UNIVERSIDADE DA CORUÑA

Escola Politécnica Superior

TRABAJO FIN DE MÁSTER

CURSO 2017/2018

BUQUE PORTACONTENEDORES POST PANAMAX 9000 TEU's

9000 TEU POST PANAMAX CONTAINERSHIP

BUQUE PORTACONTENEDORES POST PANAMAX 9000 TEU's

Máster en Ingeniería Naval y Oceánica

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FECHA

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BUQUE PORTACONTENEDORES POST PANAMAX 9000 TEU's

Máster en Ingeniería Naval y Oceánica

Cuaderno 6

PREDICCIÓN DE POTENCIA Y DISEÑO DE PROPULSORES Y TIMONES

Escola Politécnica Superior

UNIVERSIDADE DA CORUÑA

DEPARTAMENTO DE INGENIERÍA NAVAL Y OCEÁNICA

TRABAJO FIN DE MÁSTER

CURSO 2017-2018

PROYECTO NÚMERO 18-02

TIPO DE BUQUE: Buque Portacontenedores Post-panamax.

CLASIFICACIÓN, COTA Y REGLAMENTOS DE APLICACIÓN: Lloyd's Register. Marpol. Solas.

CARACTERÍSTICAS DE LA CARGA: 9000 TEUS.

VELOCIDAD Y AUTONOMÍA: Velocidad máxima de 25,5 nudos, al 85% de MCR y 10% de margen de mar.

SISTEMAS Y EQUIPOS DE CARGA / DESCARGA: Sin grúas.

PROPULSIÓN: Motor acoplado a la línea de ejes.

TRIPULACIÓN Y PASAJE: 15 camarotes oficiales, 13 camarotes tripulación.

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

Ferrol, Octubre de 2017

ALUMNO: Dª Nadia Conde Alonso.

ÍNDICE

1 INTRODUCCIÓN

El objetivo de esta entrega es la estimación de la potencia propulsora del buque y el cálculo del propulsor, analizando varias alternativas para la obtención del resultado óptimo. Además se realizarán los cálculos de dimensiones de timón así como su posición en el codaste.

Los datos que utilizaremos serán los obtenidos en cuadernos anteriores y que se muestran en la siguiente tabla:

TEU'S TOTALES	9000 TEU'S
TEU'S BODEGA	4256 TEU'S
TEU'S CUBIERTA	4744 TEU'S
ESLORA TOT *(LOA)*	333,37 m.
ESLORA PERPENDICULARES *(LPP)*	318,4 m.
MANGA *(B)*	44,23 m.
PUNTAL *(D)*	26,41 m.
CALADO *(T)*	14,73 m.
DESPLAZAMIENTO *(Δ)*	144.194 ton.
VELOCIDAD *(V)*	25,5 kn.

N FROUD	0,235
COEF BLOQUE	0,67
COEF MAESTRA	0,99
COEF PRISM	0,68

2 PREDICCIÓN DE POTENCIA

Para la realización de la estimación de la potencia propulsora del buque se utilizará el programa informático *NavCad*. Se calculará primero la resistencia al avance del buque y a partir de ahí la potencia propulsora necesaria.

Para la realización de ambas será necesario introducir en *NavCad* los datos que se muestran en el siguiente apartado.

2.1 DATOS NECESARIOS

En las diferentes pestañas del programa será necesario introducir los siguientes datos:

- CASCO, hull data:

Hull data

General			Planing		
Configuration:		Monohull	*Proj chine length:*		*0,000 m*
Chine type:		Round/multiple	*Proj bottom area:*		*0,0 m2*
Length on WL:		325,000 m	*LCG fwd TR:*	*[XCG/LP 0,000]*	*0,000 m*
Max beam on WL:	[LWL/BWL 7,348]	44,230 m	*VCG below WL:*		*0,000 m*
Max molded draft:	[BWL/T 3,003]	14,730 m	*Aft station (fwd TR):*		*0,000 m*
Displacement:	[CB 0,664]	144194,00 t	*Deadrise:*		*0,00 deg*
Wetted surface:	[CS 2,755]	18622,6 m2	*Chine beam:*		*0,000 m*
ITTC-78 (CT)			*Chine ht below WL:*		*0,000 m*
LCB fwd TR:	[XCB/LWL 0,463]	150,430 m	*Fwd station (fwd TR):*		*0,000 m*
LCF fwd TR:	[XCF/LWL 0,423]	137,600 m	*Deadrise:*		*0,00 deg*
Max section area:	[CX 0,993]	647,0 m2	*Chine beam:*		*0,000 m*
Waterplane area:	[CWP 0,819]	11768,9 m2	*Chine ht below WL:*		*0,000 m*
Bulb section area:		50,2 m2	*Propulsor type:*		*Propeller*
Bulb ctr below WL:		6,640 m	*Max prop diameter:*		*9700,0 mm*
Bulb nose fwd TR:		333,000 m	*Shaft angle to WL:*		*0,00 deg*
Imm transom area:	[ATR/AX 0,000]	0,0 m2	*Position fwd TR:*		*0,000 m*
Transom beam WL:	[BTR/BWL 0,000]	0,000 m	*Position below WL:*		*0,000 m*
Transom immersion:	[TTR/T 0,000]	0,000 m	*Transom lift device:*		*Flap*
Half entrance angle:		18,00 deg	*Device count:*		*0*
Bow shape factor:	[WL flow]	1,0	*Span:*		*0,000 m*
Stern shape factor:	[WL flow]	1,0	*Chord length:*		*0,000 m*
			Deflection angle:		*0,00 deg*
			Tow point fwd TR:		*0,000 m*
			Tow point below WL:		*0,000 m*

Report ID20171005-1235 HydroComp NavCad 2014 14.02.0029.S1002.539

Tanto los valores de las dimensiones principales del buque a la flotación como las áreas han sido obtenidas a partir de las hidrostáticas del buque al calado de diseño, 14,73 m.

Displacement	144194 t
Volume (displaced)	140677,28 m^3
Draft Amidships	14,73 m
Immersed depth	14,73 m
WL Length	325,285 m
Beam max extents on WL	44,23 m
Wetted Area	18622,63 m^2
Max sect. area	647,07 m^2
Waterpl. Area	11768,86 m^2
Prismatic coeff. (Cp)	0,68
Block coeff. (Cb)	0,67
Max Sect. area coeff. (Cm)	0,99
Waterpl. area coeff. (Cwp)	0,83
LCB length	150,43 from zero pt. (+ve fwd)
LCF length	137,60 from zero pt. (+ve fwd)
LCB %	47,25 from zero pt. (+ve fwd)
LCF %	43,22 from zero pt. (+ve fwd)
KB	7,97 m
KG fluid	0 m
BMt	11,69 m
BML	543,07 m
GMt corrected	19,66 m
GML	551,04 m
KMt	19,66 m
KML	551,04 m
Immersion (TPc)	120,63 tonne/cm
MTc	2495,49 tonne.m
RM at 1deg = GMt.Disp.sin(1)	49487,27 tonne.m
Length:Beam ratio	7,18
Beam:Draft ratio	3,01
Length:Vol^0.333 ratio	6,12
Precision	Medium 66 stations

En el caso del bulbo y del espejo:

- Área del bulbo, 50,2 m^2. Esta área ha sido obtenida a partir de la curva de áreas seccionales del buque.
- Altura, 6,64 m obtenida del Cuaderno 3, y protuberancia del bulbo desde el espejo de popa, 333 m a partir del plano de formas.
- Área del espejo, 393 m^2. Obtenida a partir del plano de formas.
-

El semi-ángulo de entrada del casco en proa, 18^0, se ha obtenido del plano de formas del buque.

Los factores de proa y popa son 1 debido a las formas en "U" del buque.

- APÉNDICES, appendage data.

Appendage data

General		Skeg/Keel	
Definition:	Component	Count:	0
Percent of hull drag:	0,00 %	Type:	Skeg
Planing influence		Mean length:	0,000 m
LCE fwd TR:	0,000 m	Mean width:	0,000 m
VCE below WL:	0,000 m	Height aft:	0,000 m
Shafting		Height mid:	0,000 m
Count:	1	Height fwd:	0,000 m
Max prop diameter:	8900,0 mm	Projected area:	0,0 m2
Shaft angle to WL:	0,00 deg	Wetted surface:	0,0 m2
Exposed shaft length:	0,000 m	**Stabilizer**	
Shaft diameter:	0,000 m	Count:	0
Wetted surface:	0,0 m2	Root chord:	0,000 m
Strut bossing length:	0,000 m	Tip chord:	0,000 m
Bossing diameter:	0,000 m	Span:	0,000 m
Wetted surface:	0,0 m2	T/C ratio:	0,000
Hull bossing length:	0,000 m	LE sweep:	0,00 deg
Bossing diameter:	0,000 m	Wetted surface:	0,0 m2
Wetted surface:	0,0 m2	Projected area:	0,0 m2
Strut (per shaft line)		Dynamic multiplier:	1,00
Count:	0	**Bilge keel**	
Root chord:	0,000 m	Count:	0
Tip chord:	0,000 mm	Mean length:	0,000 m
Span:	0,000 m	Mean base width:	0,000 m
T/C ratio:	0,000	Mean projection:	0,000 m
Projected area:	0,0 m2	Wetted surface:	0,0 m2
Wetted surface:	0,0 m2	**Tunnel thruster**	
Exposed palm depth:	0,000 m	Count:	0
Exposed palm width:	0,000 m	Diameter:	0,000 m
Rudder		**Sonar dome**	
Count:	1	Count:	0
Rudder location:	Behind propeller	Wetted surface:	0,0 m2
Type:	Balanced foil	**Miscellaneous**	
Root chord:	6,410 m	Count:	0
Tip chord:	5,290 m	Drag area:	0,0 m2
Span:	11,070 m	Drag coef:	0,00
T/C ratio:	0,150		
LE sweep:	0,00 deg		
Projected area:	58,0 m2		
Wetted surface:	63,1 m2		

En el apartado del timón, rudder, situado a popa de la hélice, introduciremos las dimensiones de este calculadas, más adelante, en el apartado 5.

- Altura de la pala, 11,07 m.
- Longitud inferior, 6,41 m.
- Longitud superior, 5,29 m.

Para el diámetro de la hélice se tomará un margen adicional para las claras utilizando un diámetro de 8900 mm ya que, comprobándolo mediante la realización del estudio con ambos diámetros, con un diámetro menor el resultado final en cuanto al rendimiento de esta es mejor.

- ENTORNO, environment data.

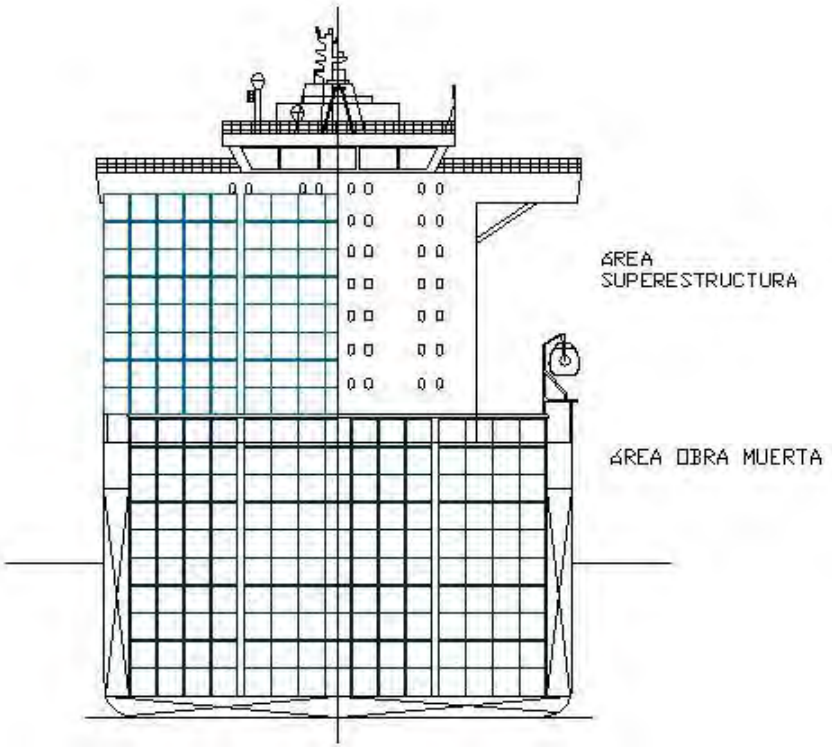
Environment data

Wind		Seas	
Wind speed:	0,00 kt	Significant wave ht:	0,000 m
Angle off bow:	0,00 deg	Modal wave period:	0,0 sec
Gradient correction:	Off	**Shallow/channel**	
Exposed hull		Water depth:	0,000 m
Transverse area:	612,8 m2	Type:	Shallow water
VCE above WL:	0,000 m	Channel width:	0,000 m
Profile area:	0,0 m2	Channel side slope:	0,00 deg
Superstructure		Hull girth:	0,000 m
Superstructure shape:	Container ship		
Transverse area:	838,3 m2		
VCE above WL:	0,000 m		
Profile area:	0,0 m2		

En esta pestaña se introducirá el área transversal de la obra muerta del buque así como el área transversal de la superestructura, indicando que nuestro buque es un portacontenedores.

- Área transversal de la obra muerta, 612,8 m^2.
- Área transversal de la superestructura, 838,3 m^2.

Se muestra a continuación un croquis de ambas áreas.



- MARGEN, margin. Se introduce un margen del 10% dado en las RPA y se define como "Hull drag only".

2.2 CÁLCULO DE LA RESISTENCIA

Una vez introducidos los datos anteriores se procede al cálculo de la resistencia del buque en el modo *Resistance* del programa.

Se realizará el cálculo para 10 velocidades distintas, de un nudo en un nudo hasta llegar a la velocidad de diseño, 25,5 kn, y pasando medio nudo de esta.

SPEED [kt]
19,00
20,00
21,00
22,00
23,00
24,00
24,50
25,00
+ 25,50 +
26,00

Para el cálculo de la resistencia se utilizará el Método Andersen ya que para este tipo de buque resulta el más acertado:

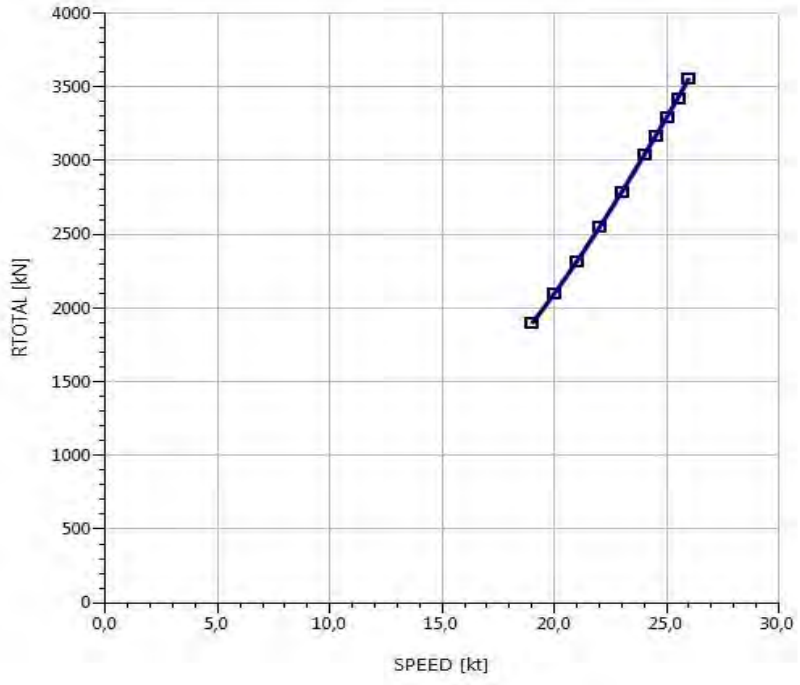
Analysis parameters

Vessel drag	**ITTC-78 (CT)**	**Added drag**	
Technique:	[Calc] **Prediction**	Appendage:	[Calc] **Holtrop (Component)**
Prediction:	**Andersen**	Wind:	[Off]
Reference ship:		Seas:	[Off]
Model LWL:		Shallow/channel:	[Off]
Expansion:	**Standard**	Towed:	[Off]
Friction line:	**ITTC-57**	Margin:	[Calc] **Hull drag only [10%]**
Hull form factor:	[On] **1,195**	**Water properties**	
Speed corr:	[Off]	Water type:	**Salt**
Spray drag corr:	[Off]	Density:	**1026,00 kg/m3**
Corr allowance:	**ITTC-78 (v2008)**	Viscosity:	**1,18920e-6 m2/s**
Roughness [mm]:	[Off]		

Tras el cálculo se obtiene para 25,5 kn, una resistencia al avance de **3.424 kN.**

Esta será la resistencia que nuestro propulsor tendrá que vencer para hacer avanzar al buque en una dirección con esta velocidad.

A continuación podemos ver una gráfica en que se ven enfrentados los valores de resistencia y velocidad. Se trata de una gráfica exponencial, a medida que aumenta la velocidad lo hace con mayor medida la resistencia:



Se mostrarán en el Anexo I los resultados completos del análisis de la resistencia.

2.3 CÁLCULO DE LA POTENCIA

Una vez obtenida la resistencia se calculará la potencia del buque utilizando el modo *Propulsion* del programa.

Además de los datos ya introducidos en el cálculo de la resistencia se utilizará una pestaña más para este cálculo en la que se introducirán los datos de la propulsión del buque.

- PROPULSOR, propulsor data.

En esta pestaña se introducen el diámetro de la hélice, obtenido en el Cuaderno 3, y la altura del eje desde la línea base obtenida del plano de la disposición general del buque.

Propulsor data

Propulsor				Propeller options	
Count:		1		Oblique angle corr:	Off
Propulsor type:		Propeller series		Shaft angle to WL:	0,00 deg
Propeller type:		FPP		Added rise of run:	0,00 deg
Propeller series:		B Series		Propeller cup:	0,0 mm
Propeller sizing:		By thrust		KTKQ corrections:	Custom
Reference prop:				Scale correction:	Full ITTC
Blade count:		5		KT multiplier:	1,000
Expanded area ratio:		1,0500	[Size]	KQ multiplier:	1,000
Propeller diameter:		8900,0 mm	[Size]	Blade T/C [0.7R]:	0,00
Propeller mean pitch:	[P/D 0,9731]	8660,2 mm	[Size]	Roughness:	0,00 mm
Hub immersion:		6000,0 mm		Cav breakdown:	Off

Para una primera aproximación de la potencia, se hará el estudio con una hélice de cuatro palas a 102 revoluciones. Para ello debemos seleccionar la función de *propeller sizing* y elegir la opción "By thrust" es decir, que la potencia requerida es proporcional a la resistencia al avance del buque o empuje obtenido en el apartado anterior.

En los datos de la hélice, se dejará que el propio programa calcule sus parámetros principales.

Para el cálculo de la potencia se utilizará también el Método Andersen y las mismas velocidades que en el cálculo de la resistencia:

Analysis parameters

Hull-propulsor interaction		System analysis	
Technique:	[Calc] Prediction	Cavitation criteria:	Keller eqn
Prediction:	Andersen	Analysis type:	Free run
Reference ship:		CPP method:	
Max prop diam:	8900,0 mm	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	[Off]	RPM constraint:	
Rudder location:		Limit [RPM/s]:	
Friction line:		**Water properties**	
Hull form factor:		Water type:	Salt
Corr allowance:		Density:	1026,00 kg/m3
Roughness [mm]:		Viscosity:	1,18920e-6 m2/s
Ducted prop corr:	[Off]		
Tunnel stern corr:	[Off]		
Effective diam:			
Recess depth:			

Una vez calculado, obtenemos para esta primera estimación una potencia de 56.606 kW y unas revoluciones óptimas del propulsor de 96 rpm.

El motor propulsor del buque proyecto deberá funcionar al 85% de su régimen, por lo que la potencia mínima requerida será:

$$\boldsymbol{Potencia\ al\ 85\%\ MCR} = \frac{56.606\ kW}{0{,}85} = \boldsymbol{66.595\ kW}$$

A continuación como ya se conoce la potencia demandada por el buque, se busca en catálogos de casas fabricantes de motores un modelo que sea capaz de proporcionar la potencia requerida.

3 SELECCIÓN DEL MOTOR Y CÁLCULO DEL PROPULSOR

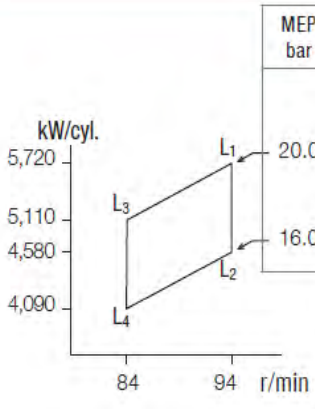
En base a los datos obtenidos a través del estudio con el programa *NavCad* y utilizando la similitud con otros buques de mismas características se establece un motor **MAN modelo K90ME9-TII de 12 cilindros**. Es un motor de 2 tiempos de gran tamaño que a 94revoluciones por minuto nos ofrece una potencia de **68.640 kW/92.045 hp.**

En la siguiente tabla se puede comparar la potencia seleccionada con la potencia de algunos buques reales:

Maersk Algol, 9.034 TEU	68.640 kW, Wärtsilä 12RT-flex96C
MSC Beatrice, 13.798 TEU	72.240 kW, MAN 12K98MC-C7
Colombo Express, 8.600 TEU	68.640 kW, MAN 12K98ME
Cosco Guangzhou, 9.500 TEU	74.760 kW, MAN 12K98MC

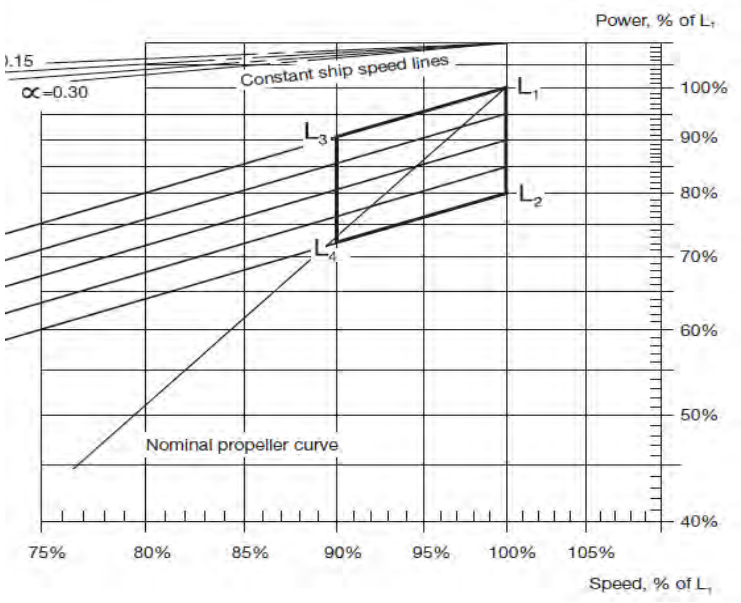
La potencia otorgada es ligeramente superior a la requerida lo cual no es negativo porque nos ofrece un margen de error en la predicción de la potencia

	Cyl.	L_1 kW
K90 ME9 Stroke: 2,870 mm	6	34,320
	7	40,040
	8	45,760
	9	51,480
	10	57,200
	11	62,920
	12	68,640



MEP bar	SFOC g/kWh	
	MCR	Minimum at Part Load
20.0	174	170
16.0	168	164

Se introducirán las curvas de potencia de carga nominal y de máxima carga, utilizando en nuestro caso la misma para ambas, para así poder realizar el cálculo del propulsor según el motor que hemos seleccionado.



POTENCIA MOTOR, KW	RPM
68640	94
65208	91
61776	90
58344	89
54912	87
48048	83
44616	81
41184	79

En este caso como el análisis será mediante la potencia, "by power".

Propulsor data

Propulsor				**Propeller options**	
Count:		1		Oblique angle corr:	Off
Propulsor type:		Propeller series		Shaft angle to WL:	0,00 deg
Propeller type:		FPP		Added rise of run:	0,00 deg
Propeller series:		B Series		Propeller cup:	0,0 mm
Propeller sizing:		By power		KTKQ corrections:	Custom
Reference prop:				Scale correction:	Full ITTC
Blade count:		5		KT multiplier:	1,000
Expanded area ratio:		1,0499	[Size]	KQ multiplier:	1,000
Propeller diameter:		8900,0 mm	[Size]	Blade T/C [0.7R]:	0,00
Propeller mean pitch:	[P/D 1,0047]	8942,2 mm	[Size]	Roughness:	0,00 mm
Hub immersion:		6000,0 mm		Cav breakdown:	Off
Engine/gear				**Design condition**	
Engine data:		12k90me9		Max prop diam:	8900,0 mm
Rated RPM:		94 RPM		Design speed:	25,50 kt
Rated power:		68640,0 kW		Reference power:	68640,0 kW
Gear efficiency:		1,000		Design point:	0,850
Load correction:		Off		Reference RPM:	94,0
Gear ratio:		1,000	[Keep]	Design point:	1,000
Shaft efficiency:		0,970			

Report ID20161121-2013 HydroComp NavCad 2014 14.02.0029.S1002.539

Tras el cálculo, utilizando al igual que para la primera predicción el Método Andersen, se obtiene:

$$\boldsymbol{Potencia\ (al\ 85\%\ MCR)} = \frac{57.689}{0.85} = \boldsymbol{67.869\ kW}$$

Se mostrarán en el Anexo II los resultados completos del análisis de la potencia.

Por último se realizará el cálculo del propulsor más eficiente. Para esto se variará el número de palas de la hélice en 4, 5 y 6 buscando la mejor eficiencia de la misma, obteniendo:

NÚMERO DE PALAS	EFICIENCIA	POTENCIA	POTENCIA, 85% RÉGIMEN
4	0,7786	57.689	67.869 kW
5	**0,7904**	**56.827**	**66.855 kW**
6	0,7952	56.484	66.452 kW

La hélice escogida será la de 5 palas ya que, aunque la hélice de 6 palas tiene ligeramente una mayor eficiencia, esta tiene una mayor potencia y es común en este tipo de buques.

Se presentan como Anexo III los resultados del análisis por potencia para propulsores de 4, 5 y 6 palas y Anexo IV las características técnicas del motor utilizado.

4 CLARAS DEL CODASTE

Las claras del codaste están definidas por las Sociedades de Clasificación y que hemos calculado en el Cuaderno 3 mediante dos formulaciones distintas y haciendo una media.

En este apartado se realizará el cálculo de las claras definitivas utilizando el número de palas más favorable obtenido en el apartado anterior y la formulación especificada por el Lloyd's Register, *Pt 3, Ch 6, 7.6 Propeller hull clearances.*

Se escogerá la siguiente formulación para un propulsor de 4 palas, ya que dependiendo del número de palas sus coeficientes variarán:

- *Clara a:* $a = 1 \times K \times D_P$

siendo,

$$K = \left(0{,}1 + \frac{L_{PP}}{3050}\right) \times \left(\frac{2{,}56 \times C_B \times BHP}{L_{PP}} + 0{,}3\right)$$

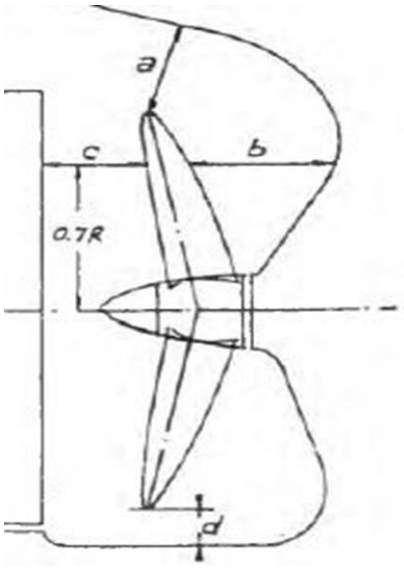
$$K = \left(0{,}1 + \frac{318{,}4}{3050}\right) \times \left(\frac{2{,}56 \times 0{,}67 \times 93360}{318{,}4} + 0{,}3\right) = 103$$

$$a = 1 \times K \times D_P = 1\ m$$
$$a_{min} = 0{,}10 \times D_P = 0{,}97\ m$$

- *Clara b:* $b = 1{,}5 \times K \times D_P = 1{,}5\ m$
$b_{min} = 0{,}15 \times D_P = 1{,}45\ m$

- *Clara c:* $c = 0{,}12 \times D_P = 0{,}12 \times 9{,}7 = 1{,}17\ m$

- *Clara d:* $d = 0{,}03 \times D_P = 0{,}03 \times 9{,}7 = 0{,}29\ m$



Sobre el plano pueden medirse las siguientes claras que cumplen con las mínimas exigidas por el reglamento:

- *Clara a:* $\boldsymbol{a = 1,12\ m}$
- *Clara b:* $\boldsymbol{b = 1,68\ m}$
- *Clara c:* $\boldsymbol{c = 1,53 m}$
- *Clara b*: $\boldsymbol{d = 0,29\ m}$

Se adjuntará un plano en el Anexo VI del conjunto de la hélice, codaste y timón.

5 CÁLCULO DEL TIMÓN

Para la obtención de las dimensiones del timón se utilizarán las fórmulas extraídas del Reglamento Lloyd's Register of Shipping, *Pt 3, Ch 13, 2 Rudders*.

Se realizará el cálculo de la fuerza lateral del timón a partir de la siguiente fórmula:

$$P_L = 132 c_1 c_2 c_3 C_{TH} A_R V^2$$

donde:

- c_1, es un factor que depende de la relación de aspecto λ del área del timón.

$$c_1 = \frac{\lambda + 2}{3} = \frac{2+2}{3} = 1{,}33$$

- c_2, coeficiente del perfil del timón, que será para el tipo NACA-00, 1,1 para avance y 0,8 para ciar.
- $c_3 = 1$, coeficiente que depende del montaje de timones convencionales.
- $C_{TH} = 1$
- $V = 25{,}5\ kn$, velocidad máxima. En el caso de ciar $V = 0{,}5V = 12{,}75\ kn$.
- $\lambda = {h_R}^2 / A_T$, pero no se tomará mayor que 2.
-

$$\lambda = \frac{{h_R}^2}{A_T} = \frac{11{,}07^2}{58} = 2{,}11 > 2 \rightarrow \lambda = 2$$

- h_R, altura de la pala del timón.
- A_R, área de la pala del timón
- A_T, suma del área de la pala del timón más el área a proa de la mecha.

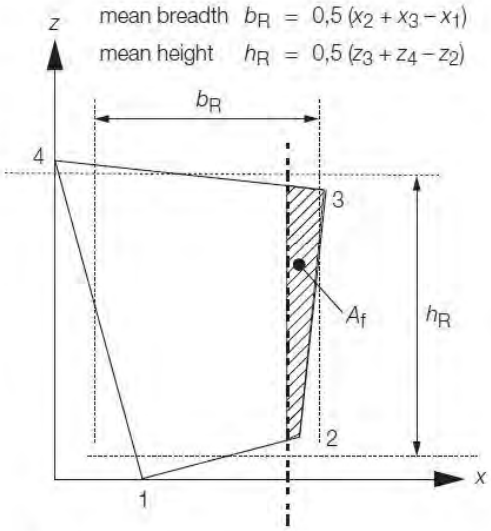


Figure 13.2.2 Rudder co-ordinate system

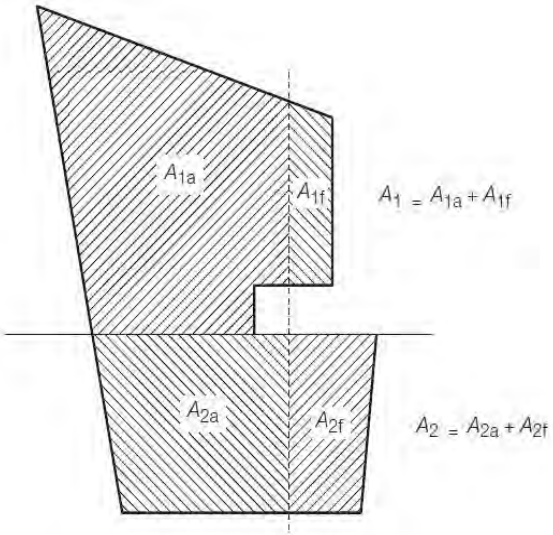


Figure 13.2.3 Rudder areas

Se muestra a continuación una tabla con los resultados del cálculo de las dimensiones y áreas del timón que utilizaremos para obtener la fuerza.

	A1a				**A2a**		**A1f**		**A2f**	
	A11a		**A12a**							
	x, m	**z, m**	**x, m**	**z, m**	**x, m**	**z, m**	**x, m**	**x, m**	**x, m**	**z, m**
1	0	0	0	0	0	0	0	0	0	0
2	4,79	0	4,29	0	4,79	0	0,5	0	0,5	0
3	4,79	3,32	4,29	0,66	4,79	7,09	0,5	3,32	0,5	7,09
4	0	3,2	0	0,66	0	7,09	0	3,32	0	7,09
TOTAL	**16,37 m2**		**2,83 m2**		**33,96 m2**		**1,66 m2**		**3,54 m2**	

	DIMENSIONES	
	bR	**hR**
	x, m	**z, m**
1	0	0
2	6,41	0
3	5,29	11,07
4	0	11,07
TOTAL	**5,85 m**	**11,07 m**

AT			
AR		**Af**	
A1a	A2a	A1f	A2f
19,2 m2	33,96 m2	1,66 m2	3,54 m2
52,8 m2		**5,2 m2**	
58 m2			

Los resultados obtenidos para la fuerza lateral en la pala del timón serán dependiendo del caso a estudiar:

	AHEAD	ASTERN
FUERZA P_L, kN	6.178 kN	1.123 kN

Para el cálculo del par se obtendrá a partir de la siguiente expresión:

$$M_T = M_1 + M_2$$

donde:

- $M_1 = P_{L1} x_{P1}$
- $M_2 = P_{L2} x_{P2}$
- $P_{L1} = \left(\frac{A_1}{A_R}\right) \times P_L$
- $P_{L2} = (A_2/A_R) \times P_L$
- $x_{P1} = b_{R1}(\alpha - k_1)$
- $x_{P2} = b_{R2}(\alpha - k_2)$
- $A_1 = A_{1a} + A_{1f} = 19{,}2 + 1{,}66 = 20{,}86\ m^2$
- $A_2 = A_{2a} + A_{2f} = 33{,}96 + 3{,}54 = 37{,}5\ m^2$
- $b_{R1} = 5{,}29\ m$, ancho del área parcial A_1.
- $b_{R2} = 6{,}41\ m$, ancho del área parcial A_2.
- α, será 0,25 para avante y 0,55 para ciar.
- $k_1 = \frac{A_{1f}}{A_1} = \frac{1{,}66}{20{,}86} = 0{,}079$
- $k_2 = A_{2f}/A_2 = 3{,}54/37{,}5 = 0{,}094$

	Ahead	Astern
α	0,25	0,55
x_{P1}, m	0,904	2,49
x_{P2}, m	0,99	2,92
P_L, N	6.178.225	112.332
P_{L1}, N	2.440.867	44.380
P_{L2}, N	4.387.944	79.781
M_1, Nm	2.206.544	110.506
M_2, Nm	4.344.065	232.961

Los resultados obtenidos para el par del timón serán dependiendo del caso a estudiar:

	AHEAD	ASTERN
PAR M_T, kN	6.551 kN	343 kN

Además para el caso de avante, M_T no se debe tomar menor de:

$$\boldsymbol{M_{Tmin}} = 0{,}1P_L \times \frac{A_1 b_{R1} + A_2 b_{R2}}{A_R} = 4.103.890\ Nm = \mathbf{4.104\ kN}$$

Se adjunta un plano del timón en el Anexo V junto con un plano de la situación propulsor, codaste y timón en el Anexo VI.

6 POTENCIA DEL SERVOMOTOR

El reglamento internacional SOLAS nos dice en el *Capítulo II-1, Parte C, Regla 29* lo siguiente:

El aparato de gobierno principal y la mecha del timón:

1 tendrán resistencia suficiente y permitirán el gobierno del buque a la velocidad máxima de servicio en marcha avante, el cual deberá quedar demostrado;

2 permitirán el cambio de timón de una posición de 35° a una banda hasta otra de 35° a la banda opuesta encontrándose el buque navegando a la velocidad máxima de servicio en marcha avante e con su calado máximo en agua salada, y, dadas las mismas condiciones, desde una posición de 35° a cualquiera de ambas bandas hasta otra de 30° a la banda opuesta sin que eso lleve más de 28 segundos.

Por lo tanto, para obtener la potencia necesaria que debe tener el servomotor tendremos que hacer lo siguiente:

$$P_{SERVO} = M_T \times \omega$$

Para calcular la velocidad angular aplicamos la siguiente fórmula:

$$\omega = \frac{65^o}{28\ s} \times \frac{2\pi\ rad}{360^o} = 0{,}0405\ rad/s$$

Obteniendo finalmente:

$$\boldsymbol{P_{SERVO}} = 6551 \times 0{,}0405 = \boldsymbol{265{,}4\ kW}$$

ANEXO I: RESULTADOS ANÁLISIS RESISTENCIA

Resistance

29 ene 2018 05:43
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Analysis parameters

Vessel drag		Added drag	
Technique:	[Calc] Prediction	Appendage:	[Calc] Holtrop (Component)
Prediction:	Andersen	Wind:	[Off]
Reference ship:		Seas:	[Off]
Model LWL:		Shallow/channel:	[Off]
Expansion:	Standard	Towed:	[Off]
Friction line:	ITTC-57	Margin:	[Calc] Hull drag only [10%]
Hull form factor:	[On] 1,195	**Water properties**	
Speed corr:	[Off]	Water type:	Salt
Spray drag corr:	[Off]	Density:	1026,00 kg/m3
Corr allowance:	ITTC-78 (v2008)	Viscosity:	1,18920e-6 m2/s
Roughness [mm]:	[Off]		

Prediction method check [Andersen]

Parameters	FN [design]	CVOL	CB	LWL/BWL
Value	0,23	6,25	0,66	7,35
Range	0,05··0,33	4,00··6,00	0,55··0,85	5,00··8,00

Prediction results

	SPEED COEFS		ITTC-78 COEFS						
SPEED [kt]	FN	FV	RN	CF	[CTLT/CF]	CR	dCF	CA	CT
19,00	0,173	0,433	2,67e9	0,001360	1,195	0,000079	0,000000	0,000172	0,001876
20,00	0,182	0,456	2,81e9	0,001352	1,195	0,000097	0,000000	0,000164	0,001876
21,00	0,191	0,478	2,95e9	0,001344	1,195	0,000116	0,000000	0,000156	0,001878
22,00	0,200	0,501	3,09e9	0,001337	1,195	0,000135	0,000000	0,000149	0,001881
23,00	0,210	0,524	3,23e9	0,001330	1,195	0,000153	0,000000	0,000142	0,001884
24,00	0,219	0,547	3,37e9	0,001323	1,195	0,000169	0,000000	0,000135	0,001886
24,50	0,223	0,558	3,44e9	0,001320	1,195	0,000176	0,000000	0,000131	0,001885
25,00	0,228	0,570	3,51e9	0,001317	1,195	0,000182	0,000000	0,000128	0,001884
+ 25,50 +	0,232	0,581	3,59e9	0,001314	1,195	0,000187	0,000000	0,000125	0,001883
26,00	0,237	0,592	3,66e9	0,001311	1,195	0,000195	0,000000	0,000122	0,001883

	RESISTANCE								
SPEED [kt]	RBARE [kN]	RAPP [kN]	RWIND [kN]	RSEAS [kN]	RCHAN [kN]	RTOWED [kN]	RMARGIN [kN]	RTOTAL [kN]	
19,00	1712,20	11,04	0,00	0,00	0,00	171,22	171,22	1894,46	
20,00	1897,59	12,14	0,00	0,00	0,00	189,76	189,76	2099,49	
21,00	2094,24	13,28	0,00	0,00	0,00	209,42	209,42	2316,95	
22,00	2302,08	14,47	0,00	0,00	0,00	230,21	230,21	2546,77	
23,00	2520,12	15,71	0,00	0,00	0,00	252,01	252,01	2787,85	
24,00	2745,91	16,99	0,00	0,00	0,00	274,59	274,59	3037,49	
24,50	2860,76	17,65	0,00	0,00	0,00	286,08	286,08	3164,48	
25,00	2976,88	18,32	0,00	0,00	0,00	297,69	297,69	3292,89	
+ 25,50 +	3095,35	19,00	0,00	0,00	0,00	309,54	309,54	3423,88	
26,00	3218,82	19,69	0,00	0,00	0,00	321,88	321,88	3560,40	

	EFFECTIVE POWER		OTHER			
SPEED [kt]	PEBARE [kW]	PETOTAL [kW]	CTLR	CTLT	RBARE/W	
19,00	16735,8	18517,3	0,00170	0,04039	0,00121	
20,00	19524,1	21601,4	0,00209	0,04040	0,00134	
21,00	22624,8	25030,8	0,00250	0,04044	0,00148	
22,00	26054,5	28823,7	0,00291	0,04051	0,00163	
23,00	29818,7	32986,4	0,00330	0,04057	0,00178	
24,00	33902,8	37502,9	0,00365	0,04060	0,00194	
24,50	36056,7	39884,8	0,00379	0,04059	0,00202	
25,00	38286,0	42350,2	0,00391	0,04056	0,00211	
+ 25,50 +	40605,8	44915,6	0,00404	0,04054	0,00219	
26,00	43053,6	47622,3	0,00419	0,04055	0,00228	

Resistance

29 ene 2018 05:43

HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**

Description

File name **sistemaspropulsion - copia.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**325,000 m**
Max beam on WL:	[LWL/BWL 7,348]	**44,230 m**
Max molded draft:	[BWL/T 3,003]	**14,730 m**
Displacement:	[CB 0,664]	**144194,00 t**
Wetted surface:	[CS 2,755]	**18622,6 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,463]	**150,430 m**
LCF fwd TR:	[XCF/LWL 0,423]	**137,600 m**
Max section area:	[CX 0,993]	**647,0 m2**
Waterplane area:	[CWP 0,819]	**11768,9 m2**
Bulb section area:		**50,2 m2**
Bulb ctr below WL:		**6,640 m**
Bulb nose fwd TR:		**333,000 m**
Imm transom area:	[ATR/AX 0,000]	**0,0 m2**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**
Half entrance angle:		**18,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[WL flow]	**1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***8900,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Resistance

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HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Appendage data

General	
Definition:	**Component**
Percent of hull drag:	**0,00 %**
Planing influence	
LCE fwd TR:	**0,000 m**
VCE below WL:	**0,000 m**
Shafting	
Count:	**1**
Max prop diameter:	**8900,0 mm**
Shaft angle to WL:	**0,00 deg**
Exposed shaft length:	**0,000 m**
Shaft diameter:	**0,000 m**
Wetted surface:	**0,0 m2**
Strut bossing length:	**0,000 m**
Bossing diameter:	**0,000 m**
Wetted surface:	**0,0 m2**
Hull bossing length:	**0,000 m**
Bossing diameter:	**0,000 m**
Wetted surface:	**0,0 m2**
Strut (per shaft line)	
Count:	**0**
Root chord:	**0,000 m**
Tip chord:	**0,000 mm**
Span:	**0,000 m**
T/C ratio:	**0,000**
Projected area:	**0,0 m2**
Wetted surface:	**0,0 m2**
Exposed palm depth:	**0,000 m**
Exposed palm width:	**0,000 m**
Rudder	
Count:	**1**
Rudder location:	**Behind propeller**
Type:	**Balanced foil**
Root chord:	**6,410 m**
Tip chord:	**5,290 m**
Span:	**11,070 m**
T/C ratio:	**0,150**
LE sweep:	**0,00 deg**
Projected area:	**58,0 m2**
Wetted surface:	**63,1 m2**

Skeg/Keel	
Count:	**0**
Type:	**Skeg**
Mean length:	**0,000 m**
Mean width:	**0,000 m**
Height aft:	**0,000 m**
Height mid:	**0,000 m**
Height fwd:	**0,000 m**
Projected area:	**0,0 m2**
Wetted surface:	**0,0 m2**
Stabilizer	
Count:	**0**
Root chord:	**0,000 m**
Tip chord:	**0,000 m**
Span:	**0,000 m**
T/C ratio:	**0,000**
LE sweep:	**0,00 deg**
Wetted surface:	**0,0 m2**
Projected area:	**0,0 m2**
Dynamic multiplier:	**1,00**
Bilge keel	
Count:	**0**
Mean length:	**0,000 m**
Mean base width:	**0,000 m**
Mean projection:	**0,000 m**
Wetted surface:	**0,0 m2**
Tunnel thruster	
Count:	**0**
Diameter:	**0,000 m**
Sonar dome	
Count:	**0**
Wetted surface:	**0,0 m2**
Miscellaneous	
Count:	**0**
Drag area:	**0,0 m2**
Drag coef:	**0,00**

Environment data

Wind	
Wind speed:	**0,00 kt**
Angle off bow:	**0,00 deg**
Gradient correction:	**Off**
Exposed hull	
Transverse area:	**612,8 m2**
VCE above WL:	**0,000 m**
Profile area:	**0,0 m2**
Superstructure	
Superstructure shape:	**Container ship**
Transverse area:	**838,3 m2**
VCE above WL:	**0,000 m**
Profile area:	**0,0 m2**

Seas	
Significant wave ht:	**0,000 m**
Modal wave period:	**0,0 sec**
Shallow/channel	
Water depth:	**0,000 m**
Type:	**Shallow water**
Channel width:	**0,000 m**
Channel side slope:	**0,00 deg**
Hull girth:	**0,000 m**

Resistance

29 ene 2018 05:43

HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**

Description

File name **sistemaspropulsion - copia.hcnc**

Symbols and values

SPEED =	Vessel speed
FN =	Froude number [LWL]
FV =	Froude number [VOL]
RN =	Reynolds number [LWL]
CF =	Frictional resistance coefficient
CV/CF =	Viscous/frictional resistance coefficient ratio [dynamic form factor]
CR =	Residuary resistance coefficient
dCF =	Added frictional resistance coefficient for roughness
CA =	Correlation allowance [dynamic]
CT =	Total bare-hull resistance coefficient
RBARE =	Bare-hull resistance
RAPP =	Additional appendage resistance
RWIND =	Additional wind resistance
RSEAS =	Additional sea-state resistance
RCHAN =	Additional shallow/channel resistance
RTOWED =	Additional towed object resistance
RMARGIN =	Resistance margin
RTOTAL =	Total vessel resistance
PEBARE =	Bare-hull effective power
PETOTAL =	Total effective power
CTLR =	Telfer residuary resistance coefficient
CTLT =	Telfer total bare-hull resistance coefficient
RBARE/W =	Bare-hull resistance to weight ratio
+ =	Design speed indicator
* =	Exceeds parameter limit

ANEXO II: RESULTADOS ANÁLISIS DE POTENCIA

Propulsion

21 nov 2016 07:55
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion.hcnc**

Analysis parameters

Hull-propulsor interaction		**System analysis**	
Technique:	**[Calc] Prediction**	Cavitation criteria:	**Keller eqn**
Prediction:	**Andersen**	Analysis type:	**Free run**
Reference ship:		CPP method:	
Max prop diam:	**8900,0 mm**	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	**[Off]**	RPM constraint:	
Rudder location:		Limit [RPM/s]:	
Friction line:		**Water properties**	
Hull form factor:		Water type:	**Salt**
Corr allowance:		Density:	**1026,00 kg/m3**
Roughness [mm]:		Viscosity:	**1,18920e-6 m2/s**
Ducted prop corr:	**[Off]**		
Tunnel stern corr:	**[Off]**		
Effective diam:			
Recess depth:			

Prediction method check [Andersen]

Parameters	FN [design]	CVOL	CB	LWL/BWL
Value	**0,23**	**6,25**	**0,66**	**7,35**
Range	**0,05··0,33**	**4,00··6,00**	**0,55··0,85**	**5,00··8,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBPROP [kW]	FUEL [L/h]	LOADENG [%]
19,00	**18517,3**	**0,3947**	**0,1394**	**1,0200**	**76**	**23316,8**	**---**	**0,0**
20,00	**21601,4**	**0,3947**	**0,1394**	**1,0200**	**80**	**27201,5**	**---**	**0,0**
21,00	**25030,8**	**0,3947**	**0,1394**	**1,0200**	**84**	**31527,8**	**---**	**0,0**
22,00	**28823,7**	**0,3947**	**0,1394**	**1,0200**	**88**	**36319,4**	**---**	**0,0**
23,00	**32986,4**	**0,3947**	**0,1394**	**1,0200**	**92**	**41580,7**	**---**	**0,0**
24,00	**37502,9**	**0,3947**	**0,1394**	**1,0200**	**96**	**47281,7**	**---**	**0,0**
24,50	**39884,8**	**0,3947**	**0,1394**	**1,0200**	**98**	**50281,1**	**---**	**0,0**
25,00	**42350,2**	**0,3947**	**0,1394**	**1,0200**	**100**	**53380,7**	**---**	**0,0**
+ 25,50 +	**44915,6**	**0,3947**	**0,1394**	**1,0200**	**102**	**56605,9**	**---**	**0,0**
26,00	**47622,3**	**0,3947**	**0,1394**	**1,0200**	**104**	**60020,8**	**---**	**0,0**

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
19,00	**71**	**3099,14**	**2901,72**	**22617,3**	**23316,8**	**23316,8**	**23316,8**	**592,8**
20,00	**75**	**3434,50**	**3215,73**	**26385,5**	**27201,5**	**27201,5**	**27201,5**	**534,9**
21,00	**79**	**3790,03**	**3548,61**	**30582,0**	**31527,8**	**31527,8**	**31527,8**	**484,5**
22,00	**82**	**4165,59**	**3900,24**	**35229,8**	**36319,4**	**36319,4**	**36319,4**	**440,6**
23,00	**86**	**4559,48**	**4269,04**	**40333,3**	**41580,7**	**41580,7**	**41580,7**	**402,4**
24,00	**90**	**4967,59**	**4651,16**	**45863,2**	**47281,7**	**47281,7**	**47281,7**	**369,3**
24,50	**92**	**5175,36**	**4845,69**	**48772,7**	**50281,1**	**50281,1**	**50281,1**	**354,5**
25,00	**94**	**5385,58**	**5042,51**	**51779,3**	**53380,7**	**53380,7**	**53380,7**	**340,7**
+ 25,50 +	**96**	**5600,02**	**5243,30**	**54907,7**	**56605,9**	**56605,9**	**56605,9**	**327,7**
26,00	**97**	**5823,19**	**5452,26**	**58220,1**	**60020,8**	**60020,8**	**60020,8**	**315,1**

	EFFICIENCY				THRUST	
SPEED [kt]	EFFO	EFFG	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
19,00	**0,5646**	**1,0000**	**0,7942**	**0,56041**	**2201,43**	**1894,45**
20,00	**0,5646**	**1,0000**	**0,7941**	**0,56043**	**2439,67**	**2099,48**
21,00	**0,5645**	**1,0000**	**0,7939**	**0,56057**	**2692,38**	**2316,95**
22,00	**0,5642**	**1,0000**	**0,7936**	**0,56078**	**2959,44**	**2546,76**
23,00	**0,5640**	**1,0000**	**0,7933**	**0,561**	**3239,57**	**2787,84**
24,00	**0,5639**	**1,0000**	**0,7932**	**0,56108**	**3529,67**	**3037,48**
24,50	**0,5640**	**1,0000**	**0,7932**	**0,56105**	**3677,24**	**3164,48**
25,00	**0,5641**	**1,0000**	**0,7934**	**0,56096**	**3826,46**	**3292,89**
+ 25,50 +	**0,5641**	**1,0000**	**0,7935**	**0,56088**	**3978,68**	**3423,88**
26,00	**0,5641**	**1,0000**	**0,7934**	**0,56091**	**4137,31**	**3560,39**

Propulsion

21 nov 2016 07:55

HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**

Description

File name **sistemaspropulsion.hcnc**

Prediction results [Propulsor]

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KTJ2	KQJ3	CTH	CP	RNPROP	
19,00	**0,5612**	**0,2436**	**0,03854**	**0,77373**	**0,2181**	**1,9703**	**3,4211**	**8,67e7**	
20,00	**0,5611**	**0,2437**	**0,03854**	**0,77386**	**0,21814**	**1,9706**	**3,4219**	**9,13e7**	
21,00	**0,5610**	**0,2437**	**0,03855**	**0,77462**	**0,21841**	**1,9725**	**3,4261**	**9,59e7**	
22,00	**0,5607**	**0,2439**	**0,03857**	**0,77581**	**0,21883**	**1,9756**	**3,4327**	**1,00e8**	
23,00	**0,5604**	**0,2440**	**0,03859**	**0,777**	**0,21925**	**1,9786**	**3,4393**	**1,05e8**	
24,00	**0,5603**	**0,2441**	**0,03860**	**0,7775**	**0,21943**	**1,9799**	**3,4421**	**1,10e8**	
24,50	**0,5604**	**0,2441**	**0,03860**	**0,77729**	**0,21936**	**1,9793**	**3,4409**	**1,12e8**	
25,00	**0,5605**	**0,2440**	**0,03859**	**0,7768**	**0,21918**	**1,9781**	**3,4382**	**1,14e8**	
+ 25,50 +	**0,5606**	**0,2440**	**0,03858**	**0,77634**	**0,21902**	**1,9769**	**3,4356**	**1,16e8**	
26,00	**0,5605**	**0,2440**	**0,03858**	**0,77654**	**0,21909**	**1,9774**	**3,4367**	**1,19e8**	

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
19,00	**8,91**	**2,81**	**0,54**	**33,13**	**0,686**	**33,70**	**2,0**	**2,0**	**6800,8**
20,00	**8,04**	**2,53**	**0,49**	**34,87**	**0,739**	**37,35**	**2,0**	**2,0**	**6800,7**
21,00	**7,29**	**2,29**	**0,45**	**36,63**	**0,795**	**41,22**	**2,1**	**2,1**	**6800,0**
22,00	**6,64**	**2,09**	**0,41**	**38,39**	**0,854**	**45,31**	**2,5**	**2,5**	**6799,0**
23,00	**6,08**	**1,91**	**0,37**	**40,15**	**0,916**	**49,59**	**3,0**	**3,0**	**6797,9**
24,00	**5,58**	**1,75**	**0,34**	**41,91**	**0,980**	**54,04**	**3,6**	**3,6**	**6797,5**
24,50	**5,36**	**1,68**	**0,33**	**42,78**	**1,012**	**56,29**	**4,0**	**4,0**	**6797,7**
25,00	**5,15**	**1,62**	**0,31**	**43,64**	**1,045**	**58,58**	**4,4**	**4,4**	**6798,1**
+ 25,50 +	**4,95**	**1,55**	**0,30**	**44,50**	**1,079**	**60,91**	**4,8**	**4,8**	**6798,5**
26,00	**4,76**	**1,49**	**0,29**	**45,38**	**1,114**	**63,34**	**5,3**	**5,3**	**6798,3**

Propulsion

21 nov 2016 07:55
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**325,000 m**
Max beam on WL:	[LWL/BWL 7,348]	**44,230 m**
Max molded draft:	[BWL/T 3,003]	**14,730 m**
Displacement:	[CB 0,664]	**144194,00 t**
Wetted surface:	[CS 2,755]	**18622,6 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,463]	**150,430 m**
LCF fwd TR:	[XCF/LWL 0,423]	**137,600 m**
Max section area:	[CX 0,993]	**647,0 m2**
Waterplane area:	[CWP 0,819]	**11768,9 m2**
Bulb section area:		**50,2 m2**
Bulb ctr below WL:		**6,640 m**
Bulb nose fwd TR:		**333,000 m**
Imm transom area:	[ATR/AX 0,000]	**0,0 m2**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**
Half entrance angle:		**18,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[WL flow]	**1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***8900,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Propulsor data

Propulsor			
Count:		**1**	
Propulsor type:		**Propeller series**	
Propeller type:		**FPP**	
Propeller series:		**B Series**	
Propeller sizing:		**By thrust**	
Reference prop:			
Blade count:		**5**	
Expanded area ratio:		**1,0500**	**[Size]**
Propeller diameter:		**8900,0 mm**	**[Size]**
Propeller mean pitch:	[P/D 0,9731]	**8660,2 mm**	**[Size]**
Hub immersion:		**6000,0 mm**	

Engine/gear			
Engine data:			
Rated RPM:		**0 RPM**	
Rated power:		**0,0 kW**	
Gear efficiency:		**1,000**	
Load correction:		**Off**	
Gear ratio:		**1,068**	**[Size]**
Shaft efficiency:		**0,970**	

Propeller options	
Oblique angle corr:	**Off**
Shaft angle to WL:	**0,00 deg**
Added rise of run:	**0,00 deg**
Propeller cup:	**0,0 mm**
KTKQ corrections:	**Custom**
Scale correction:	**Full ITTC**
KT multiplier:	**1,000**
KQ multiplier:	**1,000**
Blade T/C [0.7R]:	**0,00**
Roughness:	**0,00 mm**
Cav breakdown:	**Off**

Design condition	
Max prop diam:	**8900,0 mm**
Design speed:	**25,50 kt**
Reference power:	**0,0 kW**
Design point:	**0,000**
Reference RPM:	**102,0**
Design point:	**1,000**

Propulsion

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HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion.hcnc**

Symbols and values

SPEED =	Vessel speed
PETOTAL =	Total vessel effective power
WFT =	Taylor wake fraction coefficient
THD =	Thrust deduction coefficient
EFFR =	Relative-rotative efficiency
RPMENG =	Engine RPM
PBPROP =	Brake power per propulsor
FUEL =	Fuel rate per engine
LOADENG =	Percentage of engine max available power at given RPM
RPMPROP =	Propulsor RPM
QPROP =	Propulsor open water torque
QENG =	Engine torque
PDPROP =	Delivered power per propulsor
PSPROP =	Shaft power per propulsor
PSTOTAL =	Total vessel shaft power
PBTOTAL =	Total vessel brake power
TRANSP =	Transport factor
EFFO =	Propulsor open-water efficiency
EFFG =	Gear efficiency (load corrected)
EFFOA =	Overall propulsion efficiency [=PETOTAL/PSTOTAL]
MERIT =	Propulsor merit coefficient
THRPROP =	Open-water thrust per propulsor
DELTHR =	Total vessel delivered thrust
J =	Propulsor advance coefficient
KT =	Propulsor thrust coefficient [horizontal, if in oblique flow]
KQ =	Propulsor torque coefficient
KTJ2 =	Propulsor thrust loading ratio
KQJ3 =	Propulsor torque loading ratio
CTH =	Horizontal component of bare-hull resistance coefficient
CP =	Propulsor thrust loading coefficient
RNPROP =	Propeller Reynolds number at 0.7R
SIGMAV =	Cavitation number of propeller by vessel speed
SIGMAN =	Cavitation number of propeller by RPM
SIGMA07R =	Cavitation number of blade section at 0.7R
TIPSPEED =	Propeller circumferential tip speed
MINBAR =	Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS =	Average propeller loading pressure
CAVAVG =	Average predicted back cavitation percentage
CAVMAX =	Peak predicted back cavitation percentage [if in oblique flow]
PITCHFC =	Minimum recommended pitch to avoid face cavitation
+ =	Design speed indicator
* =	Exceeds recommended parameter limit
! =	Exceeds recommended cavitation criteria [warning]
!! =	Substantially exceeds recommended cavitation criteria [critical]
!!! =	Thrust breakdown is indicated [severe]
--- =	Insignificant or not applicable

ANEXO III: RESULTADOS ANÁLISIS DEL PROPULSOR

Propulsion

6 oct 2017 12:01
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Analysis parameters

Hull-propulsor interaction		**System analysis**	
Technique:	**[Calc] Prediction**	Cavitation criteria:	**Keller eqn**
Prediction:	**Andersen**	Analysis type:	**Free run**
Reference ship:		CPP method:	
Max prop diam:	**8900,0 mm**	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	**[Off]**	RPM constraint:	
Rudder location:		Limit [RPM/s]:	
Friction line:		**Water properties**	
Hull form factor:		Water type:	**Salt**
Corr allowance:		Density:	**1026,00 kg/m3**
Roughness [mm]:		Viscosity:	**1,18920e-6 m2/s**
Ducted prop corr:	**[Off]**		
Tunnel stern corr:	**[Off]**		
Effective diam:			
Recess depth:			

Prediction method check [Andersen]

Parameters	FN [design]	CVOL	CB	LWL/BWL
Value	**0,23**	**6,25**	**0,66**	**7,35**
Range	**0,05··0,33**	**4,00··6,00**	**0,55··0,85**	**5,00··8,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBPROP [kW]	FUEL [L/h]	LOADENG [%]
19,00	**18517,3**	**0,3947**	**0,1394**	**1,0200**	**67**	**23761,9**	**---**	**34,6**
20,00	**21601,4**	**0,3947**	**0,1394**	**1,0200**	**71**	**27720,7**	**---**	**40,4**
21,00	**25030,8**	**0,3947**	**0,1394**	**1,0200**	**74**	**32130,0**	**---**	**46,8**
22,00	**28823,7**	**0,3947**	**0,1394**	**1,0200**	**78**	**37014,1**	**---**	**53,9**
23,00	**32986,4**	**0,3947**	**0,1394**	**1,0200**	**81**	**42376,8**	**---**	**61,7**
24,00	**37502,9**	**0,3947**	**0,1394**	**1,0200**	**85**	**48187,2**	**---**	**70,2**
24,50	**39884,8**	**0,3947**	**0,1394**	**1,0200**	**86**	**51243,9**	**---**	**74,7**
25,00	**42350,2**	**0,3947**	**0,1394**	**1,0200**	**88**	**54402,5**	**---**	**79,3**
+ 25,50 +	**44915,6**	**0,3947**	**0,1394**	**1,0200**	**90**	**57688,8**	**---**	**84,0**
26,00	**47622,3**	**0,3947**	**0,1394**	**1,0200**	**92**	**61169,6**	**---**	**89,1**

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
19,00	**67**	**3351,68**	**3351,68**	**23049,0**	**23761,9**	**23761,9**	**23761,9**	**581,7**
20,00	**71**	**3714,38**	**3714,38**	**26889,1**	**27720,7**	**27720,7**	**27720,7**	**524,8**
21,00	**74**	**4098,93**	**4098,93**	**31166,1**	**32130,0**	**32130,0**	**32130,0**	**475,5**
22,00	**78**	**4505,20**	**4505,20**	**35903,7**	**37014,1**	**37014,1**	**37014,1**	**432,4**
23,00	**81**	**4931,28**	**4931,28**	**41105,5**	**42376,8**	**42376,8**	**42376,8**	**394,8**
24,00	**85**	**5372,70**	**5372,70**	**46741,6**	**48187,2**	**48187,2**	**48187,2**	**362,3**
24,50	**86**	**5597,40**	**5597,40**	**49706,6**	**51243,9**	**51243,9**	**51243,9**	**347,8**
25,00	**88**	**5824,72**	**5824,72**	**52770,4**	**54402,5**	**54402,5**	**54402,5**	**334,3**
+ 25,50 +	**90**	**6056,60**	**6056,60**	**55958,2**	**57688,8**	**57688,8**	**57688,8**	**321,6**
26,00	**92**	**6298,01**	**6298,01**	**59334,5**	**61169,6**	**61169,6**	**61169,6**	**309,2**

	EFFICIENCY				THRUST	
SPEED [kt]	EFFO	EFFG	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
19,00	**0,5540**	**1,0000**	**0,7793**	**0,54991**	**2201,42**	**1894,45**
20,00	**0,5540**	**1,0000**	**0,7792**	**0,54994**	**2439,67**	**2099,47**
21,00	**0,5539**	**1,0000**	**0,7790**	**0,55006**	**2692,37**	**2316,94**
22,00	**0,5536**	**1,0000**	**0,7787**	**0,55026**	**2959,44**	**2546,77**
23,00	**0,5534**	**1,0000**	**0,7784**	**0,55046**	**3239,57**	**2787,84**
24,00	**0,5533**	**1,0000**	**0,7783**	**0,55054**	**3529,67**	**3037,48**
24,50	**0,5534**	**1,0000**	**0,7783**	**0,5505**	**3677,24**	**3164,47**
25,00	**0,5535**	**1,0000**	**0,7785**	**0,55042**	**3826,46**	**3292,89**
+ 25,50 +	**0,5535**	**1,0000**	**0,7786**	**0,55035**	**3978,68**	**3423,88**
26,00	**0,5535**	**1,0000**	**0,7785**	**0,55038**	**4137,32**	**3560,40**

Propulsion

6 oct 2017 12:01

HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**

Description

File name **sistemaspropulsion - copia.hcnc**

Prediction results [Propulsor]

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KTJ2	KQJ3	CTH	CP	RNPROP	
19,00	**0,5955**	**0,2744**	**0,04694**	**0,77372**	**0,22226**	**1,9703**	**3,4864**	**1,02e8**	
20,00	**0,5955**	**0,2744**	**0,04694**	**0,77386**	**0,22231**	**1,9706**	**3,4872**	**1,08e8**	
21,00	**0,5953**	**0,2745**	**0,04696**	**0,77462**	**0,22258**	**1,9725**	**3,4915**	**1,13e8**	
22,00	**0,5950**	**0,2747**	**0,04698**	**0,77581**	**0,22302**	**1,9756**	**3,4983**	**1,19e8**	
23,00	**0,5947**	**0,2748**	**0,04700**	**0,777**	**0,22345**	**1,9786**	**3,5051**	**1,24e8**	
24,00	**0,5946**	**0,2749**	**0,04701**	**0,7775**	**0,22363**	**1,9799**	**3,508**	**1,30e8**	
24,50	**0,5947**	**0,2749**	**0,04701**	**0,77728**	**0,22356**	**1,9793**	**3,5068**	**1,32e8**	
25,00	**0,5948**	**0,2748**	**0,04700**	**0,7768**	**0,22338**	**1,9781**	**3,504**	**1,35e8**	
+ 25,50 +	**0,5949**	**0,2747**	**0,04699**	**0,77633**	**0,22321**	**1,9769**	**3,5013**	**1,38e8**	
26,00	**0,5948**	**0,2748**	**0,04700**	**0,77654**	**0,22328**	**1,9774**	**3,5025**	**1,40e8**	

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
19,00	**8,91**	**3,16**	**0,61**	**31,21**	**0,634**	**33,70**	**2,0**	**2,0**	**7217,3**
20,00	**8,04**	**2,85**	**0,55**	**32,86**	**0,681**	**37,35**	**2,3**	**2,3**	**7217,2**
21,00	**7,29**	**2,58**	**0,50**	**34,51**	**0,731**	**41,22**	**2,7**	**2,7**	**7216,4**
22,00	**6,64**	**2,35**	**0,45**	**36,17**	**0,784**	**45,31**	**3,2**	**3,2**	**7215,3**
23,00	**6,08**	**2,15**	**0,41**	**37,84**	**0,839**	**49,60**	**3,8**	**3,8**	**7214,1**
24,00	**5,58**	**1,97**	**0,38**	**39,49**	**0,896**	**54,04**	**4,6**	**4,6**	**7213,6**
24,50	**5,36**	**1,89**	**0,37**	**40,31**	**0,925**	**56,30**	**5,0**	**5,0**	**7213,9**
25,00	**5,15**	**1,82**	**0,35**	**41,12**	**0,955**	**58,58**	**5,4**	**5,4**	**7214,3**
+ 25,50 +	**4,95**	**1,75**	**0,34**	**41,94**	**0,985**	**60,91**	**5,9**	**5,9**	**7214,8**
26,00	**4,76**	**1,68**	**0,32**	**42,76**	**1,016**	**63,34**	**6,5**	**6,5**	**7214,6**

Propulsion

6 oct 2017 12:01
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**325,000 m**
Max beam on WL:	[LWL/BWL 7,348]	**44,230 m**
Max molded draft:	[BWL/T 3,003]	**14,730 m**
Displacement:	[CB 0,664]	**144194,00 t**
Wetted surface:	[CS 2,755]	**18622,6 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,463]	**150,430 m**
LCF fwd TR:	[XCF/LWL 0,423]	**137,600 m**
Max section area:	[CX 0,993]	**647,0 m2**
Waterplane area:	[CWP 0,819]	**11768,9 m2**
Bulb section area:		**50,2 m2**
Bulb ctr below WL:		**6,640 m**
Bulb nose fwd TR:		**333,000 m**
Imm transom area:	[ATR/AX 0,000]	**0,0 m2**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**
Half entrance angle:		**18,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[WL flow]	**1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***8900,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Propulsor data

Propulsor			
Count:		**1**	
Propulsor type:		**Propeller series**	
Propeller type:		**FPP**	
Propeller series:		**B Series**	
Propeller sizing:		**By power**	
Reference prop:			
Blade count:		**4**	
Expanded area ratio:		**1,0499**	**[Size]**
Propeller diameter:		**8900,0 mm**	**[Size]**
Propeller mean pitch:	[P/D 1,0767]	**9582,4 mm**	**[Size]**
Hub immersion:		**6000,0 mm**	

Engine/gear		
Engine data:	**12k90me9**	
Rated RPM:	**94 RPM**	
Rated power:	**68640,0 kW**	
Gear efficiency:	**1,000**	
Load correction:	**Off**	
Gear ratio:	**1,000**	**[Keep]**
Shaft efficiency:	**0,970**	

Propeller options	
Oblique angle corr:	**Off**
Shaft angle to WL:	**0,00 deg**
Added rise of run:	**0,00 deg**
Propeller cup:	**0,0 mm**
KTKQ corrections:	**Custom**
Scale correction:	**Full ITTC**
KT multiplier:	**1,000**
KQ multiplier:	**1,000**
Blade T/C [0.7R]:	**0,00**
Roughness:	**0,00 mm**
Cav breakdown:	**Off**

Design condition	
Max prop diam:	**8900,0 mm**
Design speed:	**25,50 kt**
Reference power:	**68640,0 kW**
Design point:	**1,000**
Reference RPM:	**94,0**
Design point:	**1,000**

Propulsion

6 oct 2017 12:01
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Symbols and values

SPEED =	Vessel speed
PETOTAL =	Total vessel effective power
WFT =	Taylor wake fraction coefficient
THD =	Thrust deduction coefficient
EFFR =	Relative-rotative efficiency
RPMENG =	Engine RPM
PBPROP =	Brake power per propulsor
FUEL =	Fuel rate per engine
LOADENG =	Percentage of engine max available power at given RPM
RPMPROP =	Propulsor RPM
QPROP =	Propulsor open water torque
QENG =	Engine torque
PDPROP =	Delivered power per propulsor
PSPROP =	Shaft power per propulsor
PSTOTAL =	Total vessel shaft power
PBTOTAL =	Total vessel brake power
TRANSP =	Transport factor
EFFO =	Propulsor open-water efficiency
EFFG =	Gear efficiency (load corrected)
EFFOA =	Overall propulsion efficiency [=PETOTAL/PSTOTAL]
MERIT =	Propulsor merit coefficient
THRPROP =	Open-water thrust per propulsor
DELTHR =	Total vessel delivered thrust
J =	Propulsor advance coefficient
KT =	Propulsor thrust coefficient [horizontal, if in oblique flow]
KQ =	Propulsor torque coefficient
KTJ2 =	Propulsor thrust loading ratio
KQJ3 =	Propulsor torque loading ratio
CTH =	Horizontal component of bare-hull resistance coefficient
CP =	Propulsor thrust loading coefficient
RNPROP =	Propeller Reynolds number at 0.7R
SIGMAV =	Cavitation number of propeller by vessel speed
SIGMAN =	Cavitation number of propeller by RPM
SIGMA07R =	Cavitation number of blade section at 0.7R
TIPSPEED =	Propeller circumferential tip speed
MINBAR =	Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS =	Average propeller loading pressure
CAVAVG =	Average predicted back cavitation percentage
CAVMAX =	Peak predicted back cavitation percentage [if in oblique flow]
PITCHFC =	Minimum recommended pitch to avoid face cavitation
+ =	Design speed indicator
* =	Exceeds recommended parameter limit
! =	Exceeds recommended cavitation criteria [warning]
!! =	Substantially exceeds recommended cavitation criteria [critical]
!!! =	Thrust breakdown is indicated [severe]
--- =	Insignificant or not applicable

Propulsion

6 oct 2017 11:59
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Analysis parameters

Hull-propulsor interaction		**System analysis**	
Technique:	**[Calc] Prediction**	Cavitation criteria:	**Keller eqn**
Prediction:	**Andersen**	Analysis type:	**Free run**
Reference ship:		CPP method:	
Max prop diam:	**8900,0 mm**	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	**[Off]**	RPM constraint:	
Rudder location:		Limit [RPM/s]:	
Friction line:		**Water properties**	
Hull form factor:		Water type:	**Salt**
Corr allowance:		Density:	**1026,00 kg/m3**
Roughness [mm]:		Viscosity:	**1,18920e-6 m2/s**
Ducted prop corr:	**[Off]**		
Tunnel stern corr:	**[Off]**		
Effective diam:			
Recess depth:			

Prediction method check [Andersen]

Parameters	FN [design]	CVOL	CB	LWL/BWL
Value	**0,23**	**6,25**	**0,66**	**7,35**
Range	**0,05··0,33**	**4,00··6,00**	**0,55··0,85**	**5,00··8,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBPROP [kW]	FUEL [L/h]	LOADENG [%]
19,00	**18517,3**	**0,3947**	**0,1394**	**1,0200**	**67**	**23406,7**	**---**	**34,1**
20,00	**21601,4**	**0,3947**	**0,1394**	**1,0200**	**70**	**27306,3**	**---**	**39,8**
21,00	**25030,8**	**0,3947**	**0,1394**	**1,0200**	**74**	**31649,8**	**---**	**46,1**
22,00	**28823,7**	**0,3947**	**0,1394**	**1,0200**	**77**	**36460,9**	**---**	**53,1**
23,00	**32986,4**	**0,3947**	**0,1394**	**1,0200**	**81**	**41743,6**	**---**	**60,8**
24,00	**37502,9**	**0,3947**	**0,1394**	**1,0200**	**84**	**47467,1**	**---**	**69,2**
24,50	**39884,8**	**0,3947**	**0,1394**	**1,0200**	**86**	**50478,1**	**---**	**73,5**
25,00	**42350,2**	**0,3947**	**0,1394**	**1,0200**	**88**	**53589,4**	**---**	**78,1**
+ 25,50 +	**44915,6**	**0,3947**	**0,1394**	**1,0200**	**90**	**56826,6**	**---**	**82,8**
26,00	**47622,3**	**0,3947**	**0,1394**	**1,0200**	**91**	**60255,4**	**---**	**87,8**

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
19,00	**67**	**3315,75**	**3315,75**	**22704,5**	**23406,7**	**23406,7**	**23406,7**	**590,5**
20,00	**70**	**3674,56**	**3674,56**	**26487,2**	**27306,3**	**27306,3**	**27306,3**	**532,8**
21,00	**74**	**4054,98**	**4054,98**	**30700,3**	**31649,8**	**31649,8**	**31649,8**	**482,7**
22,00	**77**	**4456,87**	**4456,87**	**35367,0**	**36460,9**	**36460,9**	**36460,9**	**438,9**
23,00	**81**	**4878,38**	**4878,38**	**40491,3**	**41743,6**	**41743,6**	**41743,6**	**400,8**
24,00	**84**	**5315,04**	**5315,04**	**46043,1**	**47467,1**	**47467,1**	**47467,1**	**367,8**
24,50	**86**	**5537,33**	**5537,33**	**48963,7**	**50478,1**	**50478,1**	**50478,1**	**353,1**
25,00	**88**	**5762,22**	**5762,22**	**51981,7**	**53589,4**	**53589,4**	**53589,4**	**339,4**
+ 25,50 +	**90**	**5991,62**	**5991,62**	**55121,8**	**56826,6**	**56826,6**	**56826,6**	**326,4**
26,00	**91**	**6230,44**	**6230,44**	**58447,7**	**60255,4**	**60255,4**	**60255,4**	**313,9**

	EFFICIENCY				THRUST	
SPEED [kt]	EFFO	EFFG	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
19,00	**0,5625**	**1,0000**	**0,7911**	**0,55826**	**2201,43**	**1894,45**
20,00	**0,5624**	**1,0000**	**0,7911**	**0,55828**	**2439,67**	**2099,48**
21,00	**0,5623**	**1,0000**	**0,7909**	**0,55841**	**2692,38**	**2316,94**
22,00	**0,5621**	**1,0000**	**0,7905**	**0,55861**	**2959,44**	**2546,77**
23,00	**0,5618**	**1,0000**	**0,7902**	**0,55881**	**3239,58**	**2787,84**
24,00	**0,5617**	**1,0000**	**0,7901**	**0,55889**	**3529,67**	**3037,48**
24,50	**0,5618**	**1,0000**	**0,7901**	**0,55885**	**3677,24**	**3164,47**
25,00	**0,5619**	**1,0000**	**0,7903**	**0,55877**	**3826,46**	**3292,89**
+ 25,50 +	**0,5619**	**1,0000**	**0,7904**	**0,5587**	**3978,68**	**3423,88**
26,00	**0,5619**	**1,0000**	**0,7903**	**0,55873**	**4137,32**	**3560,40**

Propulsion

6 oct 2017 11:59

HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**

Description

File name **sistemaspropulsion - copia.hcnc**

Prediction results [Propulsor]

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KTJ2	KQJ3	CTH	CP	RNPROP	
19,00	**0,5981**	**0,2768**	**0,04684**	**0,77373**	**0,21894**	**1,9703**	**3,4343**	**8,16e7**	
20,00	**0,5980**	**0,2768**	**0,04684**	**0,77386**	**0,21899**	**1,9706**	**3,4351**	**8,59e7**	
21,00	**0,5979**	**0,2769**	**0,04685**	**0,77462**	**0,21926**	**1,9725**	**3,4393**	**9,03e7**	
22,00	**0,5976**	**0,2770**	**0,04688**	**0,77581**	**0,21968**	**1,9756**	**3,446**	**9,46e7**	
23,00	**0,5973**	**0,2772**	**0,04690**	**0,777**	**0,22011**	**1,9786**	**3,4528**	**9,89e7**	
24,00	**0,5972**	**0,2772**	**0,04691**	**0,7775**	**0,22029**	**1,9799**	**3,4556**	**1,03e8**	
24,50	**0,5972**	**0,2772**	**0,04690**	**0,77728**	**0,22021**	**1,9793**	**3,4543**	**1,05e8**	
25,00	**0,5973**	**0,2772**	**0,04690**	**0,7768**	**0,22004**	**1,9781**	**3,4516**	**1,08e8**	
+ 25,50 +	**0,5974**	**0,2771**	**0,04689**	**0,77633**	**0,21987**	**1,9769**	**3,449**	**1,10e8**	
26,00	**0,5974**	**0,2771**	**0,04689**	**0,77654**	**0,21995**	**1,9774**	**3,4501**	**1,12e8**	

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
19,00	**8,91**	**3,19**	**0,61**	**31,08**	**0,686**	**33,70**	**2,0**	**2,0**	**7248,3**
20,00	**8,04**	**2,88**	**0,55**	**32,72**	**0,739**	**37,35**	**2,2**	**2,2**	**7248,1**
21,00	**7,29**	**2,61**	**0,50**	**34,36**	**0,795**	**41,22**	**2,5**	**2,5**	**7247,4**
22,00	**6,64**	**2,37**	**0,46**	**36,02**	**0,854**	**45,31**	**3,0**	**3,0**	**7246,2**
23,00	**6,08**	**2,17**	**0,42**	**37,67**	**0,916**	**49,60**	**3,6**	**3,6**	**7245,0**
24,00	**5,58**	**1,99**	**0,38**	**39,32**	**0,980**	**54,04**	**4,3**	**4,3**	**7244,5**
24,50	**5,36**	**1,91**	**0,37**	**40,14**	**1,012**	**56,30**	**4,7**	**4,7**	**7244,7**
25,00	**5,15**	**1,84**	**0,35**	**40,95**	**1,045**	**58,58**	**5,2**	**5,2**	**7245,2**
+ 25,50 +	**4,95**	**1,77**	**0,34**	**41,76**	**1,079**	**60,91**	**5,6**	**5,6**	**7245,7**
26,00	**4,76**	**1,70**	**0,33**	**42,58**	**1,114**	**63,34**	**6,1**	**6,1**	**7245,5**

Propulsion

6 oct 2017 11:59

HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**325,000 m**
Max beam on WL:	[LWL/BWL 7,348]	**44,230 m**
Max molded draft:	[BWL/T 3,003]	**14,730 m**
Displacement:	[CB 0,664]	**144194,00 t**
Wetted surface:	[CS 2,755]	**18622,6 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,463]	**150,430 m**
LCF fwd TR:	[XCF/LWL 0,423]	**137,600 m**
Max section area:	[CX 0,993]	**647,0 m2**
Waterplane area:	[CWP 0,819]	**11768,9 m2**
Bulb section area:		**50,2 m2**
Bulb ctr below WL:		**6,640 m**
Bulb nose fwd TR:		**333,000 m**
Imm transom area:	[ATR/AX 0,000]	**0,0 m2**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**
Half entrance angle:		**18,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[WL flow]	**1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***8900,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Propulsor data

Propulsor			
Count:		**1**	
Propulsor type:		**Propeller series**	
Propeller type:		**FPP**	
Propeller series:		**B Series**	
Propeller sizing:		**By power**	
Reference prop:			
Blade count:		**5**	
Expanded area ratio:		**1,0499**	**[Size]**
Propeller diameter:		**8900,0 mm**	**[Size]**
Propeller mean pitch:	[P/D 1,0632]	**9462,6 mm**	**[Size]**
Hub immersion:		**6000,0 mm**	

Engine/gear			
Engine data:		**12k90me9**	
Rated RPM:		**94 RPM**	
Rated power:		**68640,0 kW**	
Gear efficiency:		**1,000**	
Load correction:		**Off**	
Gear ratio:		**1,000**	**[Keep]**
Shaft efficiency:		**0,970**	

Propeller options	
Oblique angle corr:	**Off**
Shaft angle to WL:	**0,00 deg**
Added rise of run:	**0,00 deg**
Propeller cup:	**0,0 mm**
KTKQ corrections:	**Custom**
Scale correction:	**Full ITTC**
KT multiplier:	**1,000**
KQ multiplier:	**1,000**
Blade T/C [0.7R]:	**0,00**
Roughness:	**0,00 mm**
Cav breakdown:	**Off**

Design condition	
Max prop diam:	**8900,0 mm**
Design speed:	**25,50 kt**
Reference power:	**68640,0 kW**
Design point:	**1,000**
Reference RPM:	**94,0**
Design point:	**1,000**

Propulsion

6 oct 2017 11:59

HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Symbols and values

SPEED =	Vessel speed
PETOTAL =	Total vessel effective power
WFT =	Taylor wake fraction coefficient
THD =	Thrust deduction coefficient
EFFR =	Relative-rotative efficiency
RPMENG =	Engine RPM
PBPROP =	Brake power per propulsor
FUEL =	Fuel rate per engine
LOADENG =	Percentage of engine max available power at given RPM
RPMPROP =	Propulsor RPM
QPROP =	Propulsor open water torque
QENG =	Engine torque
PDPROP =	Delivered power per propulsor
PSPROP =	Shaft power per propulsor
PSTOTAL =	Total vessel shaft power
PBTOTAL =	Total vessel brake power
TRANSP =	Transport factor
EFFO =	Propulsor open-water efficiency
EFFG =	Gear efficiency (load corrected)
EFFOA =	Overall propulsion efficiency [=PETOTAL/PSTOTAL]
MERIT =	Propulsor merit coefficient
THRPROP =	Open-water thrust per propulsor
DELTHR =	Total vessel delivered thrust
J =	Propulsor advance coefficient
KT =	Propulsor thrust coefficient [horizontal, if in oblique flow]
KQ =	Propulsor torque coefficient
KTJ2 =	Propulsor thrust loading ratio
KQJ3 =	Propulsor torque loading ratio
CTH =	Horizontal component of bare-hull resistance coefficient
CP =	Propulsor thrust loading coefficient
RNPROP =	Propeller Reynolds number at 0.7R
SIGMAV =	Cavitation number of propeller by vessel speed
SIGMAN =	Cavitation number of propeller by RPM
SIGMA07R =	Cavitation number of blade section at 0.7R
TIPSPEED =	Propeller circumferential tip speed
MINBAR =	Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS =	Average propeller loading pressure
CAVAVG =	Average predicted back cavitation percentage
CAVMAX =	Peak predicted back cavitation percentage [if in oblique flow]
PITCHFC =	Minimum recommended pitch to avoid face cavitation
+ =	Design speed indicator
* =	Exceeds recommended parameter limit
! =	Exceeds recommended cavitation criteria [warning]
!! =	Substantially exceeds recommended cavitation criteria [critical]
!!! =	Thrust breakdown is indicated [severe]
--- =	Insignificant or not applicable

Propulsion

6 oct 2017 12:03
HydroComp NavCad 2014

Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Analysis parameters

Hull-propulsor interaction		**System analysis**	
Technique:	**[Calc] Prediction**	Cavitation criteria:	**Keller eqn**
Prediction:	**Andersen**	Analysis type:	**Free run**
Reference ship:		CPP method:	
Max prop diam:	**8900,0 mm**	Engine RPM:	
Corrections		Mass multiplier:	
Viscous scale corr:	**[Off]**	RPM constraint:	
Rudder location:		Limit [RPM/s]:	
Friction line:		**Water properties**	
Hull form factor:		Water type:	**Salt**
Corr allowance:		Density:	**1026,00 kg/m3**
Roughness [mm]:		Viscosity:	**1,18920e-6 m2/s**
Ducted prop corr:	**[Off]**		
Tunnel stern corr:	**[Off]**		
Effective diam:			
Recess depth:			

Prediction method check [Andersen]

Parameters	FN [design]	CVOL	CB	LWL/BWL
Value	**0,23**	**6,25**	**0,66**	**7,35**
Range	**0,05··0,33**	**4,00··6,00**	**0,55··0,85**	**5,00··8,00**

Prediction results [System]

	HULL-PROPULSOR				ENGINE			
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBPROP [kW]	FUEL [L/h]	LOADENG [%]
19,00	**18517,3**	**0,3947**	**0,1394**	**1,0200**	**67**	**23266,5**	**---**	**33,9**
20,00	**21601,4**	**0,3947**	**0,1394**	**1,0200**	**70**	**27142,7**	**---**	**39,5**
21,00	**25030,8**	**0,3947**	**0,1394**	**1,0200**	**74**	**31459,8**	**---**	**45,8**
22,00	**28823,7**	**0,3947**	**0,1394**	**1,0200**	**77**	**36241,5**	**---**	**52,8**
23,00	**32986,4**	**0,3947**	**0,1394**	**1,0200**	**81**	**41491,5**	**---**	**60,4**
24,00	**37502,9**	**0,3947**	**0,1394**	**1,0200**	**84**	**47180,7**	**---**	**68,7**
24,50	**39884,8**	**0,3947**	**0,1394**	**1,0200**	**86**	**50173,6**	**---**	**73,1**
25,00	**42350,2**	**0,3947**	**0,1394**	**1,0200**	**88**	**53266,4**	**---**	**77,6**
+ 25,50 +	**44915,6**	**0,3947**	**0,1394**	**1,0200**	**89**	**56484,4**	**---**	**82,3**
26,00	**47622,3**	**0,3947**	**0,1394**	**1,0200**	**91**	**59892,4**	**---**	**87,3**

	POWER DELIVERY							
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
19,00	**67**	**3302,41**	**3302,41**	**22568,5**	**23266,5**	**23266,5**	**23266,5**	**594,1**
20,00	**70**	**3659,76**	**3659,76**	**26328,4**	**27142,7**	**27142,7**	**27142,7**	**536,0**
21,00	**74**	**4038,60**	**4038,60**	**30516,0**	**31459,8**	**31459,8**	**31459,8**	**485,6**
22,00	**77**	**4438,81**	**4438,81**	**35154,2**	**36241,5**	**36241,5**	**36241,5**	**441,6**
23,00	**81**	**4858,51**	**4858,51**	**40246,8**	**41491,5**	**41491,5**	**41491,5**	**403,3**
24,00	**84**	**5293,41**	**5293,41**	**45765,3**	**47180,7**	**47180,7**	**47180,7**	**370,0**
24,50	**86**	**5514,80**	**5514,80**	**48668,4**	**50173,6**	**50173,6**	**50173,6**	**355,2**
25,00	**88**	**5738,80**	**5738,80**	**51668,4**	**53266,4**	**53266,4**	**53266,4**	**341,4**
+ 25,50 +	**89**	**5967,30**	**5967,30**	**54789,8**	**56484,4**	**56484,4**	**56484,4**	**328,4**
26,00	**91**	**6205,14**	**6205,14**	**58095,6**	**59892,4**	**59892,4**	**59892,4**	**315,8**

	EFFICIENCY				THRUST	
SPEED [kt]	EFFO	EFFG	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]
19,00	**0,5658**	**1,0000**	**0,7959**	**0,56163**	**2201,43**	**1894,46**
20,00	**0,5658**	**1,0000**	**0,7958**	**0,56165**	**2439,68**	**2099,48**
21,00	**0,5657**	**1,0000**	**0,7956**	**0,56178**	**2692,37**	**2316,94**
22,00	**0,5655**	**1,0000**	**0,7953**	**0,56199**	**2959,44**	**2546,77**
23,00	**0,5652**	**1,0000**	**0,7950**	**0,5622**	**3239,56**	**2787,82**
24,00	**0,5651**	**1,0000**	**0,7949**	**0,56228**	**3529,67**	**3037,48**
24,50	**0,5652**	**1,0000**	**0,7949**	**0,56225**	**3677,24**	**3164,47**
25,00	**0,5653**	**1,0000**	**0,7951**	**0,56216**	**3826,46**	**3292,88**
+ 25,50 +	**0,5654**	**1,0000**	**0,7952**	**0,56208**	**3978,67**	**3423,88**
26,00	**0,5653**	**1,0000**	**0,7951**	**0,56212**	**4137,32**	**3560,40**

Propulsion

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Description
File name **sistemaspropulsion - copia.hcnc**

Prediction results [Propulsor]

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KTJ2	KQJ3	CTH	CP	RNPROP	
19,00	**0,5993**	**0,2779**	**0,04683**	**0,77373**	**0,21763**	**1,9703**	**3,4137**	**6,79e7**	
20,00	**0,5992**	**0,2779**	**0,04684**	**0,77386**	**0,21767**	**1,9706**	**3,4145**	**7,15e7**	
21,00	**0,5990**	**0,2780**	**0,04685**	**0,77462**	**0,21794**	**1,9725**	**3,4187**	**7,51e7**	
22,00	**0,5987**	**0,2781**	**0,04687**	**0,77581**	**0,21836**	**1,9756**	**3,4253**	**7,87e7**	
23,00	**0,5985**	**0,2783**	**0,04689**	**0,777**	**0,21878**	**1,9786**	**3,4319**	**8,23e7**	
24,00	**0,5983**	**0,2783**	**0,04690**	**0,7775**	**0,21896**	**1,9799**	**3,4347**	**8,59e7**	
24,50	**0,5984**	**0,2783**	**0,04690**	**0,77728**	**0,21889**	**1,9793**	**3,4335**	**8,77e7**	
25,00	**0,5985**	**0,2783**	**0,04689**	**0,7768**	**0,21871**	**1,9781**	**3,4308**	**8,95e7**	
+ 25,50 +	**0,5986**	**0,2782**	**0,04688**	**0,77633**	**0,21855**	**1,9769**	**3,4282**	**9,12e7**	
26,00	**0,5986**	**0,2782**	**0,04688**	**0,77654**	**0,21862**	**1,9774**	**3,4294**	**9,30e7**	

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
19,00	**8,91**	**3,20**	**0,62**	**31,02**	**0,738**	**33,70**	**2,0**	**2,0**	**7262,6**
20,00	**8,04**	**2,89**	**0,56**	**32,65**	**0,797**	**37,35**	**2,1**	**2,1**	**7262,5**
21,00	**7,29**	**2,62**	**0,50**	**34,30**	**0,859**	**41,22**	**2,4**	**2,4**	**7261,7**
22,00	**6,64**	**2,38**	**0,46**	**35,95**	**0,924**	**45,31**	**2,9**	**2,9**	**7260,5**
23,00	**6,08**	**2,18**	**0,42**	**37,60**	**0,992**	**49,59**	**3,5**	**3,5**	**7259,3**
24,00	**5,58**	**2,00**	**0,38**	**39,24**	**1,063**	**54,03**	**4,1**	**4,1**	**7258,8**
24,50	**5,36**	**1,92**	**0,37**	**40,06**	**1,099**	**56,29**	**4,5**	**4,5**	**7259,0**
25,00	**5,15**	**1,84**	**0,35**	**40,87**	**1,136**	**58,58**	**4,9**	**4,9**	**7259,5**
+ 25,50 +	**4,95**	**1,77**	**0,34**	**41,68**	**1,173**	**60,91**	**5,4**	**5,4**	**7260,0**
26,00	**4,76**	**1,70**	**0,33**	**42,50**	**1,212**	**63,34**	**5,9**	**5,9**	**7259,8**

Propulsion

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Project ID **PORTACONTENEDORES**
Description
File name **sistemaspropulsion - copia.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**325,000 m**
Max beam on WL:	[LWL/BWL 7,348]	**44,230 m**
Max molded draft:	[BWL/T 3,003]	**14,730 m**
Displacement:	[CB 0,664]	**144194,00 t**
Wetted surface:	[CS 2,755]	**18622,6 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,463]	**150,430 m**
LCF fwd TR:	[XCF/LWL 0,423]	**137,600 m**
Max section area:	[CX 0,993]	**647,0 m2**
Waterplane area:	[CWP 0,819]	**11768,9 m2**
Bulb section area:		**50,2 m2**
Bulb ctr below WL:		**6,640 m**
Bulb nose fwd TR:		**333,000 m**
Imm transom area:	[ATR/AX 0,000]	**0,0 m2**
Transom beam WL:	[BTR/BWL 0,000]	**0,000 m**
Transom immersion:	[TTR/T 0,000]	**0,000 m**
Half entrance angle:		**18,00 deg**
Bow shape factor:	[WL flow]	**1,0**
Stern shape factor:	[WL flow]	**1,0**

Planing		
Proj chine length:		***0,000 m***
Proj bottom area:		***0,0 m2***
LCG fwd TR:	*[XCG/LP 0,000]*	***0,000 m***
VCG below WL:		***0,000 m***
Aft station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Fwd station (fwd TR):		***0,000 m***
Deadrise:		***0,00 deg***
Chine beam:		***0,000 m***
Chine ht below WL:		***0,000 m***
Propulsor type:		***Propeller***
Max prop diameter:		***8900,0 mm***
Shaft angle to WL:		***0,00 deg***
Position fwd TR:		***0,000 m***
Position below WL:		***0,000 m***
Transom lift device:		***Flap***
Device count:		***0***
Span:		***0,000 m***
Chord length:		***0,000 m***
Deflection angle:		***0,00 deg***
Tow point fwd TR:		***0,000 m***
Tow point below WL:		***0,000 m***

Propulsor data

Propulsor			
Count:		**1**	
Propulsor type:		**Propeller series**	
Propeller type:		**FPP**	
Propeller series:		**B Series**	
Propeller sizing:		**By power**	
Reference prop:			
Blade count:		**6**	
Expanded area ratio:		**1,0500**	**[Size]**
Propeller diameter:		**8900,0 mm**	**[Size]**
Propeller mean pitch:	[P/D 1,0460]	**9309,5 mm**	**[Size]**
Hub immersion:		**6000,0 mm**	

Engine/gear			
Engine data:		**12k90me9**	
Rated RPM:		**94 RPM**	
Rated power:		**68640,0 kW**	
Gear efficiency:		**1,000**	
Load correction:		**Off**	
Gear ratio:		**1,000**	**[Keep]**
Shaft efficiency:		**0,970**	

Propeller options	
Oblique angle corr:	**Off**
Shaft angle to WL:	**0,00 deg**
Added rise of run:	**0,00 deg**
Propeller cup:	**0,0 mm**
KTKQ corrections:	**Custom**
Scale correction:	**Full ITTC**
KT multiplier:	**1,000**
KQ multiplier:	**1,000**
Blade T/C [0.7R]:	**0,00**
Roughness:	**0,00 mm**
Cav breakdown:	**Off**

Design condition	
Max prop diam:	**8900,0 mm**
Design speed:	**25,50 kt**
Reference power:	**68640,0 kW**
Design point:	**1,000**
Reference RPM:	**94,0**
Design point:	**1,000**

Propulsion

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Project ID **PORTACONTENEDORES**
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Symbols and values

SPEED =	Vessel speed
PETOTAL =	Total vessel effective power
WFT =	Taylor wake fraction coefficient
THD =	Thrust deduction coefficient
EFFR =	Relative-rotative efficiency
RPMENG =	Engine RPM
PBPROP =	Brake power per propulsor
FUEL =	Fuel rate per engine
LOADENG =	Percentage of engine max available power at given RPM
RPMPROP =	Propulsor RPM
QPROP =	Propulsor open water torque
QENG =	Engine torque
PDPROP =	Delivered power per propulsor
PSPROP =	Shaft power per propulsor
PSTOTAL =	Total vessel shaft power
PBTOTAL =	Total vessel brake power
TRANSP =	Transport factor
EFFO =	Propulsor open-water efficiency
EFFG =	Gear efficiency (load corrected)
EFFOA =	Overall propulsion efficiency [=PETOTAL/PSTOTAL]
MERIT =	Propulsor merit coefficient
THRPROP =	Open-water thrust per propulsor
DELTHR =	Total vessel delivered thrust
J =	Propulsor advance coefficient
KT =	Propulsor thrust coefficient [horizontal, if in oblique flow]
KQ =	Propulsor torque coefficient
KTJ2 =	Propulsor thrust loading ratio
KQJ3 =	Propulsor torque loading ratio
CTH =	Horizontal component of bare-hull resistance coefficient
CP =	Propulsor thrust loading coefficient
RNPROP =	Propeller Reynolds number at 0.7R
SIGMAV =	Cavitation number of propeller by vessel speed
SIGMAN =	Cavitation number of propeller by RPM
SIGMA07R =	Cavitation number of blade section at 0.7R
TIPSPEED =	Propeller circumferential tip speed
MINBAR =	Minimum expanded blade area ratio recommended by selected cavitation criteria
PRESS =	Average propeller loading pressure
CAVAVG =	Average predicted back cavitation percentage
CAVMAX =	Peak predicted back cavitation percentage [if in oblique flow]
PITCHFC =	Minimum recommended pitch to avoid face cavitation
+ =	Design speed indicator
* =	Exceeds recommended parameter limit
! =	Exceeds recommended cavitation criteria [warning]
!! =	Substantially exceeds recommended cavitation criteria [critical]
!!! =	Thrust breakdown is indicated [severe]
--- =	Insignificant or not applicable

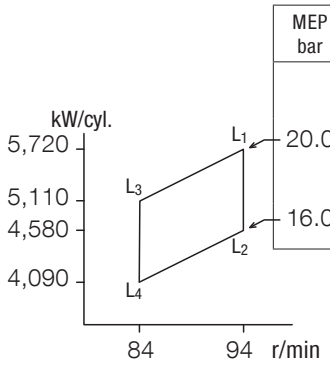
ANEXO IV: CARACTERÍSTICAS MOTOR PRINCIPAL

Power, Speed and Lubricating Oil

MAN B&W K90ME9-TII

Power and Speed

	Cyl.	L_1 kW
Stroke: 2,870 mm	6	**34,320**
	7	**40,040**
	8	**45,760**
	9	**51,480**
	10	**57,200**
	11	**62,920**
	12	**68,640**



MEP bar	SFOC g/kWh	
	MCR	Minimum at Part Load
20.0	174	170
16.0	168	164

Fuel and lubricating oil consumption

At load Layout point	Specific fuel oil consumption g/kWH		Lubricating oil consumption	
	With high efficiency turbocharger		System oil Approximate g/kWH	MAN B&W Alpha cylinder lubricator
	100%	70%		
L_1 and L_2	174	170	0.1	0.65
L_3 and L_4	168	164		

Fig 1.03.01: Power, speed, fuel and lubrication oil

Engine Power Range and Fuel Oil Consumption

Engine Power

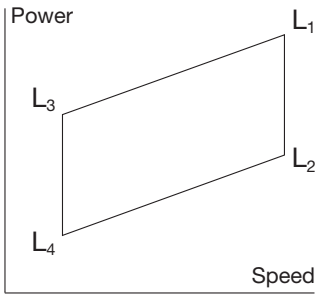
The following tables contain data regarding the power, speed and specific fuel oil consumption of the engine.

Engine power is specified in kW for each cylinder number and layout points L_1, L_2, L_3 and L_4:

Discrepancies between kW and metric horsepower (1 BHP = 75 kpm/s = 0.7355 kW) are a consequence of the rounding off of the BHP values.

L_1 designates nominal maximum continuous rating (nominal MCR), at 100% engine power and 100% engine speed.

L_2, L_3 and L_4 designate layout points at the other three corners of the layout area, chosen for easy reference.



178 51 48-9.0

Fig. 1.04.01: Layout diagram for engine power and speed

Overload corresponds to 110% of the power at MCR, and may be permitted for a limited period of one hour every 12 hours.

The engine power figures given in the tables remain valid up to tropical conditions at sea level as stated in IACS M28 (1978), i.e.:

Blower inlet temperature ..... 45 °C
Blower inlet pressure ..... 1000 mbar
Seawater temperature ..... 32 °C
Relative humidity 60%

Specific Fuel Oil Consumption (SFOC)

The figures given in this folder represent the values obtained when the engine and turbocharger are matched with a view to obtaining the lowest possible SFOC values while also fulfilling the IMO NOX Tier II emission limitations.

Stricter emission limits can be met on request, using proven technologies.

The SFOC figures are given in **g/kWh** with a tolerance of 5% and are based on the use of fuel with a lower calorific value of 42,700 kJ/kg (~10,200 kcal/kg) at ISO conditions:

Ambient air pressure ..... 1,000 mbar
Ambient air temperature ..... 25 °C
Cooling water temperature ..... 25 °C

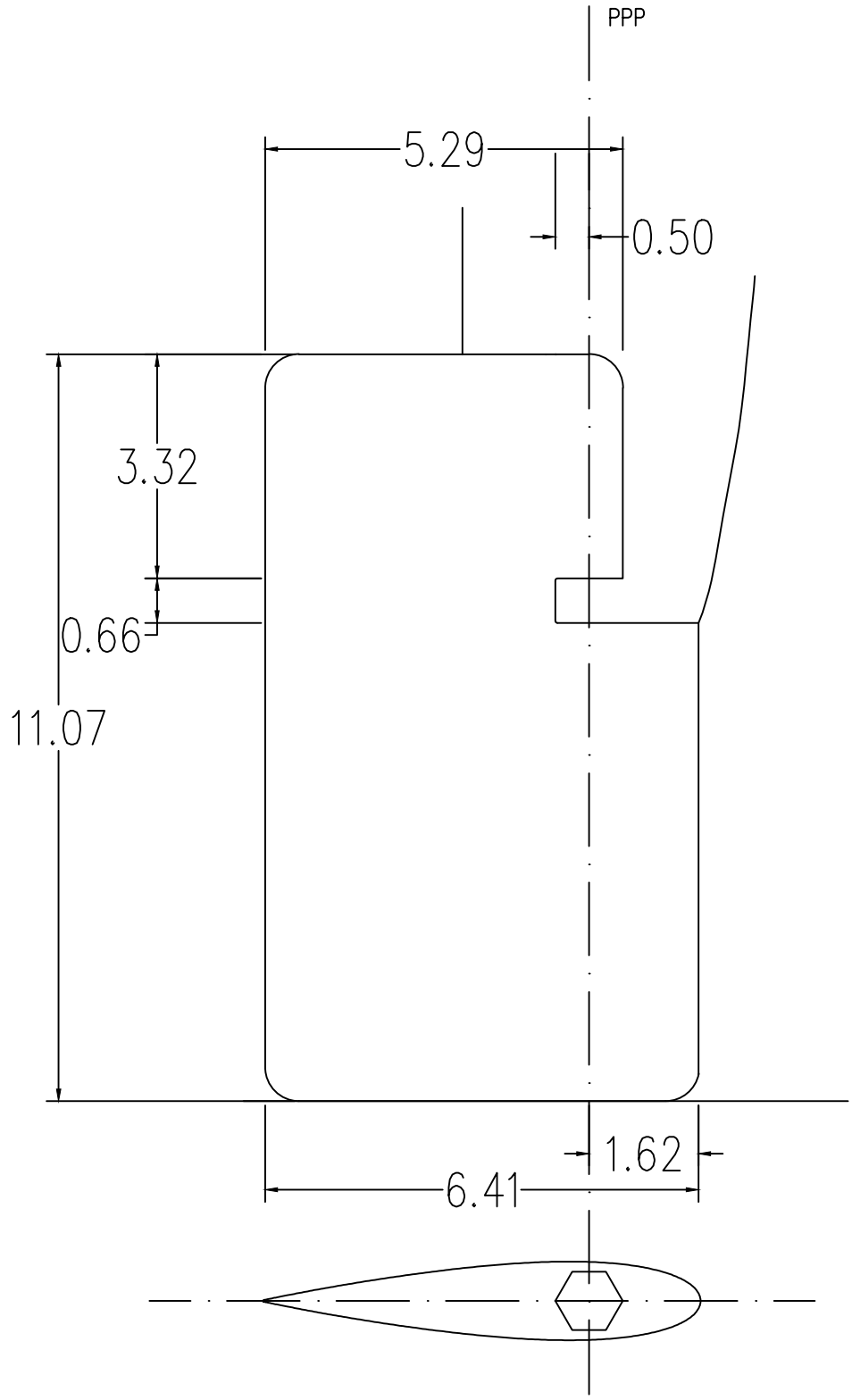
Although the engine will develop the power specified up to tropical ambient conditions, specific fuel oil consumption varies with ambient conditions and fuel oil lower calorific value. For calculation of these changes, see Chapter 2.

Lubricating oil data

The cylinder oil consumption figures stated in the tables are valid under normal conditions.

During running-in periods and under special conditions, feed rates of up to 1.5 times the stated values should be used.

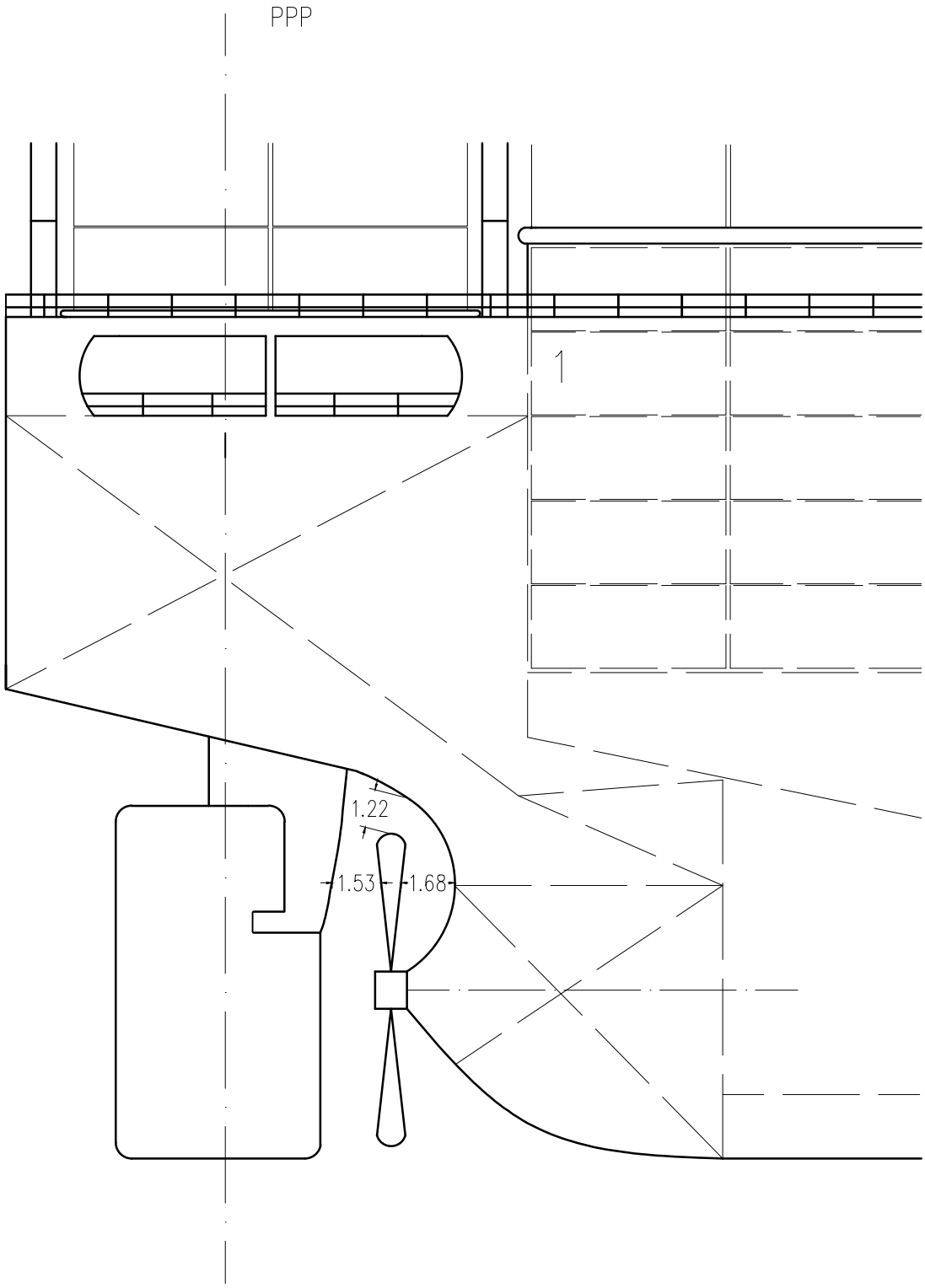
ANEXO V: TIMÓN



Estado	Fecha	Nombre	Firmas	Proyecto:	A4
Dibujado	01/02/18	Nadia Conde		Portacontenedores 9000 TEU's	
Comprobado					

Escala:	Num proyecto: 18 – 02	Escuela Politécnica Superior de Ferrol	
1:100	Alumna: Nadia Conde Alonso		
	Título: TIMÓN	Num plano: 12 Rev:	Hoja: 1/1
	Sustituido por:	Sustituye a:	

ANEXO VI: SITUACIÓN PROPULSOR, CODASTE, TIMÓN



Estado	Fecha	Nombre	Firmas	Proyecto:	A4
Dibujado	01/02/18	Nadia Conde		Portacontenedores 9000 TEU's	
Comprobado					

Escala:	Num proyecto: 18 – 02	Escuela Politécnica Superior de Ferrol	
1: 200	Alumna: Nadia Conde Alonso		
	Título: PROPULSOR, TIMÓN, CODASTE	Num plano: 13 Rev:	Hoja: 1/1
	Sustituido por:	Sustituye a:	