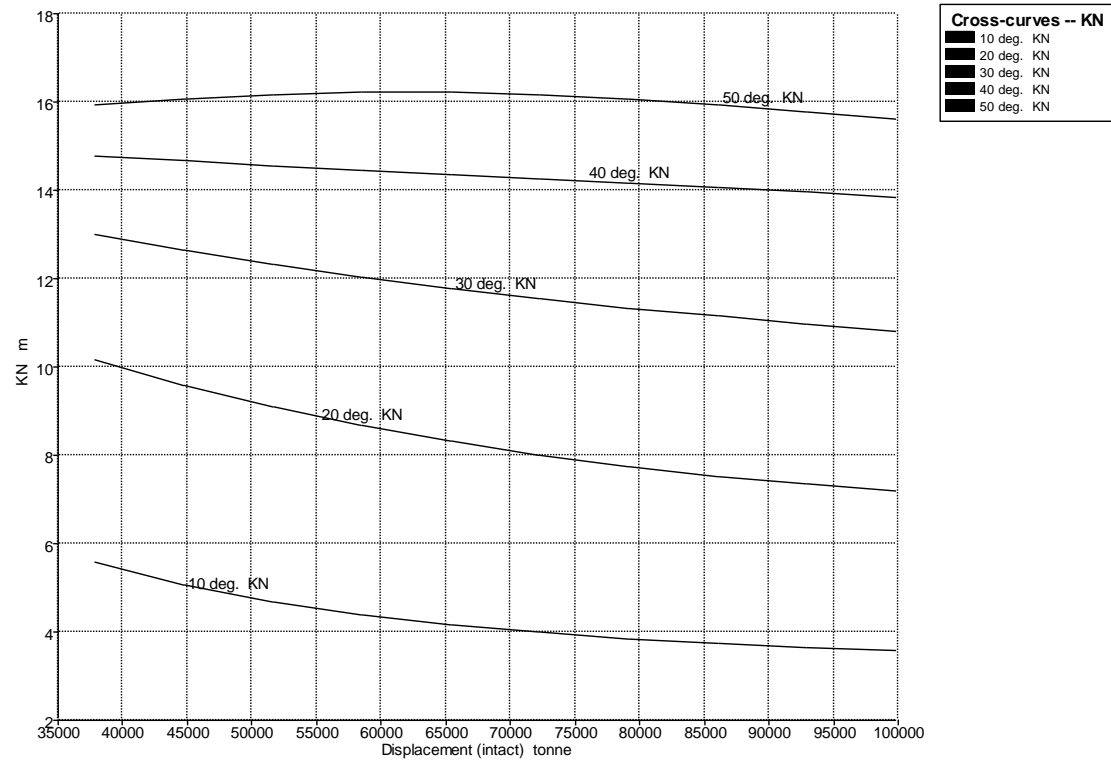
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### Damage Case - Intact

Fixed Trim = 3,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,981	3,500 (fixed)	125,424	0,000	0,000	5,593	10,160	12,993	14,780	15,942
44777	5,746	3,500 (fixed)	126,300	0,000	0,000	5,077	9,591	12,631	14,665	16,062
51667	6,493	3,500 (fixed)	126,852	0,000	0,000	4,692	9,104	12,311	14,554	16,162
58557	7,223	3,500 (fixed)	127,166	0,000	0,000	4,398	8,682	12,027	14,447	16,221
65447	7,941	3,500 (fixed)	127,317	0,000	0,000	4,169	8,316	11,772	14,343	16,224
72338	8,645	3,500 (fixed)	127,345	0,000	0,000	3,988	8,006	11,543	14,247	16,170
79228	9,339	3,500 (fixed)	127,277	0,000	0,000	3,846	7,747	11,336	14,158	16,072
86118	10,022	3,500 (fixed)	127,129	0,000	0,000	3,733	7,530	11,147	14,066	15,943
93008	10,696	3,500 (fixed)	126,915	0,000	0,000	3,643	7,349	10,974	13,959	15,788
99898	11,361	3,500 (fixed)	126,663	0,000	0,000	3,571	7,199	10,816	13,834	15,613



## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

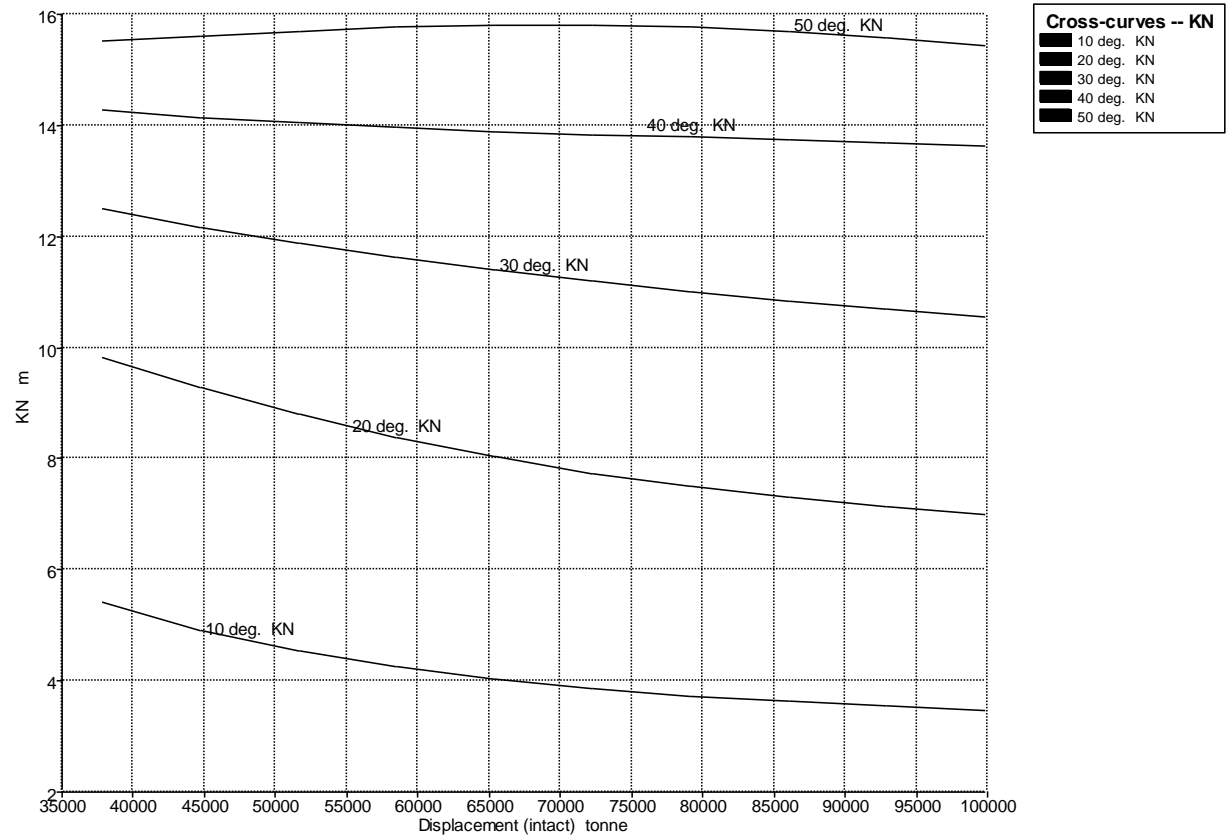
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### Damage Case - Intact

Fixed Trim = -3,5 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,957	-3,500 (fixed)	147,944	0,000	0,000	5,411	9,821	12,503	14,282	15,507
44777	5,733	-3,500 (fixed)	146,229	0,000	0,000	4,911	9,273	12,167	14,149	15,601
51667	6,525	-3,500 (fixed)	145,420	0,000	0,000	4,542	8,799	11,879	14,043	15,689
58557	7,283	-3,500 (fixed)	144,348	0,000	0,000	4,261	8,387	11,626	13,957	15,769
65447	8,028	-3,500 (fixed)	143,378	0,000	0,000	4,042	8,033	11,397	13,887	15,814
72338	8,763	-3,500 (fixed)	142,474	0,000	0,000	3,871	7,737	11,191	13,832	15,813
79228	9,487	-3,500 (fixed)	141,623	0,000	0,000	3,735	7,494	11,006	13,787	15,767
86118	10,201	-3,500 (fixed)	140,807	0,000	0,000	3,627	7,296	10,842	13,744	15,686
93008	10,905	-3,500 (fixed)	140,029	0,000	0,000	3,541	7,137	10,696	13,690	15,577
99898	11,600	-3,500 (fixed)	139,289	0,000	0,000	3,473	7,010	10,565	13,616	15,445

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

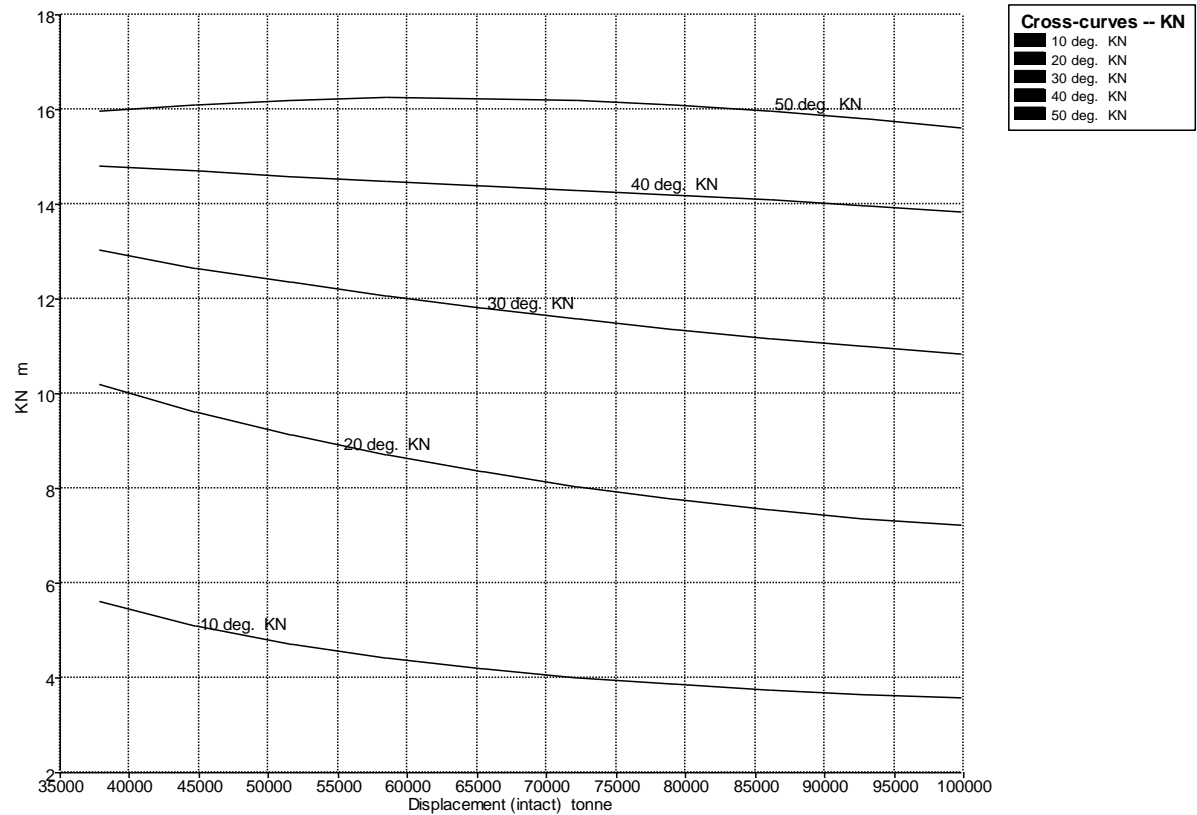
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### Damage Case - Intact

Fixed Trim = 4 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,974	4,000 (fixed)	123,741	0,000	0,000	5,606	10,178	13,020	14,809	15,974
44777	5,738	4,000 (fixed)	124,779	0,000	0,000	5,090	9,612	12,659	14,697	16,094
51667	6,483	4,000 (fixed)	125,449	0,000	0,000	4,704	9,127	12,340	14,587	16,191
58557	7,212	4,000 (fixed)	125,862	0,000	0,000	4,410	8,706	12,055	14,480	16,243
65447	7,928	4,000 (fixed)	126,094	0,000	0,000	4,180	8,341	11,800	14,374	16,241
72338	8,631	4,000 (fixed)	126,188	0,000	0,000	3,999	8,030	11,570	14,276	16,185
79228	9,323	4,000 (fixed)	126,177	0,000	0,000	3,857	7,769	11,361	14,184	16,086
86118	10,003	4,000 (fixed)	126,074	0,000	0,000	3,744	7,550	11,170	14,086	15,953
93008	10,675	4,000 (fixed)	125,905	0,000	0,000	3,653	7,367	10,996	13,973	15,795
99898	11,339	4,000 (fixed)	125,698	0,000	0,000	3,580	7,214	10,836	13,844	15,618

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

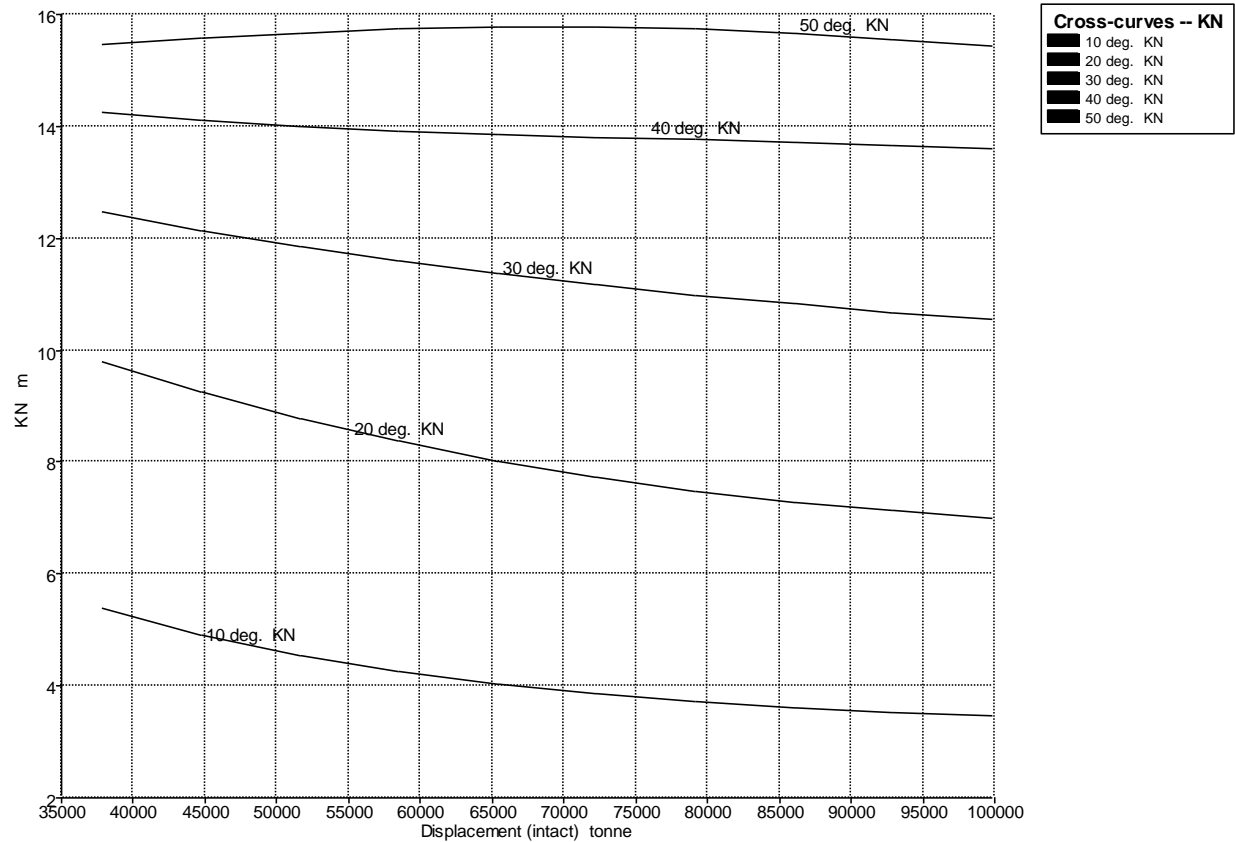
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### Damage Case - Intact

Fixed Trim = -4 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,952	-4,000 (fixed)	149,569	0,000	0,000	5,397	9,787	12,463	14,243	15,477
44777	5,730	-4,000 (fixed)	147,677	0,000	0,000	4,906	9,248	12,132	14,112	15,566
51667	6,521	-4,000 (fixed)	146,667	0,000	0,000	4,533	8,778	11,847	14,008	15,654
58557	7,281	-4,000 (fixed)	145,499	0,000	0,000	4,253	8,369	11,598	13,924	15,733
65447	8,029	-4,000 (fixed)	144,446	0,000	0,000	4,035	8,017	11,373	13,857	15,778
72338	8,765	-4,000 (fixed)	143,478	0,000	0,000	3,865	7,722	11,169	13,804	15,779
79228	9,492	-4,000 (fixed)	142,571	0,000	0,000	3,729	7,480	10,987	13,762	15,738
86118	10,208	-4,000 (fixed)	141,711	0,000	0,000	3,622	7,284	10,824	13,722	15,660
93008	10,915	-4,000 (fixed)	140,900	0,000	0,000	3,536	7,126	10,679	13,669	15,555
99898	11,612	-4,000 (fixed)	140,130	0,000	0,000	3,469	6,999	10,550	13,596	15,427

## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

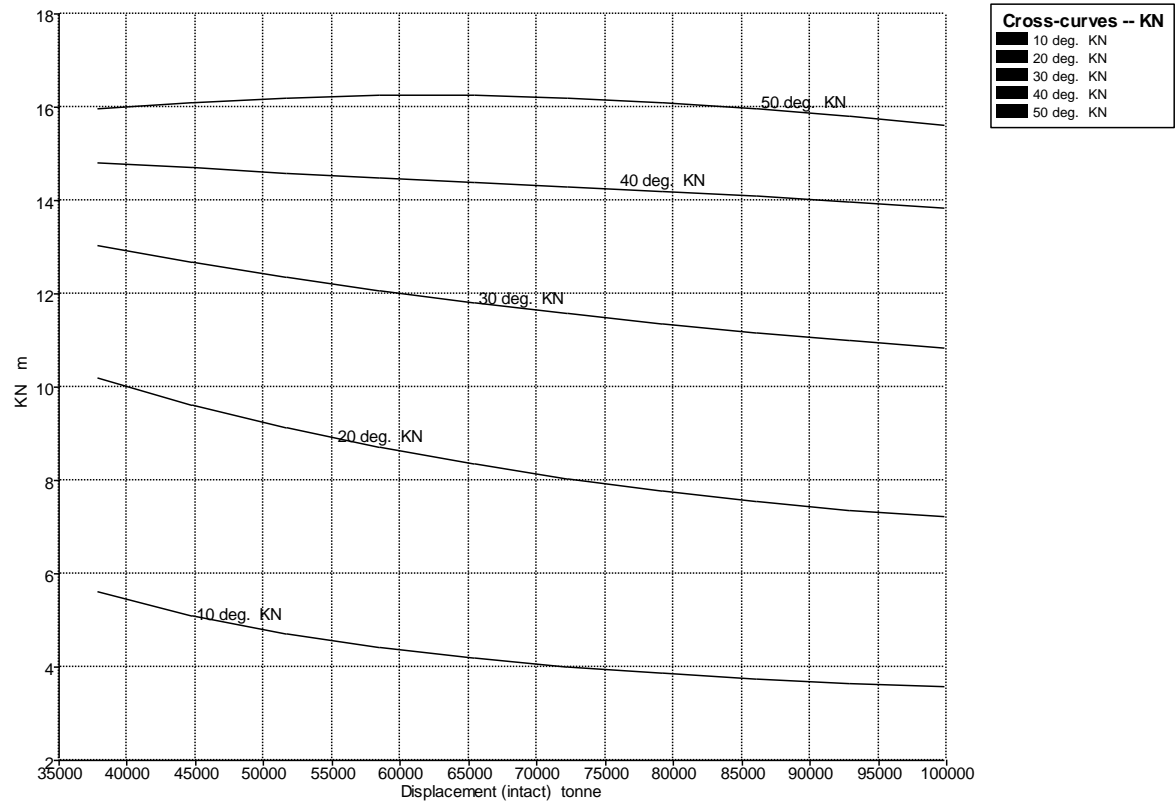
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### Damage Case - Intact

Fixed Trim = 4,05 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m



Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,973	4,050 (fixed)	123,573	0,000	0,000	5,607	10,179	13,022	14,812	15,977
44777	5,737	4,050 (fixed)	124,627	0,000	0,000	5,091	9,614	12,662	14,700	16,097
51667	6,482	4,050 (fixed)	125,308	0,000	0,000	4,706	9,130	12,343	14,590	16,193
58557	7,211	4,050 (fixed)	125,731	0,000	0,000	4,411	8,709	12,058	14,483	16,246
65447	7,926	4,050 (fixed)	125,971	0,000	0,000	4,181	8,343	11,803	14,377	16,243
72338	8,629	4,050 (fixed)	126,072	0,000	0,000	4,001	8,032	11,573	14,279	16,187
79228	9,321	4,050 (fixed)	126,066	0,000	0,000	3,858	7,771	11,363	14,187	16,087
86118	10,002	4,050 (fixed)	125,968	0,000	0,000	3,745	7,552	11,172	14,088	15,954
93008	10,673	4,050 (fixed)	125,803	0,000	0,000	3,654	7,369	10,998	13,975	15,796
99898	11,337	4,050 (fixed)	125,601	0,000	0,000	3,581	7,216	10,838	13,845	15,619



## KN Calculation - Modelo casco final

Stability 20.00.04.9, build: 9

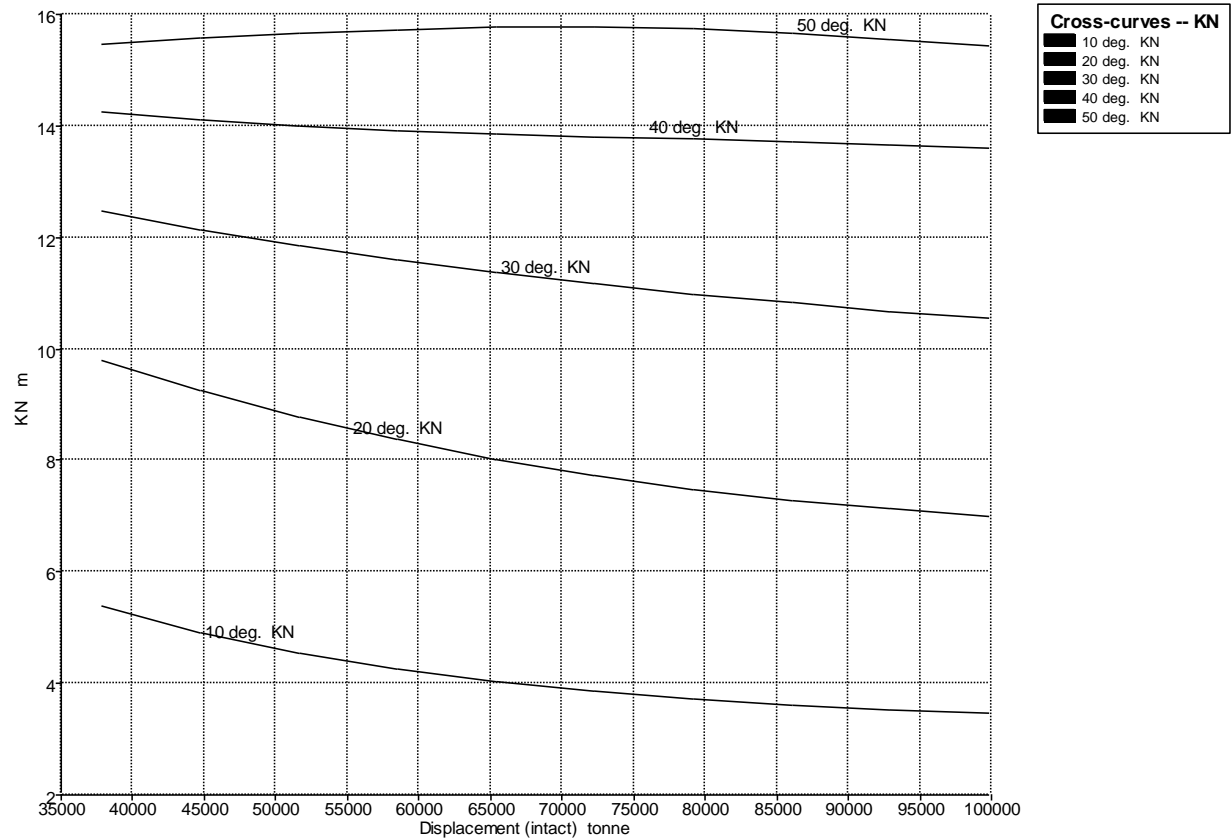
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### Damage Case - Intact

Fixed Trim = -4,05 m (+ve by stern)

Specific gravity = 1,025; (Density = 1,025 tonne/m<sup>3</sup>)

VCG = 0 m; TCG = 0 m

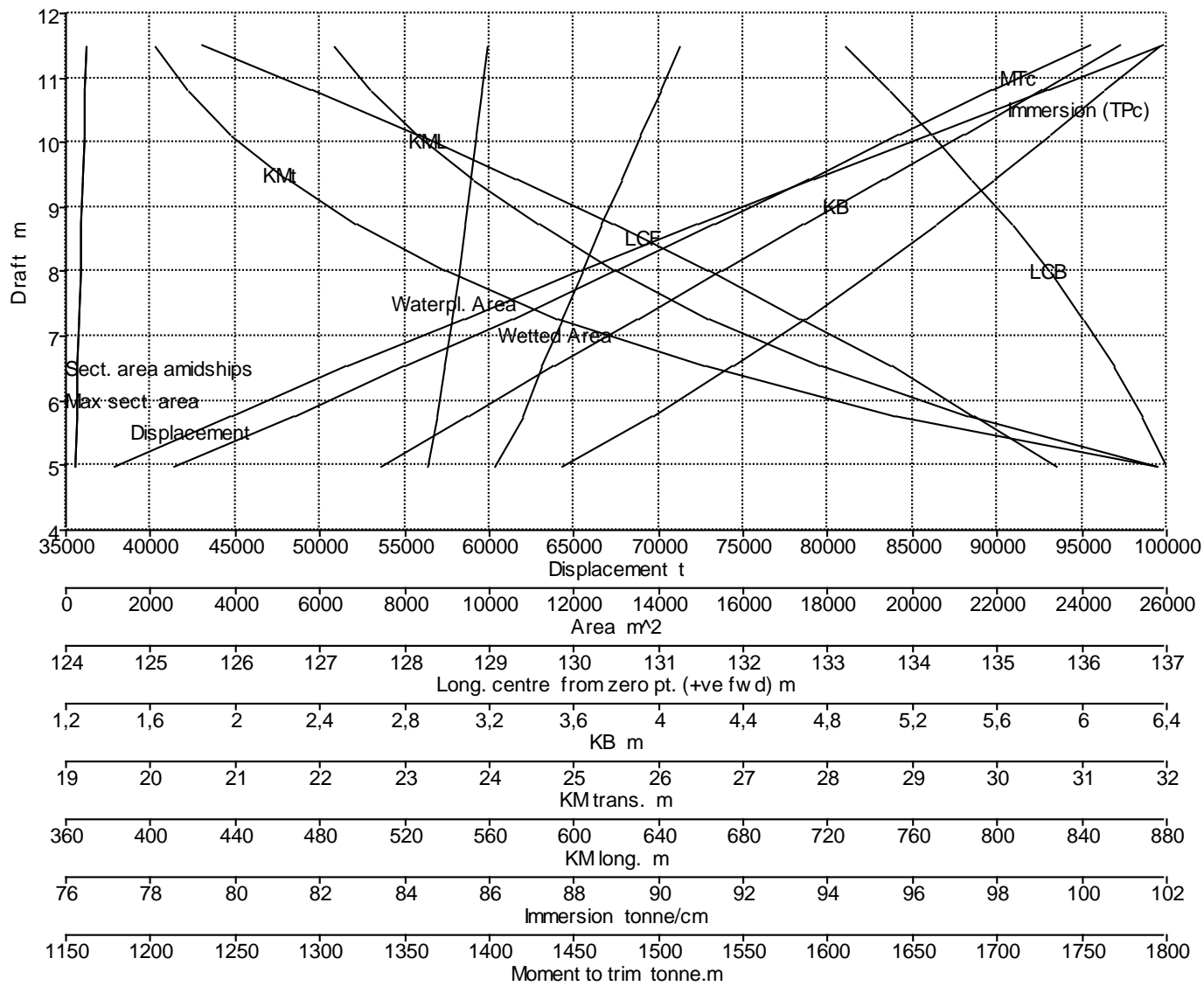


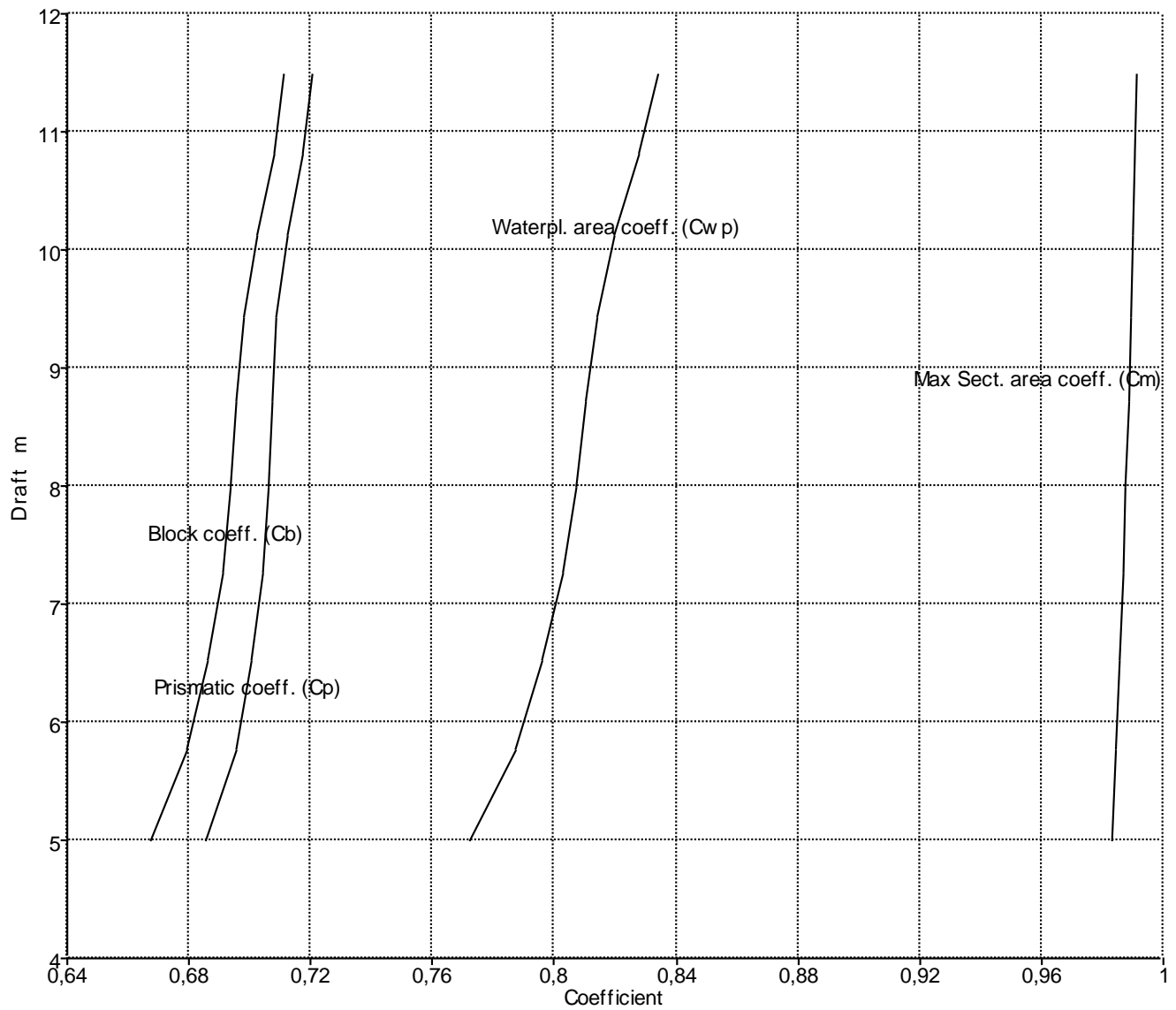
Displacement (intact) tonne	Draft Amidships m	Trim (+ve by stern) m	LCG m	TCG m	Assumed VCG m	KN 10,0 deg. Starb.	KN 20,0 deg. Starb.	KN 30,0 deg. Starb.	KN 40,0 deg. Starb.	KN 50,0 deg. Starb.
37887	4,951	-4,050 (fixed)	149,730	0,000	0,000	5,396	9,784	12,459	14,239	15,474
44777	5,730	-4,050 (fixed)	147,821	0,000	0,000	4,905	9,245	12,128	14,108	15,563
51667	6,520	-4,050 (fixed)	146,791	0,000	0,000	4,532	8,776	11,844	14,004	15,650
58557	7,281	-4,050 (fixed)	145,613	0,000	0,000	4,252	8,367	11,595	13,921	15,730
65447	8,029	-4,050 (fixed)	144,552	0,000	0,000	4,035	8,015	11,370	13,854	15,774
72338	8,766	-4,050 (fixed)	143,578	0,000	0,000	3,864	7,721	11,167	13,801	15,776
79228	9,492	-4,050 (fixed)	142,665	0,000	0,000	3,729	7,479	10,985	13,760	15,735
86118	10,209	-4,050 (fixed)	141,802	0,000	0,000	3,621	7,283	10,822	13,720	15,658
93008	10,915	-4,050 (fixed)	140,987	0,000	0,000	3,536	7,125	10,677	13,667	15,553
99898	11,613	-4,050 (fixed)	140,214	0,000	0,000	3,468	6,998	10,549	13,594	15,425

# ANEXO V

Tablas de hidrostáticas







**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)

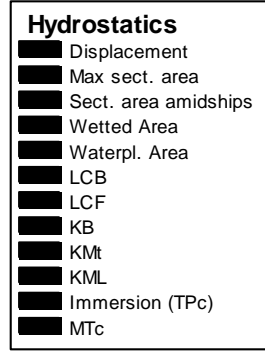
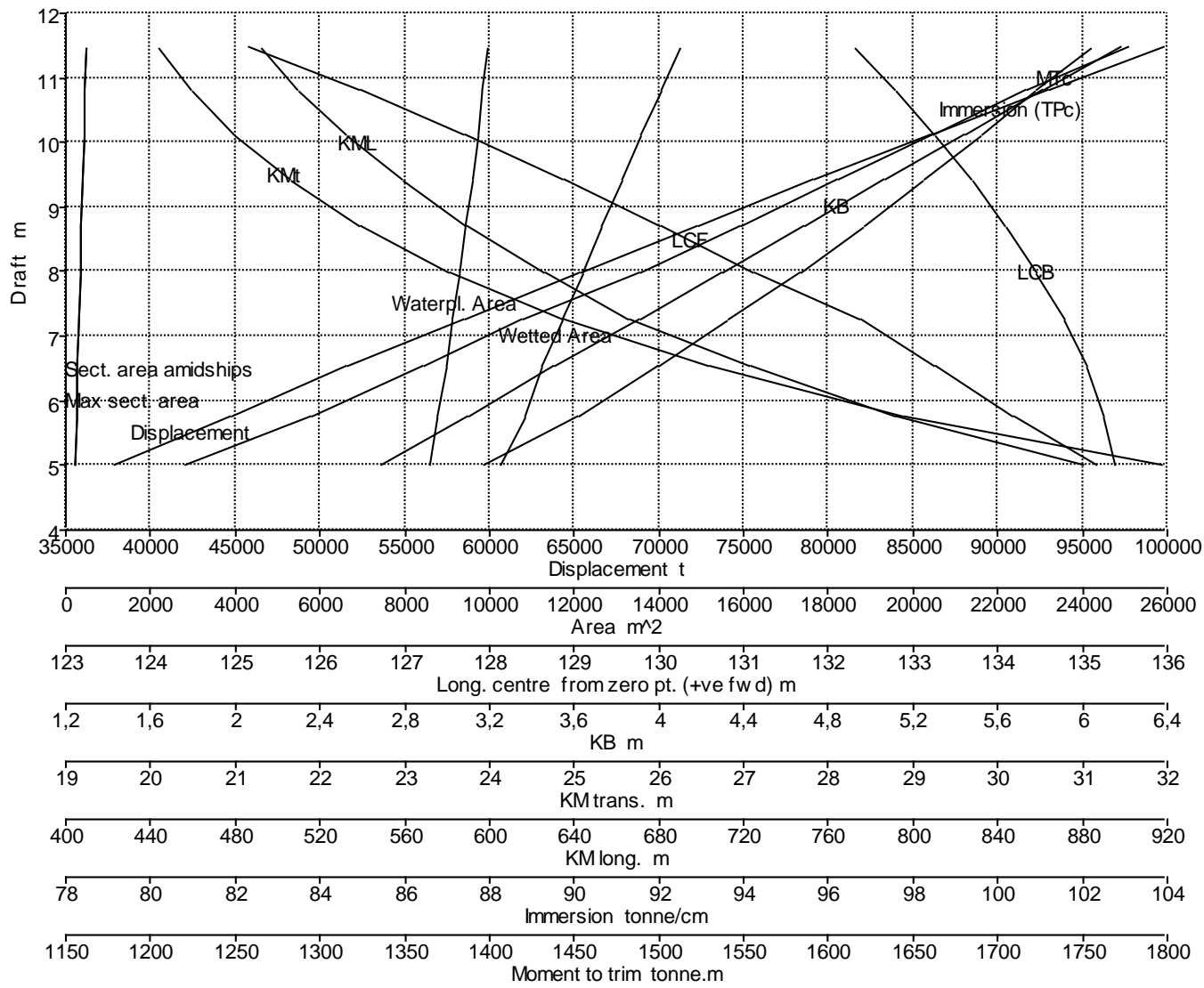
Block coeff. (Cb)

Prismatic coeff. (Cp)

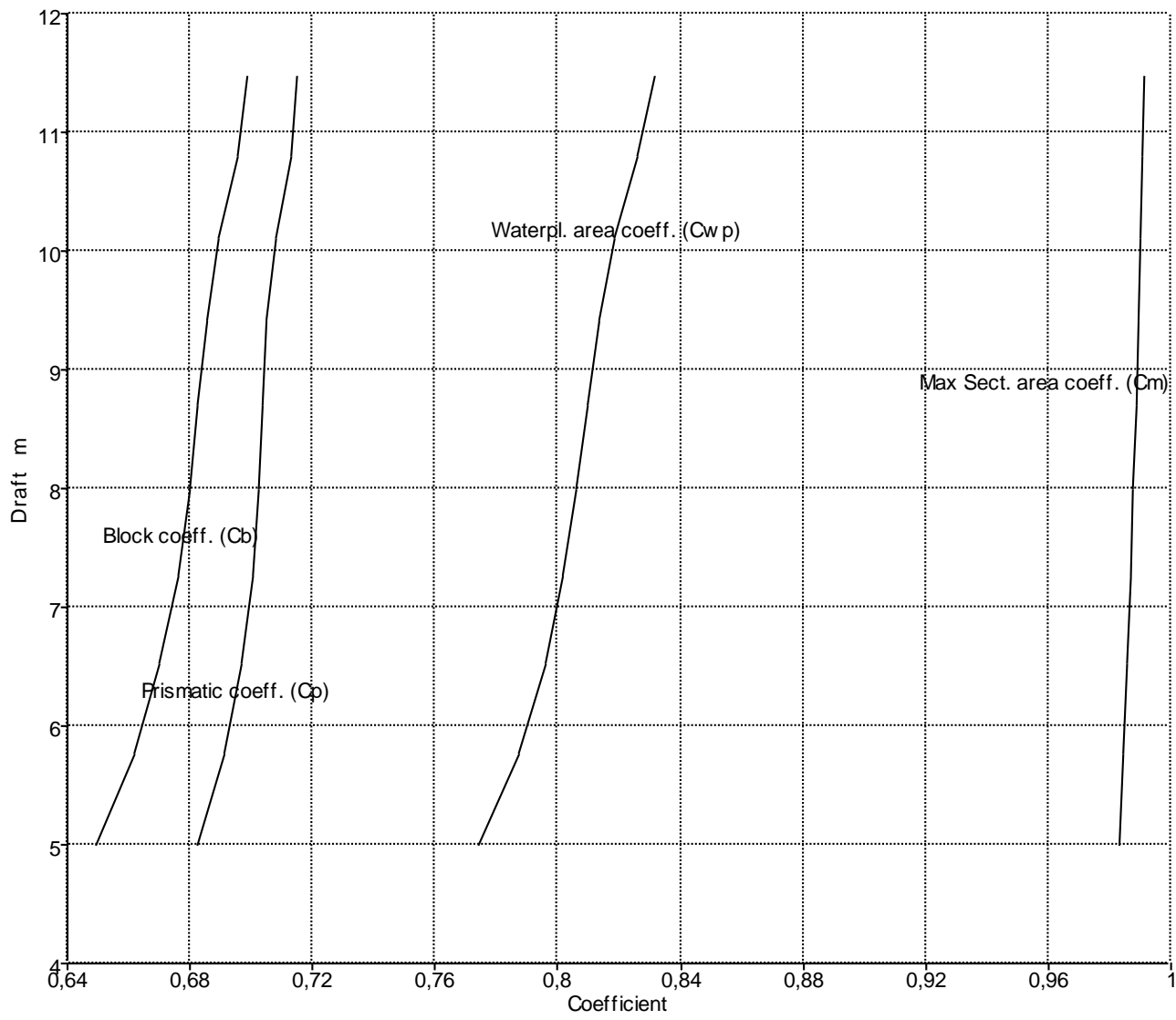
Waterpl. area coeff. (Cwp)

Max Sect. area coeff. (Cm)





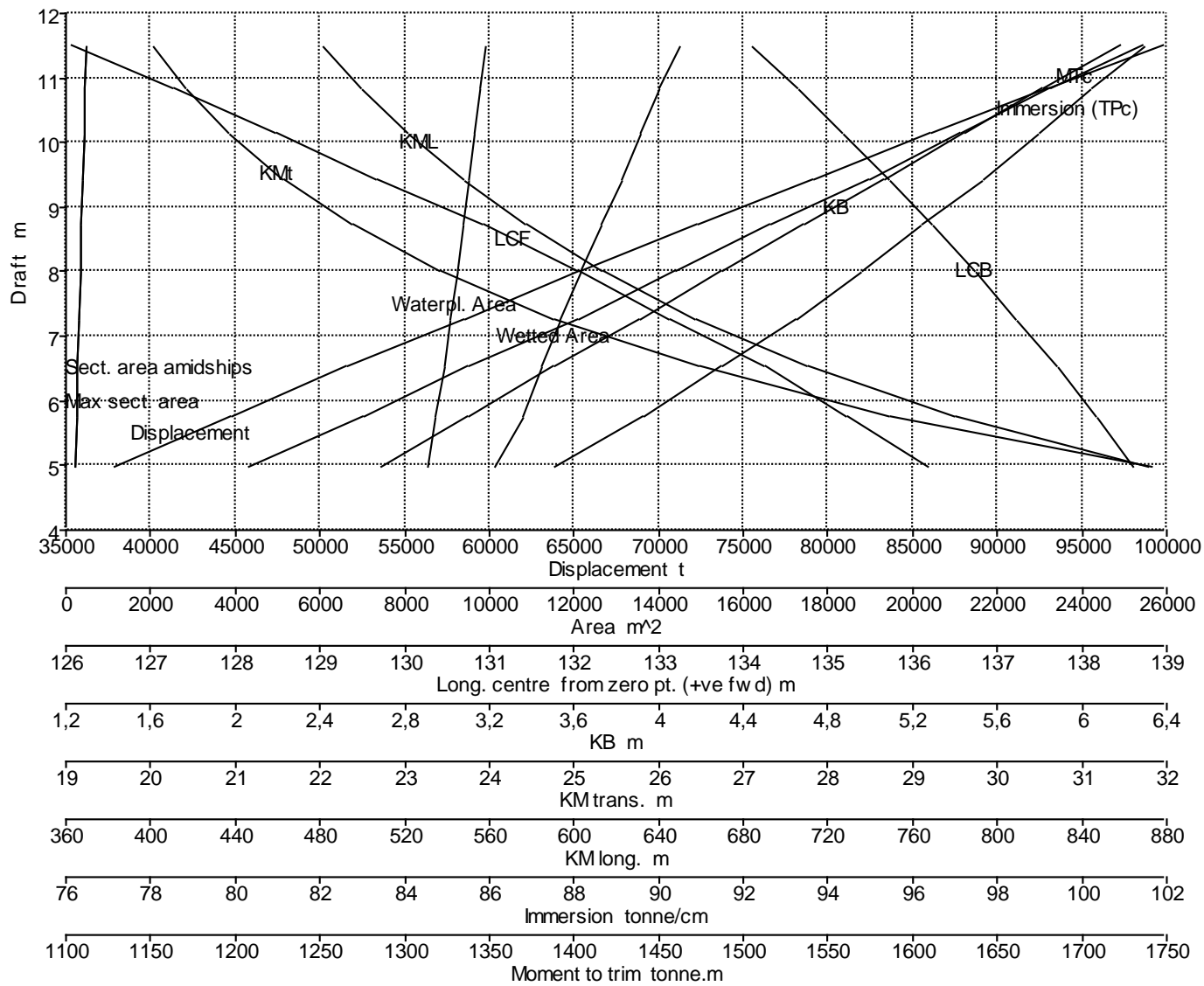




**Curves of Form**

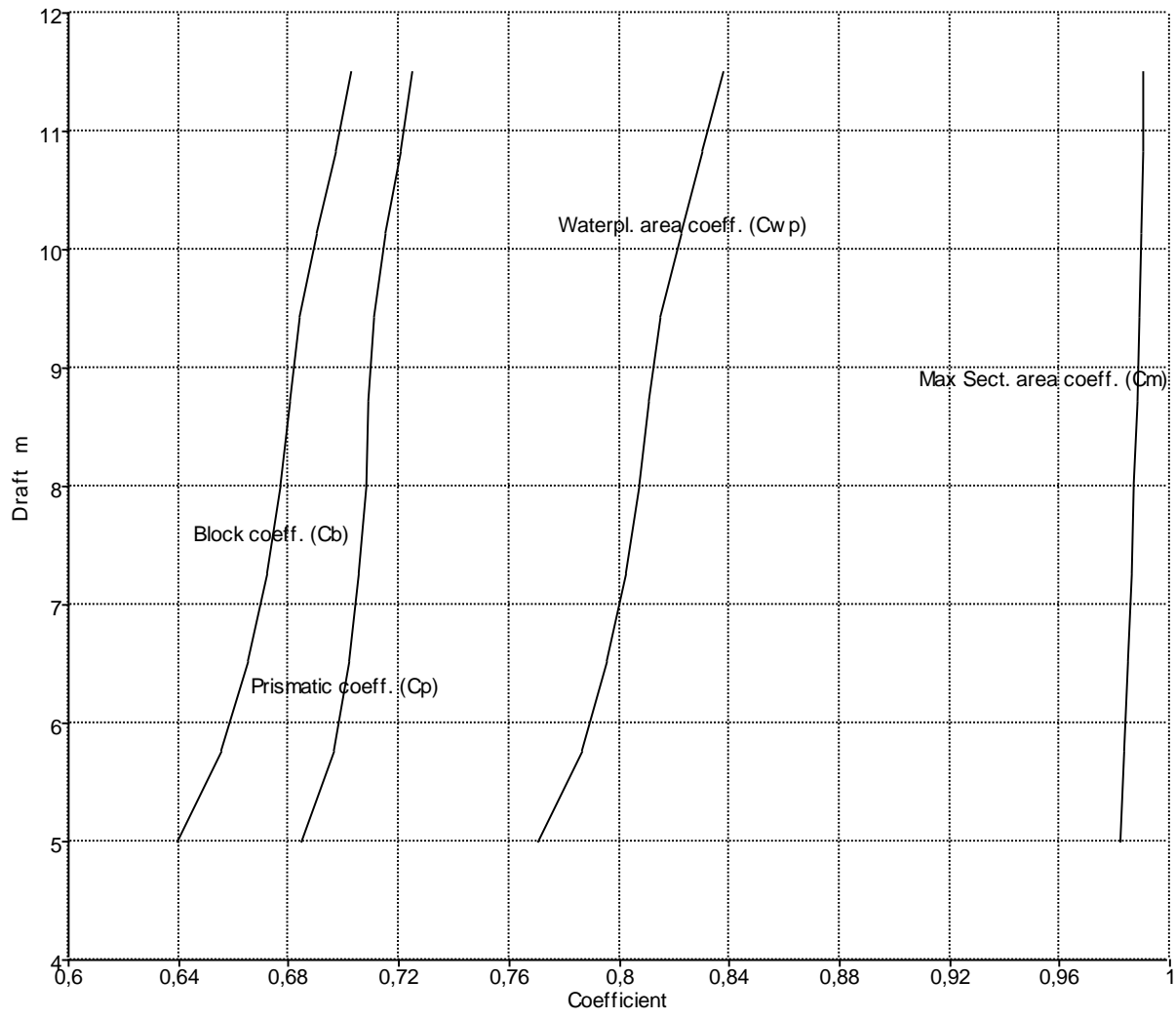
- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)





**Hydrostatics**

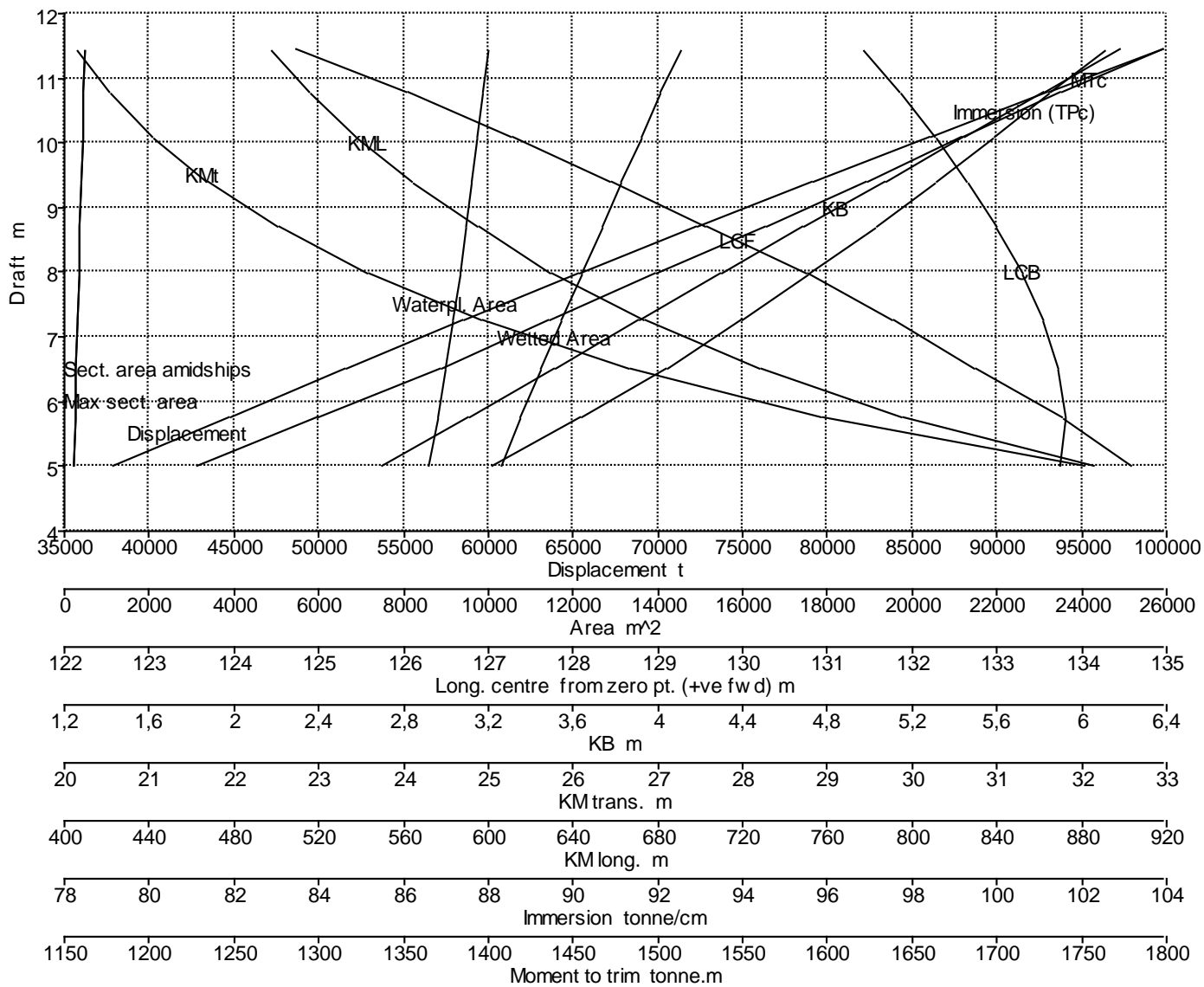
- Displacement
- Max sect. area
- Sect. area amidships
- Wetted Area
- Waterpl. Area
- LCB
- LCF
- KB
- KMt
- KML
- Immersion (TPc)
- MTc



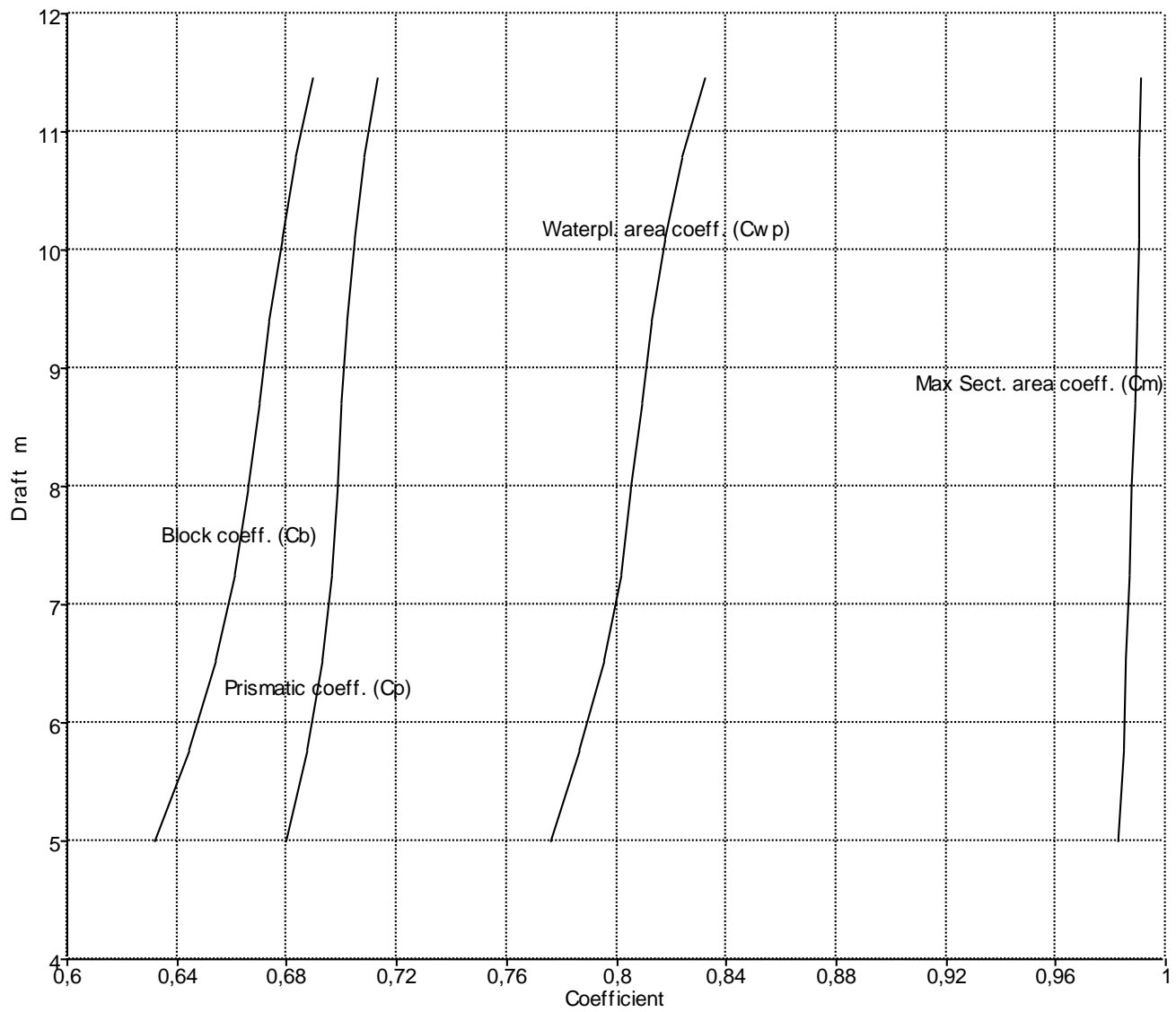
**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)





- Hydrostatics**
- Displacement
  - Max sect. area
  - Sect. area amidships
  - Wetted Area
  - Waterpl. Area
  - LCB
  - LCF
  - KB
  - KMt
  - KML
  - Immersion (TPc)
  - MTC

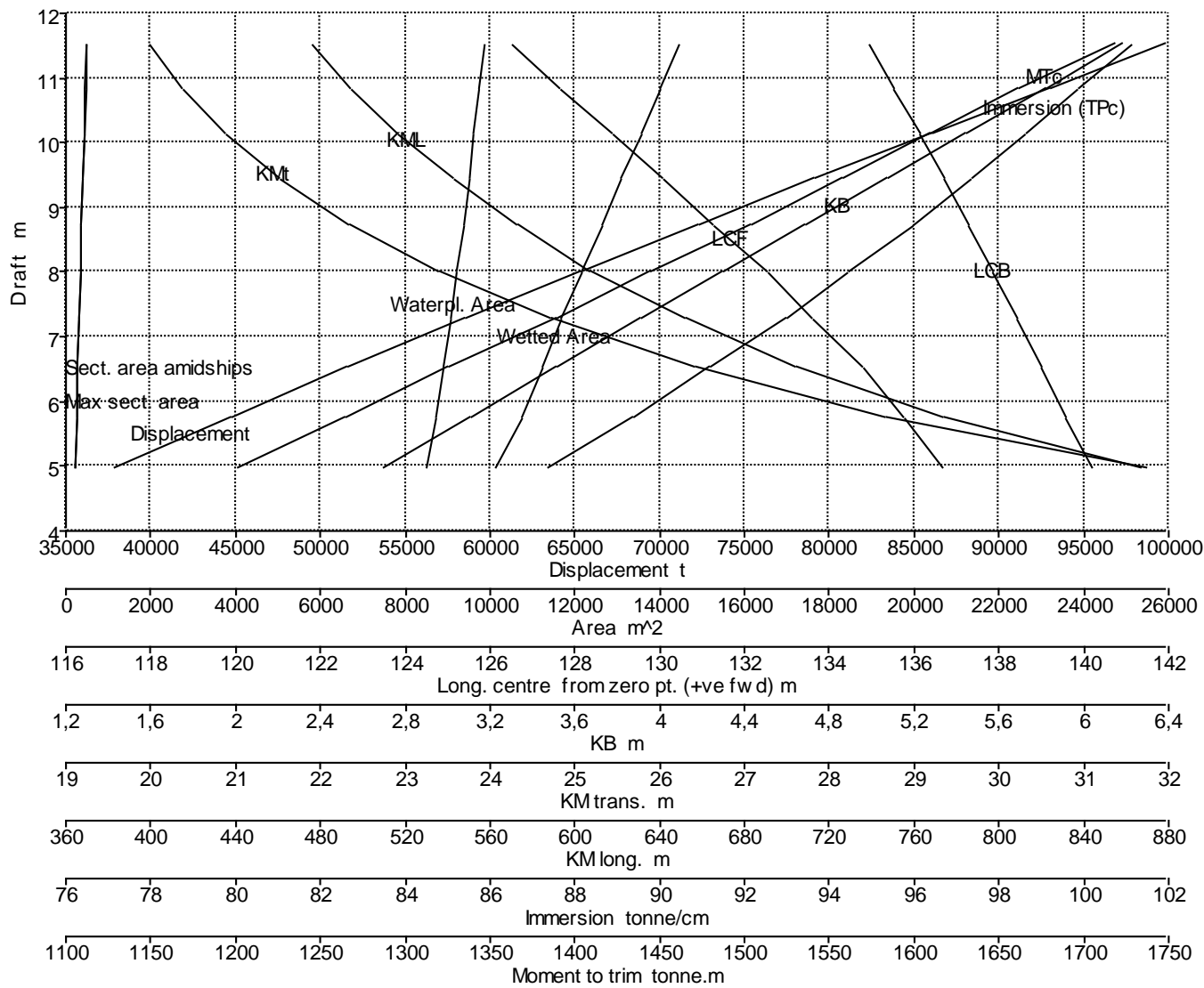


**Curves of Form**

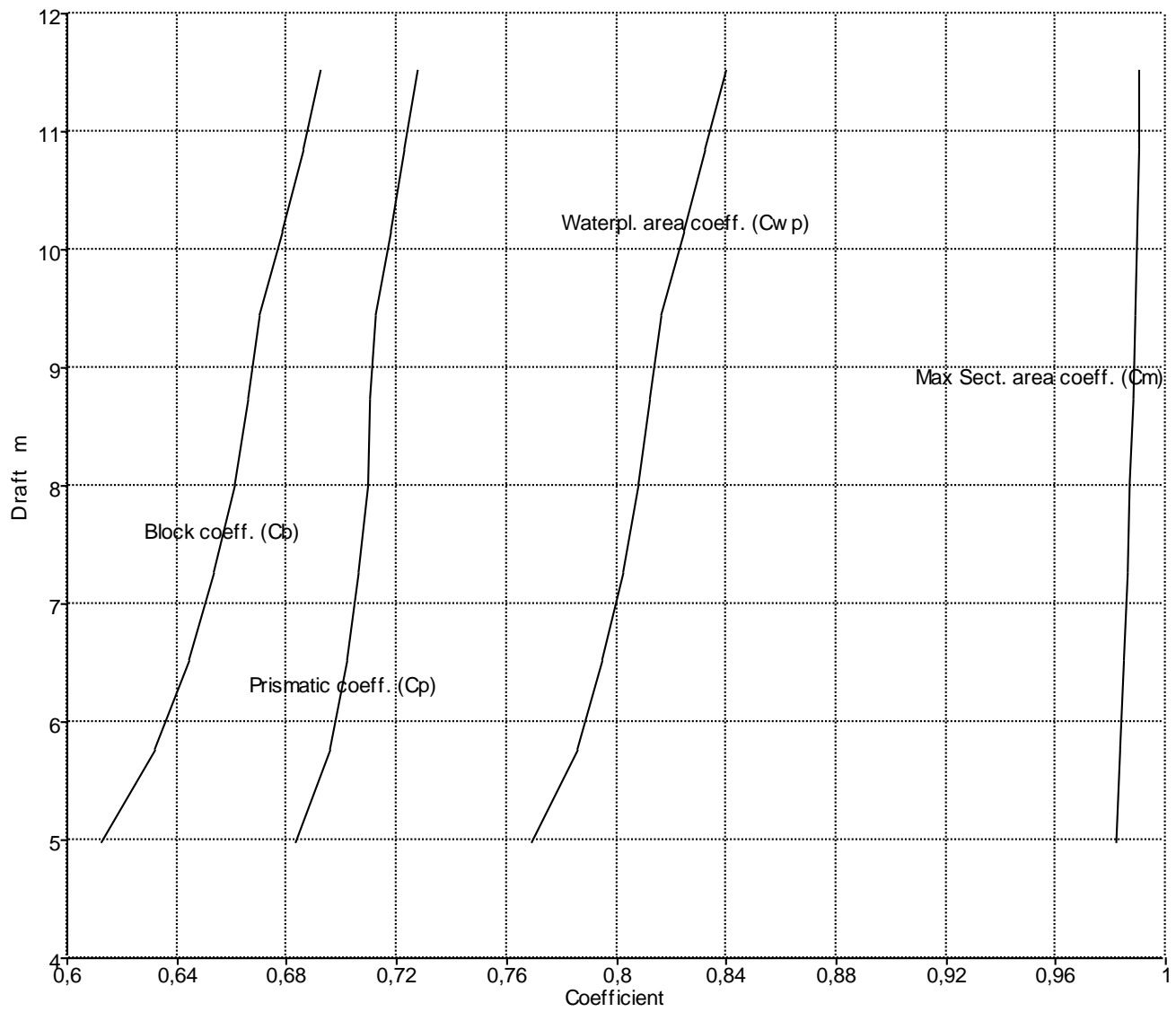
- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)







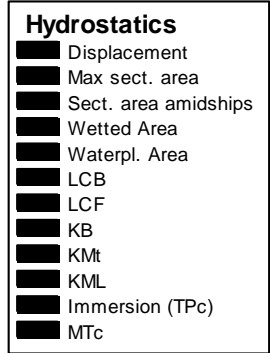
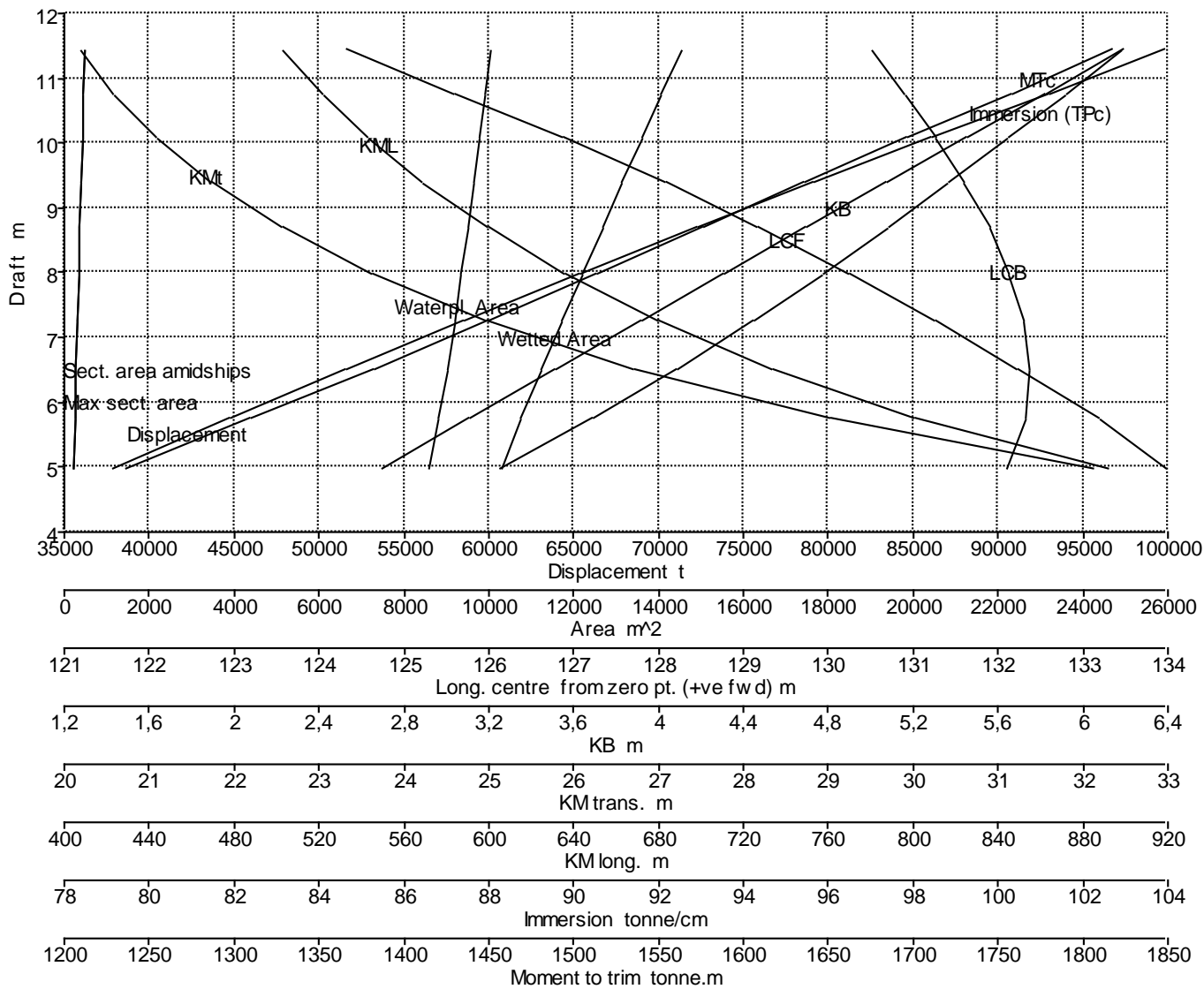
- Hydrostatics**
- Displacement
  - Max sect. area
  - Sect. area amidships
  - Waterpl. Area
  - LCB
  - LCF
  - KB
  - KMT
  - KML
  - Immersion (TPc)
  - MTc

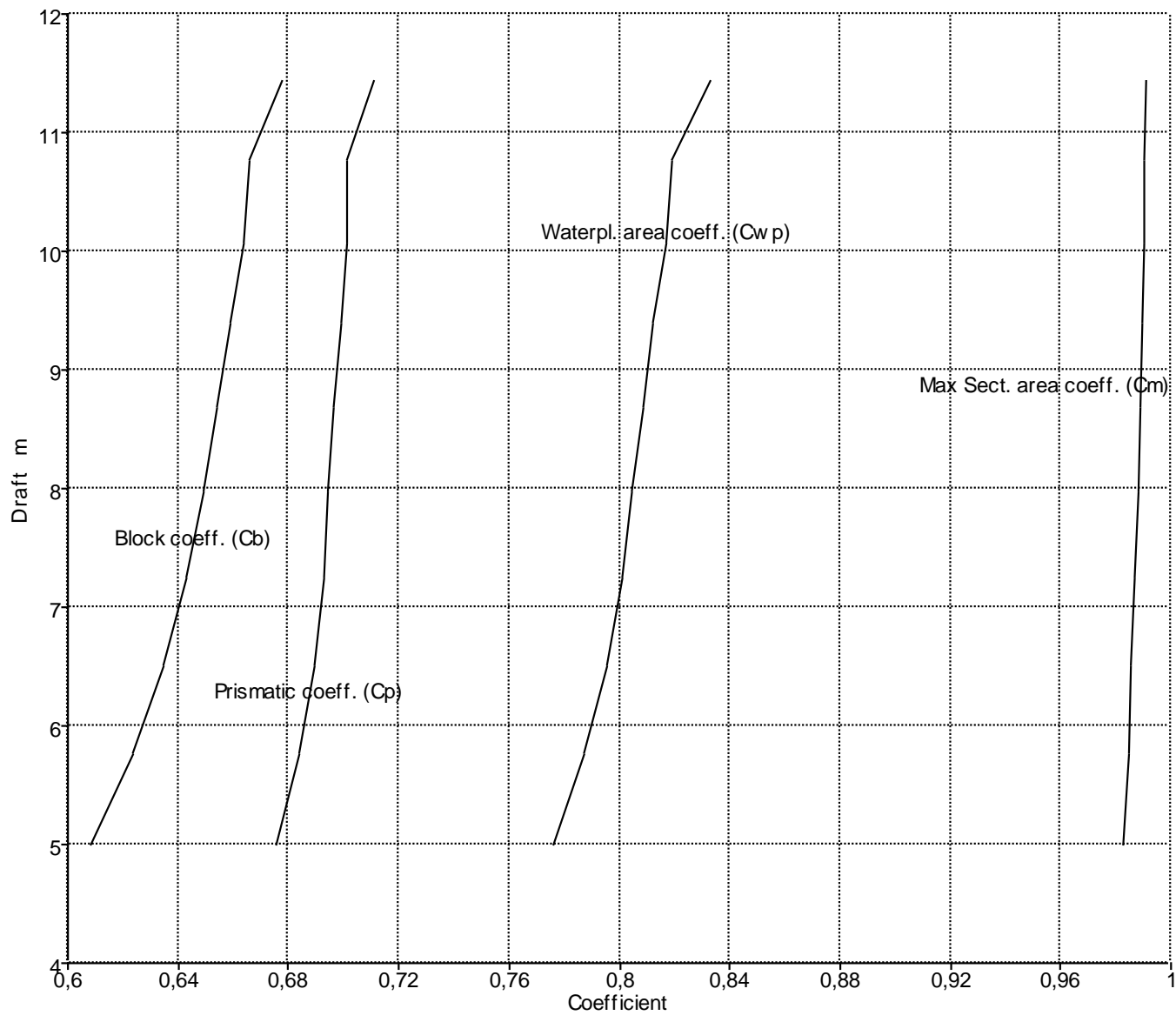


**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)



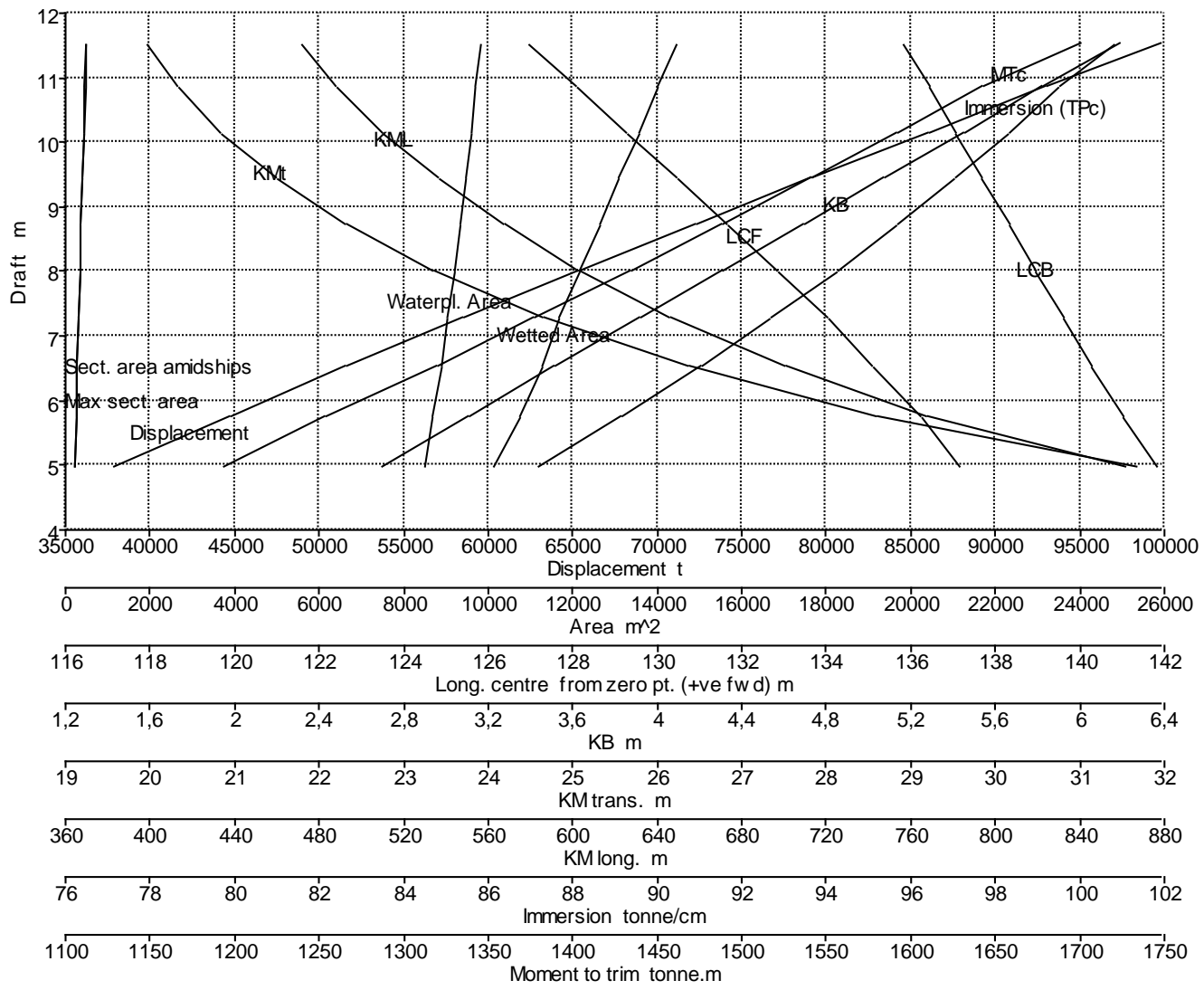




**Curves of Form**

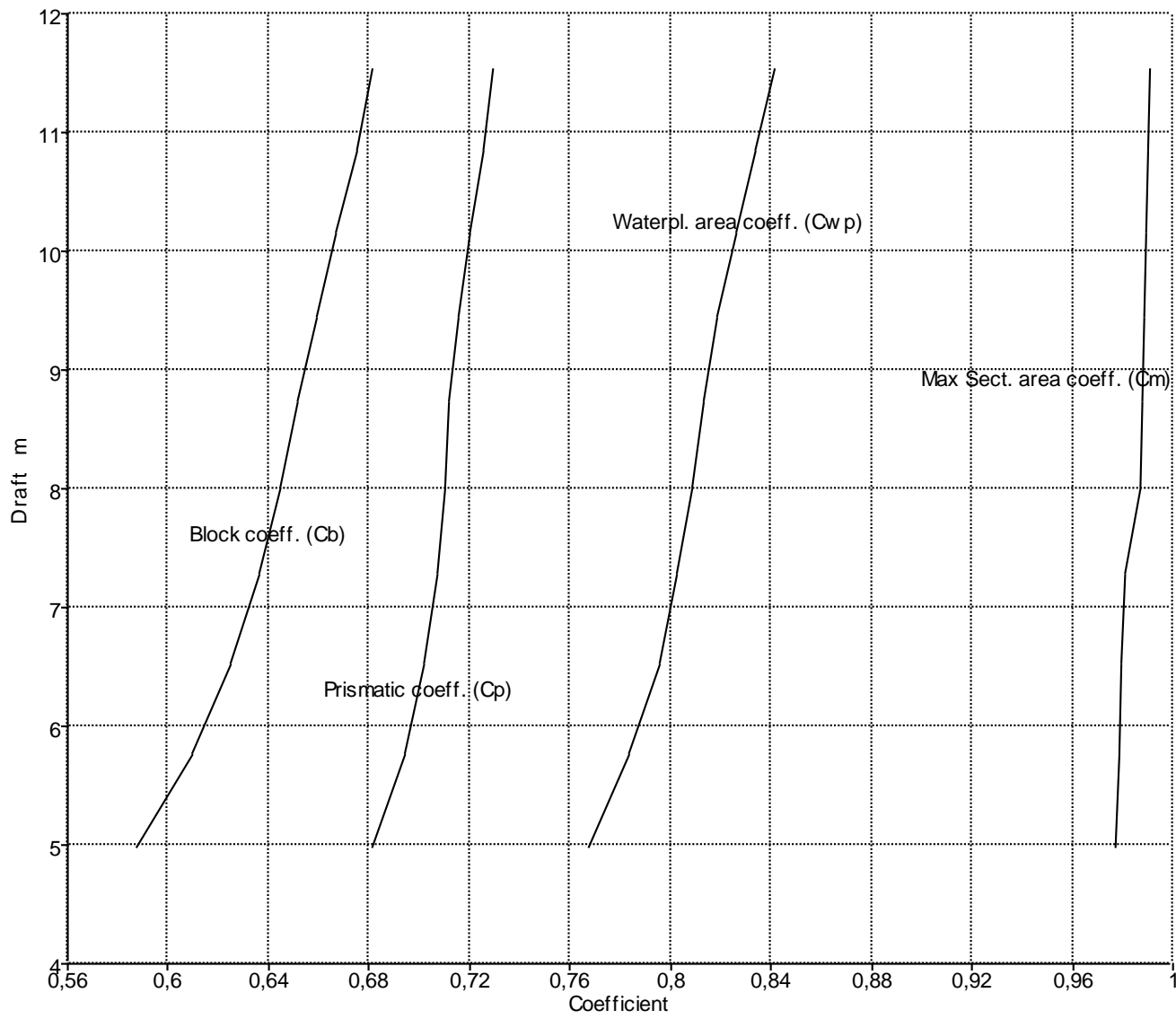
- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)





**Hydrostatics**

- Displacement
- Max sect. area
- Sect. area amidships
- Wetted Area
- Waterpl. Area
- LCB
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- KB
- KMt
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- Immersion (TPc)
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**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)

Block coeff. (Cb)

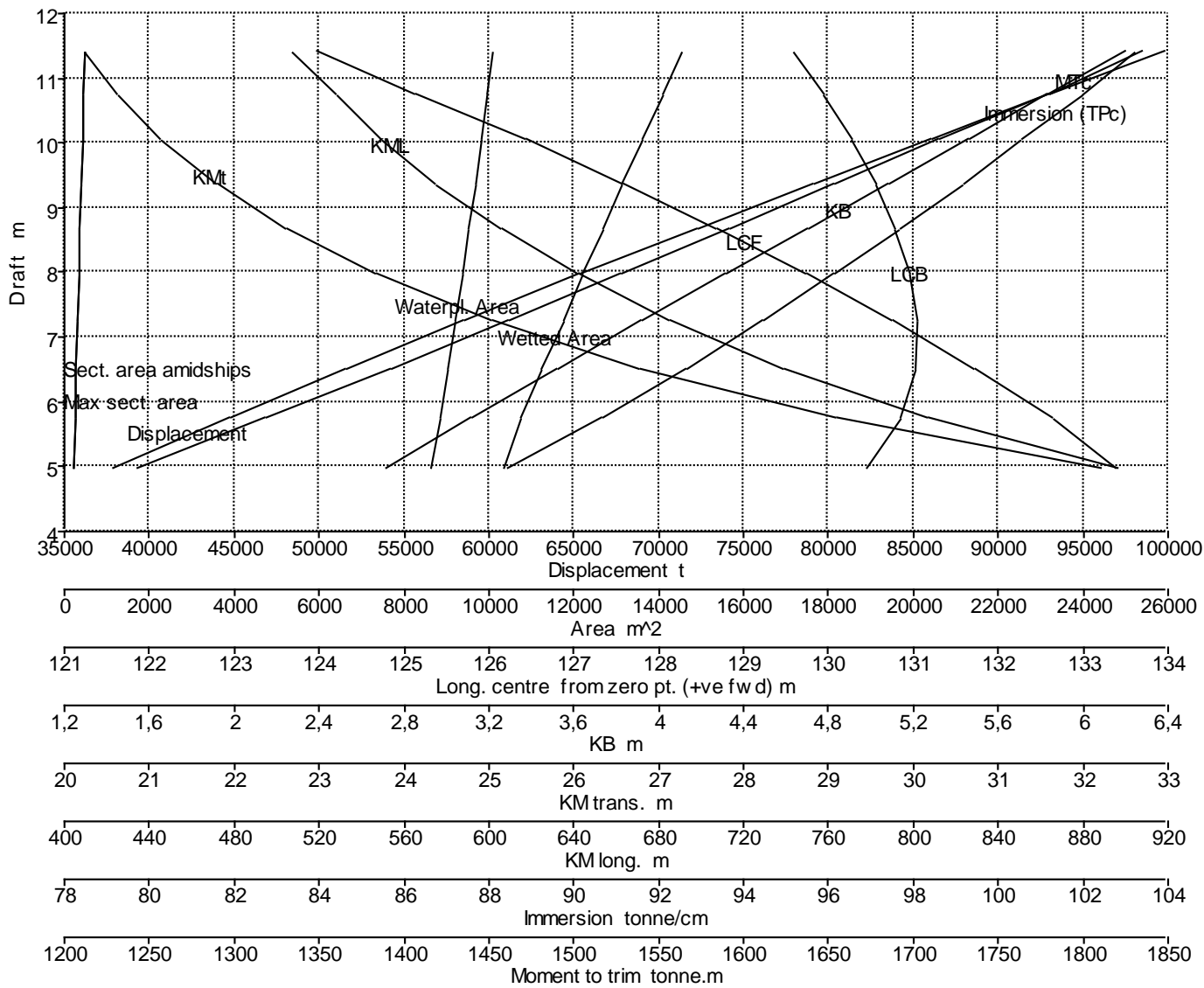
Prismatic coeff. (Cp)

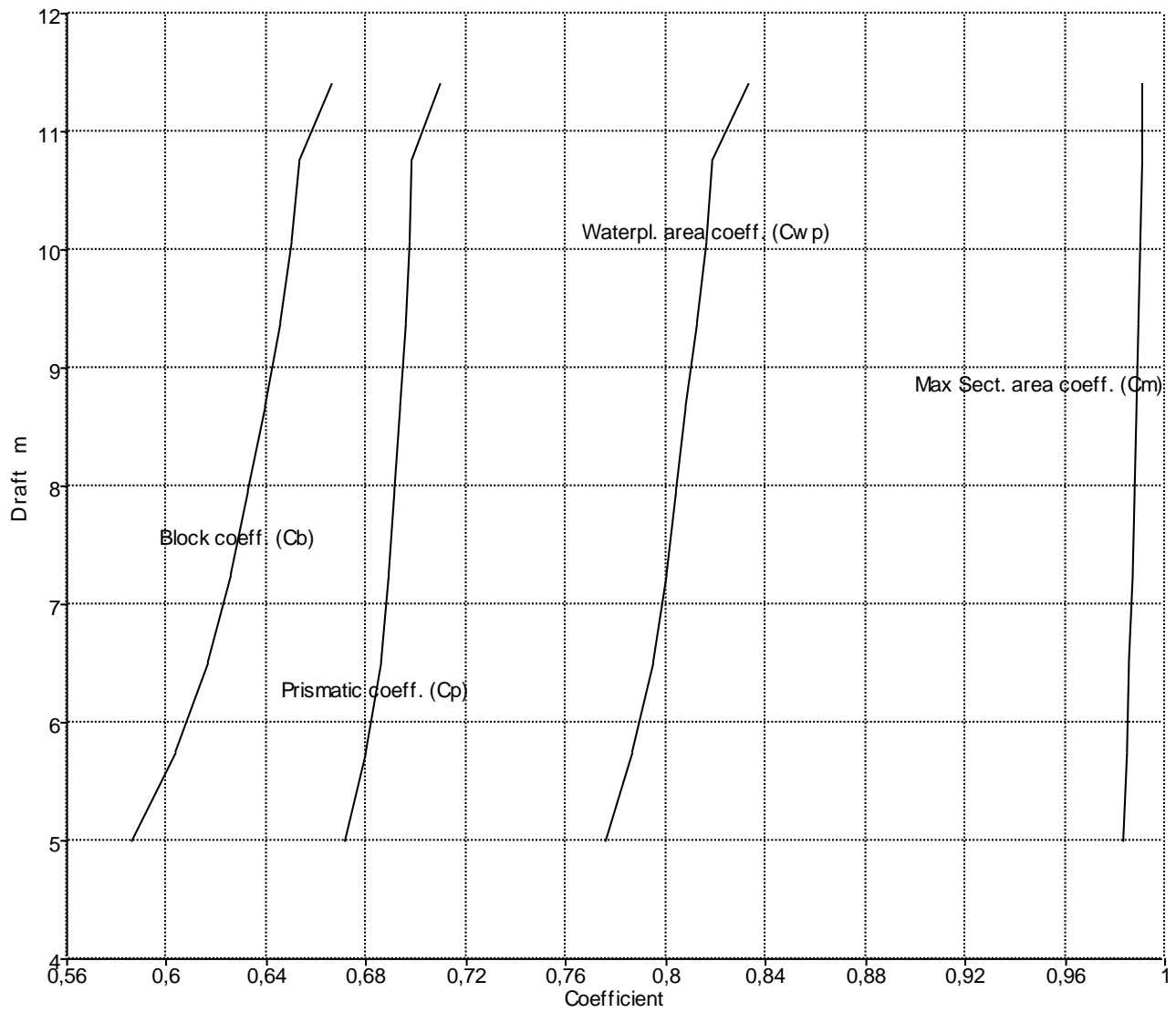
Waterpl. area coeff. (Cwp)

Max Sect. area coeff. (Cm)





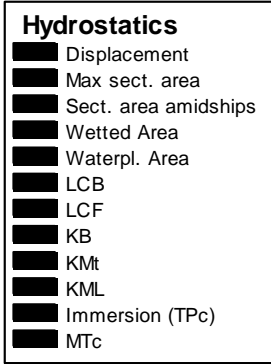
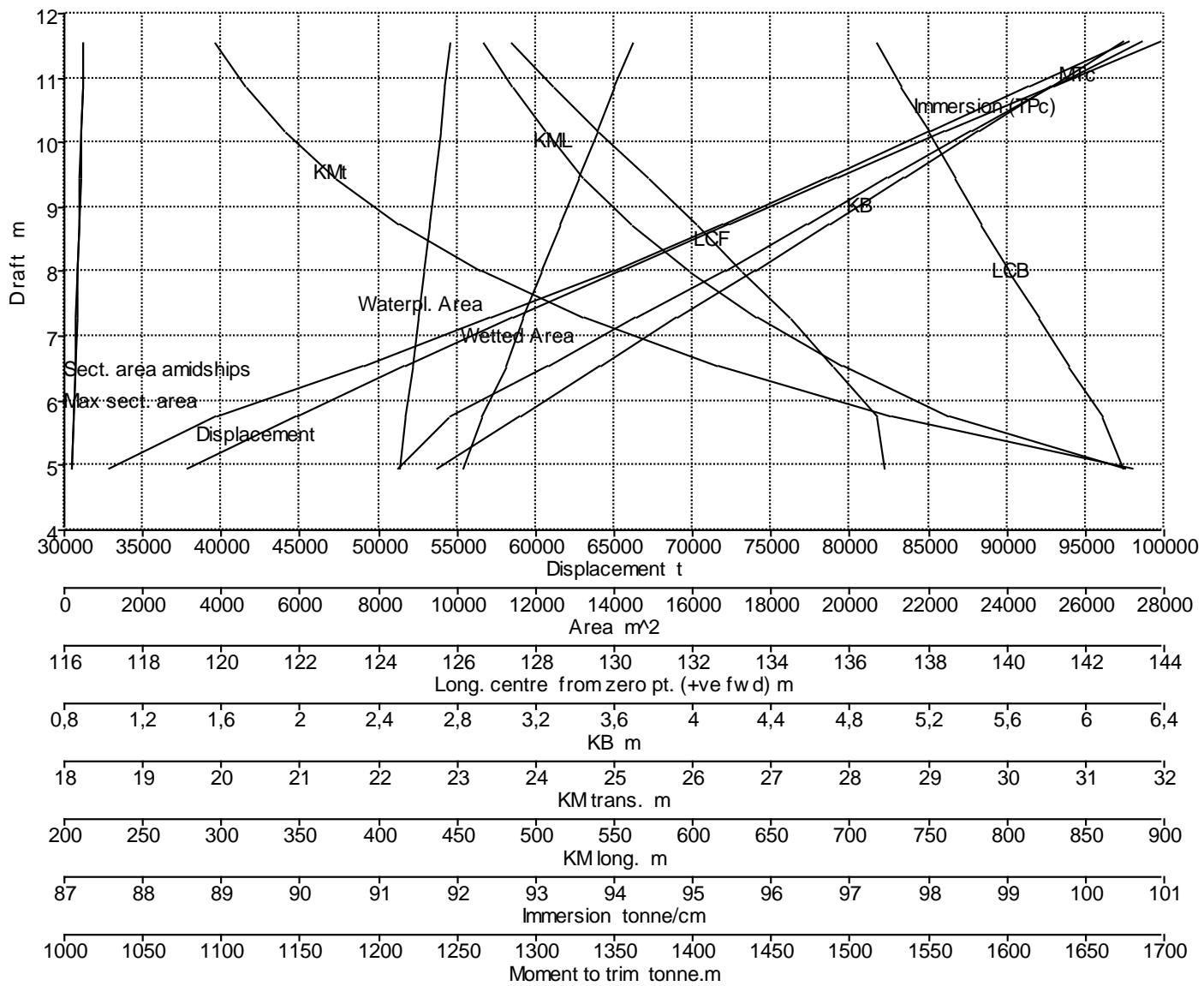


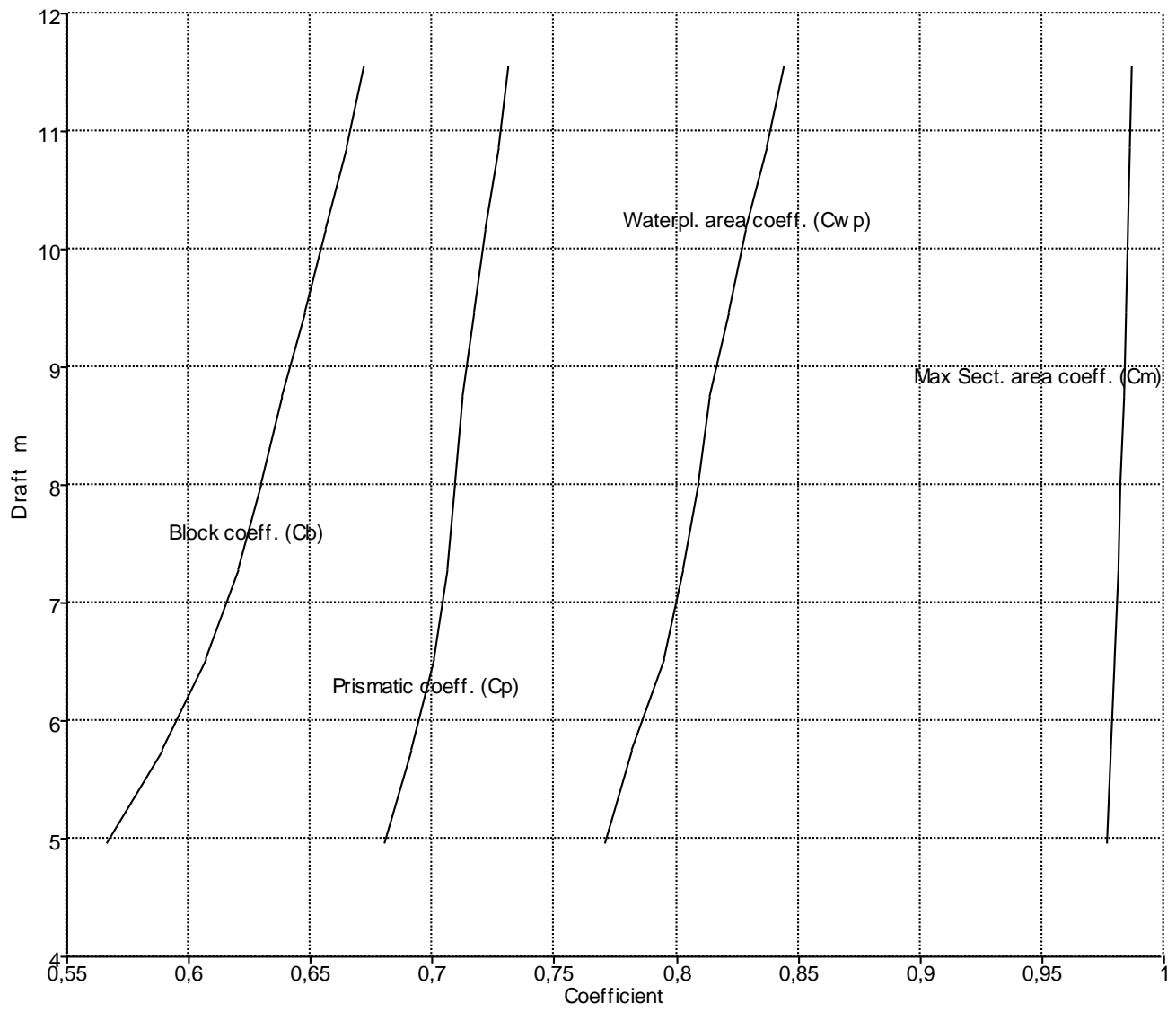


**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)



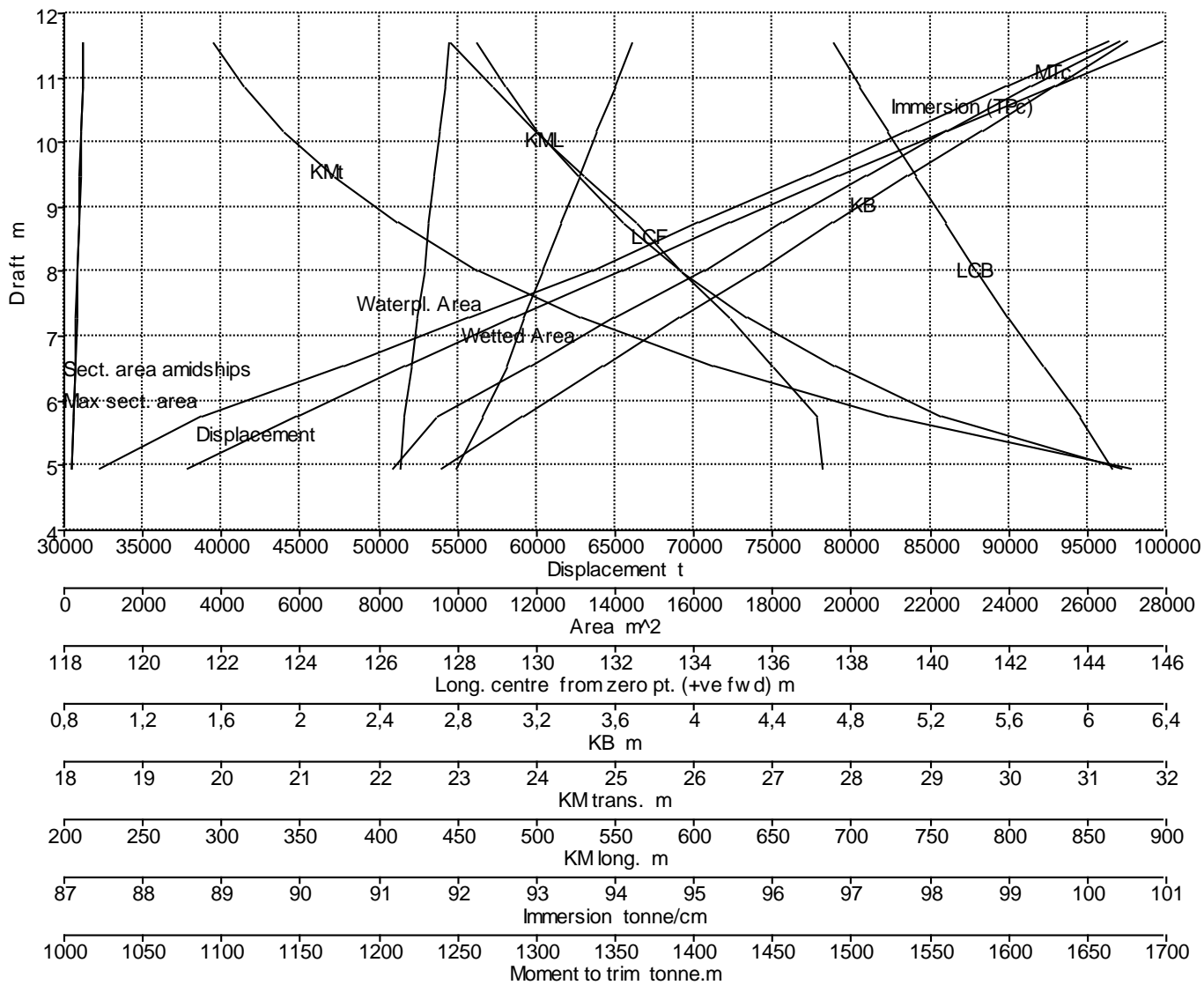




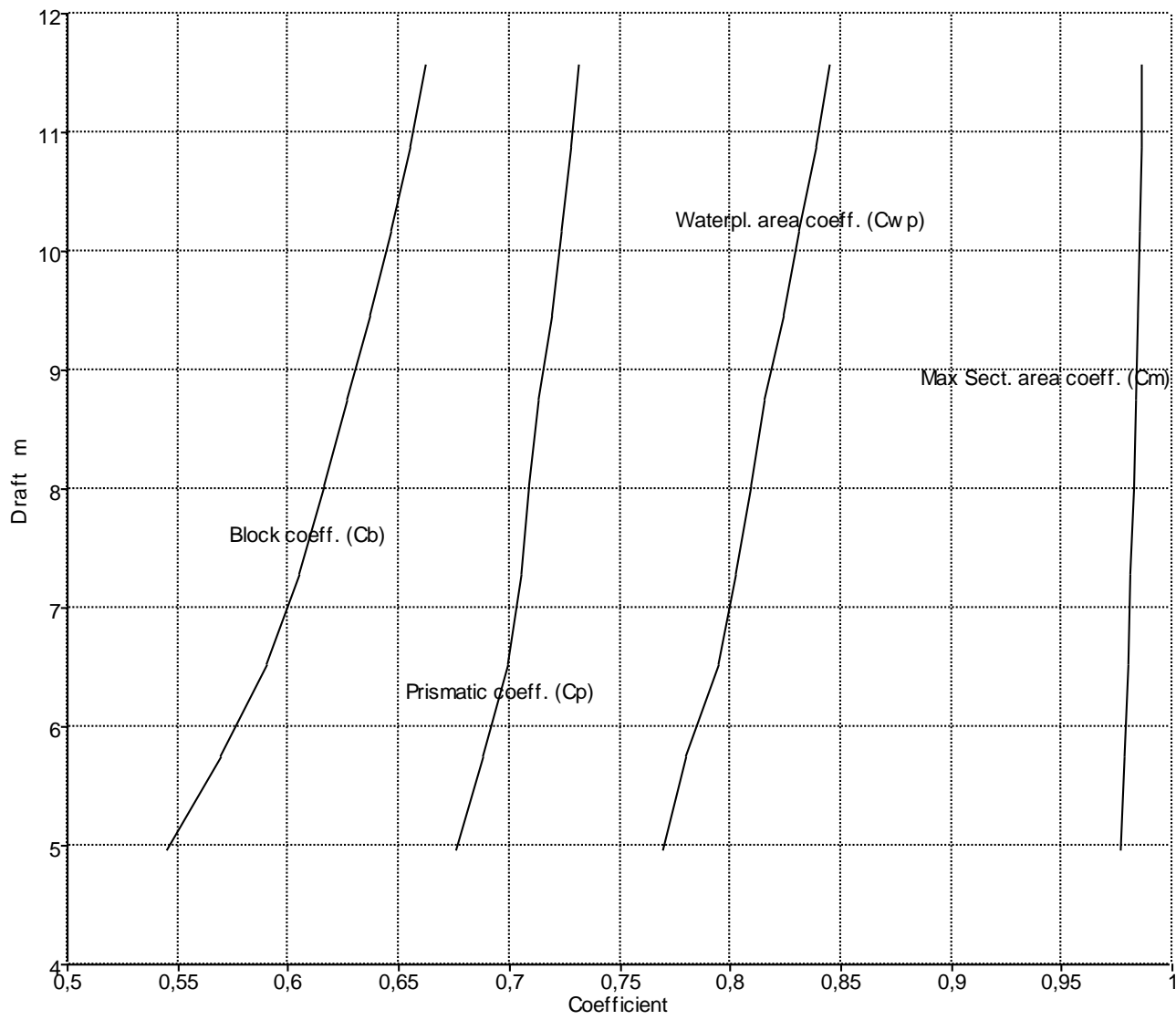
**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)





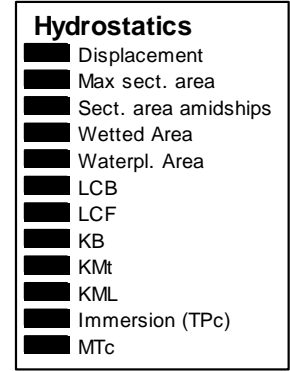
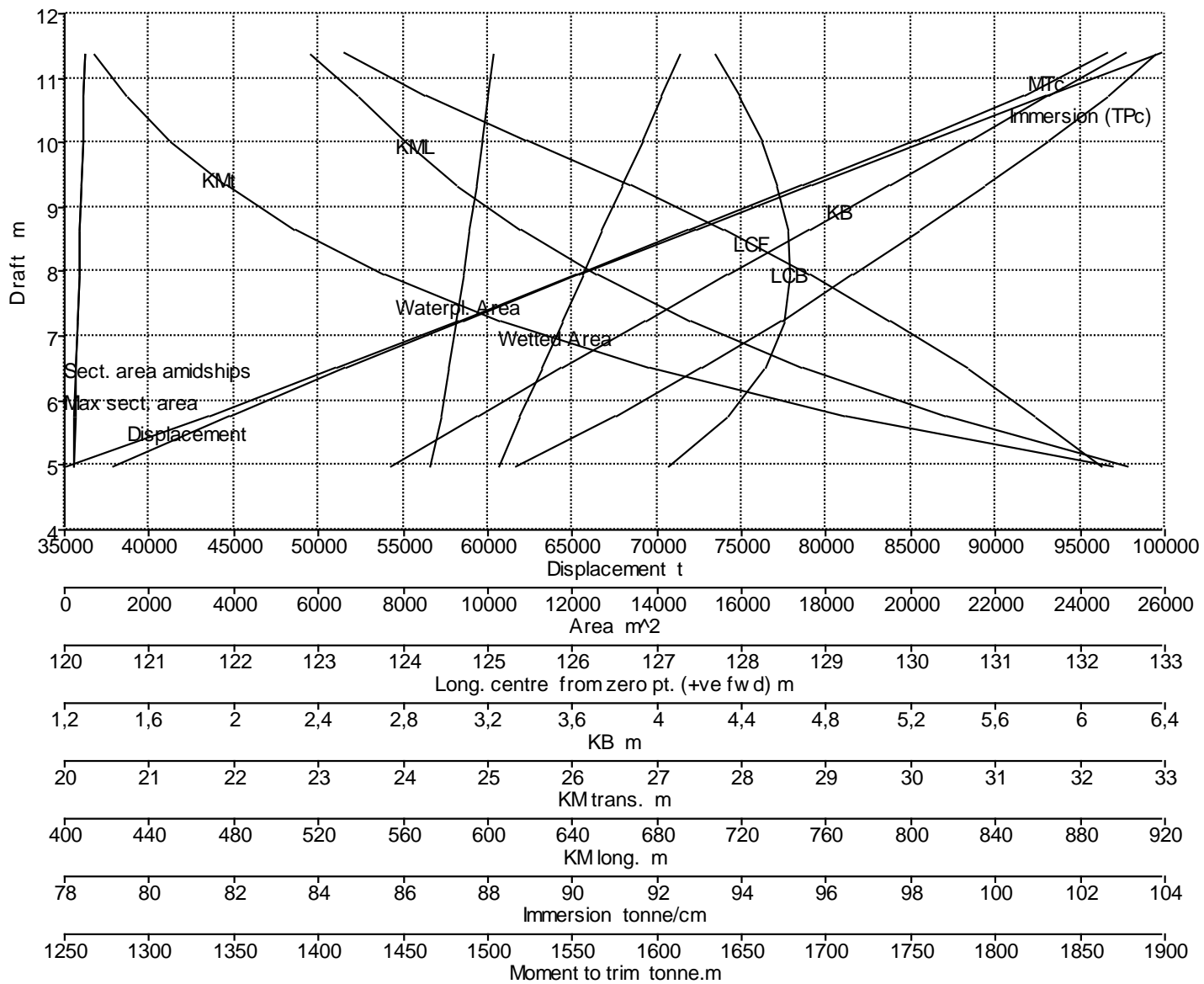


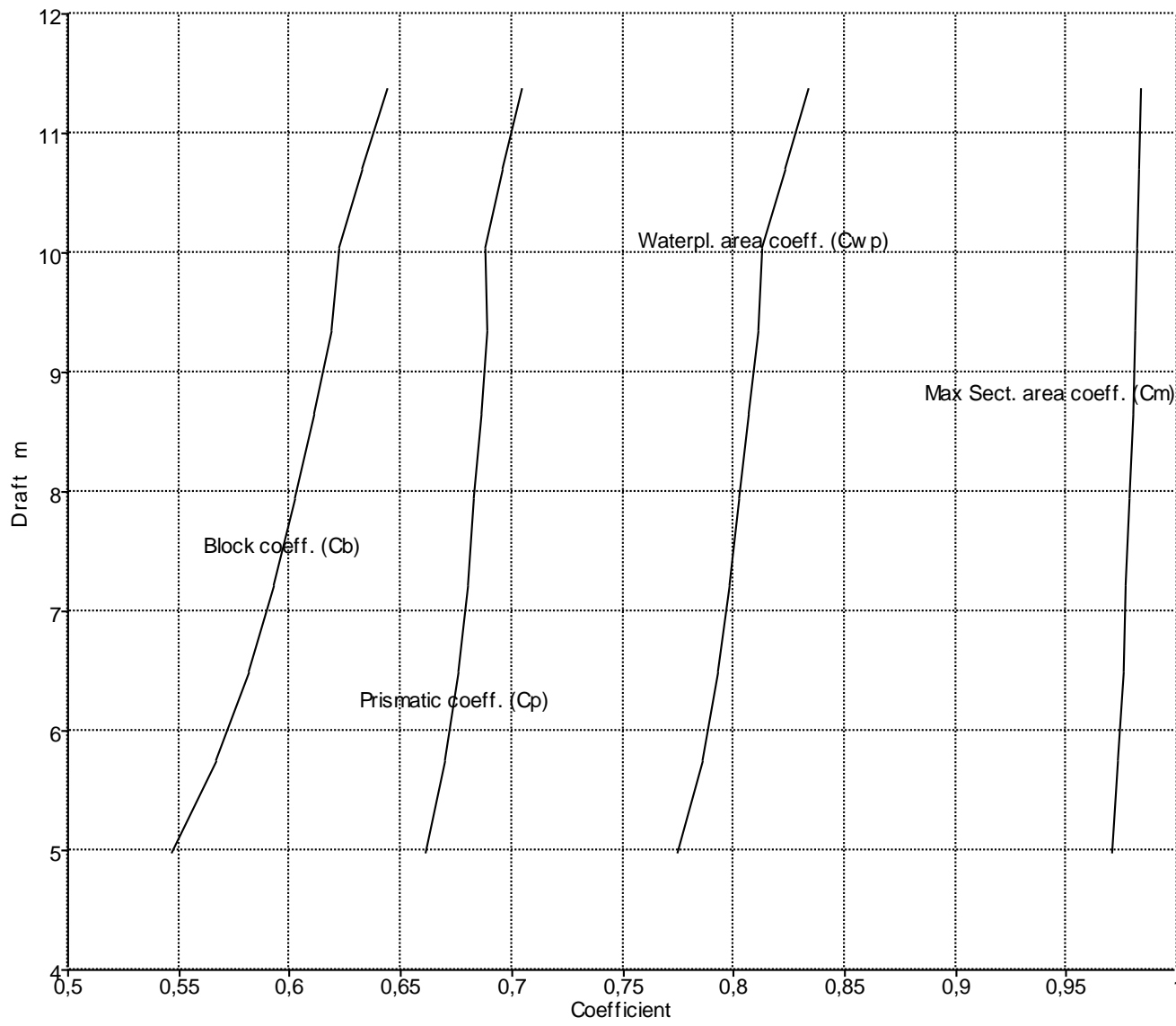


**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)



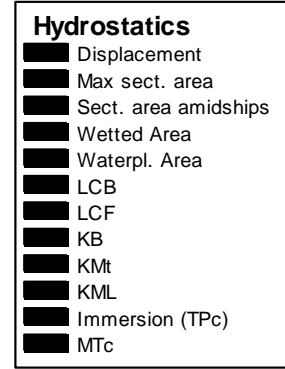
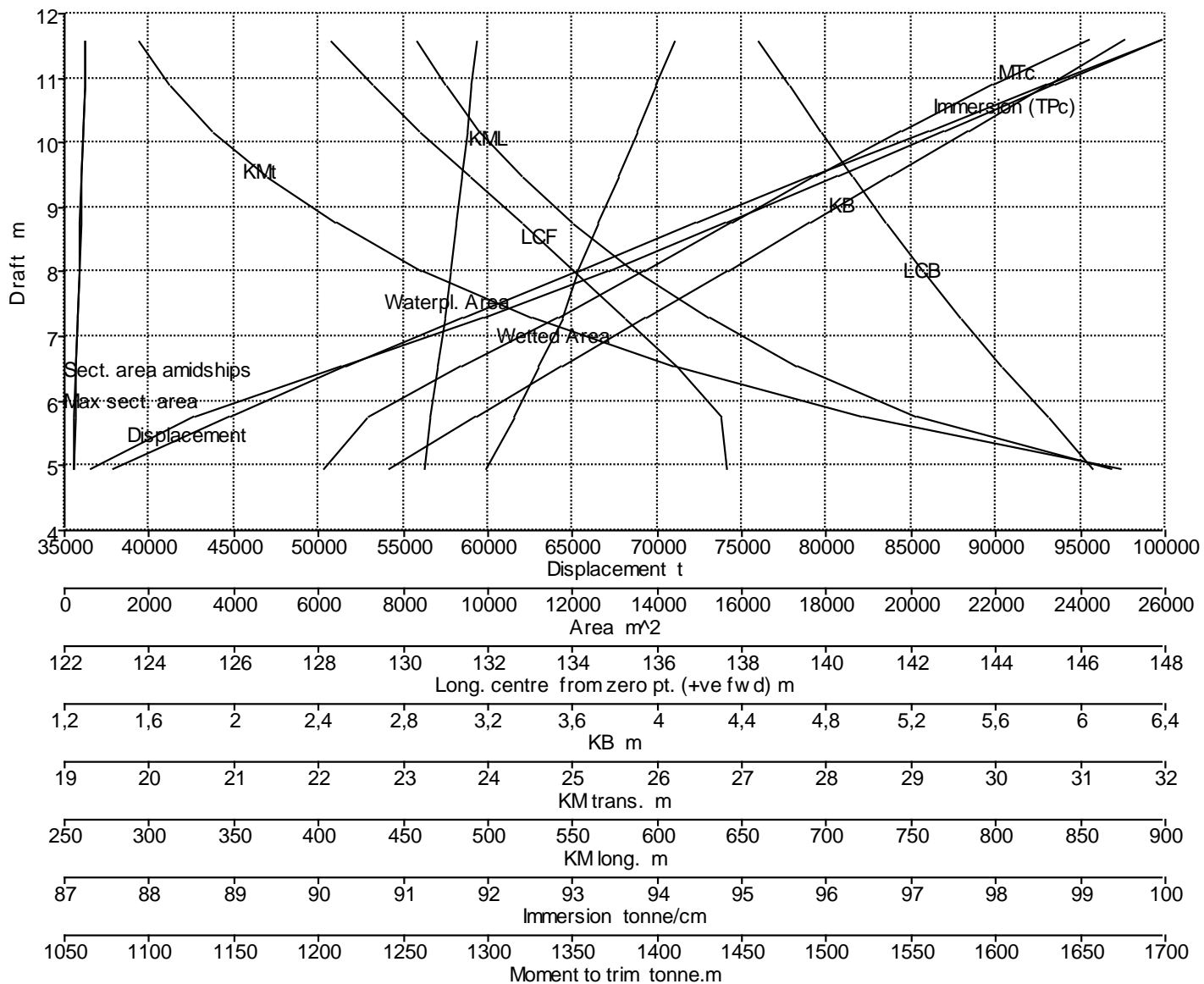


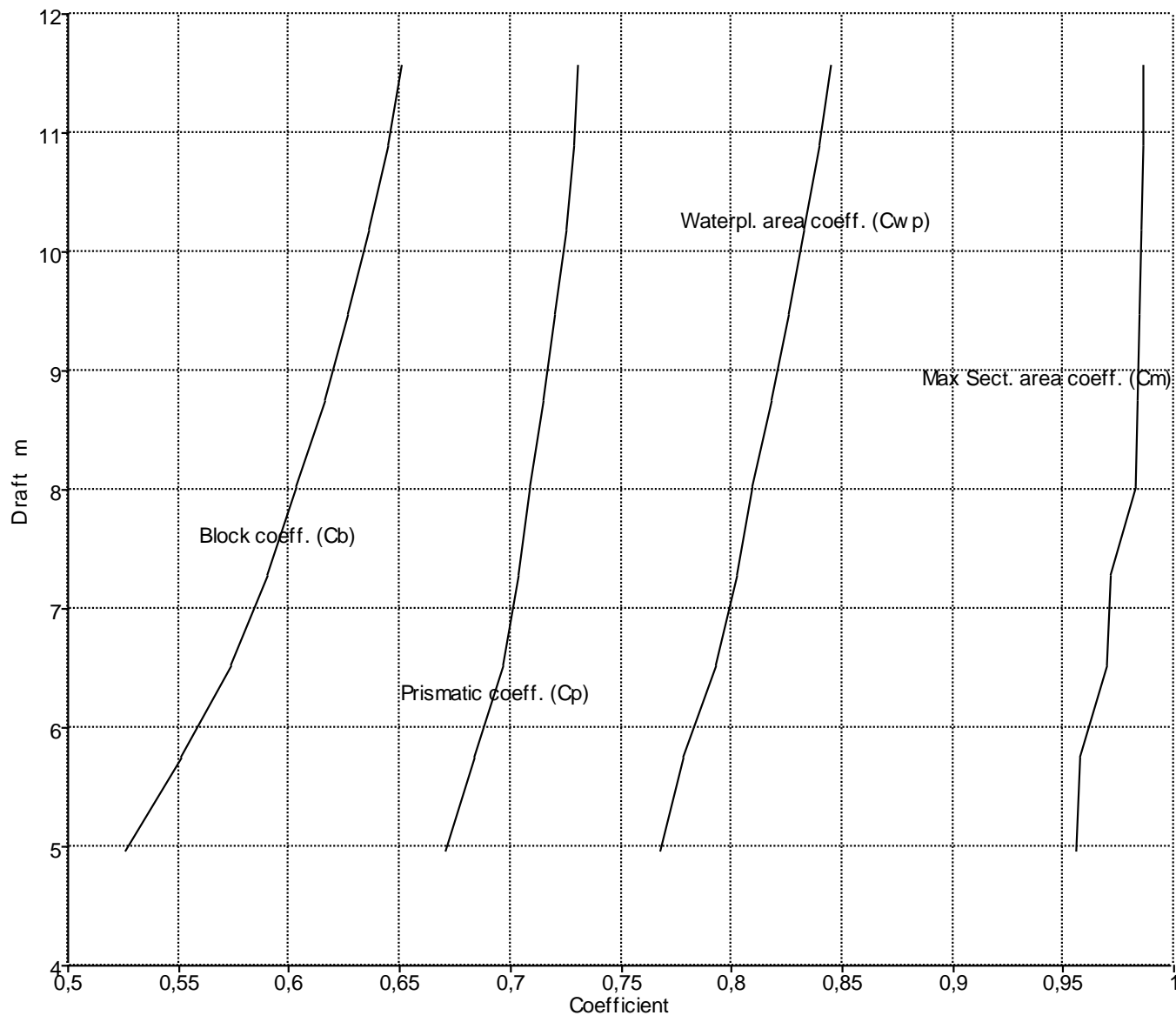


**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)





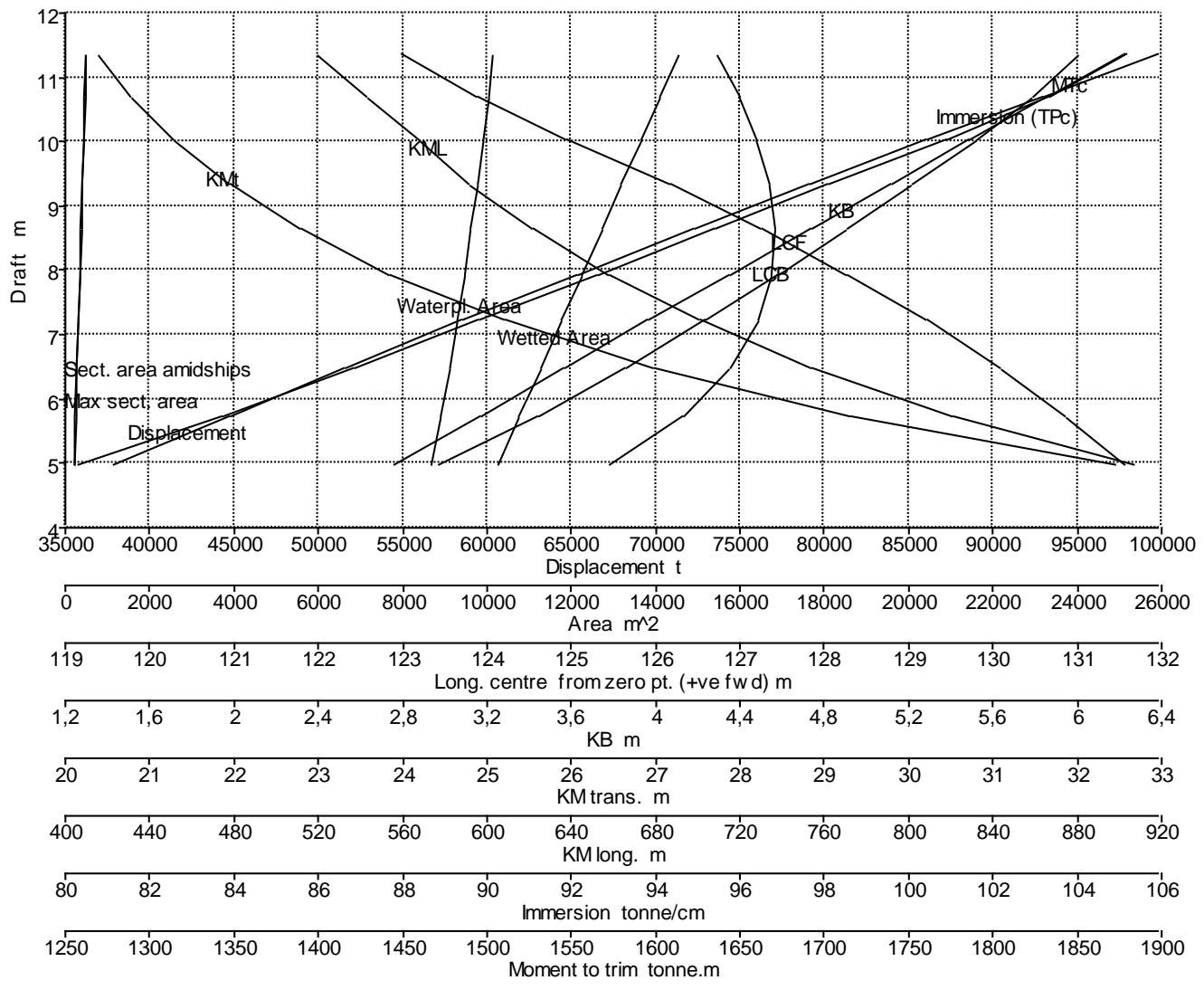


**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)

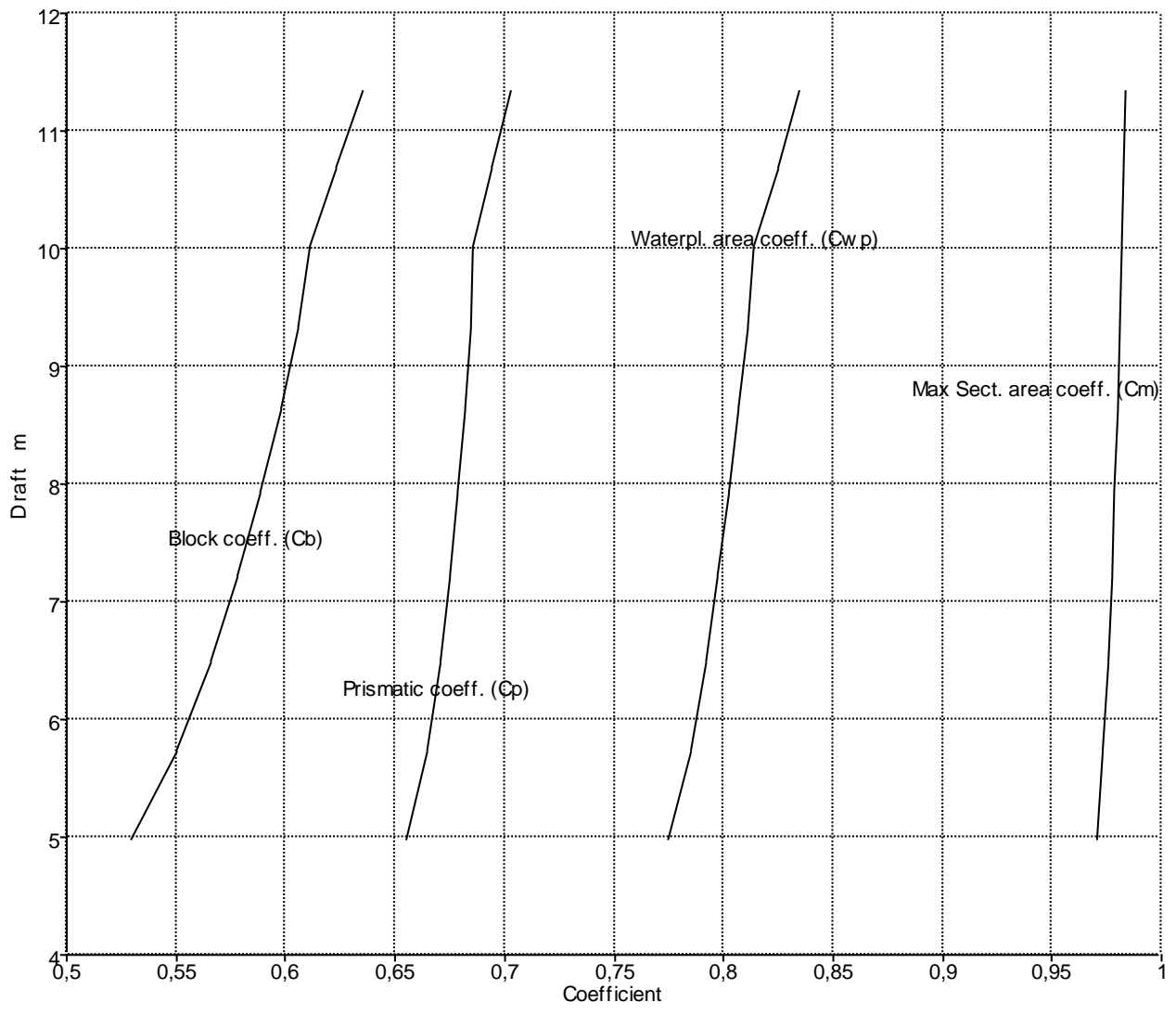






**Hydrostatics**

- Displacement
- Max sect. area
- Sect. area amidships
- Wette Area
- Waterpl. Area
- LCB
- LCF
- KB
- KMt
- KML
- Immersion (TPc)
- MTc



**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)

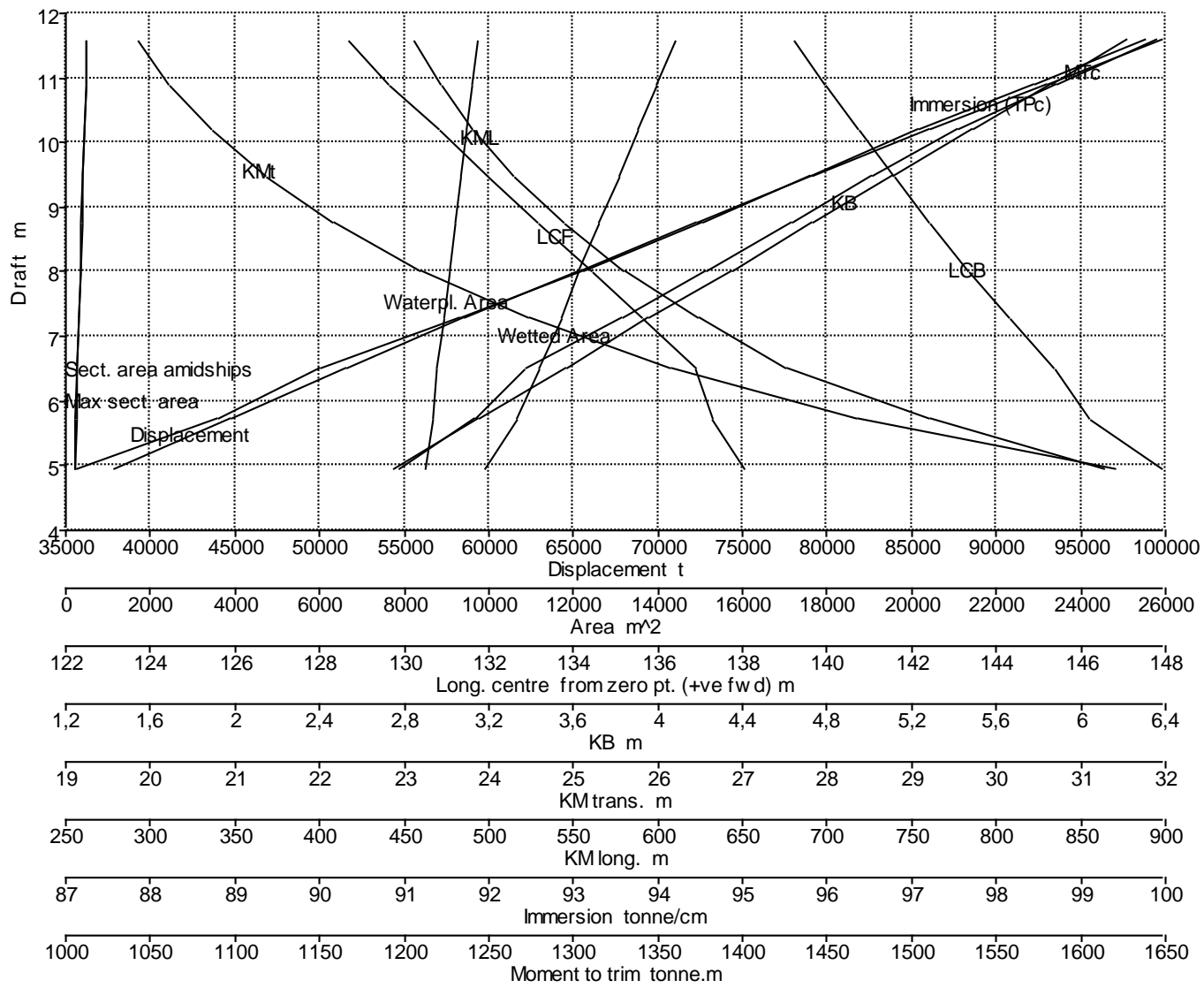
Block coeff. (Cb)

Prismatic coeff. (Cp)

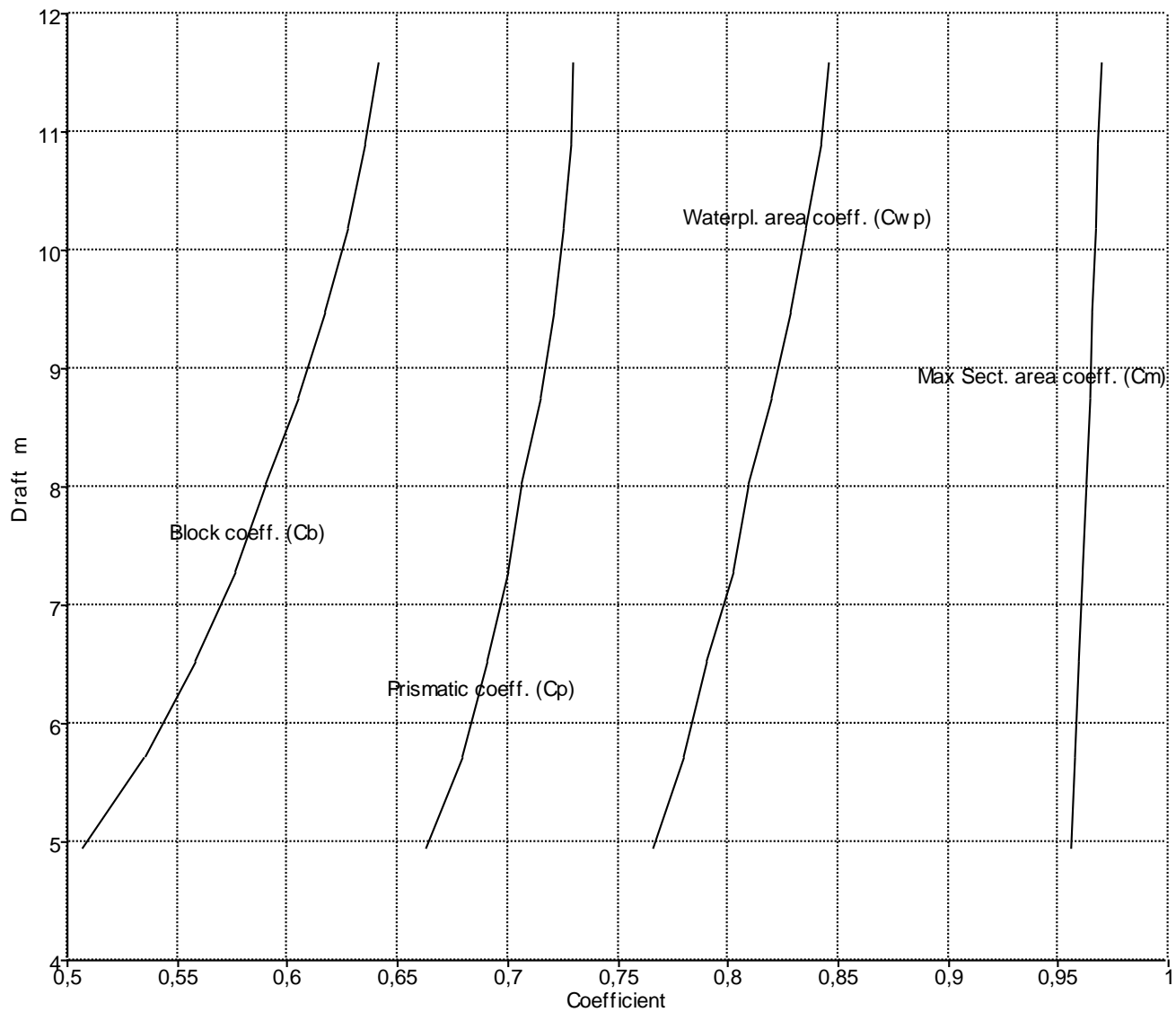
Waterpl. area coeff. (Cwp)

Max Sect. area coeff. (Cm)





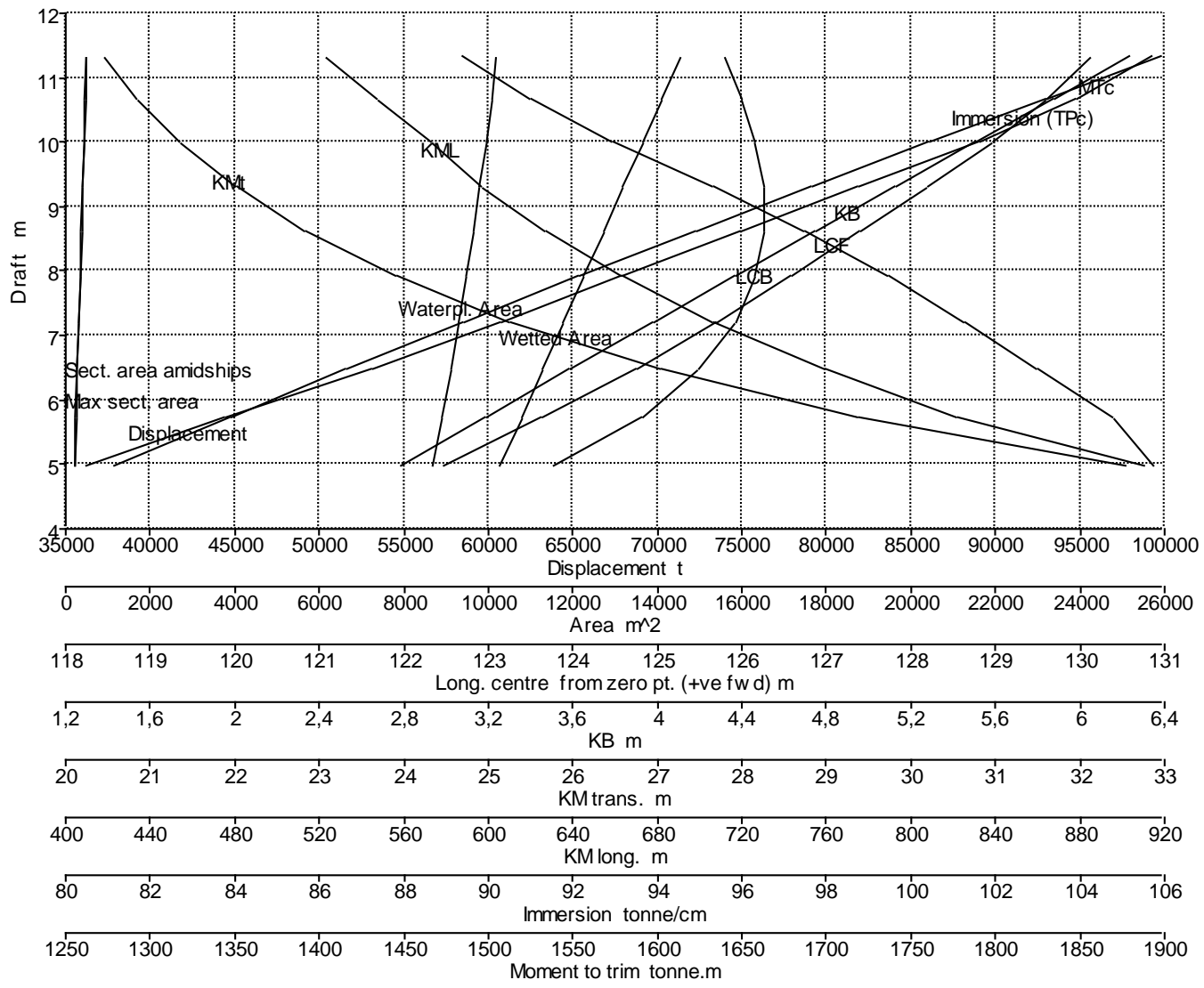
- Hydrostatics**
- Displacement
  - Max sect. area
  - Sect. area amidships
  - Wetted Area
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  - LCB
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  - KB
  - KMt
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**Curves of Form**

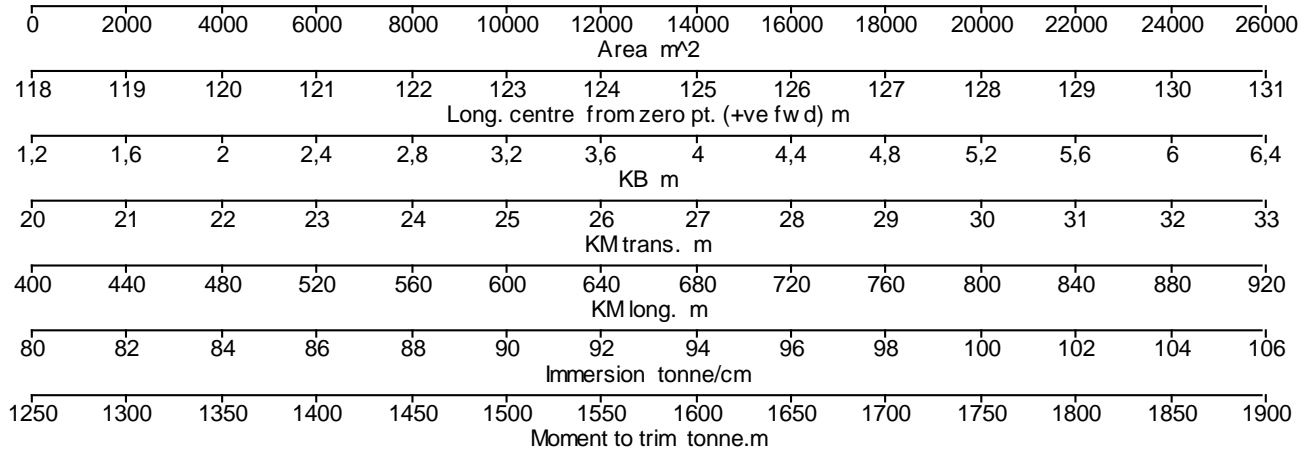
- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)

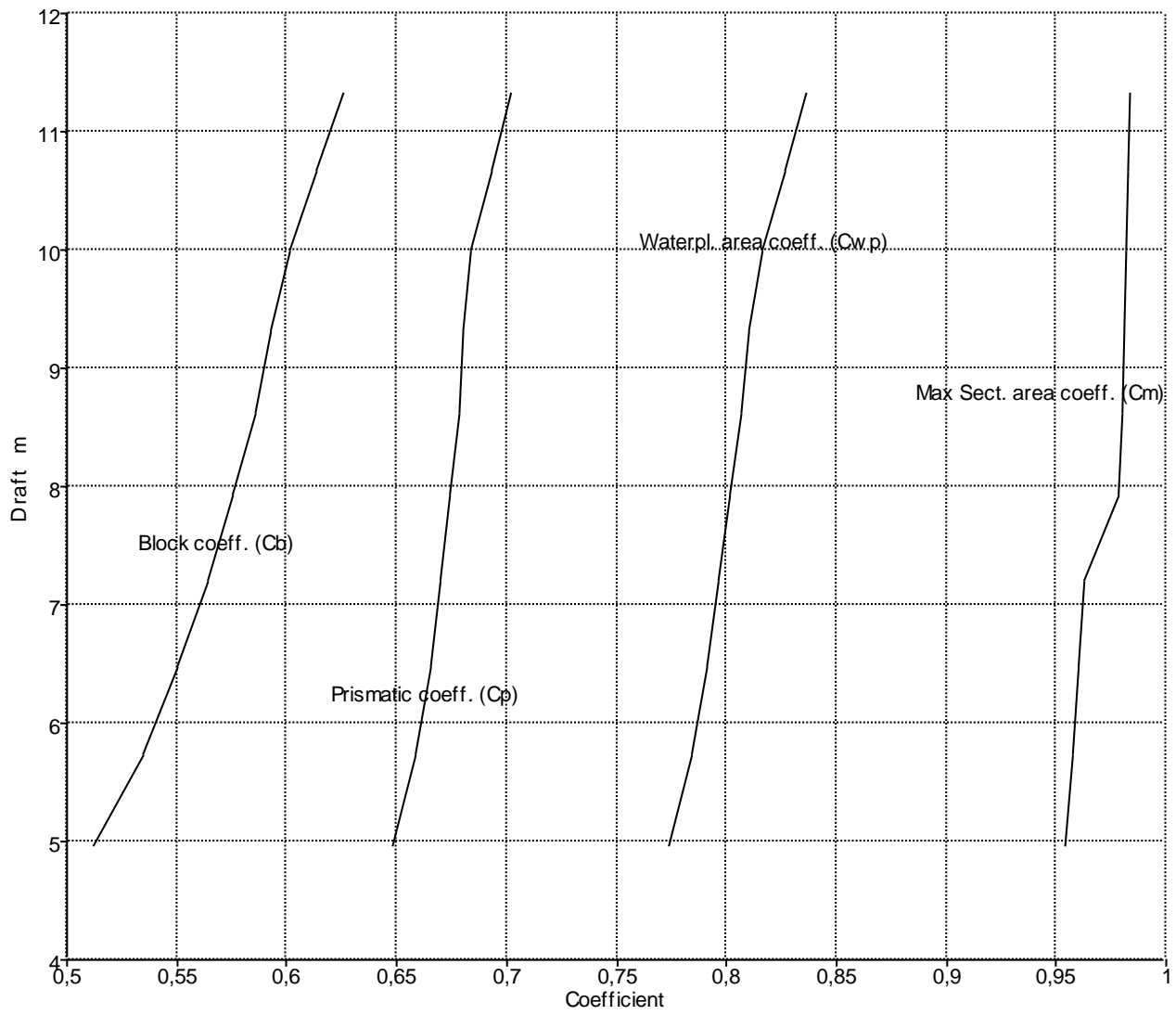




**Hydrostatics**

- Displacement
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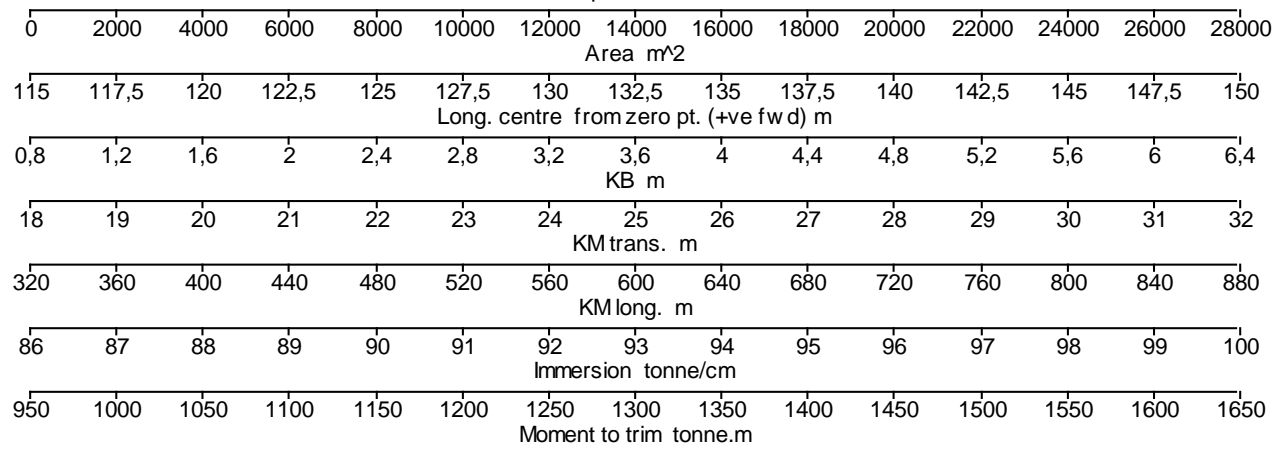
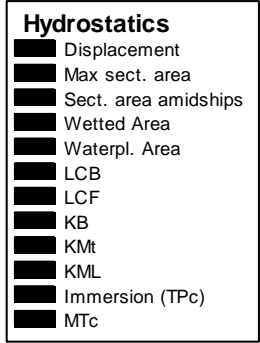
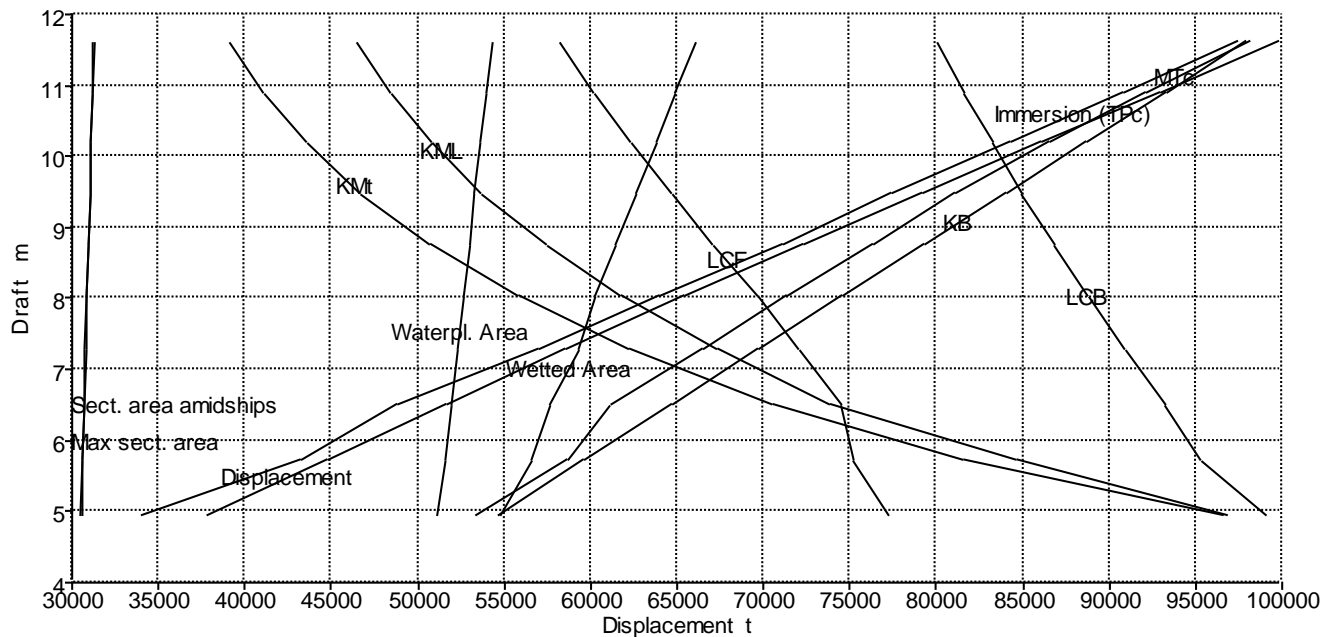


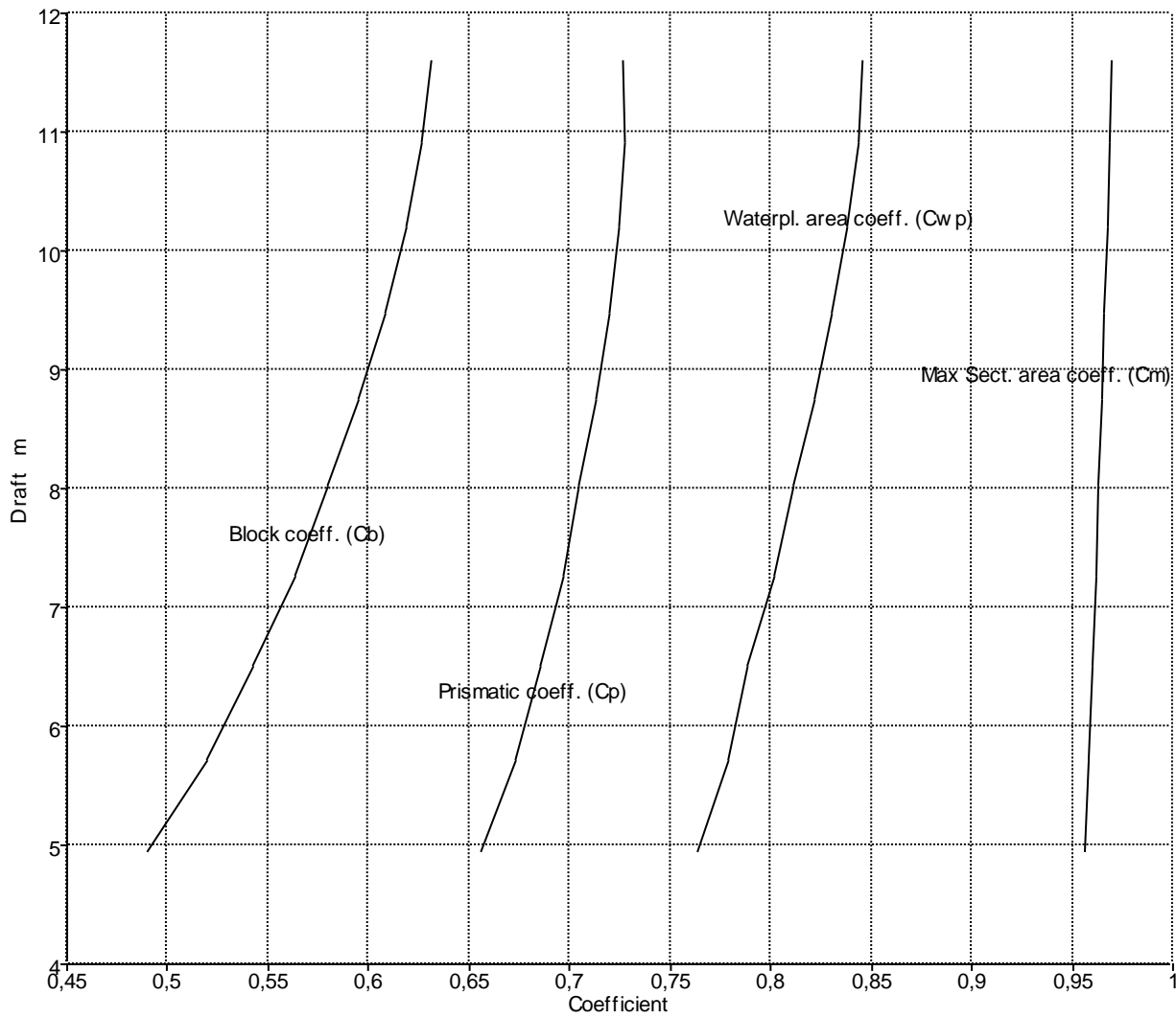
**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)





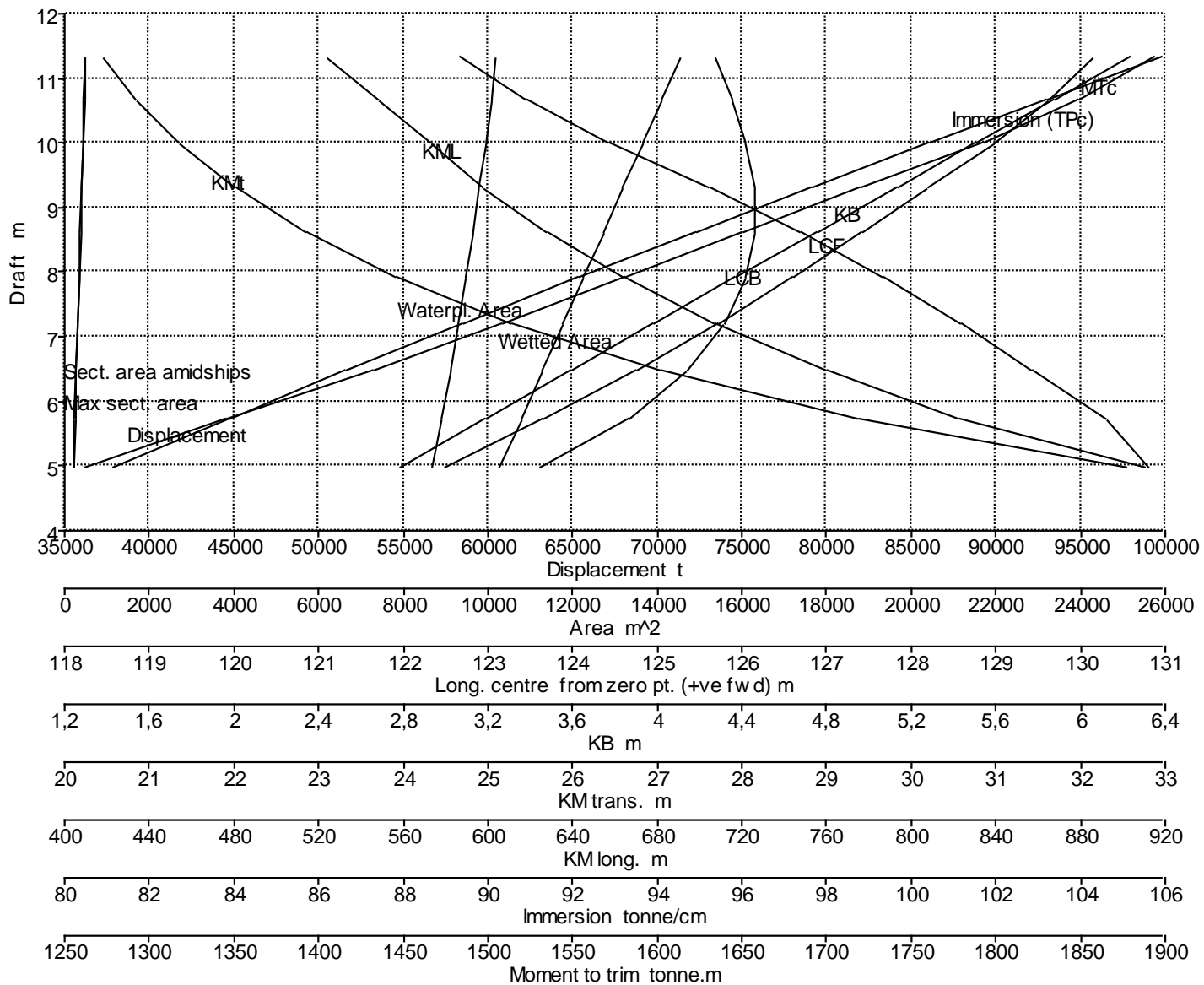




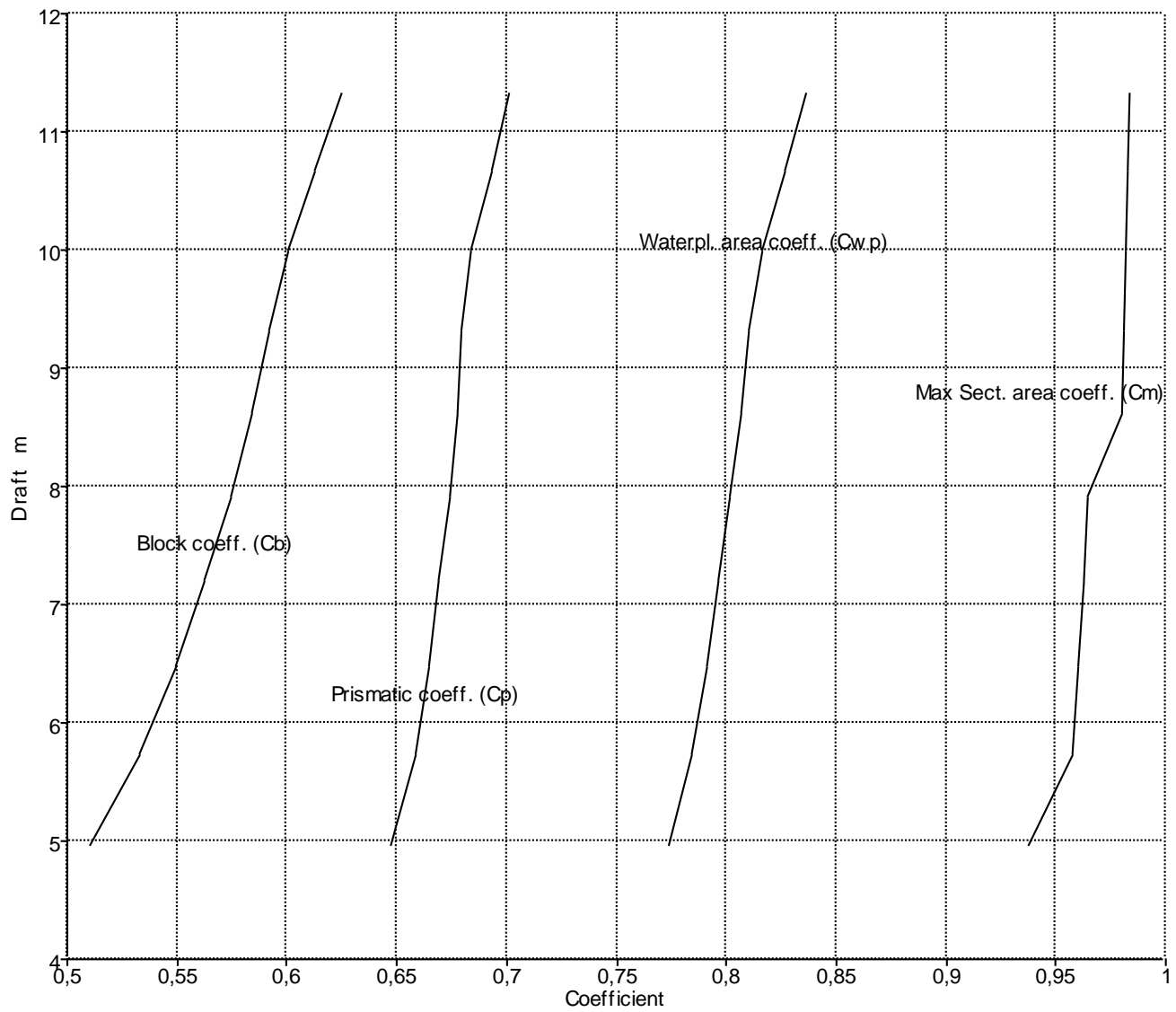
**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)





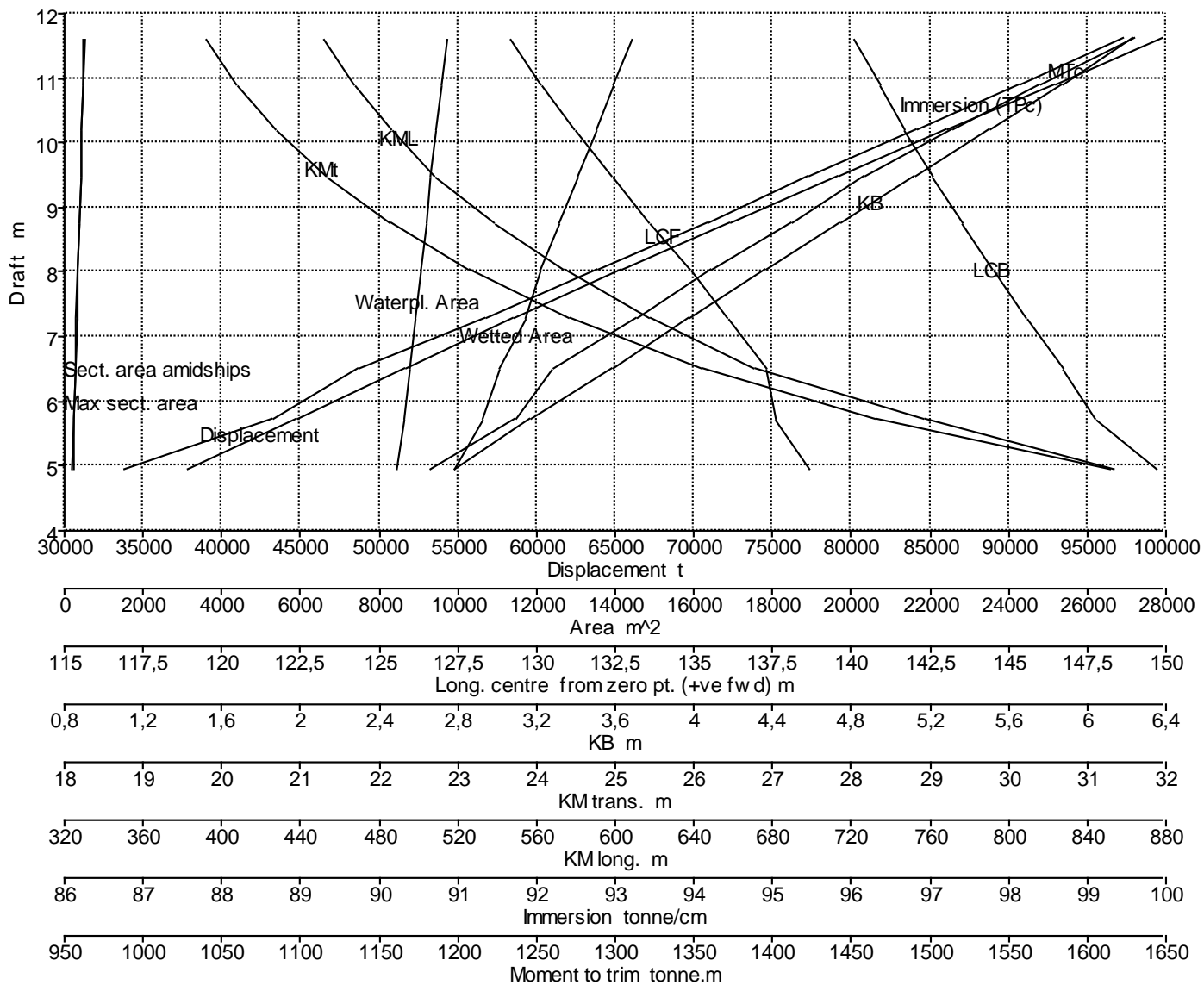
- Hydrostatics**
- Displacement
  - Max sect. area
  - Sect. area amidships
  - Wetted Area
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**Curves of Form**

- Prismatic coeff. (Cp)
- Block coeff. (Cb)
- Max Sect. area coeff. (Cm)
- Waterpl. area coeff. (Cwp)

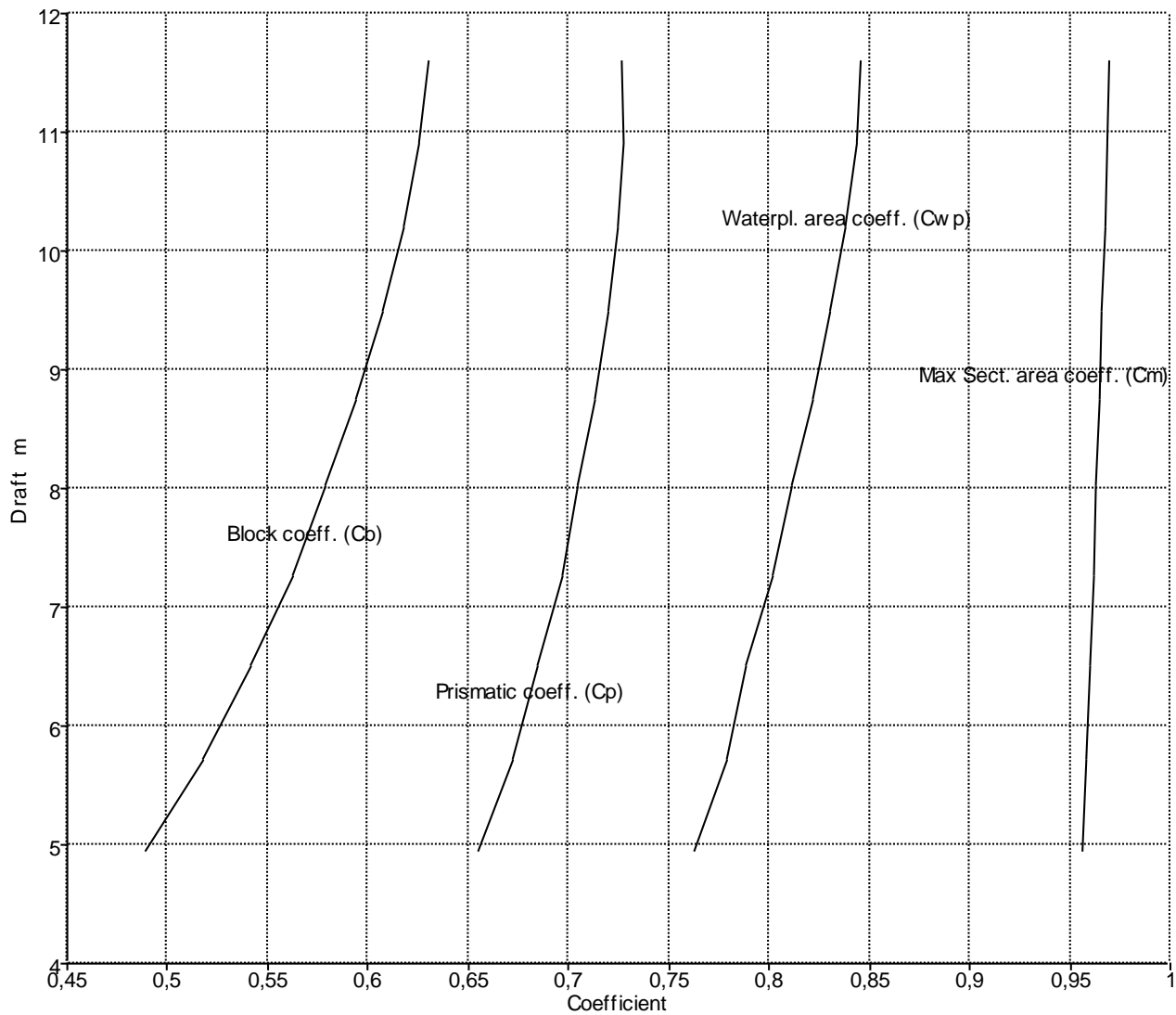




**Hydrostatics**

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- Max sect. area
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- Max Sect. area coeff. (Cm)
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