UNIVERSIDADE DA CORUÑA

Escola Politécnica Superior

Trabajo Fin de Grado
CURSO 2016/17

17-07 FERRY 1500 PAX Y 1000 ML

CUADERNO 2

CÁLCULO DE PESOS Y C.G.

Grado Ingeniería Naval y Oceánica

ALUMNO

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FECHA

2017

Escola Politécnica Superior
UNIVERSIDADE DA CORUÑA

GRADO EN INGENIERÍA NAVAL Y OCEÁNICA
TRABAJO FIN DE GRADO

CURSO 2.016-2017

PROYECTO NÚMERO 17-07

TIPO DE BUQUE: RO-PAX

CLASIFICACIÓN, COTA Y REGLAMENTOS DE APLICACIÓN: DNV GL, Marpol, Solas. SRTP.

CARACTERÍSTICAS DE LA CARGA: 1500 pasajeros, 1000 metros lineales que permitirán transportar 30 tráileres y 115 turismos simultáneamente.

VELOCIDAD Y AUTONOMÍA: 26 nudos al 90% MCR, 15% de margen de mar, autonomía de 3000 millas.

SISTEMAS Y EQUIPOS DE CARGA / DESCARGA: los propios de este tipo de buque.

PROPULSIÓN: Dual-fuel (diésel/GNL).

TRIPULACIÓN Y PASAJE: 1500 pasajeros y 55 tripulantes.

OTROS EQUIPOS E INSTALACIONES: los propios de este tipo de buque.

Ferrol, 28 Setiembre 2016

ALUMNO: **D. Marcos Covelo Fernández**

ÍNDICE:

1. INTRODUCCIÓN:

En este proyecto se diseña un buque tipo Ro-Pax. Dicho buque será diseñado con objeto de transportar 1500 pasajeros y 1000 metros lineales de carga rodada, que le permitan albergar 115 turismos y 30 tráileres simultáneamente. Estará destinado para trayectos relativamente largos, por lo que contará con acomodación adecuada para viajes nocturnos (todos los pasajeros dispondrán de camarotes o cómodas butacas) y de diversos servicios a bordo (restaurante, cafeterías, tiendas, zonas de ocio). Será dotado con propulsión dual-fuel en línea con las actuales exigencias medioambientales. El diseño se realizará de acuerdo a la Sociedad de clasificación DNV-GL y será conforme con Marpol y Solas (incluyendo el requerimiento de retorno seguro a puerto SRTP). La velocidad de servicio que deberá alcanzar será de 26 Kn con una autonomía de 3000 millas.

Neste proxecto diseñase un buque tipo Ro-Pax. Este buque estará deseñado para transportar 1500 pasaxeiros e 1000 metros lineais de carga rodada, o que lle permite acomodar 115 vehículos e 30 tráileres simultaneamente. Estará destinado a viaxes relativamente longas, polo que terá aloxamento adecuado para viaxes nocturnas (todos os pasaxeiros terán cabinas ou cómodos asentos) e varios servizos a bordo (restaurante, cafeterías, tendas, áreas de lecer). Estará equipado con propulsión de dobre combustible en liña cos requisitos ambientais actuais. O deseño realizarase segundo a sociedade de clasificación DNV-GL e estará de acordo con Marpol e Solas (incluído o requisito de retorno seguro a porto SRTP). A velocidade de servizo a alcanzar será de 26 Kn cunha autonomía de 3000 millas.

In this project a ship type Ro-Pax is designed. This vessel will be designed to carry 1500 passengers and 1000 linear meters of roll cargo, allowing it to accommodate 115 cars and 30 trailers simultaneously. It will be destined for long journeys, so it will have adequate accommodation for night trips (all passengers will have cabins or comfortable seats) and various services on board (restaurant, coffee shops, shops, leisure areas). It will be equipped with dual-fuel propulsion in line with current environmental requirements. The design will be made according to the DNV-GL classification society and will be in accordance with Marpol and Solas (including the safe return to port SRTP). The service speed to be achieved will be 26 knots with an autonomy of 3000 miles.

Características buque Ferry	
L_{pp}	130 m
L_{total}	145,6 m
B	24,4 m
D	7,84 m
$T_{diseño}$	5,26 m
Cb	0,58
Cm	0,960
Cp	0,60
Despl	9923,2 t
Pasajeros	1500
Tripulación	55
Velocidad	26 nudos
BKw	31768,6 Kw

En este cuaderno se realizarán los cálculos en detalle de los diferentes pesos del buque del proyecto. El peso en rosca del buque se ha dividido en diferentes partidas: aceros, maquinaria y armamento y otros equipos. Para los centros de gravedad se ha considerado como origen la perpendicular de popa a la altura de la quilla.

2. ACEROS:

2.1. Peso de la estructura de acero:

Se realizó el cálculo por dos métodos, pudiendo contrastar los resultados obtenidos de cada uno:

1) **Método de D.G.M. Watson:**
   La fórmula para el cálculo es:

$$PST = K \cdot E^{1,36} \cdot (0,65 + 0,5 \cdot Cbp)$$

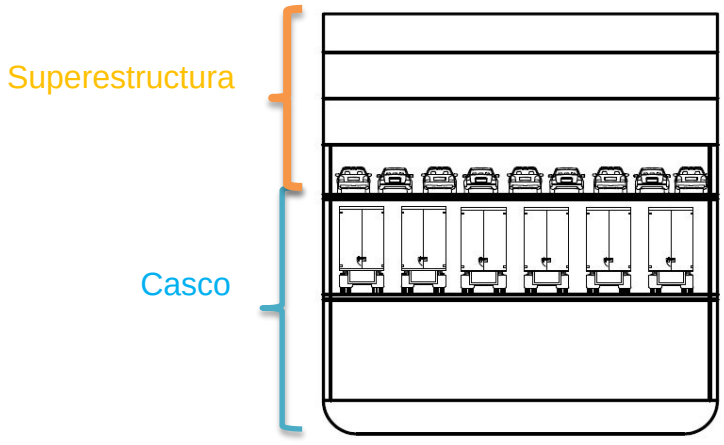
Donde:

- E: antiguo numeral de equipo del Lloyd's.

$$E = L \cdot (B + T) + 0,85 \cdot L \cdot (D - T) + 0,85 \, \Sigma \, l1 \cdot h1$$
$$E = 5571,58$$

Donde:

- l1: eslora de superestructuras.
- h1: altura superestructuras.
  Se ha considerado que el casco alcanza hasta la cubierta inmediatamente superior a la ppal, tal y como se indica en la imagen inferior. A partir de ahí se considera una superestructura, por encima de este, con 10,8 metros de alto (2,7 m por cubierta) y una eslora que se estimó en 110 metros.



- Cbp: coeficiente de bloque al 80% del puntal.

$$Cbp = Cb + (1 - Cb) \cdot (0{,}8 \cdot D - T)/(3 \cdot T)$$
$$\text{Cbp} = 0{,}607$$

- K: coeficiente obtenido de la tabla del libro “Cálculo del desplazamiento” de F. Junco. Para ferry se tomó el valor medio entre los propuestos: K=0,0305.

Se obtuvo un peso de:

PST = 3615,45 t

2) Método de J. L. García Garcés:

Para buques de carga rodada, propone la siguiente fórmula:

$$PST = 0{,}0384 \cdot L^{1,5} \cdot B \cdot D^{0,5}$$

Se obtuvo un peso de:

PST = 3890,75 t

Se comprueba que son valores próximos. Se ha tomado como valor definitivo el obtenido en el método de Watson, por ser una formulación ampliamente probada y aconsejada por el profesorado:

PST = 3615,45 t

El cálculo del centro de gravedad de la estructura de acero se realizó de la siguiente forma:

- **Ordenada del C.G.:**

  Se usó la fórmula:

$$ZST = 0.01 \cdot D \cdot (46{,}6 + 0{,}135 \cdot (0{,}81 - CB) \cdot L^2/D^2) + (L/B - 6{,}5) \cdot 0{,}008 \cdot D$$

  Donde de nuevo se tomó como el puntal la altura hasta la cubierta de turismos. Se obtuvo:

$$ZST = 6,61m$$

Este valor se corrigió por tener el buque bulbo de proa, restándole el valor:

$$Corr = -0,002 \cdot D$$

El valor final resulta:

ZST = 6,58 metros

- **C.G. horizontal:**
  Se usó la formulación de J. L. García Garcés para buques de carga rodada:

$$XST = 0,417 \cdot L + 4,51$$

  El valor obtenido:

XST = 66,25 metros

2.2. Tecles:

El peso de los tecles se calculó con la fórmula:

$$PTM = 0,047 \cdot Lcm \cdot B \cdot 0,60$$

Donde:

- Lcm: eslora de la cámara de máquinas. Este valor se estimó en función de los buques de la base de datos en Lcm = 28 m, ya que el buque contará con doble cámara de máquinas (14 m por cada cámara).

Se obtuvo un peso de:

PTM = 19,28 t

El centro de gravedad se situó en:

- ZGTM: se estimó su posición al 86% de la altura de la cámara de máquinas.

ZGTM = 6,95 m

- XGTM: se consideró en el centro de la cámara de máquinas.

XGTM = 42 m

2.3. Tanques no estructurales:

El peso de los tanques no estructurales:

$$PTV = a + b \cdot MCR$$

Donde:

- a, b: coeficientes que dependen del valor de MCR. En este caso a = 1,2 y b = 0,0009.

PTV = 23,57 t

Se considera el centro de gravedad igual al de los tecles.

ZGTM = 6,95 m
XGTM = 42 m

3. MAQUINARIA:

3.1. Motores principales:

El modelo de los motores principales se obtuvo en el anterior cuaderno, habiendo seleccionado 4 motores Wärtsilä 8L46DF de:

Pmp = 4·130 = 520 t

El centro de gravedad se supuso en el centro de la cámara de máquinas, donde se sitúan los motores:

ZGTM = 4,67 m
XGTM = 42 m

3.2. Maquinaria restante:

En este apartado se calculó el peso de maquinaria auxiliar, calderas, generadores, bombas, comprensores, tuberías, escaleras, silenciadores y líquidos en espacios de maquinaria.

Para su cálculo se utilizó el Método estimativo de Lloyd's Register, en concreto el apartado para maquinaria diésel semirrápida. La fórmula y valores de coeficientes se tomaron del libro "Cálculo del desplazamiento" de F. Junco.

$$Prw = c_i \cdot (BHP)^{di}$$

Donde:

- c_i, d_i: coeficiente e índice de regresión, dados por el método y habiendo sido obtenidos a partir de la información de buques existentes (c_i=0,59 d_i=0,70).
- BHP: potencia de la máquina principal, en bhp métricos (35122 bhp).

Prw = 1145 t

El centro de gravedad se considera en el centro de la cámara de máquinas, al estar repartidos los diferentes pesos por toda ella:

ZGTM = 4,67 m
XGTM = 42 m

3.3. Hélices:

El buque contará con dos hélices propulsoras de paso variable y un diámetro máximo de 4 metros. Se calculó su peso con la fórmula:

$$Ph = (0{,}12 \cdot Diametro^3) \cdot 2$$

Ph = 15,36 t

El centro de gravedad se obtuvo del plano, en el estado actual de diseño, resultando:

ZGH = 2,2 m

XGH = 1,6 m

3.4. Línea de ejes:

El buque contará con dos líneas de ejes, cuyo peso se estimó:

$$Pej = Lej + 0{,}081 \cdot (n \cdot MCR / n' / rpm)^{2/3}$$

Donde:

- Lej: longitud de la línea de ejes. Se obtuvo del plano, Lej = 40 m.
- n: número de motores principales (4).
- n': número de propulsores (2).
- rpm: rpm del propulsor, se obtienen del cálculo de potencia, donde a la velocidad de servicio resultaban rpm= 204.

Pej = 94,82 t

El centro de gravedad se obtiene de su posición en el plano:

ZGEJ = 2,2 m

XGEJ = 22,1 m

3.5. Reductores:

El peso de los dos reductores se calcula:

$$Peso_{red} = a + (b \cdot T_{red} + c \cdot T_{red}^2) / 1000$$

Donde:

$$T_{red} = 28{,}758 \cdot CS^2 + 24{,}977 \cdot CS + 240{,}8$$

$$CS = \ln(P_{red}) - 0{,}0287 \cdot R_{red}^2 + 0{,}587 \cdot R_{red}$$

$$P_{red} = (MCR / RPM) \cdot Fhi$$

$$R_{red} = RPM / rpm$$

- RPM: revoluciones de los motores principales (600 rpm).
- rpm: revoluciones del propulsor (204 rpm).
- Fhi: coeficiente en función del hielo, en este caso Fhi = 1(hielo 1C o menor).
- a, b, c: coeficientes en función de T_{red}. En este caso, como T_{red} >900 resultan a = 12,30, b = -44,57 y c = 0,0531.

El valor obtenido de la formula se incrementará por estar dotado el buque de PTO. El peso a mayores se calculó como:

$$Ppto = Pot (KVA) / 1000$$

Dado que en este momento de desarrollo del proyecto se desconoce la potencia eléctrica necesaria, se estimó en función de la utilizada por otros buques de la base de datos, en torno a Pot = 2500 KVA.

$$Ppto = 2{,}5 \text{ t}$$

Resultando el peso de las reductoras:

$$\mathbf{Peso_{red} = 85{,}55 \text{ t}}$$

El centro de gravedad se estima por su posición en el plano:

ZGRED = 2,5 m

XGRED = 42 m

3.6. Instalación contra incendios en cámara de máquinas:

El cálculo del peso resulta:

$$PCICM = 0{,}125 \cdot (0{,}0046 \cdot Pmp + 0{,}0088 \cdot L \cdot B)$$

PCICM = 18,2 t

El centro de gravedad se estima en el centro de la cámara de máquinas por estar repartida uniformemente por toda ella:

ZGTM = 4,67 m
XGTM = 42 m

3.7. Bow thrusters:

El cálculo y selección de los empujadores laterales necesarios se realizó en el cuaderno 6. De este se obtiene que al buque se le dotará de 2 bow thrusters de 595 Kw cada uno.

En la siguiente imagen se muestran los datos del modelo Rolls – Royce 1300 CP que encaja con los valores calculados.

Technical data

TT size	Tip speed m/s	Motor RPM	Propeller RPM	Power		Prime mover type
				AUX	DP	
1300 CP	26.5 - 31.8	1470 - 1760	390 - 467	495 - 595	445 - 535	El. motor
1300 CP				435 - 520	390 - 475	Diesel

Por tanto, el peso de esta partida será de:

Pbwt = 2 · 6,24 = 12,48 t

Su centro de gravedad se sitúo mediante su posición en el plano:

ZGbwt = 3,7 m

XGbwt = 123 m

3.8. Instalación eléctrica:

El peso de la instalación eléctrica se obtuvo:

PIE = lc + Pmp/1000

Donde:

- Pmp: potencia motores propulsores.
- Lc: longitud de cable, calculada como:

$$Lc = 9{,}82 + 0{,}268 \cdot L + 0{,}000597 \cdot L^2$$

PIE = 79,61 t

El centro de gravedad se supone en el centro del buque por estar repartida por todo este:

ZGIE = 13,2 m

XGIE = 65 m

4. EQUIPO Y ARMAMENTO:

4.1. Equipo de gobierno:

El peso de los timones se calculó:

$$Peg = 0{,}0224 \cdot A \cdot V^{2/3} + 2$$

Donde:

- V: velocidad en pruebas, se obtiene:

$$V = 1{,}06 \cdot Vservicio$$
$$V = 27{,}59 \text{ kn}$$

- A: área de timón, se calculó en el cuaderno 6, obteniéndose:

$$A = 14{,}4 \text{ m}^2$$

Peg = 4,94 t

El centro de gravedad se obtuvo de su posición en el plano:

ZGeg = 2,3 m
XGeg = 0 m

4.2. Rampa de popa/proa:

Se dispone de dos rampas a popa y una a proa, con las siguientes dimensiones:

- Rampas popa:
  - Lrp: 6,9 m
  - Brp: 6,2 m

- Rampa proa:
  - Lrp: 8 m
  - Brp: 3,5 m

Su peso se calculó:

$$PRampa = [(0{,}17 + 0{,}075 \cdot (Lrp)) \cdot Brp \cdot Lrp]$$

Prampapp = 12,73 t

Prampapr = 4,53 t

Su centro de gravedad se sitúa, según el plano y cuando se encuentran recogidas:

Rampas popa:

ZGRAMPAPP = 10,54 m

XGRAMPAPP = -7,6 m

Rampa proa:

ZGRAMPAPR = 7,84 m

XGRAMPAPP = 130 m

4.3. Rampas interiores:

Se dispone de dos rampas interiores, una a popa y otra a proa, permitiendo el acceso a la cubierta inmediatamente superior a la ppal. Sus dimensiones son:

- Rampas interiores:
  - Lrp: 12,5 m
  - Brp: 4,2 m

Su peso se calculó:

$$PRampa = [(0{,}17 + 0{,}075 \cdot (Lrp)) \cdot Brp \cdot Lrp]$$

Prampai = 30,39 t

Su centro de gravedad se sitúa, según el plano:

Rampas interiores:

ZGRAMPAI = 10,54 m

XGRAMPAI = 65 m

4.4. Equipos de amarre y fondeo:

El peso se obtiene a partir del numeral de equipo, que se calcula:

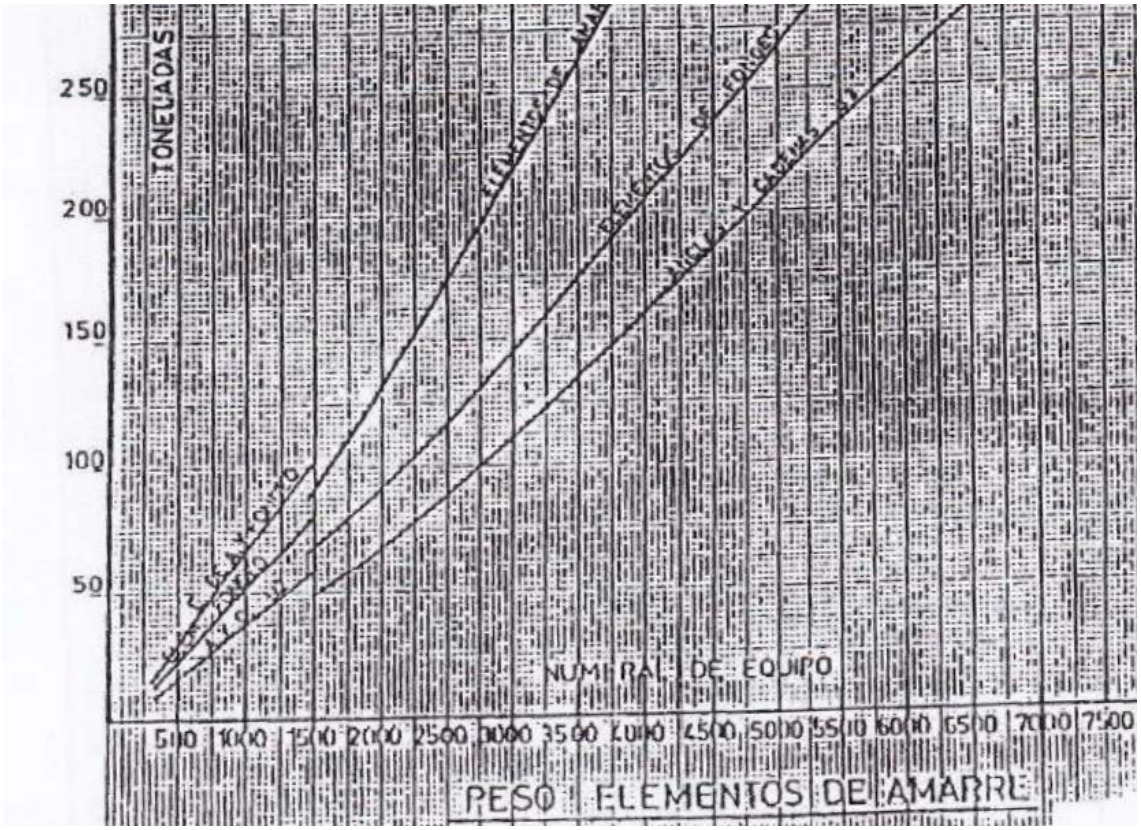
$$NE = \Delta m^{2/3} + 2 \cdot B \cdot h + A / 10$$

Donde:

- Δm: desplazamiento máximo del buque. Se considera el de máxima carga, Δ: 9983 tn.
- h: altura total del buque desde el calado de verano.
- A: área lateral del buque por encima de la línea de francobordo de verano.

NE = 1761

Con ello se entra en la tabla, obtenida del libro “Cálculo del desplazamiento” de F. Junco, y se obtiene el peso del equipo de amarre y fondeo:



Se obtiene:

Paf = 100 t

El centro de gravedad se estima que está:

ZGAF = 13,24 m

XGAF = 65 m

4.5. Pintura:

El peso de la pintura se calculó:

$$Pi = 0{,}007783 \cdot PST$$

Pi = 27,75 t

Su centro de gravedad se supone en el medio del buque:

ZGI = 13,37 m

XGI = 65 m

4.6. Equipos de salvamento:

El peso de los equipos de salvamento se obtuvo:

$$PEqSalv = 9{,}5 + (n - 35) \cdot 0{,}1$$

Donde:

- n: número de personas a bordo (1500 pasajeros y 55 tripulantes).

Este valor de peso se incrementó en 3,5 t dado que los botes serán cerrados.

PEqsalv = 165 t

Se situarán en la cubierta superior, en la zona media del buque, por lo que su centro de gravedad será:

ZGEqsalv = 22,5 m

XGEqsalv = 65 m

4.7. Habilitación:

El cálculo del peso de la habilitación se realizó mediante el desglose de los distintos espacios de las cubiertas. Los valores de Kg/m^2 de cada tipo de espacio y el peso de los módulos de camarotes se tomaron del citado libro "Cálculo del desplazamiento" de F. Junco. Los valores de áreas se midieron sobre los planos de disposición general que se adjuntan en la sección de Planos. A continuación se muestra una tabla con los valores obtenidos:

	M^2	Nº módulos	Peso kg/m^2	Peso módulo	Pesos (t)
Camarotes	3330		135		449,55
Comedores y salones	941		120		112,92
Cocina	96		200		19,2
aseo	182,6		200		36,52
Pasillos	1128		80		90,24
Butacas	1551		100		155,1
				Total	**413,98**

Por tanto, el peso de la habilitación resulta:

Phb = 413,98 t

El centro de gravedad se estimó en función de las superficies que lo componen, medidas en el plano, siendo su posición:

ZGhb = 20,95 m

XGhb = 68,42 m

5. RESUMEN PESO EN ROSCA:

Se muestra en una tabla los valores obtenidos de pesos y centros de gravedad para las distintas partidas, así como los valores totales resultantes. Se ha considerado un margen del 4% en el peso, de 0,5 m en ZG y de 1 m en XG, teniendo en cuenta las posibles desviaciones de los cálculos y tal y como se indicó en la asignatura de “Proyectos del buque”:

	Peso (t)	ZG (m)	XG (m)
Estructura acero	3615,45	6,58	66,25
Tecles	19,28	6,95	42
Tanques no estructurales	23,57	6,95	42
Motores principales	520	4,67	42
Maquinaria restante	1145	4,67	42
Hélices	15,36	2,2	1,6
Línea de ejes	94,82	2,2	22,1
Reductoras	85,55	2,5	42
Inst. contraincendios en C.M.	18,2	4,67	42
Bow thrusters	12,48	3,7	123
Inst. eléctrica	79,61	13,2	65
Equipo de gobierno	4,94	2,3	0
Rampas de popa	12,73	10,54	-7,6
Rampa de proa	4,53	7,84	130
Rampas interiores	30,39	10,54	65
Amarre y fondeo	100	13,24	65
Pintura	27,75	13,37	65
Equipo de salvamento	165	22,5	65
Habilitación	413,98	20,95	68,42
Margen	255,5	0,5	1
TOTAL	6644,2	7,73	57,32

6. PESO MUERTO:

Se indican a continuación las diferentes partidas que componen el peso muerto del buque y la estimación que se ha realizado de cada una de ellas.

- Carga rodada: 25 toneladas por tráiler y 2 por turismo (30 tráileres y 115 turismos).

  Peso = 980 t

- Personas: se considera tripulación y pasaje, 1555 personas, con un peso medio de 100 Kg (incluye posible equipaje).

  Nº = 1555 Coef = 0,1 Peso = 155,5 t

- Provisiones y víveres: se calculó en función de los valores obtenidos del libro "El proyecto básico del buque mercante", donde se indica una cifra de 15 Kg por persona y día en buques de pasaje. Dado que la autonomía es de 3000 millas y que a la velocidad de servicio (26 nudos), la duración de la navegación máxima sería de casi 5 días. Se calcularon los víveres para esa duración.

  Nº personas=1555 Víveres=15Kg/per·día Dur=4,8 días

  Peso = 111 t

- HFO/GNL: Se calculó con los consumos del motor seleccionado (182 g/Kwh) y la autonomía de 3000 millas (RPA). Dado que a estas alturas del proyecto se desconoce el porcentaje de GNL que se usará, el cálculo se realizó para la situación más desfavorable, suponiendo que todo el trayecto se realiza con HFO (menor poder calorífico).

  Peso = 710 t

- Lub oil: se considera el 4% del peso del combustible, según indica del libro "El proyecto básico del buque mercante".

  Peso = 28,43 t

- Agua fresca: se consideran 125 litros por persona y día.
  Peso = 194 t

- **PM TOTAL = 2181 t**

7. DESPLAZAMIENTO:

Con los datos de Peso en rosca y Peso muerto hallados se puede calcular cuál será el desplazamiento previsto para el buque. Para ello se utiliza la relación:

$$\Delta = PR + PM$$

$$\Delta = 6644 + 2181$$

$$\mathbf{\Delta = 8825\ t}$$

El valor obtenido es inferior al considerado hasta el momento (9923 t), por lo que de cumplirse dicho valor, el buque navegará en condición de plena carga con un calado inferior a 5,25 m.

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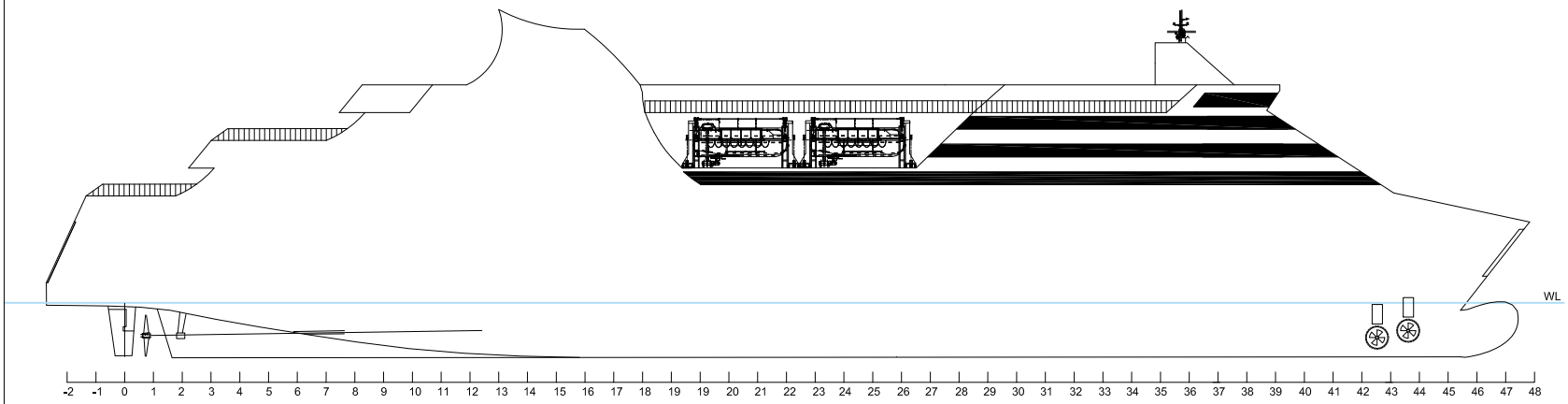
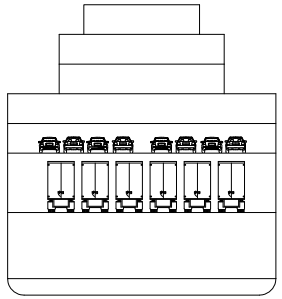
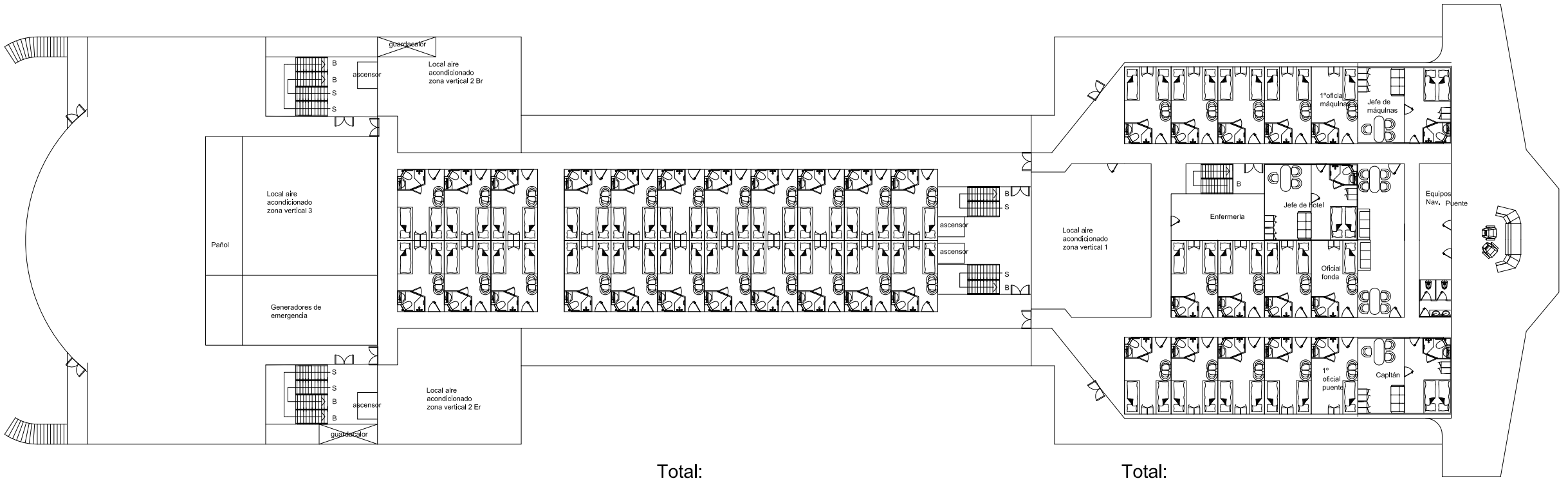
Documento

PLANOS



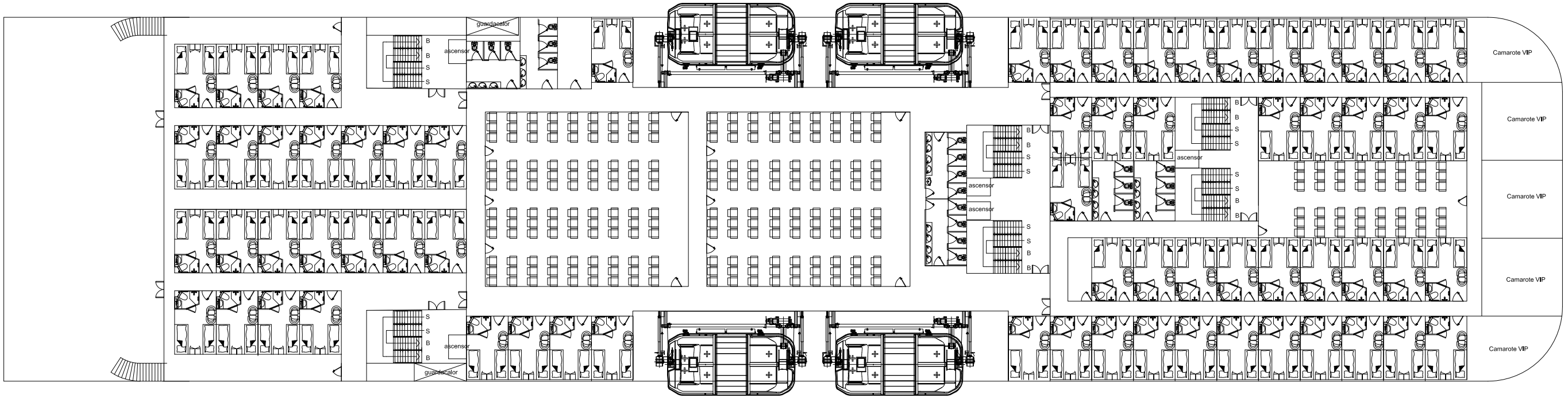


Proyecto: Ferry 1500 pax y 1000 ml		Fecha:
Autor: Marcos Covelo Fernández		
Peticionario:		
E.P.S.	PERFIL	Plano Nº 1
		Escala: 1:450



Total:
64 plazas en camarotes
18 plazas en camarotes tripulación

Total:
37 plazas en camarotes tripulación

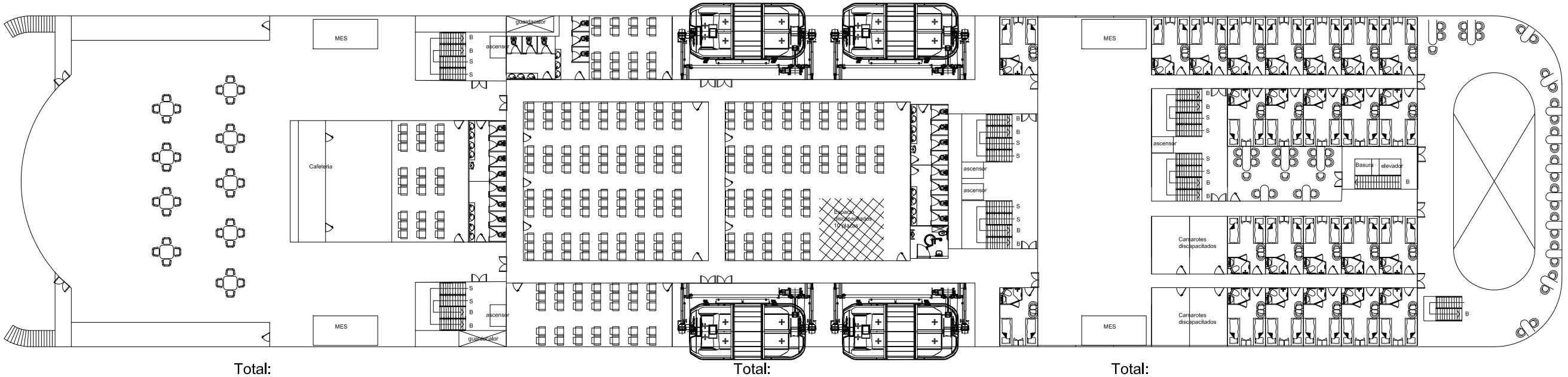


Total:
88 plazas en camarotes

Total:
216 plazas en butacas
28 plazas en camarotes

Total:
48 plazas en butacas
172 plazas en camarotes

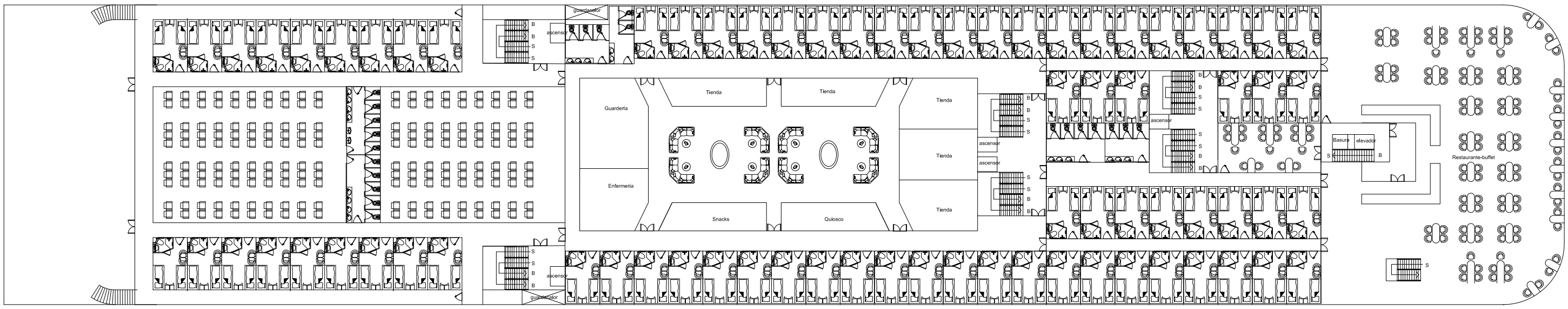
Proyecto: Ferry 1500 pax y 1000 ml		Fecha:
Autor: Marcos Covelo Fernández		
Peticionario:		
E.P.S.	DISPOSICIÓN GENERAL	Plano Nº 1
		Escala: 1:400



Total:
27 plazas en butacas

Total:
271 plazas en butacas

Total:
92 plazas en camarotes



Total:
190 plazas en butacas
72 plazas en camarotes

Total:
104 plazas en camarotes

Total:
128 plazas en camarotes

Proyecto: Ferry 1500 pax y 1000 ml		Fecha:
Autor: Marcos Covelo Fernández		
Peticionario:		
E.P.S.	DISPOSICIÓN GENERAL	Plano Nº 2 Escala: 1:400

UNIVERSIDADE DA CORUÑA

Escola Politécnica Superior

Trabajo Fin de Grado
CURSO 2016/17

17-07 FERRY 1500 PAX 1000 ML

Grado en Ingeniería Naval y Oceánica

Documento

ANEXO

1. Main Data and Outputs

The Wärtsilä 46DF is a 4-stroke, non-reversible, turbocharged and intercooled diesel engine with direct fuel injection (twin pump).

Cylinder bore	460 mm
Stroke	580 mm
Piston displacement	96.4 l/cyl
Number of valves	2 inlet valves and 2 exhaust valves
Cylinder configuration	6, 7, 8 and 9 in-line; 12, 14 and 16 in V-form
Direction of rotation	clockwise, counter-clockwise on request
Speed	600 rpm
Mean piston speed	11.6 m/s

1.1 Maximum continuous output

Table 1-1 Maximum continuos output

Cylinder configuration	IMO Tier 2	
	kW	bhp
W 6L46DF	6870	9340
W 7L46DF	8015	10900
W 8L46DF	9160	12450
W 9L46DF	10305	14010
W 12V46DF	13740	18680
W 14V46DF	16030	21790
W 16V46DF	18320	24910

The mean effective pressure P_e can be calculated using the following formula:

$$P_e = \frac{P \times c \times 1.2 \times 10^9}{D^2 \times L \times n \times \pi}$$

where:

P_e = mean effective pressure [bar]

P = output per cylinder [kW]

n = engine speed [r/min]

D = cylinder diameter [mm]

L = length of piston stroke [mm]

c = operating cycle (4)

1.5 Dimensions and weights

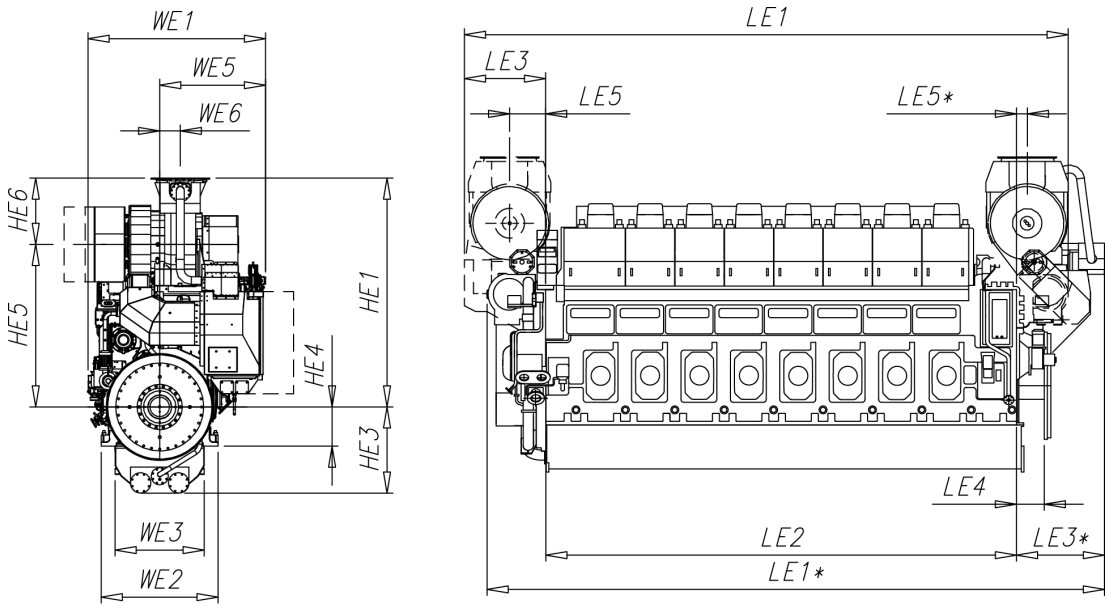


Fig 1-3 In-line engines (DAAR038987)

Engine	LE1*	LE1	LE2	LE3*	LE3	LE4	LE5*	LE5	HE1	HE3
6L46DF	8670	8953	6170	1520	-	460	292	699	3255	1430
7L46DF	9635	9773	6990	1520	-	460	292	699	3255	1430
8L46DF	10310	10593	7810	1520	1883	460	292	658	3445	1430
9L46DF	11130	11413	8630	1520	1883	460	292	658	3445	1430

Engine	HE4	HE5	HE6	WE1	WE2	WE3	WE5	WE6	Weight [ton]
6L46DF	650	2605	650	3185	1940	1480	1780	330	102
7L46DF	650	2605	650	3185	1940	1480	1780	330	118
8L46DF	650	2605	755	3185	1940	1480	1780	398	130
9L46DF	650	2605	755	3185	1940	1480	1780	398	146

* Turbocharger at driving end

All dimensions in mm. The weights are dry weights of rigidly mounted engines without flywheel.

Table 1-2 Additional weights [ton]:

Item	6L46DF	7L46DF	8L46DF	9L46DF
Flywheel	1...2	1...2	1...2	1...2
Flexible mounting (without limiters)	3	3	3	3

3.4 Wärtsilä 8L46DF

Wärtsilä 8L46DF		ME		DE	
		Gas mode	Diesel mode	Gas mode	Diesel mode
Cylinder output	**kW**	**1145**		**1145**	
Engine speed	**rpm**	**600**		**600**	
Engine output	kW	9160		9160	
Mean effective pressure	MPa	2.38		2.38	
Combustion air system (Note 1)					
Flow at 100% load	kg/s	14.7	16.4	14.7	16.4
Temperature at turbocharger intake, max.	°C	45		45	
Temperature after air cooler, nom. (TE 601)	°C	45	50	45	50
Exhaust gas system (Note 2)					
Flow at 100% load	kg/s	15.1	16.9	15.1	16.9
Flow at 75% load	kg/s	11.6	13.2	11.4	13.8
Temperature after turbocharger at 100% load (TE 517)	°C	354	354	354	354
Temperature after turbocharger at 75% load (TE 517)	°C	373	399	405	377
Backpressure, max.	kPa	4		4	
Calculated exhaust diameter for 35 m/s	mm	986	1041	986	1041
Heat balance at 100% load (Note 3)					
Jacket water, HT-circuit	kW	928	1472	920	1472
Charge air, HT-circuit	kW	2008	2448	2008	2448
Charge air, LT-circuit	kW	808	920	808	920
Lubricating oil, LT-circuit	kW	624	1104	624	1104
Radiation	kW	264	272	264	272
Fuel consumption (Note 4)					
Total energy consumption at 100% load	kJ/kWh	7460	-	7440	-
Total energy consumption at 85% load	kJ/kWh	7490	-	7540	-
Total energy consumption at 75% load	kJ/kWh	7590	-	7640	-
Total energy consumption at 50% load	kJ/kWh	8080	-	8220	-
Fuel gas consumption at 100% load	kJ/kWh	7413	-	7397	-
Fuel gas consumption at 85% load	kJ/kWh	7441	-	7487	-
Fuel gas consumption at 75% load	kJ/kWh	7535	-	7585	-
Fuel gas consumption at 50% load	kJ/kWh	7934	-	8070	-
Fuel oil consumption at 100% load	g/kWh	1.0	186	1.0	185
Fuel oil consumption at 85% load	g/kWh	1.2	178	1.2	182
Fuel oil consumption at 75% load	g/kWh	1.3	184	1.3	187
Fuel oil consumption 50% load	g/kWh	3.4	185	3.4	192
Fuel gas system (Note 5)					
Gas pressure at engine inlet, min (PT901)	kPa (a)	517	-	517	-
Gas pressure to Gas Valve unit, min	kPa (a)	517	-	517	-
Gas temperature before Gas Valve Unit	°C	0...60	-	0...60	-

Wärtsilä 8L46DF		ME		DE	
		Gas mode	Diesel mode	Gas mode	Diesel mode
Cylinder output	**kW**	**1145**		**1145**	
Engine speed	**rpm**	**600**		**600**	
Fuel oil system					
Pressure before injection pumps (PT 101)	kPa	800±0		800±0	
Fuel oil flow to engine, approx	m³/h	9.6		9.6	
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	40		40	
Leak fuel quantity (HFO), clean fuel at 100% load	kg/h	-	6.0	-	6.0
Leak fuel quantity (MDF), clean fuel at 100% load	kg/h	15.5	30.0	16.0	30.0
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 outlet pressure, max	kPa	150		150	
Pilot fuel return flow at 100% load	kg/h	550		550	
Lubricating oil system					
Pressure before bearings, nom. (PT 201)	kPa	500		500	
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	56		56	
Temperature after engine, approx.	°C	75		75	
Pump capacity (main), engine driven	m³/h	228		207	
Pump capacity (main), electrically driven	m³/h	198		198	
Oil flow through engine	m³/h	170		170	
Priming pump capacity (50/60Hz)	m³/h	45.0 / 45.0		45.0 / 45.0	
Oil volume in separate system oil tank	m³	17		17	
Oil consumption at 100% load, approx.	g/kWh	0.5		0.5	
Crankcase ventilation flow rate at full load	l/min	1700		1700	
Crankcase volume	m³	4.2		4.2	
Crankcase ventilation backpressure, max.	Pa	300		300	
Oil volume in turning device	l	8.5...9.5		8.5...9.5	
Oil volume in speed governor	l	1.7		1.7	
HT cooling water system					
Pressure at engine, after pump, nom. (PT 401)	kPa	250 + static		250 + static	
Pressure at engine, after pump, max. (PT 401)	kPa	530		530	
Temperature before cylinders, approx. (TE 401)	°C	74		74	
Temperature after charge air cooler, nom.	°C	91		91	
Capacity of engine driven pump, nom.	m³/h	180		180	
Pressure drop over engine, total	kPa	100		100	
Pressure drop in external system, max.	kPa	150		150	
Pressure from expansion tank	kPa	70...150		70...150	

Wärtsilä 8L46DF		ME		DE	
		Gas mode	Diesel mode	Gas mode	Diesel mode
Cylinder output	**kW**	**1145**		**1145**	
Engine speed	**rpm**	**600**		**600**	
Water volume in engine	m^3	1.4		1.4	
LT cooling water system					
Pressure at engine, after pump, nom. (PT 471)	kPa	250+ static		250+ static	
Pressure at engine, after pump, max. (PT 471)	kPa	530		530	
Temperature before engine, max. (TE 471)	°C	38		38	
Temperature before engine, min. (TE 471)	°C	25		25	
Capacity of engine driven pump, nom.	m^3/h	180		180	
Pressure drop over charge air cooler	kPa	50		50	
Pressure drop in external system, max.	kPa	200		200	
Pressure from expansion tank	kPa	70...150		70...150	
Starting air system (Note 6)					
Pressure, nom. (PT 301)	kPa	3000		3000	
Pressure at engine during start, min. (20 °C)	kPa	1500		1500	
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^3	8.0		8.0	
Consumption per start at 20 °C (with slowturn)	Nm^3	9.0		9.0	

Notes:

Note 1 At ISO 15550 conditions (ambient air temperature 25°C, LT-water 25°C) and 100% load. Flow tolerance 5%.

Note 2 At ISO 15550 conditions (ambient air temperature 25°C, LT-water 25°C). Flow tolerance 5% and temperature tolerance 15°C.

Note 3 At ISO 15550 conditions (ambient air temperature 25°C, LT-water 25°C) and 100% load. Tolerance for cooling water heat 10%, tolerance for radiation heat 30%. Fouling factors and a margin to be taken into account when dimensioning heat exchangers.

Note 4 According to ISO 15550, lower calorific value 42700 kJ/kg, with engine driven pumps (two cooling water + one lubricating oil pumps). Tolerance 5%. The fuel consumption at 85 % load is guaranteed and the values at other loads are given for indication only.

Note 5 Fuel gas pressure given at LHV ≥ 36MJ/m^3N. 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 6 At manual starting the consumption may be 2...3 times lower.

ME = Engine driving propeller, variable speed

DE = Diesel-Electric engine driving generator

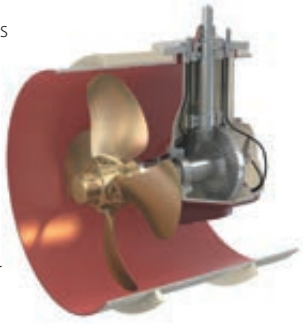
Subject to revision without notice.

Tunnel thrusters

The tunnel thruster is designed to provide side force to the ship to enhance manoeuvring capability in port or additional station keeping power when dynamic positioning. Versions specified should be matched to the vessel application. All are available with CP or FP propellers, and for ships requiring maximum passenger comfort, we have the 'Super Silent' range. A system normally consists of the thruster unit with tunnel, hydraulic equipment, remote control and electric drive motor with starter.

Tunnel thrusters

Users can select from eleven diameters and four different models, in each size designed to suit a specific application.



AUX: Standard type for auxiliary use only
ICE: High ice-class with stainless steel propeller blades
DPN: Continuous DP service - shallower draught vessels
DPD: Continuous DP service - deeper draught vessels

Units comprise standard tunnel, propeller unit, hydraulic system and remote control.

Key features:
- Available with FP or CP propellers
- Skewed blades for efficiency/ low noise
- Heavy duty propeller for DP units
- Shaft seal pressure control with drain connection in DP thrusters
- Mechanical locked bearings in DP thrusters

Technical data

TT size	Tip speed m/s	Motor RPM	Propeller RPM	Power		Prime mover type
				AUX	DP	
1100 CP	26.8 - 32.0	1465 - 1755	465 - 556	330 - 390	300 - 350	El. motor
1100 CP				290 - 340	260 - 310	Diesel
1300 CP	26.5 - 31.8	1470 - 1760	390 - 467	495 - 595	445 - 535	El. motor
1300 CP				435 - 520	390 - 475	Diesel
1300 FP	26.5 - 31.8	1470 - 1760	390 - 467	390 - 500	350 - 450	El. motor
1650 CP	27.0 - 32.3	1180 - 1770	312 - 374	720 - 865	645 - 780	El. motor
1650 CP		1475 - 1770		630 - 760	570 - 685	Diesel
1650 FP	27.0 - 32.3	1180 - 1770	312 - 374	600 - 720	530 - 640	El. motor
1850 CP	24.2 - 32.7	1180 - 1770	250 - 337	880 - 1050	700 - 950	El. motor
1850 CP	27.2 - 32.7	1475 - 1770	281 - 337	780 - 930	700 - 840	Diesel
1850 FP	24.2 - 32.7	1180 - 1770	250 - 337	620 - 860	550 - 770	El. motor
2000 CP	25.6 - 32.8	980 - 1480	245 - 313	1030 - 1400	925 - 1200	El. motor
2000 CP	25.6 - 32.2	1180 - 1480	245 - 307	905 - 1040	815 - 1025	Diesel
2000 FP	25.6 - 32.8	980 - 1480	245 - 313	830 - 1150	730 - 1050	El. motor
2200 CP	26.2 - 31.8	880 - 1190	225 - 276	1150 - 1510	1050 - 1355	El. motor
2200 CP		980 - 1190	228 - 276	1020 - 1325	925 - 1190	Diesel
2200 FP	26.2 - 31.8	980 - 1190	228 - 276	750 - 1200	680 - 1070	El. motor
2400 CP	26.6 - 32.3	980 - 1190	211 - 257	1550 - 1910	1400 - 1720	El. motor
2400 CP				1320 - 1680	1180 - 1510	Diesel
2400 FP	26.6 - 32.3	980 - 1190	211 - 257	1100 - 1600	980 - 1500	El. motor
2650 CP	26.9 - 31.6	880 - 980	194 - 228	2050 - 2400	1850 - 2160	El. motor
2650 CP	28.3 - 31.6		204 - 228	1892 - 2110	1700 - 2000	Diesel
2650 FP	26.9 - 31.6	880 - 980	194 - 228	1260 - 1520	1120 - 1350	El. motor
2800 CP	29.2 - 32.5	880 - 980	199 - 222	2380 - 2650	2140 - 2385	El. motor
2800 CP				2090 - 2330	1880 - 2095	Diesel
2800 FP	29.2 - 32.5	880 - 980	199 - 222	1630 - 1800	1450 - 1600	El. motor
3000 CP	25.9 - 32.1	710 - 880	165 - 204	2450 - 3000	2200 - 2700	El. motor
3000 CP	26.8 - 32.1	735 - 880	171 - 204	2210 - 2640	1990 - 2370	Diesel
3000 FP	25.9 - 32.1	710 - 880	165 - 204	1750 - 2150	1520 - 1880	El. motor
3300 CP	25.7 - 31.9	710 - 880	149 - 185	2700 - 3700	2700 - 3330	El. motor
3300 CP	26.6 - 31.9	735 - 880	154 - 185	2730 - 3250	2450 - 2930	Diesel
3300 FP	25.7 - 31.9	710 - 880	149 - 185	2100 - 2850	1850 - 2500	El. motor

Hull Nº
1650

1500 PASSENGERS FERRY VESSEL
Shipowner:
NAVIERA ARMAS

VOLCÁN DE TABURIENTE
Built:
2006

Hull Nº
1650

Main Particulars:

Length Overall (with appendixes): 130.45 m
Length Overall (hull): 126.10 m
Length between Perpendiculars: 115.45 m
Moulded Breadth: 21.60 m
Depth to the Deck No. 3 (main deck): 7.50 m
Depth to the Deck No. 5 (upper deck): 12.80 m
Total Number of Decks: 8
Design Draught: 5.00 m
Summer Draught: 5.00 m
Deadweight at Summer Draught: 1745 T
Service Speed: 22.5 knots
Service Range: 2000 miles approx.
Number of Superstructure Decks: 3

Classification:

Bureau Veritas: I✠HULL ✠MACH, RO-RO PASSENGER SHIP, UNRESTRICTED NAVIGATION, AUT-UMS

Propulsion & Manoeuvring Equipment:

Main Engines: 4 x 4500 kW at 600 rpm
Generating Sets: 2 x 1080 kW at 1000 rpm
Emergency Genset: 1 x 310 kW at 1500 rpm
2 x CP Main Propellers, 4 Blades, 3700 mm Diameter
2 x 720 kW CP Bow Tunnel Thrusters

Cargo Capacity:

Max. Capacity (crew + passengers): 1500 people
Number of Cargo Decks: 2 + 1 cardeck
Cargo Capacity with Cars and Trailers:
Cars Capacity: 213 / *Trailers Capacity:* 16
Max. Cargo Capacity for Trailers of 16 m and Cars:
Trailers Capacity: 28 / *Cars Capacity:* 103
Max. Cargo Capacity with Only Cars:
Capacity for Cars: 305

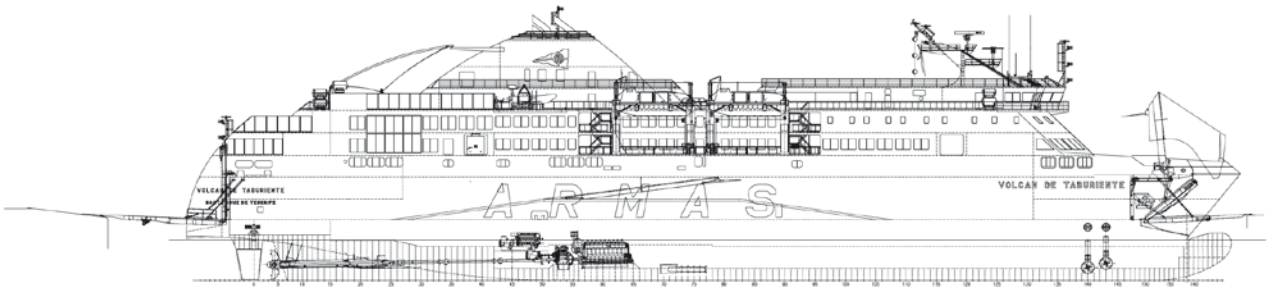
Cargo Equipment:

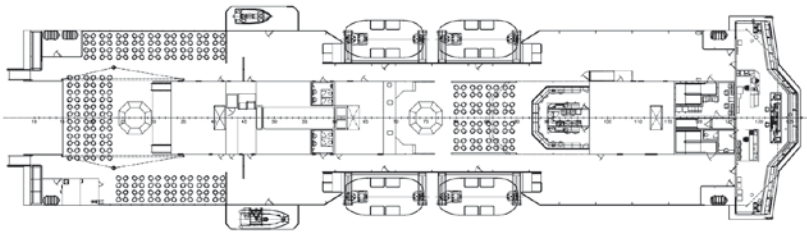
2 Stern Ramp Doors: 9.5 m length x 6.0 m width
Tilting Ramp for Access to Upper Deck
Fore Ramp-door with Bow Visor for the Access of Cars from Dock
A Movable Ramp (cardeck) in Garage between upper Deck No. 3 and 5 for transport of cars of 2 T weight

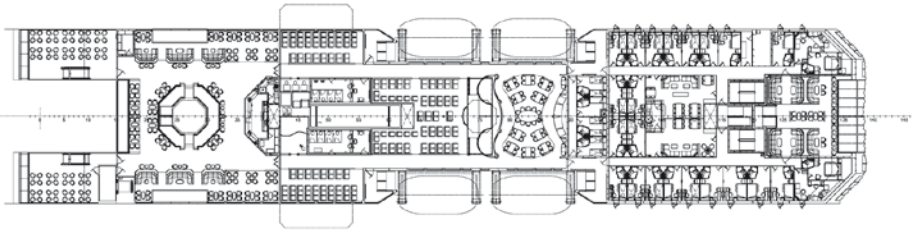
Tanks Capacity:

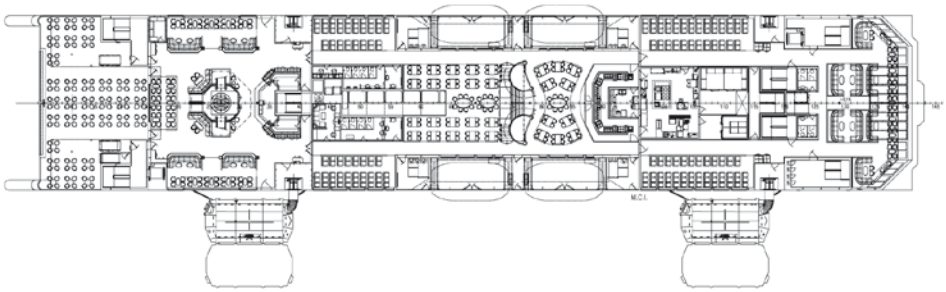
Fuel Capacity (Fuel-oil): 358 m^3 / *Fuel Capacity (Diesel-oil):* 47 m^3
Lub. Oil Capacity: 42 m^3
Fresh Water Capacity: 66 m^3
Ballast Water Capacity: 1130 m^3

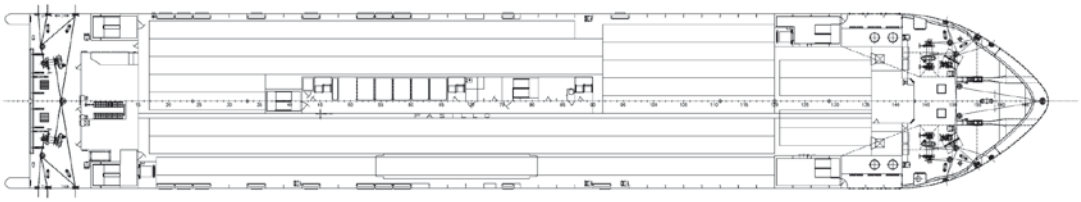
HIJOS DE J. BARRERAS

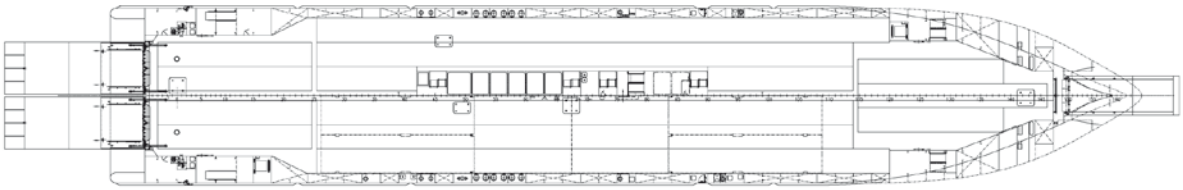

A R M A S
VOLCAN DE TABURIENTE

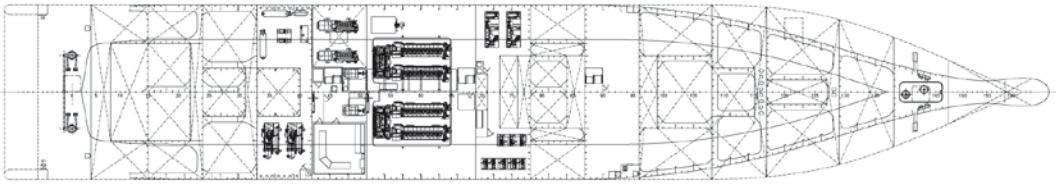












ARMORIQUE: new ro-pax ferry for Plymouth-Roscoff route

Shipbuilder: ..... **Aker Yards (Helsinki yard), Finland**
Vessel's name: ..... ***Armorique***
Hull number: **1362**
IMO number: **9364980**
Owner/operator: ..... **Brittany Ferries, France**
Designer: ..... **AIA Architects, France**
Model test establishment used: ..... **Force Technology, Denmark**
Flag: ..... **France**
Total number of sister ships already completed: ..... **Nil**
Total number of sister ships still on order: ..... **Nil**

ORIGINALLY ordered from Aker Yards (today STX Europe) as a freight-ferry sister to *Cotentin* (*Significant Ships of 2007*), *Armorique* resulted from a contract quickly changed to create a full ro-pax design for Brittany Ferries to satisfy the company's more urgent requirement for a vessel to operate on its Plymouth-Roscoff service. The conversion was facilitated by retaining the basis hull of *Cotentin,* but modifying and restyling the spaces above deck 5.

A new profile is now presented, with decks 7 to 10 extended right aft, to provide accommodation for 1500 passengers, 780 of whom can be carried as 'overnight' travellers using 248 cabins, including some suites. Once onboard, passengers have the use of a cinema, and a variety of bars, lounges and restaurants, with dedicated areas arranged for teenagers. A large shopping area is also provided and reclining seats are available for day passengers.

Vehicles are carried on three fixed decks offering a total of 1100 lane metres, equating to a total of 500 cars or some 60 trucks and, with a fast turnaround in port a requirement, two-level access is provided at both bow and stern. MacGregor supplied the access equipment, which includes a bow door and door ramp, a stern door/ramp, a ramp cover for the lower hold fixed ramp and a tilting ramp between decks 3 and 5.

The machinery installation follows closely that of *Cotentin* and uses the same MaK 12VM43C main engines, manufactured by Caterpillar Motoren GmbH, the organisation now controlling MaK, following its acquisition by the Caterpillar Group. The two engines fitted in the three-quarter aft machinery space each develop 12,000kW, and are coupled to twin CP propellers through Flender gearboxes which reduce engine speed to 153rev/min. When running at 85% MCR, a service speed of 23knots is attained.

Alternator capacity has been increased above that for *Cotentin* and consists of a Leroy Somer 2800kW alternator driven from a PTO on each gearbox, and three Wärtsilä/A van Kaick 1152kW diesel-driven sets. Environmental issues have been paramount in the development of the design of both *Cotentin* and *Armorique*, with particular attention paid to CO_2 emissions.

Two bow thrusters and one stern unit, supplied by Wärtsilä Lips, are installed, the former producing 1200kW each, and the stern unit 900kW. Passenger comfort is a particular consideration, and a pair of fin stabilisers is fitted; heeling tanks are also included for stability control during cargo handling. Lifesaving equipment supplied includes four RDF MES installations with vertical chutes: two arranged for 430 persons each and two of 321 person capacity. Four 150 person Umoe Schat-Harding lifeboats are also carried.

TECHNICAL PARTICULARS

Length, oa 168.00m
Length, bp 155.00m
Breadth, moulded 26.80m
Depth, moulded
- to main deck 9.30m
- to upper deck 10.30m

Draught
- design 6.30m
- scantling 8.50m

Gross ..... approx 28,500gt
Deadweight, design 4200dwt
Speed, service, 85% MCR 23knots
Bunkers
- heavy oil 790m³
- diesel oil 170m³

Water ballast 2060m³
Fuel consumption
- main engines only 110tonnes/day
- auxiliaries 9tonnes/day

Classification ..... Bureau Veritas I, +Hull, Ro-Ro Passenger Ship, Unrestricted Navigation, +MACH, +AUT-IMS, +AUT-PORT, SYSNEQ-1, MON-SHAFT
Heel control equipment ..... Two pairs of heeling tanks
Roll-stabilisation equipment ..... Fin stabilisers
Main engines
- Design ..... MaK
- Model 12VM43C
- Manufacturer ..... Caterpillar Motoren GmbH
- Number 2
- Type of fuel ..... HFO
- Output ..... 2 x 12,000kW

Gearboxes
- Make ..... Flender
- Model ..... Navilus GHCK
- Number 2
- Output speed 153rev/min

Propellers
- Material ..... CuNiAl
- Designer/manufacturer ..... Wärtsilä
- Number 2
- Pitch ..... Controllable
- Diameter 4800mm
- Speed 153rev/min

Main-engine driven alternators
- Number 2
- Make ..... Leroy Somer
- Output/speed ..... 2 x 2800kW/1500rev/min

Diesel-driven alternators
- Number 3
- Engine make/type Wärtsilä/6L20C
- Type of fuel ..... HFO
- Output/speed ..... 3 x 1200kW/1000rev/min
- Alternator make/type ..... A van Kaick/DSG 86/L1-6W
- Output/speed ..... 3 x 1152kW/1000rev/min

Boilers
- Number/type ..... 2 x convection tube
- Make ..... Aalborg
- Output ..... 2 x 3100kg/h

Mooring equipment
- Number of units 8
- Make ..... Rolls-Royce
- Type ..... Electro-hydraulic

Lifesaving equipment
- MES stations ..... RFD: 2 x 430person; 2 x 321person vertical chutes
- Lifeboats ..... Umoe Schat-Harding: 4 x 150 person

Vehicles
- Number of vehicle decks ..... 3 x fixed
- Total lane length 1100m
- Total cars 500
- Total freight vehicles 60

Access equipment
- Designer ..... MacGregor
- Number/type ..... 1 x bow door: 1 x bow ramp;1 x stern door/ramp: 1 x cover for lower hold fixed ramp: 1 x tiltable ramp

Complement
- Officers 24
- Crew 82

Passengers 1500
- Total number of cabins 248

Bow thrusters
- Make ..... Wärtsilä Lips
- Number 2
- Output ..... 2 x 1200kW

Stern thruster
- Make ..... Wärtsilä Lips
- Number 1
- Output 900kW

Bridge control system
- Make ..... Sperry
- One man operation ..... Yes

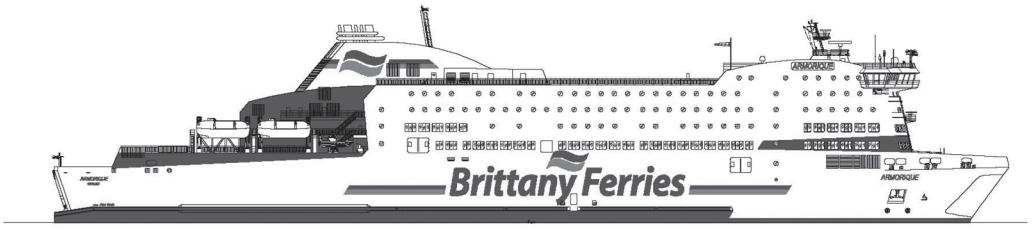
Fire detection system
- Make/type Autronica/BS-320

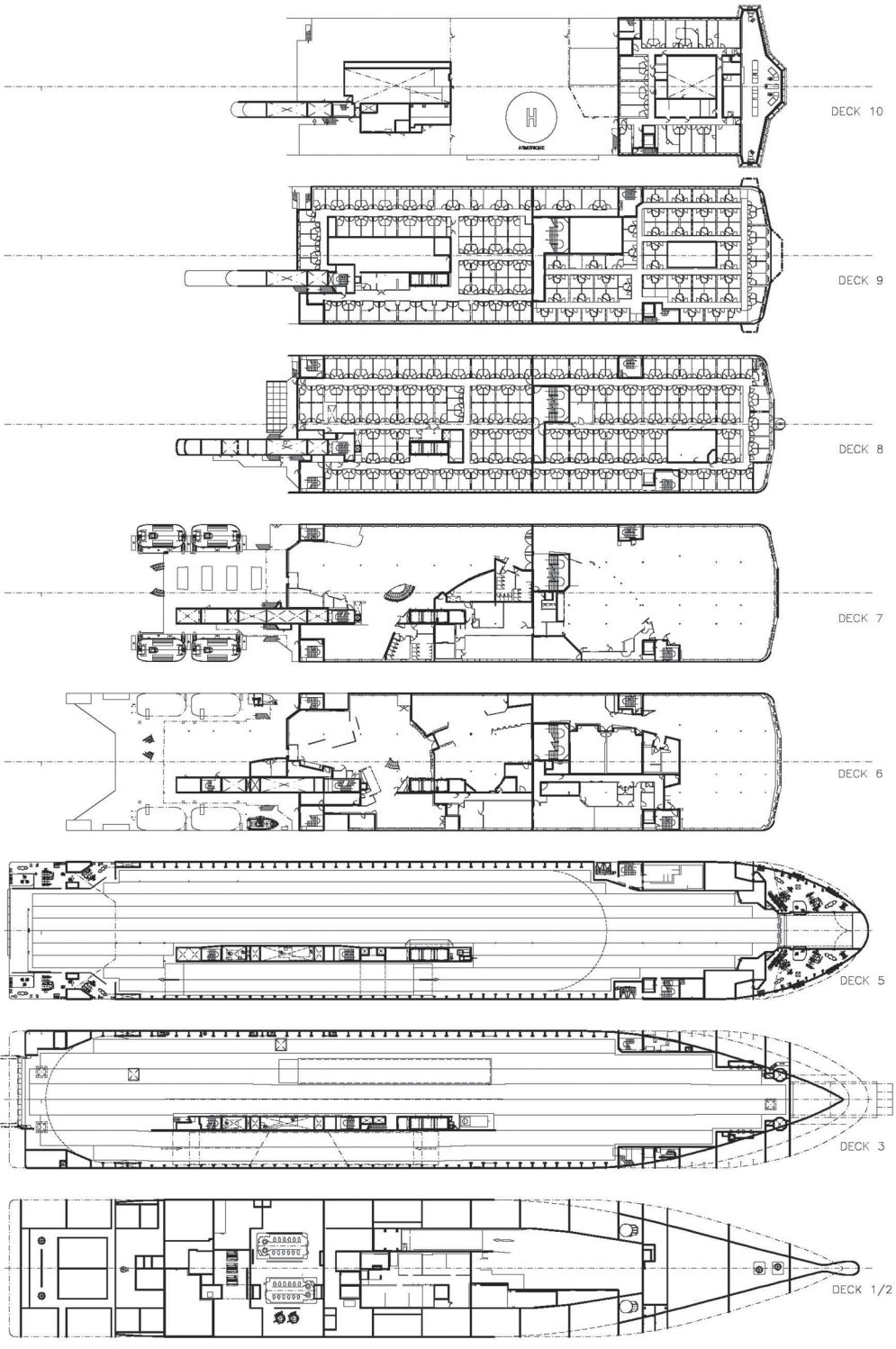
Fire extinguishing systems ..... Novenco
Radars
- Number 3
- Make ..... Sperry Marine
- Models ..... BridgeMaster

Integrated bridge system ..... Sperry Marine
Waste disposal plant
- Cardboard compactor ..... Uson
- Waste shredder ..... Uson dry water chute
- Glass chute with crusher ..... Uson

Sewage treatment system ..... Evac MPS 800
Contract date ..... 19 January 2006
Launch/float-out date ..... 7 August/11 September 2008
Delivery date ..... December 2008

ARMORIQUE


Brittany Ferries
ARMORIQUE


DECK 10
DECK 9
DECK 8
DECK 7
DECK 6
DECK 5
DECK 3
DECK 1/2

Main Particulars:

Length Overall (with appendixes): 154.51 m
Length Overall: 150.91 m
Length between Perpendiculars: 137.00 m
Moulded Breadth: 24.20 m
Depth to Upper Deck: 13.55 m
Depth to Main Deck: 8.35 m
Extreme Draught: 5.80 m
Design Moulded Draught: 5.50 m
Deadweight at 5.50 m approx.: 3200 T
Service Speed: 21.60 knots
Range at Service Speed: 3000 miles

Classification:

Bureau Veritas: 1✠Hull✠MACH Ro-Ro passenger ship, unrestricted navigation, AUT-UMS, AUT-PORT, MON-SHAFT, INWATER SURVEY

Propulsion & Manoeuvring Equipment:

Main Engines: 2 x 9000 kW at 500 rpm
Generating Sets: 3 x 1140 kW at 1000 rpm
Emergency Gensets: 1 x 280 kW at 1500 rpm
2 x CP Main Propellers, 4 Blades, 4200 mm Diameter
2 x 1000 kW CP Bow Tunnel Thrusters

Cargo Capacity:

Max. Capacity (crew + passengers): 1000 people
No. of Cabins: 46 x 4 pax cabins, 8 x 2 pax cabins and
2 x 3 pax cabins for disabled people
Number of Cargo Decks: 2 + 1 cardeck
Maximum Cargo Capacity for Cars: 125 cars (2.1 m width)
Maximum Cargo Capacity for Trailers: 1367 LM (3.0 m width)

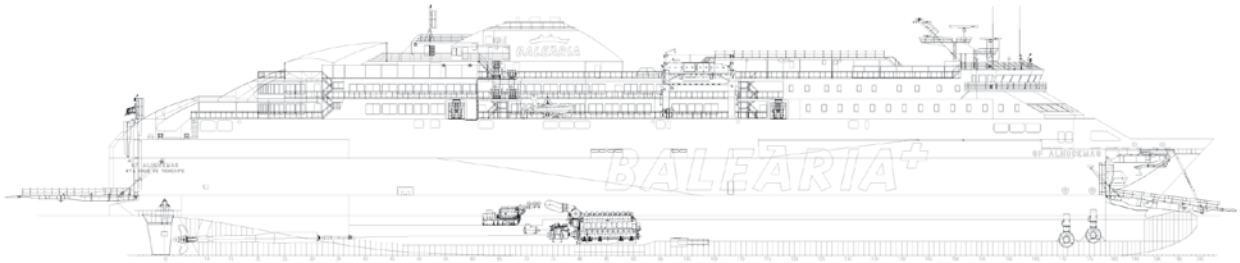
Cargo Equipment:

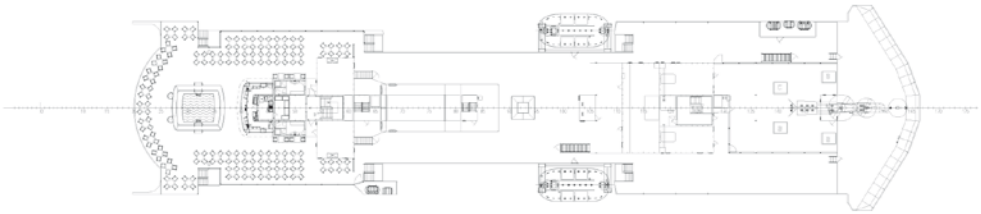
2 Stern Ramp-Doors: 16.00 m length x 8.0 m wide
1 Movable Cardeck in Garage between Deck No. 4 and 6
Fore Ramp-Door "Clamp Type" for the access of cars from shore
2 Tilting Ramps between Deck No. 3 and 4

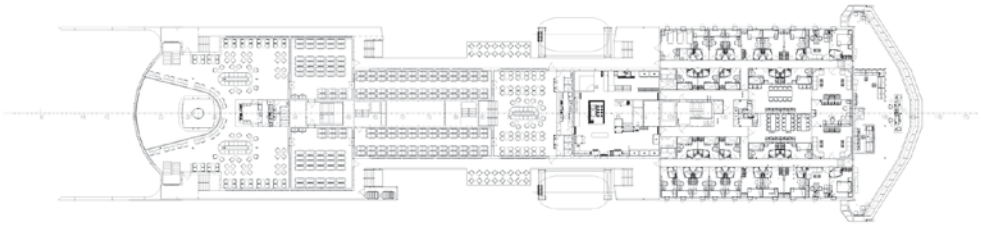
Tanks Capacity:

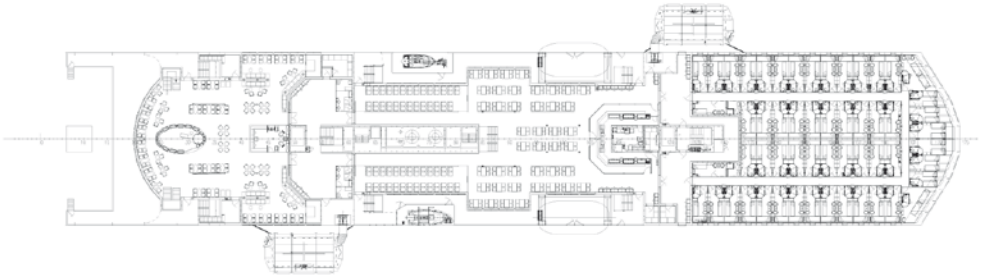
HFO Capacity: 611 m^3
DO Capacity: 92 m^3
Lub. Oil Capacity: 50 m^3
Fresh Water Capacity: 134 m^3

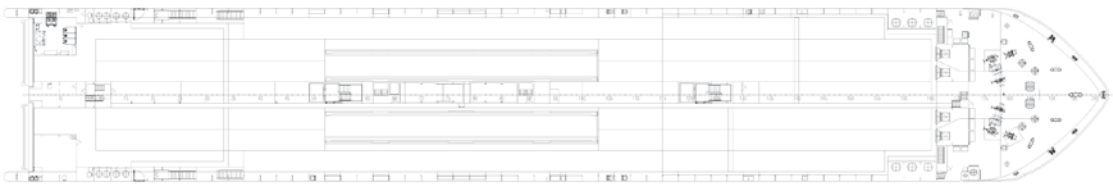
HIJOS DE J. BARRERAS

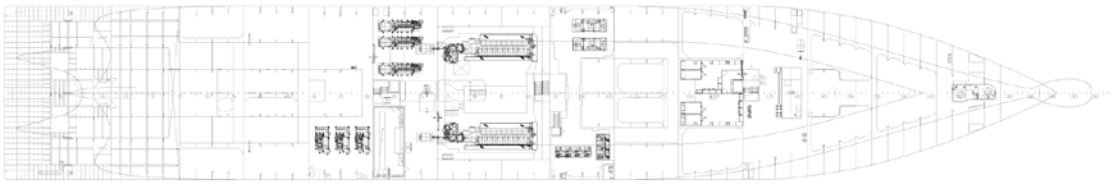












VIGO/SPAIN

T: +34 986 213 297
apillero@hjbarreras.es
www.hjbarreras.es

Main Particulars:

Length Overall (with appendixes): 165.30 m
Length Overall: 161.70 m
Length between Perpendiculars: 152.50 m
Moulded Breadth: 25.60 m
Depth to Upper Deck: 13.80 m
Depth to Main Deck: 8.50 m
Extreme Draught: 5.70 m
Design Moulded Draught: 5.50 m
Deadweight at 5.70 m approx.: 4370 T
Service Speed: 21.40 knots
Range at Service Speed: 3200 miles

Classification:

Bureau Veritas: 1✠Hull✠MACH Ro-Ro passenger ship, unrestricted navigation, AUT-UMS, AUT-PORT, INWATER SURVEY

Propulsion & Manoeuvring Equipment:

Main Engines: 2 x 9000 kW at 500 rpm
Generating Sets: 3 x 1100 kW at 1000 rpm
Emergency Gensets: 1 x 280 kW at 1500 rpm
2 x CP Main Propellers, 4 Blades, 4250 mm Diameter
2 x 1000 kW CP Bow Tunnel Thrusters

Cargo Capacity:

Max. Capacity (crew + passengers): 1200 people
No. of Cabins: 40 x 4 pax cabins, 4 x 2 pax cabins
and 2 x 2 pax cabins for disabled people
Number of Cargo Decks: 3 + 1 cardeck
Maximum Cargo Capacity for Cars: 334 cars (2.2 m width)
Maximum Cargo Capacity for Trailers: 1711 LM (2.9 m width)

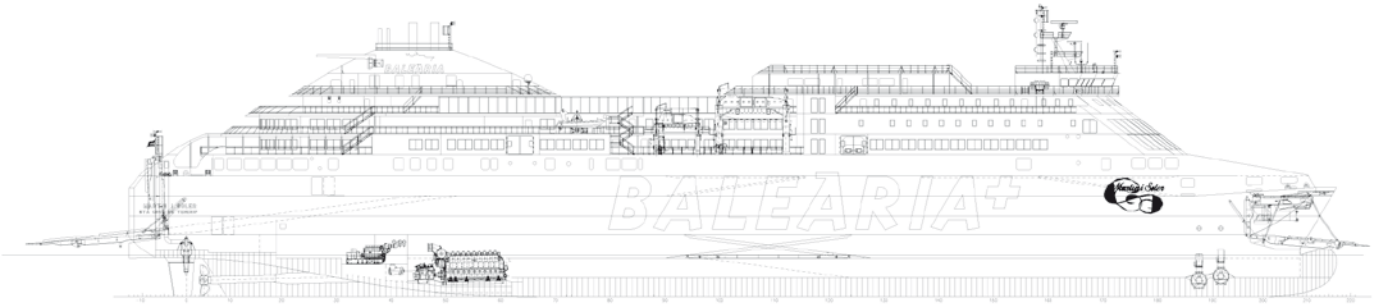
Cargo Equipment:

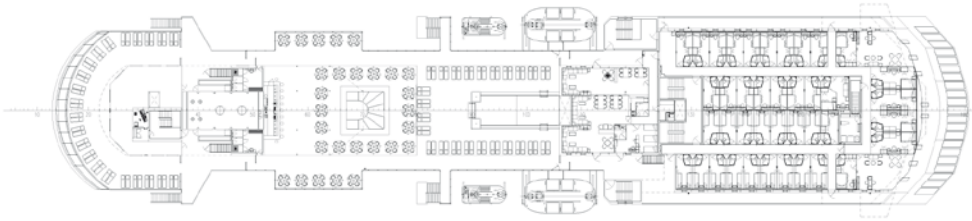
2 Stern Ramp-Doors: 15.50 m length x 9.5 m wide
1 Movable Cardeck in Garage between Deck No. 5 and 7
Fore Ramp-Door "Clamp Type" for the access of cars from shore
Tilting Ramp between Deck No. 2 and 3

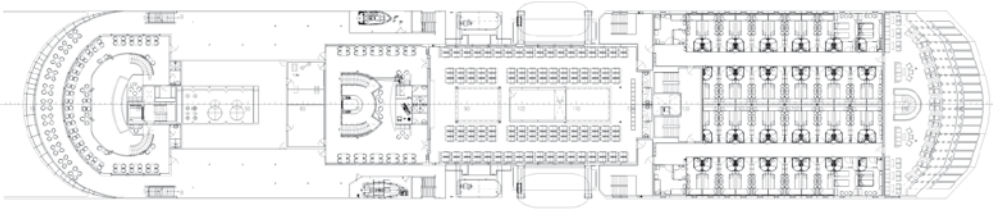
Tanks Capacity:

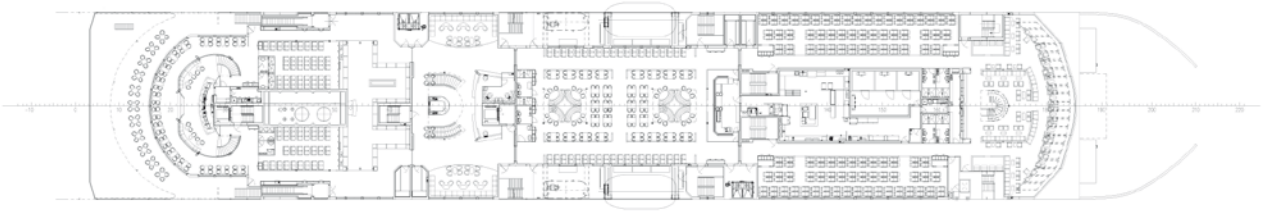
HFO Capacity: 660 m^3
MDO Capacity: 90 m^3
Lub. Oil Capacity: 28 m^3
Fresh Water Capacity: 100 m^3

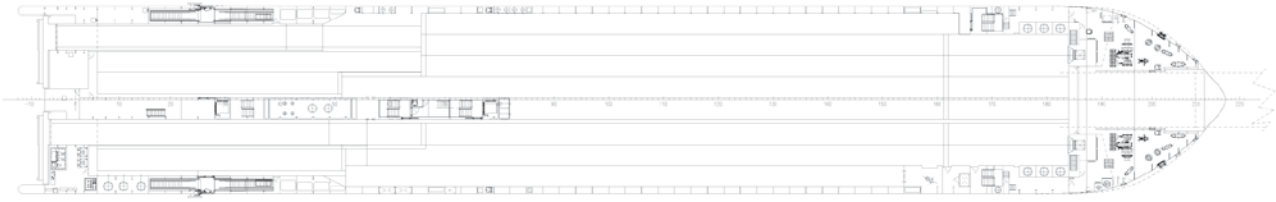
HIJOS DE J. BARRERAS

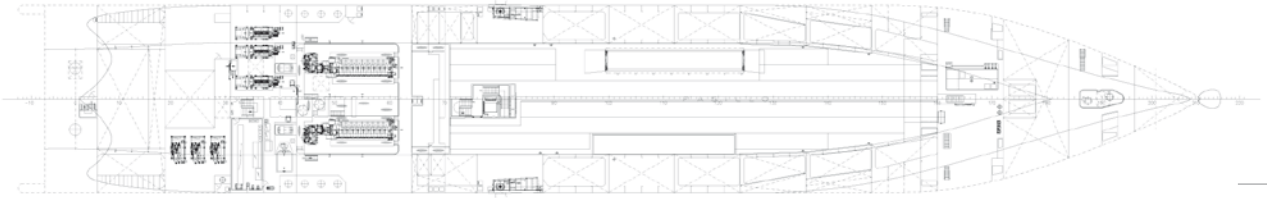

BALEARIA+











Hull Nº
1666

PASSENGER FERRY VESSEL
Shipowner:
NAVIERA ARMAS, S.A.

VOLCÁN DEL TEIDE
Built:
2011

Hull Nº
1667

VOLCÁN DE TINAMAR
Built:
2011

Hull Nº
1666

Main Particulars:

Length Overall (with appendixes): 175.70 m
Length Overall: 171.55 m
Length between Perpendiculars: 159.00 m
Moulded Breadth: 26.40 m
Depth to upper Deck: 14.94 m
Depth to main Deck: 9.50 m
Design Moulded Draught: 6.40 m
Deadweight at 6.40 m approx.: 4850 T
Service Speed: 24.00 knots
Range at Service Speed: 3600 miles

Classification:

Bureau Veritas: 1✠Hull✠MACH Ro-Ro passenger ship, unrestricted navigation, AUT-UMS, MON SHAFT, INWATER SURVEY

Propulsion & Manoeuvring Equipment:

Main Engines: 4 x 8400 kW at 500 rpm
Generating Sets: 2 x 1100 kW at 1000 rpm
Emergency Gensets: 1 x 270 kW at 1500 rpm
2 x CP main propellers, 4 blades, 4800 mm diameter
2 x 1100 kW CP Bow Tunnel Thrusters

Cargo Capacity:

Max. Capacity (Crew + Passengers): 1500 people
No. of Cabins: 114 x 4 pax cabins, 4 x 2 pax cabins, 2 x 4 pax cabins for disabled people and 2 x 2 penthouse
No. of Cargo Decks: 3 + 1 cardeck
Maximum Cargo Capacity for Cars with Unhoistable Cardeck: 353 units (2.2 m width)
Maximum Cargo Capacity for Trailers with Unhoistable Cardeck: 1578 ml (3 m width)
Maximum Cargo Capacity for Trailers with Hoistable Cardeck: 2010 ml (3 m width)

Cargo Equipment:

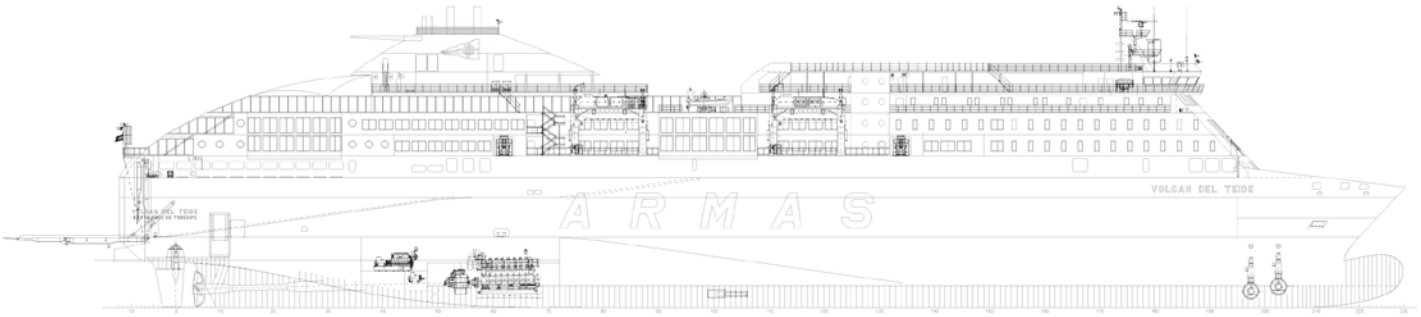
2 Stern Ramp-Doors: 16.00 m length x 8.0 m wide
1 Movable Cardeck in Garage between Deck No. 5 and 7
2 Fixed Ramps between Deck No. 3 and 5: 41 m length x 3.5 m wide

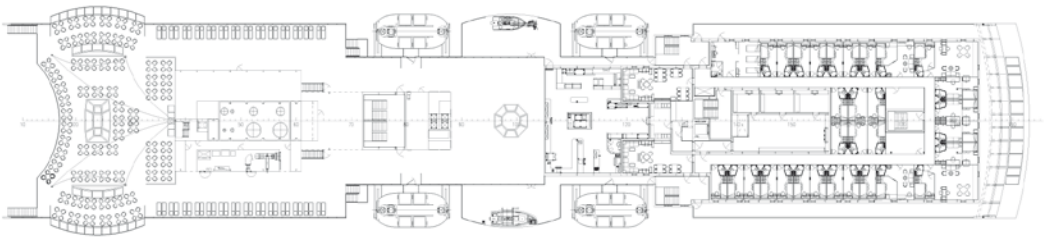
Tanks Capacity:

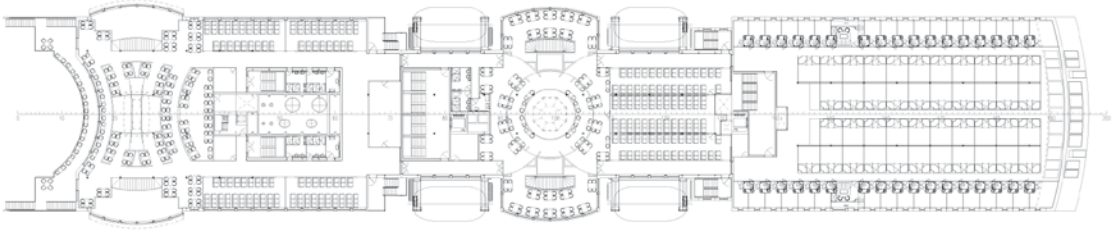
Fuel-Oil Capacity: 916 m^3
Diesel-Oil Capacity: 134 m^3
Lub. Oil Capacity: 63 m^3
Fresh Water Capacity: 160 m^3

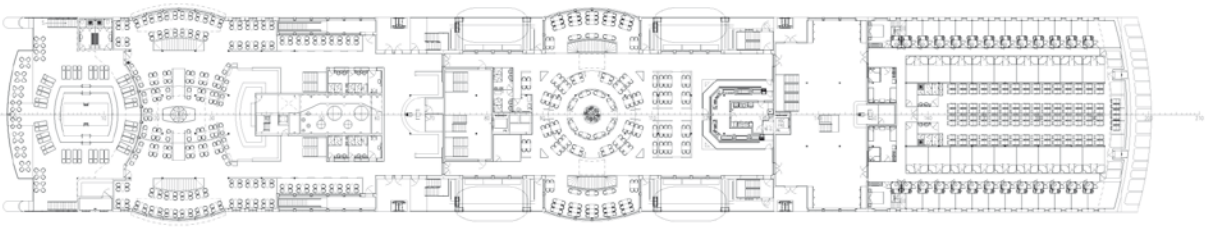
HIJOS DE J. BARRERAS

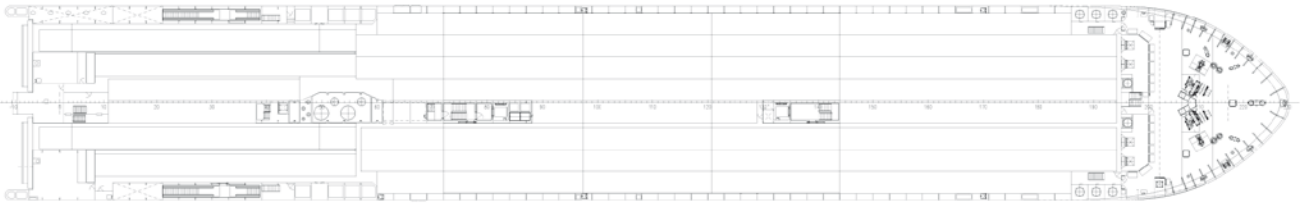
HIJOS DE J. BARRERAS

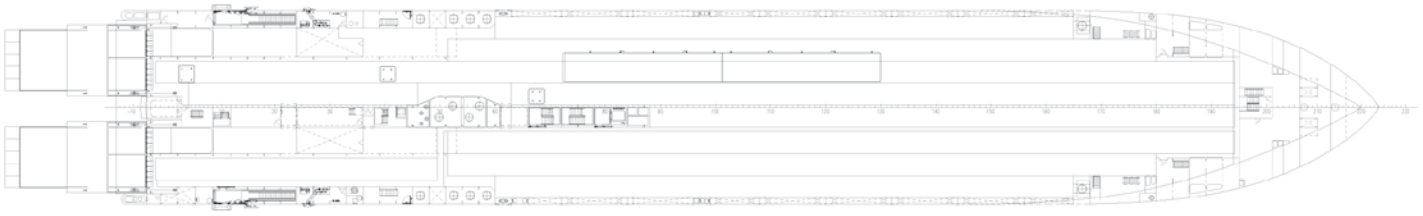


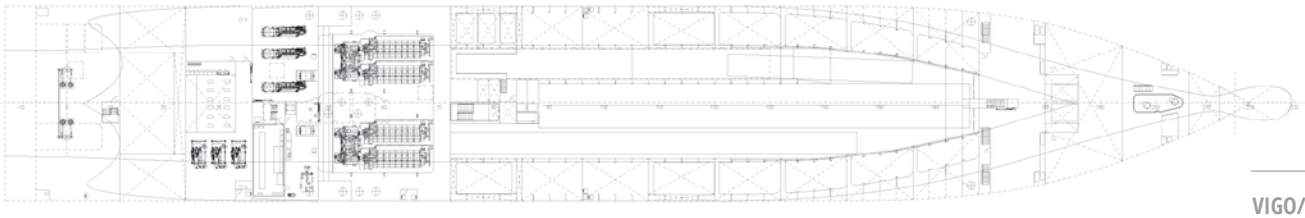












VIGO/SPAIN
T: +34 986 213 297
astillero@hjbarreras.es
www.hjbarreras.es

Hull Nº
1653

PASSENGER FERRY VESSEL
Shipowner:
NAVIERA ARMAS

VOLCAN DE TAMADABA
Built:
2007

Hull Nº
1654

VOLCAN DE TIJARAFE
Built:
2008

Hull Nº
1653

Main Particulars:

Length Overall: 154.51 m
Length between Perpendiculars: 137.00 m
Moulded Breadth: 24.20 m
Depth to Main Deck: 8.53 m
Extreme Draught: 5.80 m
Design Moulded Draught: 5.50 m
Deadweight at 5.50 m approx.: 3350 T
Service Speed: 23 knots
Range at Service Speed: 2200 miles

Classification:

I✠Hull✠MACH Ro-Ro passenger ship, Unrestricted navigation, AUT-UMS, MON-SHAFT, INWATER SURVEY

Propulsion & Manoeuvring Equipment:

Main Engines: 2 x 11700 kW at 500 rpm
Generating Sets: 2 x 1200 kW at 1000 rpm
Emergency Gensets: 1 x 250 kW at 1500 rpm
2 x CP Main Propellers, 4 Blades, 4200 mm Diameter
2 x 1000 kW CP Bow Tunnel Thrusters

Cargo Capacity:

Max. Capacity (crew + passengers): 1000 people
No. of Cabins: 46 x 4 pax cabins, 8 x 2 pax cabins and 8 x 2 pax cabins for disabled people
No. of Cargo Decks: 2 + 1 cardeck
Cargo Capacity with Cars and Trailers: 174 cars and 57 trailers
Cargo Capacity only with Trailers: 80 Trailers

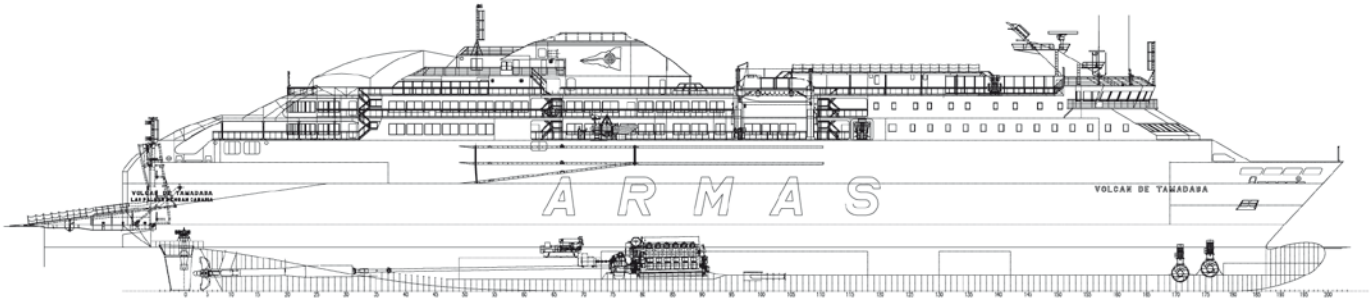
Cargo Equipment:

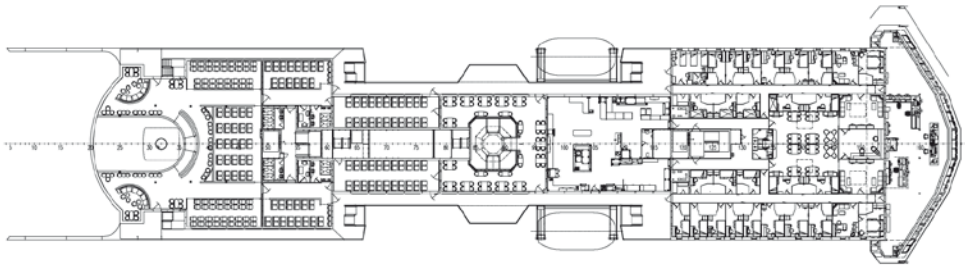
2 Stern Ramp-Coors: 16 m length x 8 m wide
1 movable Cardeck in Garage between Upper Deck No. 4 and Deck No. 6

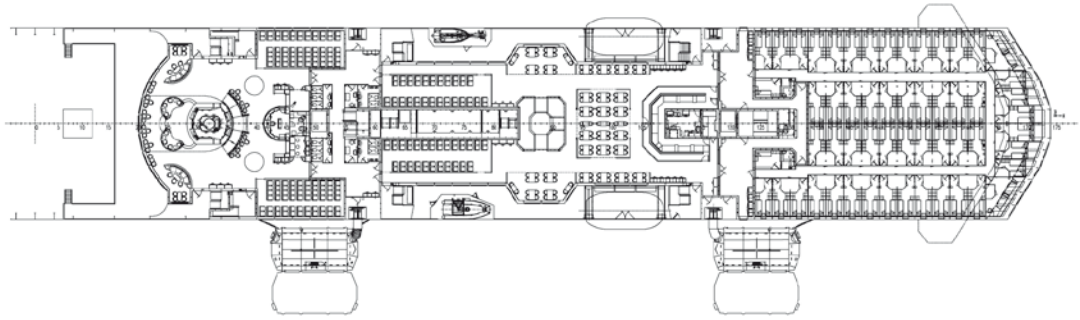
Tanks Capacity:

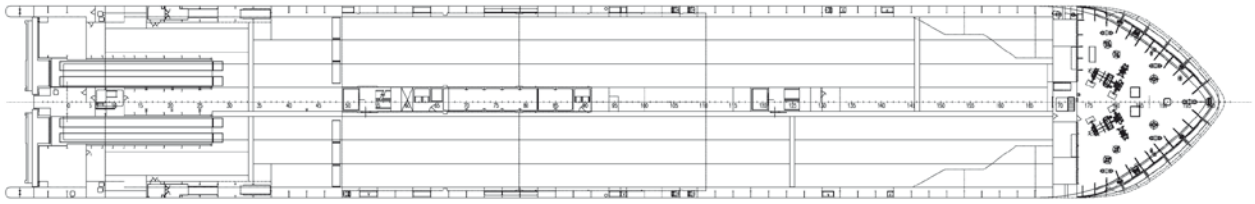
Fuel-Oil Capacity: 616 m^3
Diesel-Oil Capacity: 92 m^3
Lub. Oil Capacity: 54 m^3
Fresh Water Capacity: 93 m^3
Ballast Water Capacity: 1826 m^3

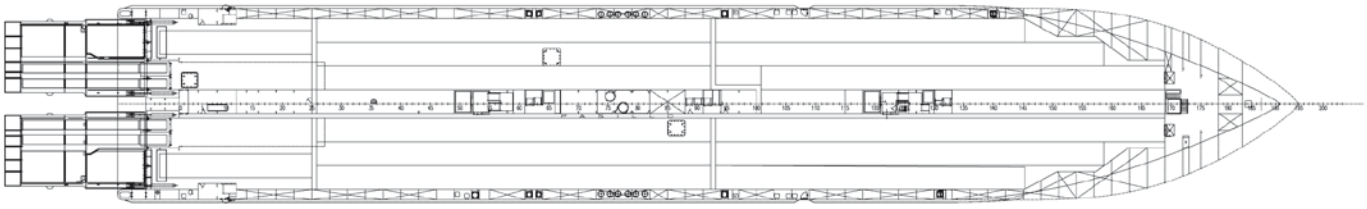
HIJOS DE J. BARRERAS

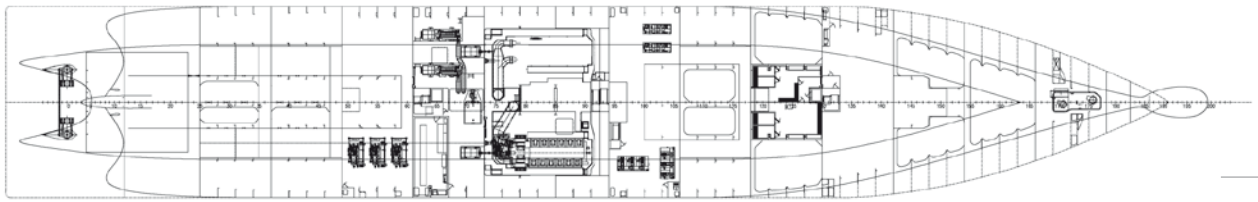

ARMAS
VOLCAN DE TAMADABA











Hull Nº
1626

Main Particulars:

Length Overall: 142.45 m
Length between Perpendiculars: 125.00 m
Moulded Breadth: 24.20 m
Depth to Deck No. 3 (Main Deck): 8.35 m
Depth to Deck No. 4 (Upper Deck): 13.55 m
Total Number of Decks: 8
Design Draught: 5.70 m
Scantling Draught: 6.00 m
Summer Draught: 5.70 m
Deadweight at Summer Draught: 3350 T
Service Speed: 22 knots
Number of Superstructure Decks: 3

Classification:

Bureau Veritas: I ✠HULL ✠MACH, RO-RO PASSENGER SHIP, UNRESTRICTED NAVIGATION, INWATER SURVEY, AUT-UMS

Propulsion & Manoeuvring Equipment:

Propelling Power: 2 x 8400 kW = 16800 kW
Generating Sets: 2 x 1100 kW at 1000 rpm
Number of Propellers: 2
Propeller Revolutions: 176 rpm
Emergency Genset: 1 x 270 kW at 1500 rpm
Bow Thrusters: 2 transverse variable pitch bow thrusters x 1000 kW each, electrically driven

Cargo Capacity:

Max. Capacity (Crew + Passengers): 1000 people
Cabins: 46x4 pax, 8x2 pax, 2x3 pax for disabled people
Number of Cargo Decks: 2 + 1 cardeck
Cargo Capacity with Cars and Trailers:
Lanes length of 2.10 m wide: 1970 m / *Lanes length of 3.00 m wide:* 600 m
Capacity for Cars: 404 / *Capacity for Trailers:* 33
Cargo Capacity Only with Trailers:
Lanes Length of 3.00 m wide: 1270 m / *Trailers Capacity:* 69

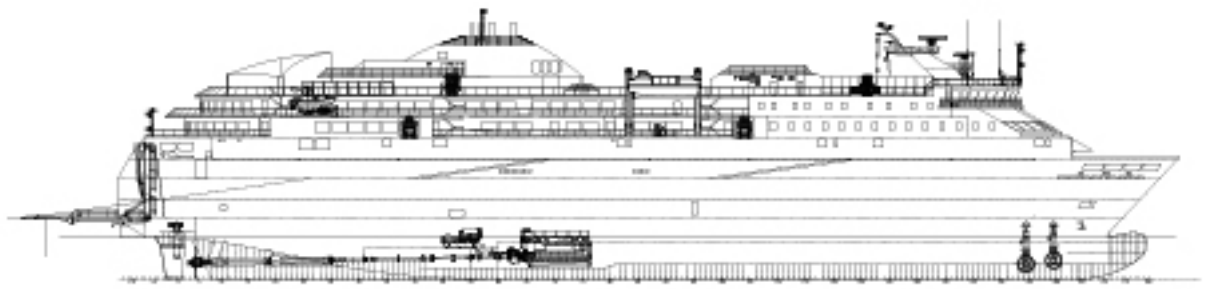
Cargo Equipment:

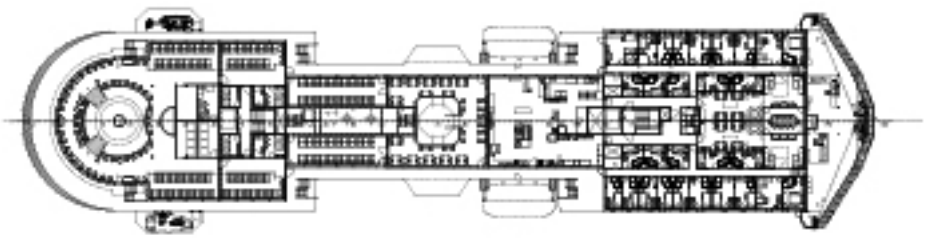
2 Stern Ramp-Doors: 16.0 m length x 8.0 m width
2 Fixed Ramps: 38.0 m length x 3.5 m width
1 Hoistable Cardeck between Upper Deck and Deck 6
2 Hoistable Ramps for Access to the Cardeck from Upper Deck Aft
2 Hoistable Ramps for Access to the Cardeck from Upper Deck Fore

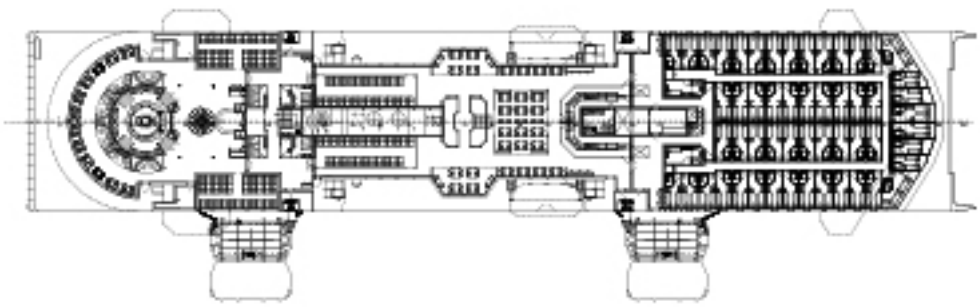
Tanks Capacity:

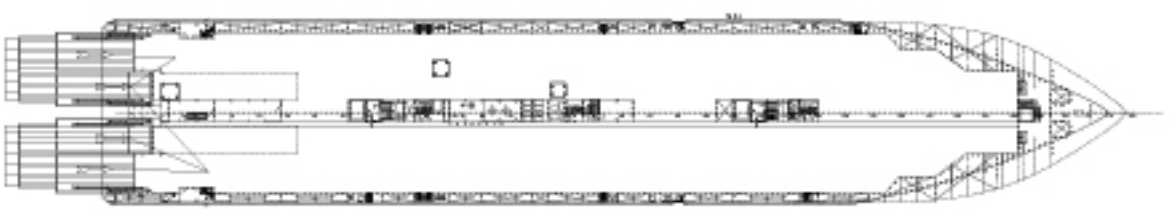
Fuel-Oil Capacity: 621 m^3 / *Diesel-Oil Capacity :* 92 m^3 / *Lub. Oil Capacity:* 45 m^3
Fresh Water Capacity: 93 m^3 / *Ballast Water Capacity:* 1685 m^3

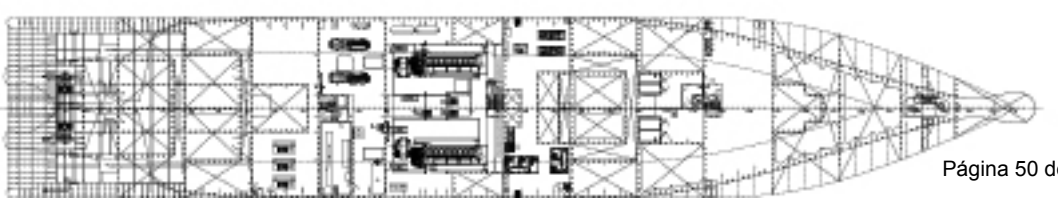
HIJOS DE J. BARRERAS











VIGO/SPAIN
T: +34 986 213 297
astillero@hjbarreras.es
www.hjbarreras.es

STAR: new-concept ferry for Estonia to Finland route

Shipbuilder: ..... Aker Yards Oy (Helsinki yard), Finland
Vessel's name: ..... *Star*
Hull number: 1356
IMO number: 9364722
Owner/operator: ..... Tallink Group, Estonia
Designer: ..... Aker Yards Oy, Finland
Flag: ..... Estonia
Total number of sister ships already completed: ..... Nil
Total number of sister ships still on order: ..... 1 option

ESTONIAN ferry group Tallink's recent acquisition of a number of its competitors trading in the Gulf of Finland and Baltic Sea areas, has made this, still comparatively young, company, the largest operator in the region, with its rapid expansion marked by a continuing newbuilding programme of ro-pax and cruise ferries, designed for service on routes linking Estonia with Finland and Sweden; Sweden with Latvia and Finland, and Finland with Germany. The first newbuilding was *Romantika*, presented in *Significant Ships of 2002*.

Latest entry into the fleet, *Star*, introduces a new dimension into these operations by providing a high-speed 'shuttle' connection between the Finnish and Estonian capitals, Helsinki and Tallinn, which completes the 80km journey in only two hours, giving rise to the claim that she is 'the fastest conventional ferry yet built for operation over such a short distance'. An important feature of the specification is the inclusion of Finnish Ice Class 1A requirements, which means that the vessel will be able to operate this unique service all year round.

Star will make three departures daily from each of the two termini, travelling at a service speed of 27knots, derived from a conventional machinery installation based on four MaK 12M43C main engines manufactured by Caterpillar Motoren, Rostock. Each develops 12,000kW at 514rev/min, and they are connected in pairs, through a twin input/single output gearbox, to a Wärtsilä CP propeller running at 144.3rev/min.

Wärtsilä also supplied three thrusters: two with an output of 1500kW installed at the bow, and one of 1000kW positioned aft. A further aid to manoeuvring comes from two Becker hinged-flap rudders, whilst passenger comfort on the relatively short journey is assisted by fitting a set of Blohm +Voss Industries retractable fin stabilisers. Electrical services are supplied from three 1688kVA Wärtsilä/A van Kaick diesel-alternator sets.

Although specifically intended for operation on a daytime, short sea shuttle run, *Star* is fully equipped to offer an alternative service of short, overnight cruises out of Tallinn if required, and for this purpose 64 x 4-berth outside, and 65 x 4-berth inside cabins, plus two x 2-berth handicapped-traveller cabins have been provided as modular units, complete with en-suite facilities, by subcontractors Kaefer and Parmarine. In all, 1900 passengers and 100 crew can be carried, making use of a pizzeria, three restaurants, pub, business lounge, observation lounge, perfume shop and a 1500m² market area, on decks 7, 8, and 9 of the 11-deck hull whilst onboard. Four 150 person lifeboats and four MES chutes cover lifesaving requirements.

Star also provides fast transit for motor vehicles, carried on the main and upper decks, with access from shore over a 18m x 4.7m bow ramp, and a 11m x 18m stern ramp, both supplied by TTS. A 49m x 6m hoistable internal ramp allows movement between the decks. With over 2000 lane metres of vehicle deck space available, up to 120 trucks or freight units, or 450 private cars can be loaded.

TECHNICAL PARTICULARS

Length, oa 186.00m
Length, bp 170.00m
Breadth, moulded 27.70m
Depth, moulded
- to main deck (No 3) 9.50m
- to upper deck (No 5) 20.90m

Draught
- design 6.50m
- scantling 6.75m

Gross 36,250gt
Deadweight, design 4700dwt
Speed, service 27knots
Bunkers
- heavy oil 975m³
- diesel oil 170m³

Water ballast 3250m³
Fuel consumption, main engines only 195tonnes/day
Classification ..... Bureau Veritas 1 + Hull Ro-Ro, Passenger Ship, + MACH, AUT, UMS, SYS-NEQ-1, Finnish Ice Class 1A
Percentage of high-tensile steel used in construction 28%
Roll stabilisation equipment ..... Blohm + Voss Industries fins
Main engines
- Design ..... MaK
- Model 12M43C
- Number 4
- Manufacturer ..... Caterpillar Motoren
- Type of fuel used ..... HFO and MDO
- Output ..... 4 x 12,000kW/514rev/min

Gearboxes
- Make ..... Flender
- Model ..... GVLQ 1300
- Number ..... 2 x twin input/single output
- Output speed 144.3rev/min

Propellers
- Material ..... Stainless steel
- Designer/manufacturer ..... Wärtsilä
- Number 2
- Pitch ..... Controllable
- Diameter 5300mm
- Speed 144.3rev/min

Diesel-driven alternators
- Number 3
- Engine make/type Wärtsilä/8L20
- Type of fuel used ..... HFO and MDO
- Output/speed ..... 3 x 1420kW/1000rev/min
- Alternator make/type ..... A van Kaick/DSG 59 K1-6W
- Output/speed ..... 3 x 1688kVA/1000rev/min

Boilers
- Number 2
- Type ..... CHB 5000
- Make ..... Aalborg Industries
- Output ..... 2 x 5000kg/h

Vehicles
- Number of vehicle decks 2
- Total lane length 2010m
- Total cars 450
- Total freight units 120

Doors/ramps
- Number/type ..... 1 x stern/1 x bow door ramp, 1 x internal ramp
- Designer ..... TTS Ships Equipment

Complement
- Officers 17
- Crew 83

Passengers
- Total 1900
- Accommodated in cabins 520
- Number of cabins 131

Bow thrusters
- Make ..... Wärtsilä
- Number/type ..... 2 x CT 225
- Output ..... 2 x 1500kW

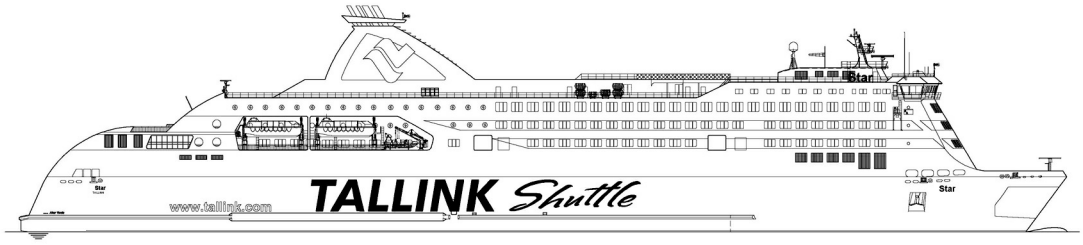
Stern thruster
- Make ..... Wärtsilä
- Number/type ..... 1 x CT 200
- Output 1000kW

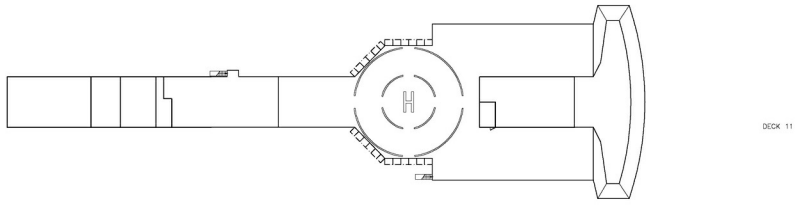
Bridge control system
- Make ..... Kelvin Hughes
- Type ..... Manta
- One man operation ..... No

Fire detection system ..... Consilium
Fire extinguishing systems
- Vehicle spaces ..... Novenco drencher
- Accommodation ..... Novenco sprinkler
- Engineroom ..... Minimax CO_2

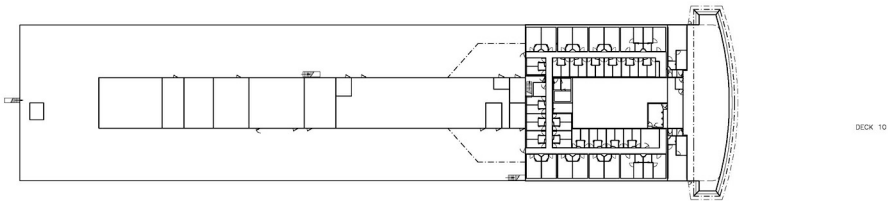
Radars ..... 3 x Kelvin Hughes Manta
Integrated bridge system ..... Kelvin Hughes Manta
Waste disposal plant
- Waste compactors ..... 2 x Kapasity 103
- Sewage plan ..... 1 x Evac Bio Unit MSP VIII

Contract date ..... 1 August 2005
Launch/float-out date ..... 23 November 2006
Delivery date ..... 10 April 2007





DECK 11



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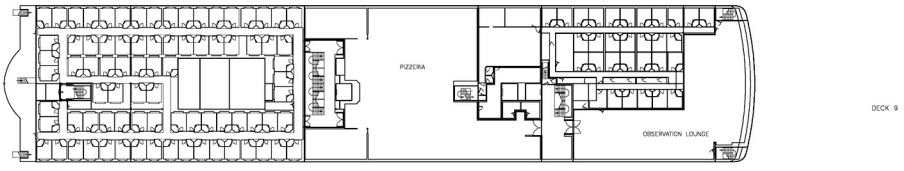

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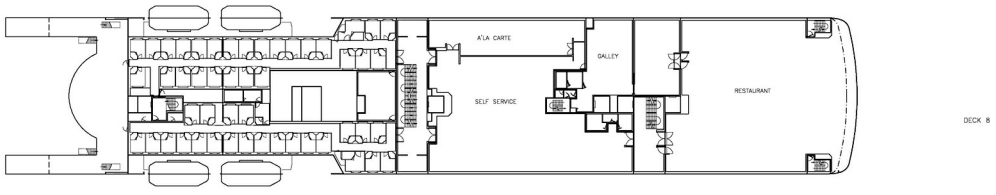

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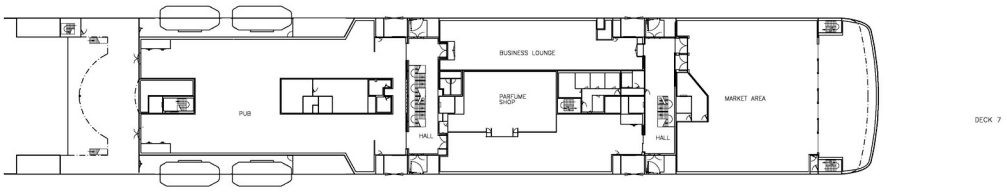
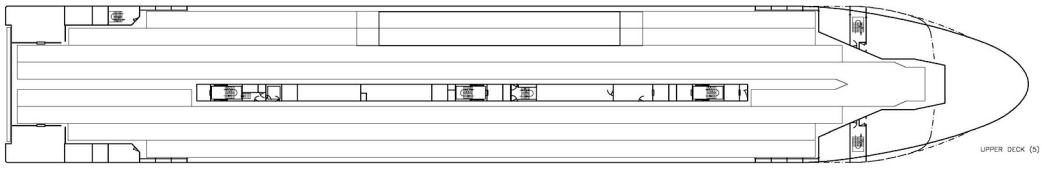
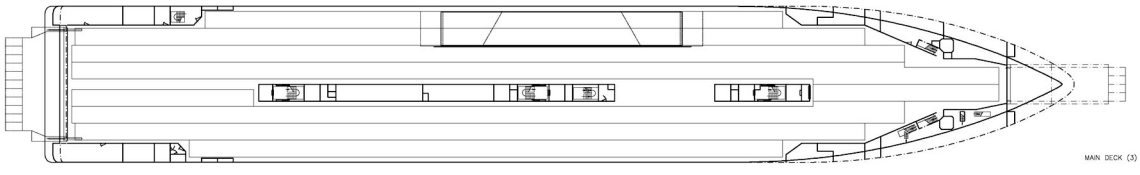


DECK 7



UPPER DECK (5)



MAIN DECK (3)

SILVER PRINCESS: advanced ro-pax from Japan

Shipbuilder: .....**Mitsubishi Heavy Industries Ltd**
Vessel's name:..... ***Silver Princess***
Hull No: **1158**
Owner/operator: **Kawasaki Kinkai Kisen Kaisya Ltd**
Country: ..... **Japan**
Designer: .....**Mitsubishi Heavy Industries Ltd**
Country: ..... **Japan**
Model test establishment used: .....**MHI Nagasaki R&D Centre, Japan**
Flag: ..... **Japan (Hachinohe)**
IMO number: **9597616**
Total number of sister ships already completed (excluding ship presented): ..... **nil**
Total number of sister ships still on order: ..... **nil**

SILVER Princess is a ro-pax ferry, for Kawasaki Kinkai Kisen Kaisya Ltd that services the Tomakomai to Hachinohe route. The vessel was designed and built at the Shimonoseki Shipyard & Machinery Works of Mitsubishi Heavy Industries, Ltd. (MHI), and delivered to the owner on 5 April.

The vessel which is a one off design for the owners, has been further optimised with the hull form of *Silver Princess* enhanced through model tank testing which, was used to significantly improve the fuel oil consumption.

The propulsion system installed on the vessel is a combination of two main engines and two controllable pitch propellers driven through two reduction gears. The latest medium speed diesel engines give a service speed of 20.5knots at 85% power. The highly skewed controllable pitch propellers contribute to the reduction in the propeller surface force.

In addition to the above, the ship is equipped with two bow thrusters manufactured by Kawasaki Heavy Industries to enable smooth manoeuvring in harbour. A pair of fin stabilisers have been installed in order to reduce the rolling of the vessel and to increase the comfort level during the voyage.

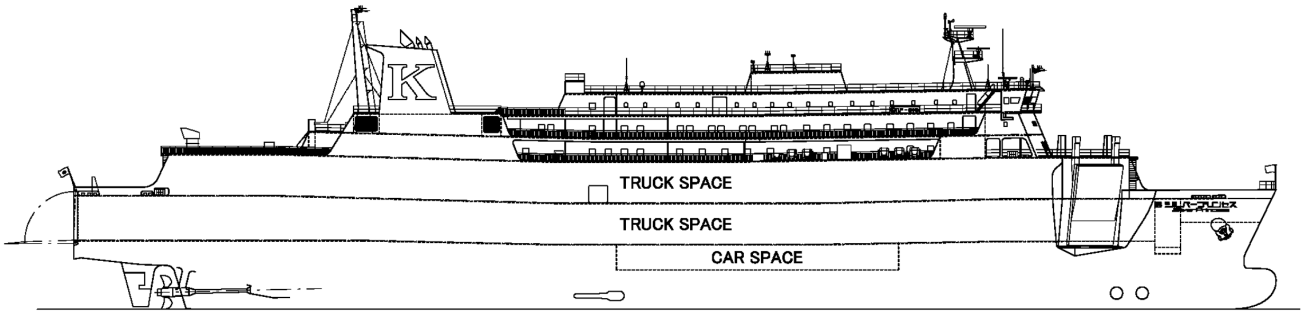
The maximum loading capacity of vehicles onboard is 92 trailers/trucks and 30 passenger cars. Two outboard ramp-ways on Deck-3 and three inboard ramp ways are arranged to give better loading/unloading at the quays on the vessel's regular route.

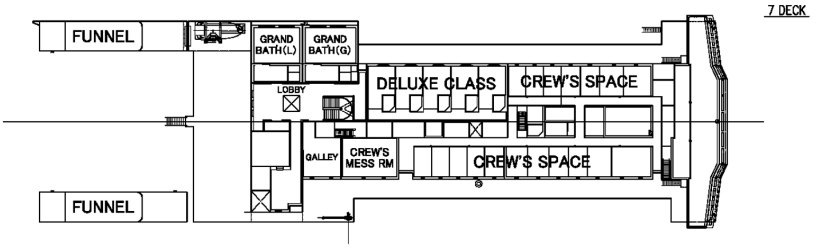
There are various cabin types onboard for passengers, such as deluxe class, first class and economy class cabins. The passengers can enjoy the time onboard at various public spaces such as the restaurant, grand bath with ocean view, entrance, lobby, kid's room and other areas. Furthermore, the Japanese barrier free rule has been applied to the vessel, so that all passengers including the handicapped can move about the vessel safely and enjoy the facilities onboard. Two elevators are fitted allowing passenger's to board and disembark and to move around the vessel's accommodation area.

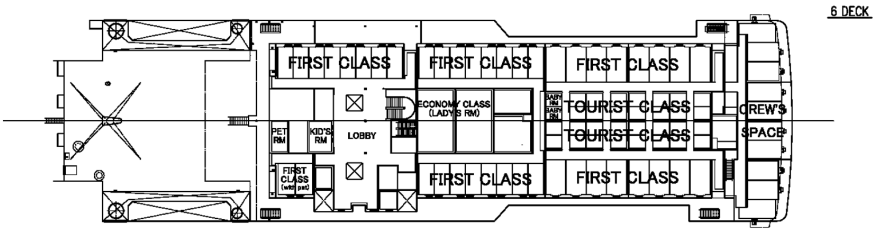
TECHNICAL PARTICULARS

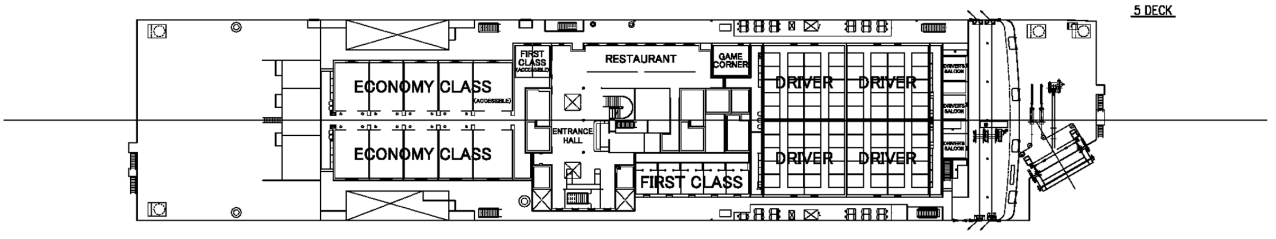
Length oa: 150.00m
Length bp: 137.50m
Breadth moulded: 25.00m
Depth moulded
  To main deck: 8.00m
  To upper deck: 13.15m
Draught
  Scantling: 5.85m
  Design: 5.70m
Gross: 10,536gt
Deadweight
  Design: 4,315dwt
  Scantling: 4,724dwt
Speed, service: 20.5knots
Bunkers
  Heavy oil: ..... 612.3m^3
  Diesel oil: ..... 124.8m^3
Water ballast: ..... 3,056.2m^3
Daily fuel consumption
  Main engine only: 55.1tonnes/day
Main engine
  Design: ..... S.E.M.T – Pielstick
  Model: 12PC2-6B
  Manufacturer: ..... JFE Engineering Corporation
  Number: 2
  Type of fuel: ..... HFO, MDO
  Output of each engine: 7,200kW
Gearboxes
  Make: ..... Kitachi Nico Transmission Co., Ltd
  Model: MGP1843H50
  Number: 2
Propellers
  Material: ALBC3
  Designer/manufacturer: ..... Kawasaki Heavy Industries
  Number: 2
  Fixed/controllable pitch: ..... Controllable
  Diameter: 4.2m
Main-engine driven alternators
  Number: 2
  Make/type: ..... Nishiba Electric Co., Ltd
Diesel-driven alternators
  Number: 3
  Engine make/type: ..... Daihatsu Diesel MFG. Co. Ltd/ 5DK-20e
  Type of fuel: ..... HFO, MDO
  Output/speed of each set: 900rpm
Boilers
  Number: 1
  Make: ..... Muira Co., Ltd
  Output, each boiler: 3,000kg/h
Mooring equipment
  Number: 4
  Make: ..... Manabe Zoki Co., Ltd
  Type: ..... Electric-hydraulic
Special lifesaving equipment
  Number of each and capacity: MES-2
  Make: ..... Fujikura Rubber Ltd
  Type: ..... FSMES-160 N
Vertical or sloping chutes: ..... Vertical
Vehicles
  Number of vehicle decks: 3
  Total cars: 30
  Total freight: 92
Doors/ramps/lifts/movable car decks
  Number of each: ..... 2 x ramps, 2 x movable car decks
Ballast control system
  Make: ..... NYK Trading Corporation
Complement
  Officers: 9
  Crew: 11
Passengers
  Total: 900
  Number of cabins: 176
Stern appendages/ special rudders: ..... Mariner
Bow thruster
  Make: ..... Kawasaki Heavy Industries
  Number: 2
Bridge control system
  Make: ..... Nabtesco
  Type: ..... electric
Fire detection system
  Make: ..... Nippon Hakuyo Electronics
  Type: ..... Smoke detector type & Temperature type
Fire extinguishing systems
  Engine room: ..... Air Water Safety Service/ CO_2
  Vehicle spaces: ..... Nohmi Bosai Ltd/ sprinkler
  Cabins/public spaces: ..... Yamato Protec/ Portable
Radars
  Number: 3
  Make: ..... JRC
Contract date: ..... 26 March 2010
Launch/float-out date: ..... 11 November 2011
Delivery date: ..... 5 April 2012

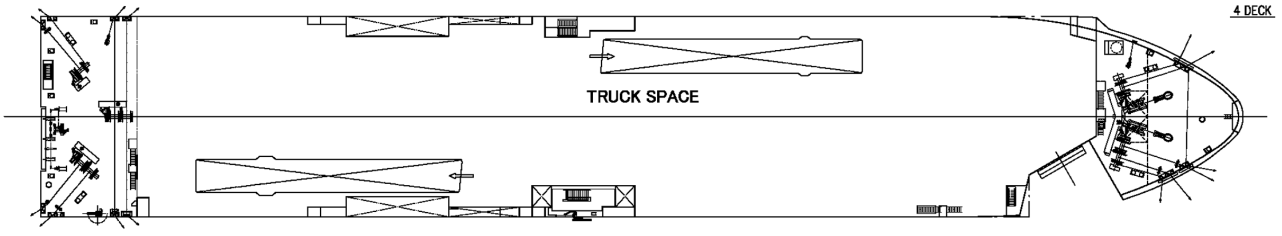
SILVER PRINCESS

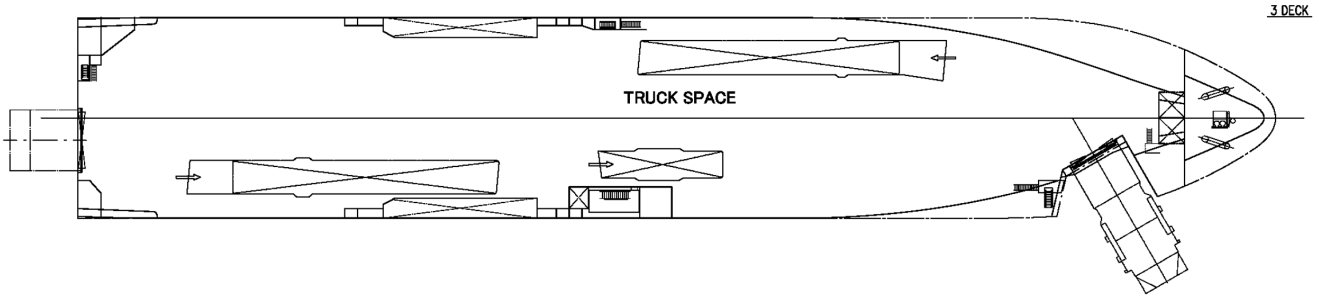












STAVANGERFJORD: LNG ferry for Norway

Shipbuilder: **Bergen Group Fosen**
Vessel's name: ***Stavangerfjord***
Hull No: **87**
Owner/operator: **Fjord Line**
Country: **Norway**
Designer: **Bergen Group Fosen**
Country: **Norway**
Model test establishment used: **Marintek**
Flag: **Denmark**
IMO number: **9586605**
Total number of sister ships already completed (excluding ship presented): **nil**
Total number of sister ships still on order: **1**

NORWAY is taking the lead when it comes to environmental shipping and *Stavangerfjord*, is another example of this initiative. The vessel was delivered to Fjord Line in July after some delay due to further testing of its LNG powered engines. *Stavangerfjord* is the first of a series of two vessels constructed at Bergen Group, Norway with the initial steel work carried out at Stocznia Gdansk shipyard. The second in the series *Bergensfjord* was launched just after *Stavangerfjord*.

Stavangerfjord is one of the most environmentally friendly passenger ships in international operation, powered by LNG enabling it to eliminate its SOx emissions as well as reducing the CO_2 emissions by 23%, NOx emissions by 92% and particulate emissions by 98%, compared to ships powered by traditional heavy fuel oil. The waste heat recovery system (WHRS) that has also been installed provides both electricity from a steam generator and heating from warm water in the accommodation areas.

Both the vessels are powered by four Bergen gas engines individually rated at 5,600kW, driving Promas integrated rudder and propeller propulsion systems for optimal fuel efficiency. Originally the ferries were ordered with diesel engines, but Fjord Line made the decision to replace these with Bergen BV35:40P12G gas engines, to pre-empt the emission regulations for emission control areas (ECAs) when they come into effect that will limit NOx and SOx emissions in those areas.

Each ship has 306 cabins, many of which will be suites, and can accommodate 1,500 passengers. The cargo decks have a total lane capacity of 1,350m^2, which has capacity for 600 vehicles or alternately a smaller number of vehicles in combination with larger trucks and cargo. *Stavangerfjord* will service the routes between Hirtshal, Denmark and Stavanger, Norway and Hirtshal and Langesund, Norway.

TECHNICAL PARTICULARS

Length oa: 170.00m
Length bp: 148.00m
Breadth moulded: 27.50m
Depth moulded
- To main deck: 9.30m

Draught
- Scantling: 6.50m
- Design: 6.35m

Gross: 31,678gt
Displacement: 15,712tonnes
Lightweight: 12,243tonnes
Deadweight
- Design: 36,200dwt

Block co-efficient: 0.5977
Speed, service: 21.5knots
Bunkers
- LNG: 600m^3

Water ballast: 1,508m^3
Classification society and notations: DNV *1A1, ICE 1B, Car Ferry A, E0, Gas Fuelled, CLEAN, NAUT-AW, WBR, MCDK, TMON, F-M, COMF V(2)
Heel control equipment: Frank Mohn
Main engine
- Model: B35: 4 OV 12 PG
- Manufacturer: Rolls-Royce Marine
- Number: 4
- Type of fuel: LNG
- Output of each engine: 6,400kW

Gearboxes
- Make: MAN Diesel & Turbo
- Model: 888 783/100
- Number: 2

Propeller
- Designer/manufacture: Rolls-Royce
- Number: 2
- Fixed/controllable pitch: Controllable
- Diameter: 4.7m

Shaft generators
- Number: 2
- Make/type: Rolls-Royce/ Marelli
- Output/speed of each set: 1,850kW

Boilers
- Number: 1
- Type: Mission
- Make: Aalborg Industries
- Capacity: 3.8tonnes/h

Other cranes
- Number: 1
- Make: Fuchs Fördertechnik
- Type: Telescopic
- Tasks: Provisions
- Performance: 7.5tonnes

Mooring equipment
- Number: 8
- Make: Rolls-Royce Marine
- Type: MW160E

Special lifesaving equipment
- Number of each and capacity: 4 x 151 persons, 6 x 153 persons, 4 x 51 persons
- Make: Fassmer/ Viking Lifesaving

Hatch covers
- Manufacturer: TTS Marine

Vehicles
- Total lane length: 1,350m
- Total cars: 600

Doors/ramps/lifts/movable car decks
- Type: Movable car deck (Deck 6)
- Designer: TTS Marine

Ballast control system
- Make: Panasia

Water ballast treatment system
- Make: Panasia

Complement
- Crew: approx. 100

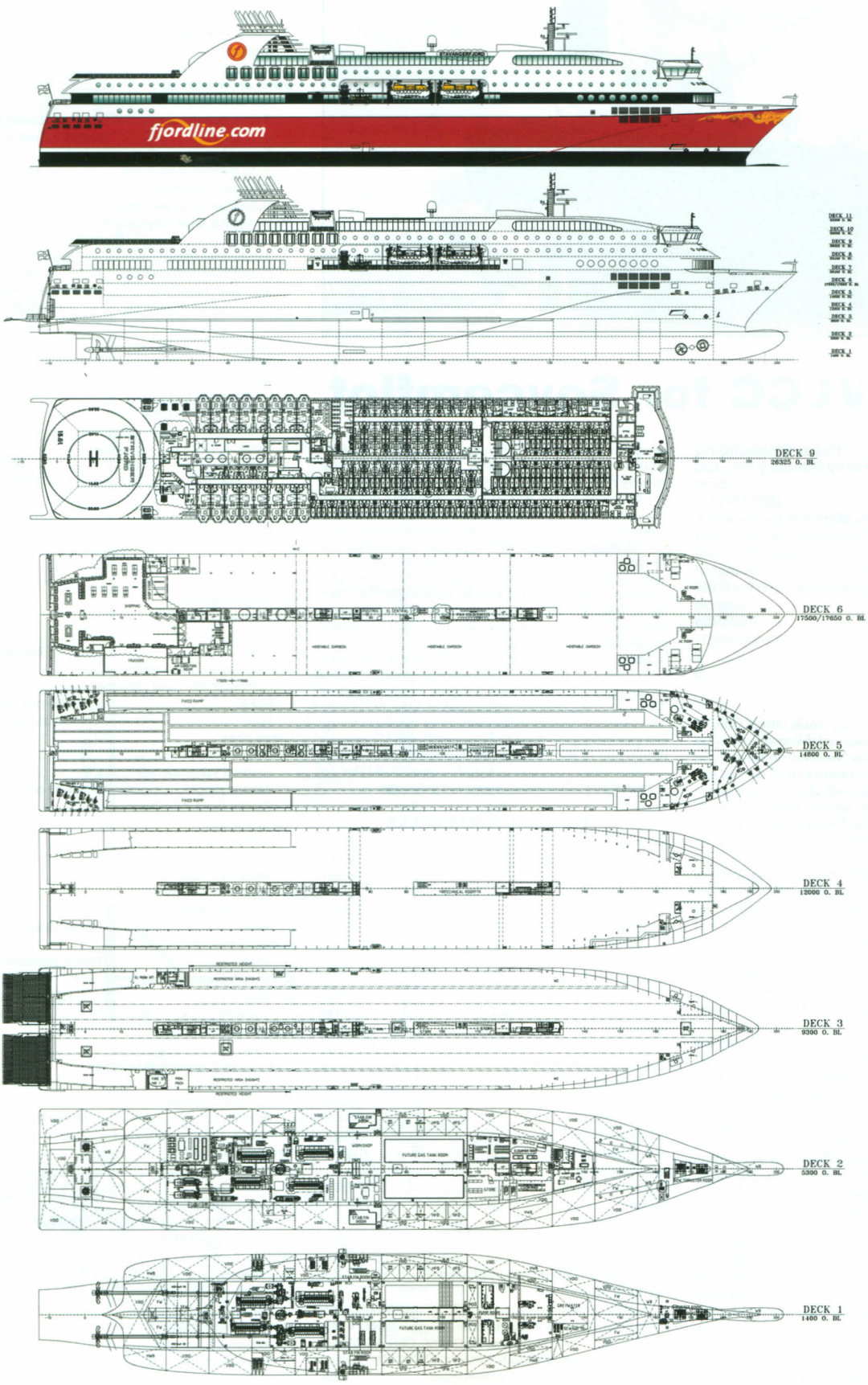
Passengers
- Total: 1,200/1,500
- Number of cabins: 303

Bow thrusters
- Make: Rolls-Royce
- Number: 2
- Output: 1,600kW

Fire detection system
- Make: Honeywell Life Safety
- Contract date: 16 March 2010

Launch/float-out date: 12 April 2012
Delivery date: 4 July 2013

STAVANGERFJORD



VIKING GRACE: Largest LNG ferry for Finland

Shipbuilder: **STX Finland, Turku**
Vessel's name: ***Viking Grace***
Hull No: **1376**
Owner/operator: **Viking Line**
Country: **Finland**
Designer: **STX Turku**
Country: **Finland**
Model test establishment used: **MARIN**
Flag: **Finnish**
IMO number: **9606900**
Total number of sister ships already completed (excluding ship presented): **nil**
Total number of sister ships still on order: **nil**

VIKING Grace heralded a new era for passenger ferries when it was launched. Deemed as one of the most advanced vessels of the time due to the use of LNG to power the vessel, *Viking Grace* also made the record books because the vessel is one of the longest LNG powered vessels ever constructed.

Viking Grace, built by STX Finland, has replaced *Isabella* on the Turku-Stockholm route, the shortest connection between Sweden and Finland. The route is demanding for the ships due to the tight schedule with as little as one hour harbour time for unloading and loading passengers and ro-ro cargo.

The ferry's main machinery is based on a cruise ship-type power plant principle, consisting of four 8-cylinder dual fuel engines driving generating sets. The power plant's principle optimal engine load on its complex route has operating speeds varying from 8knots to 15 and up to 22knots in addition to the high degree of safety and redundancy.

The engine runs off LNG, which has been pitched as the fuel of the future due to its ability to reduce a ship's emissions dramatically. The fuel in *Viking Grace* is stored in the aft end of the ship, on the open deck in two 200m^3 LNG-tanks.

The ship's propulsion consists of two five-bladed stainless steel fixed-pitch propellers with modern high-lift flap rudders, which also fulfils the requirements of Finnish-Swedish Ice class 1A Super and Lloyd's Register's highest passenger comfort rating. For better harbour manoeuvring three thrusters have installed, one aft and two forward.

The latest energy-saving technologies have been applied in the ship's design: various energy management systems, LEDs used in lighting, elevators with energy recovery, high efficiency pumps and fans, just to name a few. Excess heat produced by machinery during the voyage is stored in specific heat accumulator tanks and the stored heat is used during the time in port for pre-heating the air-conditioned air. The cold from the LNG is also used for cooling the air-conditioned air in summertime.

The public spaces are arranged on the uppermost decks to provide the most spectacular scenery as well as direct access to the outer decks. Dining facilities are located forward and entertainment facilities aft. The venues are organised around service hubs, located internally on each deck for easy and efficient access. The hubs are supported from vertically connected logistics centres, located below the ro-ro decks.

Passenger cabin areas extend from deck 5 to deck 9. A large variety of cabins are offered, including bigger cabins in the forward section accommodating cruise ship -like double beds. Crew cabins, which are required to have windows, are located sides of the private car garage on deck 5 and on life boat decks 6 and 7 with restricted view.

TECHNICAL PARTICULARS

Length oa: 218.50m
Length bp: 200.00m
Breadth moulded: 31.80m
Depth moulded
  To main deck: 9.80m
Draught
  Scantling: 7.00m
  Design: 6.80m
Gross: 57,565gt
Deadweight
  Design: 50,300dwt
  Scantling: 60,800dwt
Speed, service: 22knots
Bunkers
  LNG: 2 x 200m^3
  Diesel oil: MGO: 178m^3 HFO: 470m^3
Water ballast: 1,450m^3 + heeling 670m^3
Daily fuel consumption
  LNG: 45-48tonnes/day
  Pilot fuel (MGO): 0.5tonnes/day
Classification society and notations: Lloyd's Register of Shipping + 100A1 Passenger and vehicle ferry, IWS, ICE, 1AS, +LMC, UMS, IBS, PCAC12, PSMR*, Green passport, Movable car decks, GF
Heel control equipment: Hoppe Bordmesstechnik GmbH
Roll stabilisation equipment: Blohm & Voss, fin stabilisers, Simplex-compact s600-9m^2
Main engines
  Model: 8L50DF
  Manufacturer: Wärtsilä
  Number: 4
  Type of fuel: LNG/NG backup fuel MGO
  Output of each engine: 7,400kW
Exhaust gas system
  Manufacturer: Wärtsilä
  Model: Compact silencer system (CSS)
  Number: 4
  Type: Optimal noise attenuation, less than 50dB at 100m
Propulsion motors
  Make: ABB
  Model: AMZ 1600 2XW 12LSB
  Number: 2
  Output speed: 10.5MW x 128rpm
Propellers
  Designer/manufacturer: Wärtsilä
  Material: Stainless steel
  Number: 2
  Fixed/controllable pitch: Fixed
  Diameter: 5.2m
  Speed: 130rpm
  Special adaptations: 5 bladed built up propeller
Main generators
  Number: 4
  Make/type: ABB/AMG 1120 ME 12LSE
  Output/speed of each set: 8.191 x 500rpm
LNG tanks & related equipment
  Manufacturer/type: Wärtsilä LNGPac
  Capacity: 2 x 200m^3
Boilers
  Number: 2 x dual fuel
  Type: FMB-VM-7/7
  Make: Saacke
  Output, each boiler: 7,000kg/h at 7bar
  Type of fuel: LNG/NG/MGO
Mooring equipment
  Number: 2 x combined anchor windlasses/ self tensioning mooring winches 6 x 250kN self tensioning mooring winches
  Make/type: NDM/Electrical
Special lifesaving equipment
  Number of each and capacity: 2 x 316, 2 x 237, spare rafts 4pcs 158 persons, 4 for 50 persons
  Make/type: RFD Beaufort/Marine Ark MK 2 MES
Hatch covers
  Manufacturer/type: TTS/2 x on deck 3
Vehicles
  Number of vehicle decks: 2 x fixed, 1 x movable
  Total lane length: 1,275
  Total cars: 300
Doors/ramps/lifts/movable car decks
  Number of each: 1 x Bow doors, 1 x bow ramp/door, 1 x stern ramp/door, 1 x hoistable car deck, 2 x provisions lifts, 1 x cargo lift
Designer/manufacturer: TTS
Lifts
  Number of each: 14
Manufacturer: Kone
Passengers
  Total: 2,800
  Number of cabins: 880
  Percentage/number outboard: 34%
Rudders
  Make: Van der Velden Barkemeyer
  Rudder type: TTA 35057-23/20
  Rudder area: 20m^2
Bow thruster
  Make: Wärtsilä
  Number: 2
  Output: 2,300kW
  Type: CT2755H
  Propeller diameter: 2.75m
  Propeller speed: 243rpm
Stern thruster
  Make: Wärtsilä
  Number: 1
  Output: 1,500kW
  Type: CT225H
  Propeller Diameter: 2.25m
  Propeller speed: 243rpm
Bridge control system
  Make: L3 SAM Electronics
  Type: NACOS Platinum
  One-man operation: Yes
Integrated automation system
  Make/type: L3 SAM Electronics Valmatic Platinum
Fire detection system
  Make/type: Autronica Autromaster 5000
Fire extinguishing system
  Make/Type: Marioff/HI-Fog
Radar
  Number: 4
  Make/model: L3 SAM Electronics NACOS Platinum
Contract date: 25 November 2010
Launch/float-out date: 17 August 2012
Delivery date: 10 January 2013

VIKING GRACE