Escola Politécnica Superior
UNIVERSIDADE DA CORUÑA

LNG TANKER 160.000m^3
NÚMERO 17-05

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CUADERNO 1

ELECCIÓN DE LA CIFRA DE MÉRITO Y DEFINICIÓN DE ALTERNATIVAS. SELECCIÓN DE LA MÁS FAVORABLE.

Escola Politécnica Superior
UNIVERSIDADE DA CORUÑA

GRADO EN INGENIERÍA NAVAL Y OCEÁNICA

TRABAJO FIN DE GRADO

CURSO 2.017-2018

PROYECTO NÚMERO 17/05

TIPO DE BUQUE: LNG carrier.

CLASIFICACIÓN, COTA Y REGLAMENTOS DE APLICACIÓN: Bureau Veritas, SOLAS, MARPOL, CIG.

CARACTERÍSTICAS DE LA CARGA: LNG con una capacidad de 160000 m^3.

VELOCIDAD Y AUTONOMÍA: 19.5 knuts a velocidad de servicio, al 85% MCR + 15% MM y 5000 millas de autonomía.

SISTEMAS Y EQUIPOS DE CARGA / DESCARGA: bombas de carga y de vapor habituales en buques de este tipo.

PROPULSIÓN: dual-fuel diesel-electric (DFDE)

TRIPULACIÓN Y PASAJE: capacidad para 40 tripulantes en camarotes dobles e individuales.

OTROS EQUIPOS E INSTALACIONES: los habituales en este tipo de buques.

Ferrol, 18 Setiembre 2017

ALUMNA: Dª Carmen Seoane Fernández

ÍNDICE

1. INTRODUCCIÓN.

El uso del gas natural como combustible se remonta a 1920, hasta entonces era considerado un subproducto del petróleo sin valor. La primera planta de licuefacción se construyó en Ohio en 1941 para la industria de la calefacción.

En un periodo de 50 años, el número de clientes de este producto ha crecido, y con ello las plantas dedicadas a la explotación de gas.

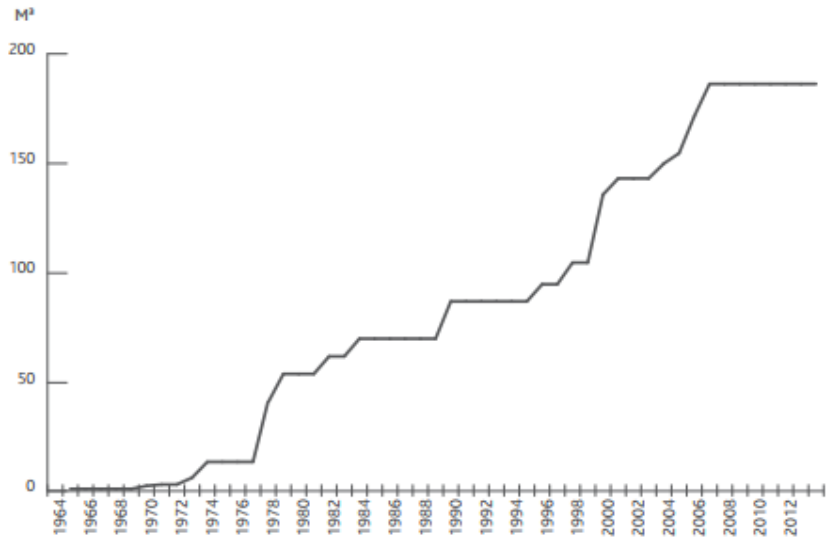


ILUSTRACIÓN 1 CAPACIDAD LICUEFACCIÓN

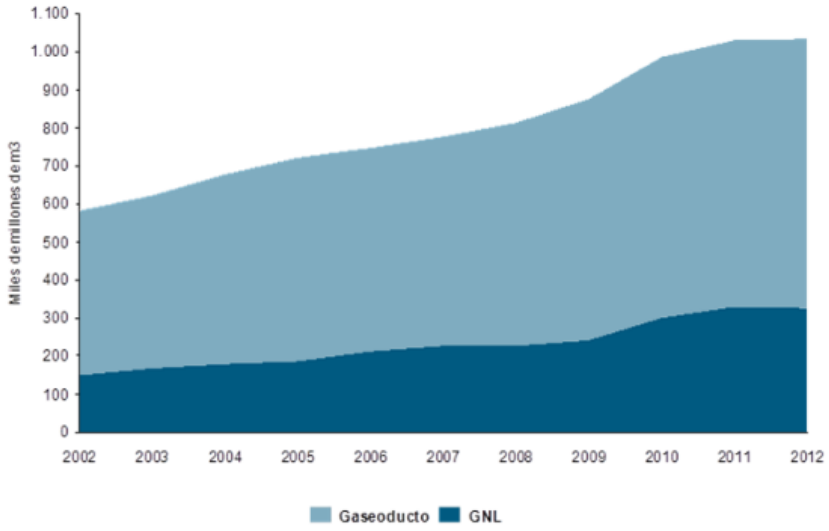


ILUSTRACIÓN 2 TRANSPORTE GASODUCTO Y BUQUE

ILUSTRACIÓN 3 FUENTES DE ENERGÍA

Como podemos observar es un mercado que está en aumento debido a las diferentes ventajas que tiene este tipo de combustible. La producción y el transporte de LNG conllevan cierta complejidad y por ello hay todo un sector especializado en dicha cadena de valor:

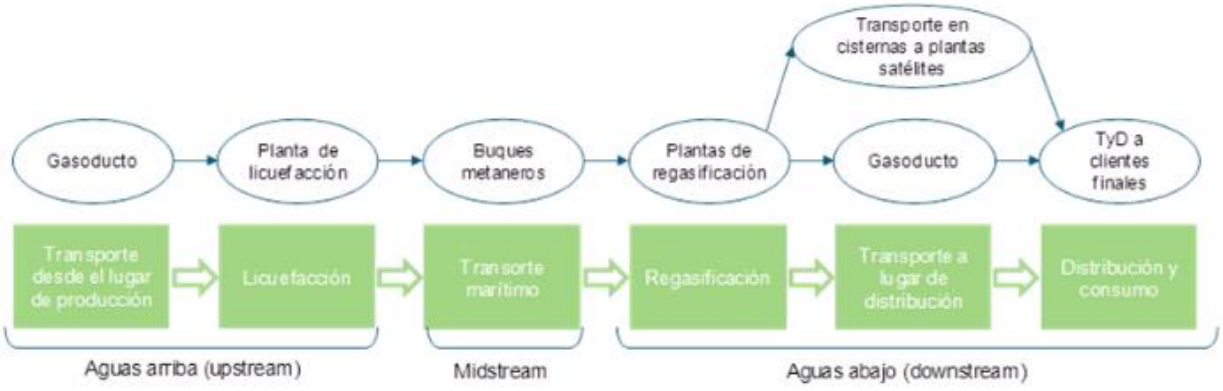


ILUSTRACIÓN 4 ACTIVIDADES RELACIONADAS LNG

Planta	no tanques	Capacidad de almacenamiento (m3 GNL)	Capacidad de regasificación (m3(n)/hora)	Titular de las instalaciones
Barcelona	8	840.000	1.950.000	ENAGAS
Huelva	5	610.000	1.350.000	ENAGAS
Cartagena	5	587.000	1.350.000	ENAGAS
BBG (Bilbao)	2	300.000	800.000	BBG
Saggas (Sagunto)	4	600.000	1.000.000	PLANTA REGASIFICADORA DE SAGUNTO
Reganosa (El Ferrol)	2	300.000	412.800	REGANOSA

ILUSTRACIÓN 5 PLANTAS REGASIFICADORAS ESPAÑA 2012

. Las zonas donde se localizan estos yacimientos suelen ser zonas remotas, y por ello podemos transportarlo con gasoductos en distancias cortas (hasta 4000Km) pero para largas distancias no salen rentables y por eso se utiliza el transporte marítimo.

El primer lugar al que llega el gas es a la planta de licuefacción donde se transforma a estado líquido. Para ello, es necesario enfriar el gas hasta una temperatura de -162ºC. Para este proceso se consume una energía de más del 10% del gas trasegado. Debido a que el gas ocupa un volumen 600 veces inferior al estar en estado líquido, compensa dicho desgaste de energía. Más adelante, se mencionarán las ventajas de este tipo de combustible.

Una vez está el gas natural licuado, podemos transportarlo mediante buques a las plantas de regasificación para llegar al consumidor final. El buque llega a la planta y mediante un sistema de tuberías descarga a los tanques el gas licuado. La planta de regasificación lo almacena para poder transportarlo mediante gasoductos o mediante camiones cisterna para llegar a los clientes finales. En España, las plantas de regasificación representan un 33% de la capacidad de almacenamiento de LNG en Europa (Fuente CNE).

A continuación, se muestran las ventajas de este tipo de combustible:

- Es el combustible fósil con mayor relación H-C proporcionando un alto poder calorífico.

Combustible	Poder calorífico superior (Kjoule/kg)
Carbón	26.500
Petróleo crudo (pesado gravedad específica 1,0)	37.122
Petróleo diesel	48.057
Gasolina	53.022
Gas natural	53.561
Leña pino (seca)	20.863

ILUSTRACIÓN 6 COMBUSTIBLES TÍPICOS

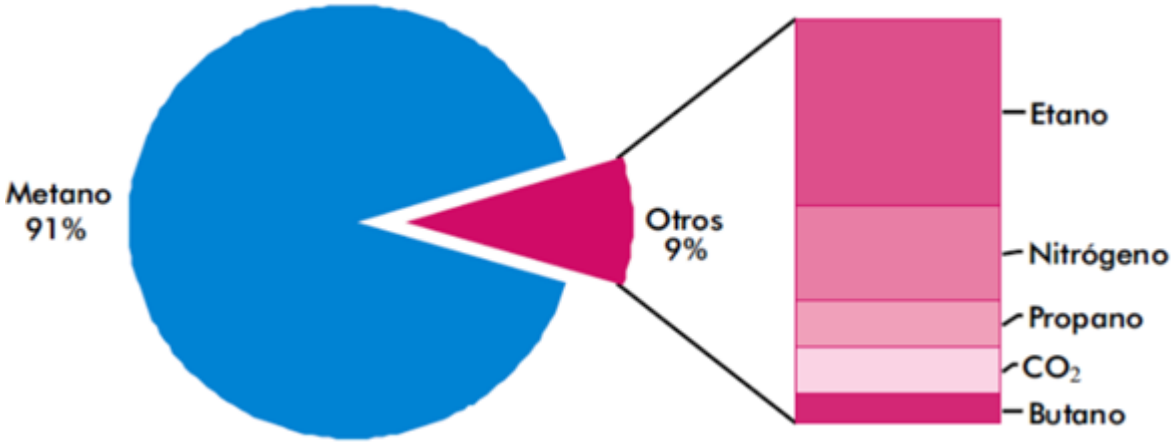


ILUSTRACIÓN 7 COMPOSICIÓN LNG

- Los derrames de LNG en contacto con la atmósfera se disipan, evitando así una contaminación en el suelo o en el agua.

- Las emisiones de dióxido de azufre, SO_2, son prácticamente inexistentes y las emisiones de dióxido de carbono, CO_2, se reducen en un 30% con respecto a otros combustibles fósiles. Las emisiones de NO_x se reducen en un 75% y desaparecen las partículas en suspensión.

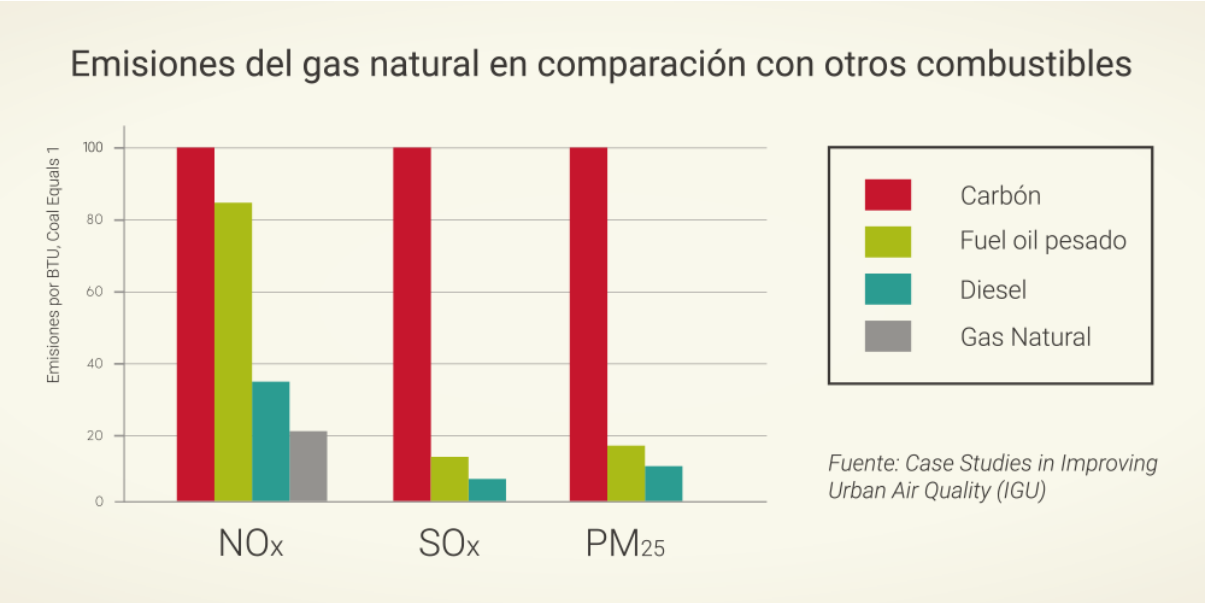


ILUSTRACIÓN 8 EMISIONES COMBUSTIBLES

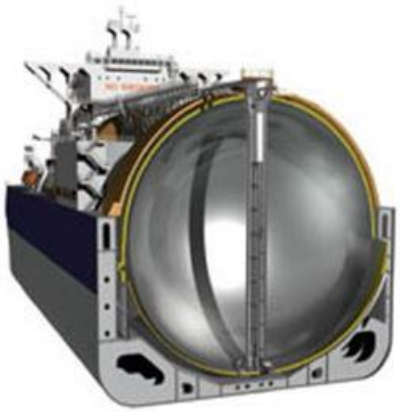
- Para que se inflame, la concentración en el ambiente debe ser entre 5 y 15% y debe existir una fuente de ignición, por tanto es un combustible seguro. Se vaporiza en el ambiente fácilmente.

1.1 TRANSPORTE LNG.

Como ya se ha mencionado en la introducción, el transporte por gasoducto será rentable para distancias menores a 4000km. Por tanto, para llevar el gas desde las plantas de extracción a los diferentes consumidores de distintos países, es necesario transportarlo mediante buques gaseros o metaneros.

Existen tres tipos de buques que transportan gas. La diferencia de estos buques se basa en los tipos de tanques que llevan para transportar el gas:

Section through Moss LNG vessel



LNG Moss Spherical Tank

ILUSTRACIÓN 9 EJEMPLO TANQUE MOSS

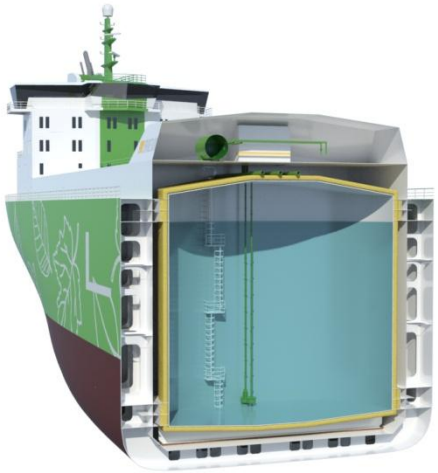


ILUSTRACIÓN 10 EJEMPLO TANQUE PRISMÁTICO

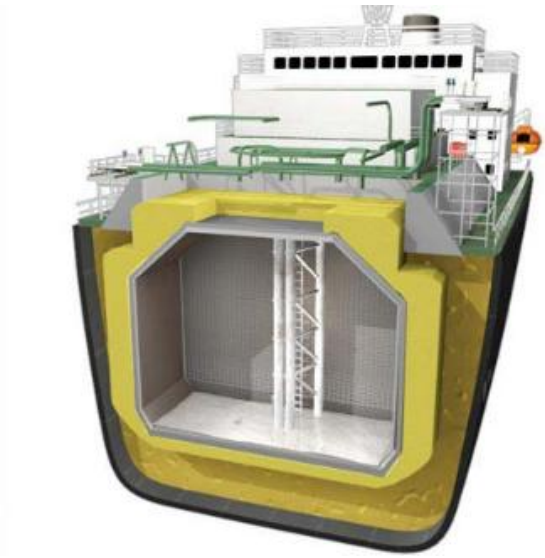


ILUSTRACIÓN 11 EJEMPLO TANQUE MEMBRANA

Para este proyecto se utilizarán los tanques de membrana NO96 GTT por diversas consideraciones:

- Los tanques tipo MOSS tienen mayor superficie expuesta al viento así como puntales mayores, costes de construcción más elevados, menor capacidad de carga y mayor tiempo de enfriamiento.

- Los tanques prismáticos presentan superficies libres mayores, derivando en mayores problemas de estabilidad.

El buque proyecto constará de cuatro tanques de membrana NO 96 GTT como sistema de contención y aislamiento. Consta de una membrana delgada y flexible con una aleación de hierro y níquel al 36% tanto para la membrana primaria como para la secundaria. Este aislamiento está formado por dos capas de cajas de aglomerado llenas de perlita a modo de aislante Este sistema permite la libre circulación de nitrógeno en su interior, por lo que permite controlar la presión del interior de los aislamientos sin dificultad. El asilamiento secundario tiene un espesor de 300mm y el principal de 230mm. Las chapas que forman estas membranas tienen 0.7 mm de espesor y 530 mm de ancho.

Estos tanques carecen de sustentación propia, van integrados en el doble casco del buque. El acero empleado (INVAR) es resistente a bajas temperaturas, aprobado por la SSCC y por la empresa GTT que es la licenciataria de este tipo de membrana. A través de coferdams se introduce glicol calentado para mantener el acero con una temperatura superior a 5ºC.

El coeficiente de expansión térmica es 2,0 x 10-6 º C entre 0º y -180º C, (cerca de 10 veces menos que para el acero inoxidable).

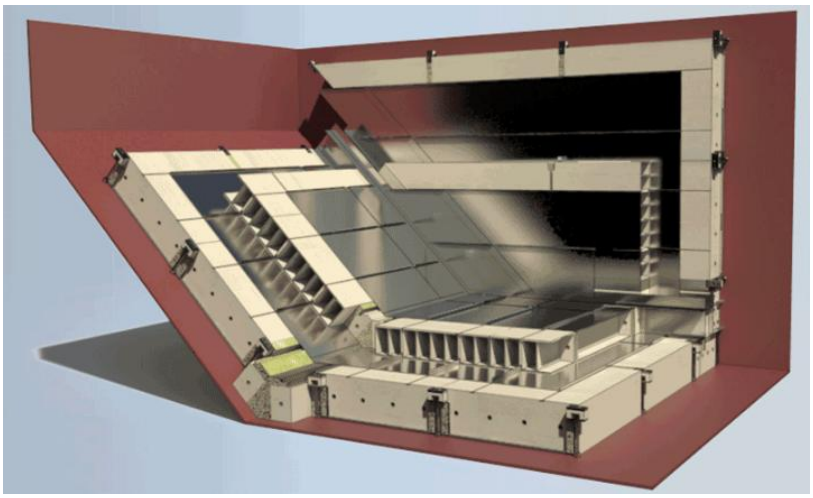


ILUSTRACIÓN 12 MEMBRANA NO-96 GTT

2. BASE DE DATOS.

BUQUE LNG	Volumen (m3)	Lpp	Loa	B	D(cub prin)
ASIA VISION 2014	160000	274,00	285,00	43,40	26,40
CORCOVADO 2014	160100	283,20	294,20	44,00	26,00
GOLAR ESKIMO 2014	160660	269,00	280,50	43,40	26,60
ABDELKADER 2010	177400	285,00	298,00	46,00	26,80
BARCELONA KNUTSEN 2010	173850	279,00	290,00	45,80	26,50
BRITISH EMERALD 2007	155000	275,00	280,00	44,20	26,00
BRITISH TRADER 2002	138200	266,00	278,80	42,60	26,00
EXPRESS 2009	151000	280,00	291,00	43,40	26,00
FERNANDO TAPIAS 2002	140627	268,80	298,00	43,40	26,00
INIGO TAPIAS 2003	138000	271,00	284,40	42,50	25,40
MAERSK QATAR 2006	145600	270,00	283,00	43,40	26,00
SERI BALHAF 2009	157720	281,60	294,60	46,50	25,80
TRINITY ARROW 2008	154982	276,00	289,00	44,70	26,00
FINIMA II 2015	174900	280,00	293,00	47,80	26,20

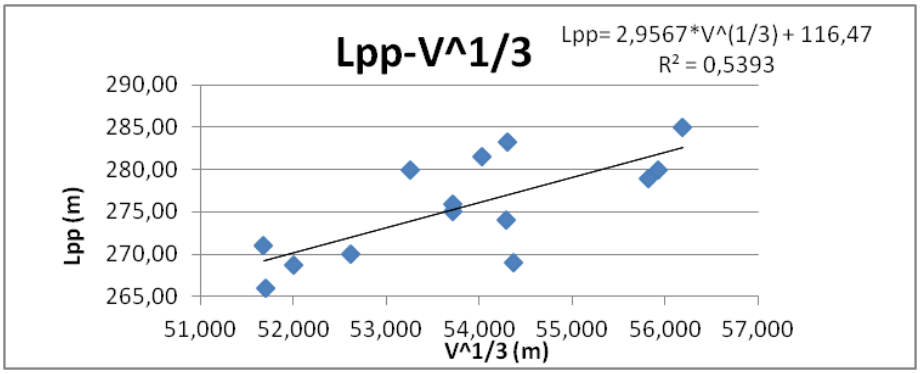
BUQUE LNG	T	V^1/3	Speed	Lpp/B	B/D
ASIA VISION 2014	12,75	54,288	19,5	6,31	1,644
CORCOVADO 2014	12,50	54,300	19,95	6,44	1,692
GOLAR ESKIMO 2014	12,75	54,363	19,9	6,20	1,632
ABDELKADER 2010	13,00	56,189	19,6	6,20	1,716
BARCELONA KNUTSEN 2010	12,90	55,812	19,5	6,09	1,728
BRITISH EMERALD 2007	12,20	53,717	20	6,22	1,700
BRITISH TRADER 2002	12,30	51,701	20,1	6,24	1,638
EXPRESS 2009	12,40	53,251	19,2	6,45	1,669
FERNANDO TAPIAS 2002	12,12	52,002	19,5	6,19	1,669
INIGO TAPIAS 2003	12,30	51,676	19,5	6,38	1,673
MAERSK QATAR 2006	12,40	52,608	20,6	6,22	1,669
SERI BALHAF 2009	12,40	54,029	19,5	6,06	1,802
TRINITY ARROW 2008	12,60	53,715	19,5	6,17	1,719
FINIMA II 2015	12,65	55,924	19,75	5,86	1,824

BUQUE LNG	Lpp/D	Lpp/T	T/D	B/T	(LBD)^1/3
ASIA VISION 2014	10,379	21,49	0,483	3,404	67,964
CORCOVADO 2014	10,892	22,66	0,481	3,520	68,681
GOLAR ESKIMO 2014	10,113	21,10	0,479	3,404	67,719
ABDELKADER 2010	10,634	21,92	0,485	3,538	70,563
BARCELONA KNUTSEN 2010	10,528	21,63	0,487	3,550	69,701
BRITISH EMERALD 2007	10,577	22,54	0,469	3,623	68,115
BRITISH TRADER 2002	10,231	21,63	0,473	3,463	66,541
EXPRESS 2009	10,769	22,58	0,477	3,500	68,109
FERNANDO TAPIAS 2002	10,338	22,18	0,466	3,581	67,189
INIGO TAPIAS 2003	10,669	22,03	0,484	3,455	66,384
MAERSK QATAR 2006	10,385	21,77	0,477	3,500	67,289
SERI BALHAF 2009	10,915	22,71	0,481	3,750	69,647
TRINITY ARROW 2008	10,615	21,90	0,485	3,548	68,454
FINIMA II 2015	10,687	22,13	0,483	3,779	70,517

3. CÁLCULO PRIMER DIMENSIONAMIENTO.

A partir de la base de datos se obtendrán unas dimensiones iniciales. Se trata de un buque de volumen con una RPA de 160000m^3, por ello, el primer cálculo será eslora frente al volumen. A partir de ésta, se calculará la manga, puntal y calado. Se obtendrá el número cúbico requerido por la regresión lineal y el que nos dan las dimensiones, con estos valores podré tener una idea inicial de si dichas dimensiones son válidas o se alejan de lo requerido.

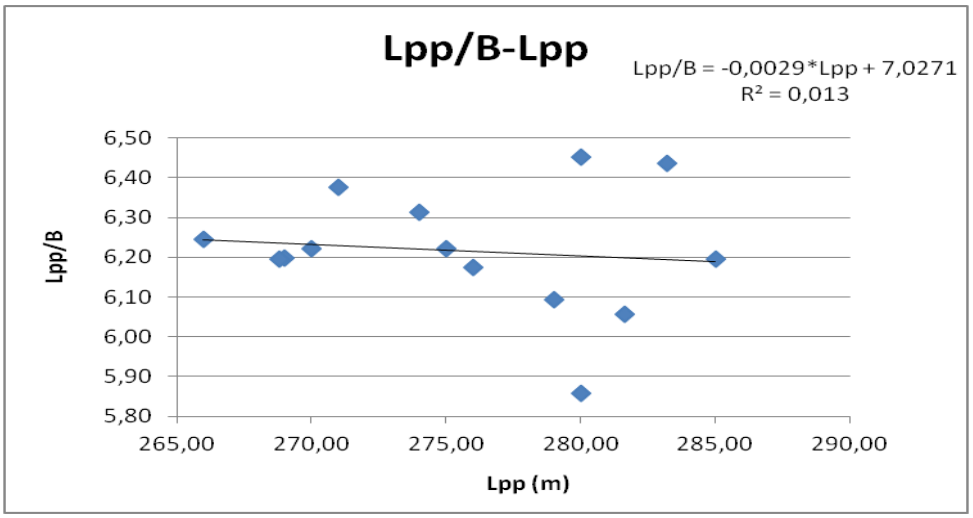
3.1 CÁLCULO ESLORA Lpp.



Con la raíz cúbica del volumen de 160000 m^3 calculamos el valor de la eslora entre perpendiculares.

Lpp= 276.98 m

3.2 CÁLCULO MANGA B.

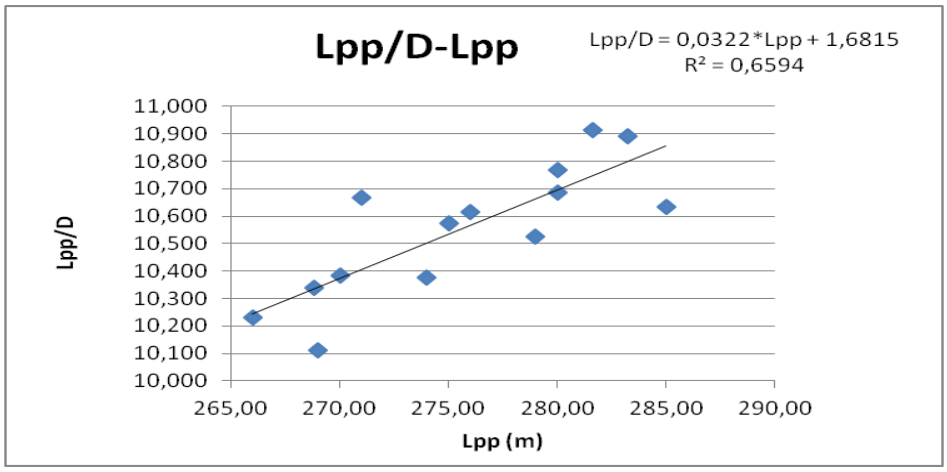


Esta gráfica representa la eslora frente a la relación de eslora y manga. Metiendo el valor de la eslora calculada antes se obtiene el valor de la manga.

B=44.50 m

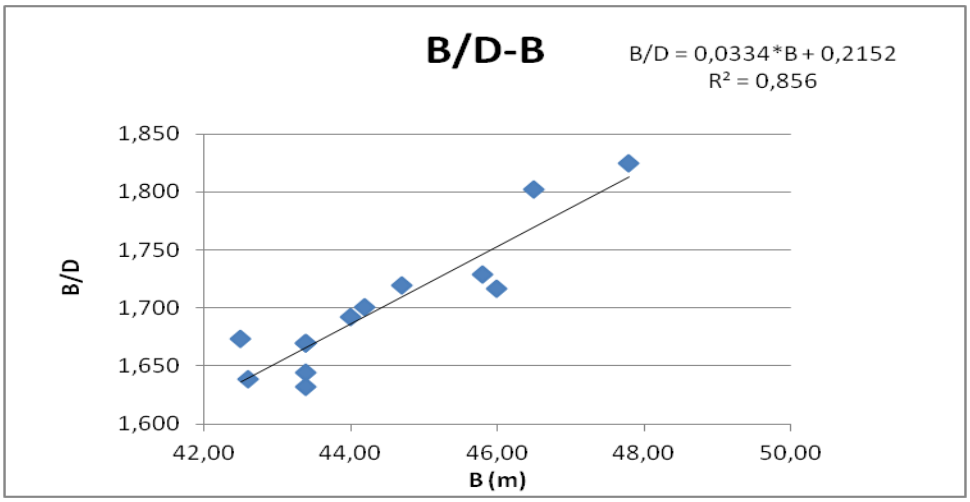
3.3 CÁLCULO PUNTAL D.

Para este cálculo utilizaré dos relaciones, por un lado la relación Lpp/D y por otro B/D. Se hará una media con los valores obtenidos.



Con la eslora obtenemos de la regresión que:

D= 26.13 m



Con el valor de la manga calculado antes obtenemos otro valor del puntal:

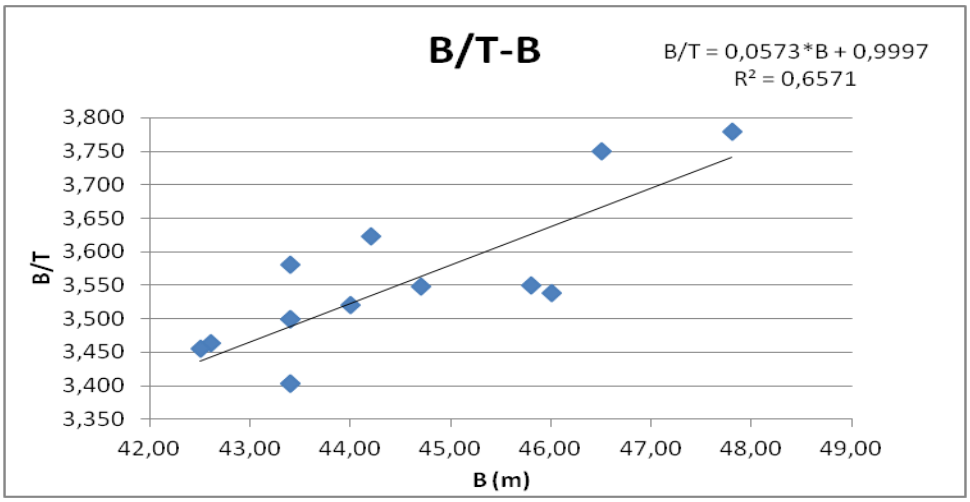
D= 26.15 m

La media de estos valores y por tanto el puntal del primer dimensionamiento es:

D= 26.14 m

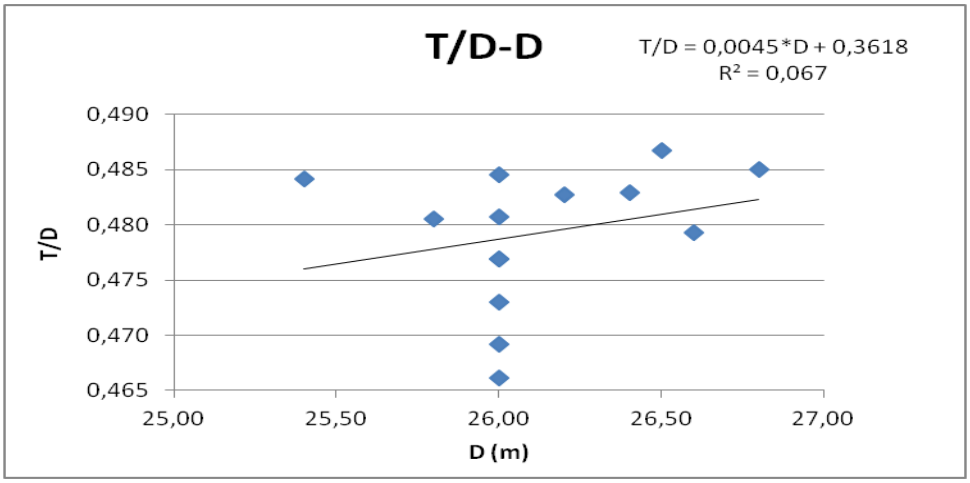
3.4 CÁLCULO CALADO T.

Para este cálculo, utilizaré tres relaciones: B/T, T/D y Lpp/T. Luego haré una media de los tres valores obtenidos.



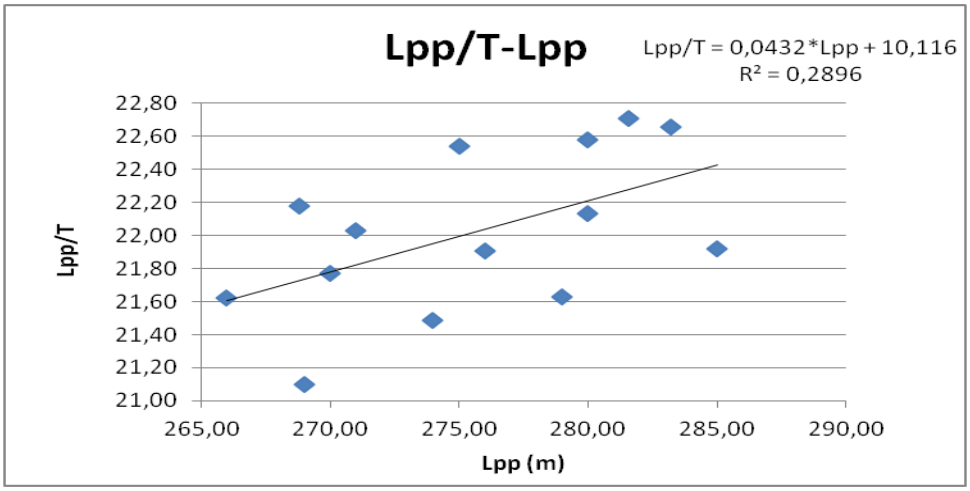
Con el valor de la manga obtenemos:

T= 12.54 m



A partir del puntal se obtiene:

T= 12.53 m



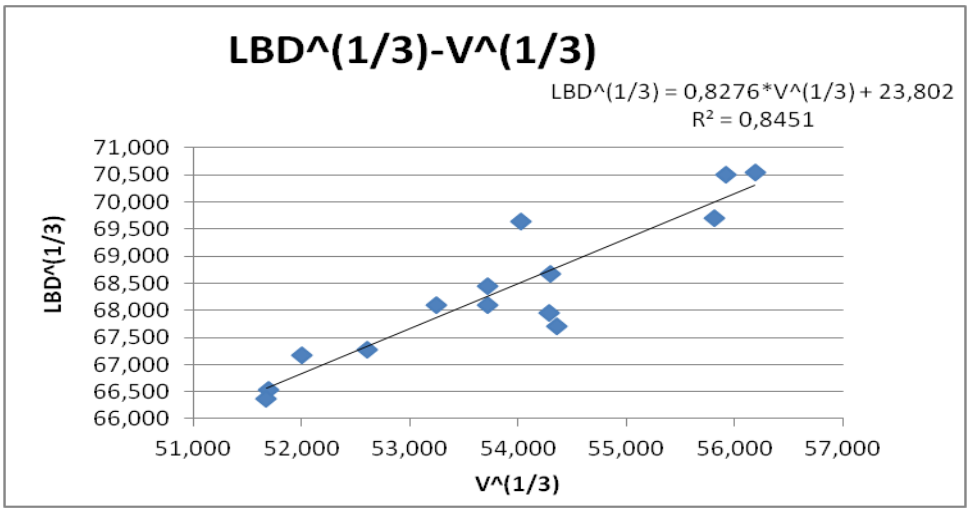
Con la eslora se obtiene otro valor del calado:

T= 12.54 m

Como se puede observar los valores son muy parecidos, el calado que utilizaremos será:

T= 12.54 m

3.5 CÁLCULO NÚMERO CÚBICO.



El número cúbico requerido para transportar el volumen necesario viene dado por la regresión lineal, por otro lado, como sabemos las dimensiones del buque podemos calcular el número cúbico utilizando las dimensiones de este primer dimensionamiento. Los resultados en m^3 son:

LBDrequerido	324682,40
LBDdimensiones	322243,89

Analizando estos resultados comprobamos que no sería el buque capaz de transportar el volumen que requiere la RPA. Para un primer dimensionamiento y teniendo en cuenta los errores de cálculo tomaremos como válido el valor dado por las regresiones.

4. RESULTADOS PRIMER DIMENSIONAMENTO.

Lpp (m)	276,98
B (m)	44,50
D (m)	26,14
T (m)	12,54
LBD (m^3)	324682,40

5. CÁLCULO COEFICIENTES.

Para el cálculo de coeficientes utilizaré fórmulas empíricas ya que no aparecen en la base de datos. Se calculará el coeficiente de bloque, el coeficiente de bloque al puntal, el coeficiente prismático, coeficiente de flotación y coeficiente de la maestra mediante las siguientes fórmulas:

$$Fn = \frac{V}{\sqrt{g * Lpp}} = 0.192\ N\acute{u}mero\ de\ Froude$$

Para calcular el coeficiente de bloque utilizaré fórmulas de diferentes autores y luego obtendré el valor medio.

- KATSOULIS, siendo f=1.04 para gaseros y Vs la velocidad de servicio 19.5 kn.

$$Cb = 0.8217 * f * Lpp^{0.42} * B^{-0.3072} * T^{0.1721} Vs^{-0.6135}$$

$$Cb = 0.706$$

- ALEXANDER, siendo k una constante que obtendré del buque base.

$$Cb = k - \frac{0.5 * V}{(3.28 * Lpp)^{0.5}}$$

Sabiendo del buque BARCELONA KNUTSEN,

$V = 19.5\ kn$

$Lpp = 279\ m$

$Cb = 0.778$

Puede calcularse el valor de la constante k,

$k = 1.10$

Por tanto, para el buque del proyecto y sabiendo el valor d k, se puede obtener el coeficiente de bloque:

$$Cb = 0.777$$

- Fórmula tipo $Cb = K1 - K2 * Fn$

Para calcular el valor de estas constantes utilizaremos los datos de dos buques de la base de datos:

	BARCELONA	MAERSK
V	19,5	20,6
Cb	0,778	0,745
Fn	0,037	0,042

Por tanto el valor de las constantes será:

$$K1 = 1.23 \quad K2 = 2.36$$

Puede obtenerse el coeficiente de bloque ya que ya se ha calculado el número de

Froude:

$$Cb = 0.776$$

Tomaremos el valor medio para el coeficiente de bloque,

$$Cb = 0.752$$

El coeficiente de bloque al puntal se calcula con el valor medio calculado, D=24.14 m y T=12.54 m.

$$C_{bD} = Cb + C * \frac{D - T}{T} * (1 - Cb)$$

Siendo C=0.3 para formas en U

$$C_{bD} = 0.833$$

Para el cálculo del coeficiente de la sección maestra se utilizarán las fórmulas de dos autores:

- KERLEN

$$Cm = 1.006 - 0.0056 * Cb^{-3.56}$$

Utilizando el valor de coeficiente de bloque medio calculado anteriormente.

$$Cm = 0.991$$

- HSVA

$$Cm = \frac{1}{1 + (1 - Cb)^{3.5}}$$

Se obtiene $Cm = 0.992$

Y el valor medio obtenido es Cm=0.992

Una vez calculados el coeficiente de bloque y el de la maestra, podemos obtener el coeficiente prismático longitudinal:

$$C_{pl} = \frac{Cb}{Cm}$$

$$C_{pl} = 0.759$$

Para el coeficiente de flotación,

- SCHNEEKLUTH, para secciones normales:

$$C_f = \frac{1 + 2 * Cb}{3}$$

Obteniéndose: Cf=0.835.

- TORROJA, con valores genéricos por falta de datos para calcular las constantes

$$C_f = 0.248 + 0.778 * Cb$$

$$C_f = 0.833$$

Como puede observarse el valor es muy parecido, se escogerá:

$$C_f = 0.835$$

Calculando estos coeficientes para los buques de la base de datos y el buque del proyecto podemos obtener unos valores aproximados. Se han calculado con un único autor salvo el buque proyecto que está representado la media de los valores.

BUQUE LNG	Fn	Cb	Cbd	Cm	Cp	Cf
ASIA VISION 2014	0,193	0,710	0,803	0,987	0,720	0,807
CORCOVADO 2014	0,195	0,705	0,800	0,987	0,714	0,803
GOLAR ESKIMO 2014	0,199	0,696	0,795	0,986	0,706	0,797
ABDELKADER 2010	0,191	0,709	0,802	0,987	0,719	0,806
BARCELONA KNUTSEN 2010	0,192	0,705	0,799	0,987	0,715	0,804
BRITISH EMERALD 2007	0,198	0,691	0,796	0,985	0,702	0,794
BRITISH TRADER 2002	0,202	0,688	0,792	0,985	0,699	0,792
EXPRESS 2009	0,188	0,720	0,812	0,988	0,729	0,813
FERNANDO TAPIAS 2002	0,195	0,698	0,802	0,986	0,708	0,799
INIGO TAPIAS 2003	0,195	0,707	0,801	0,987	0,717	0,805
MAERSK QATAR 2006	0,206	0,679	0,785	0,984	0,690	0,786
SERI BALHAF 2009	0,191	0,700	0,797	0,986	0,710	0,800
TRINITY ARROW 2008	0,193	0,705	0,799	0,987	0,714	0,803
FINIMA II 2015	0,194	0,689	0,789	0,985	0,700	0,793
BUQUE PROYECTO	0,192	**0,752**	**0,833**	**0,992**	**0,759**	**0,835**

Podemos obtener un primer valor orientativo del desplazamiento

$$\Delta = Cb * k * d * L * B * T \cong 119731.19\ t$$

Siendo los valores obtenidos anteriormente y K*d=1.030 t/m^3 la densidad del agua salada añadiendo una corrección por los apéndices del buque. En el punto 7 se calculará mediante estimación de pesos un nuevo desplazamiento, este es un valor preliminar con el fin de hacer una idea de su valor.

A continuación se muestran los valores máximos, mínimos y medios de las relaciones importantes que se utilizarán en la elección de la cifra de mérito.

	L/B	B/D	L/D	T/D
MÁXIMO	6,452	1,824	10,915	0,487
MÍNIMO	5,858	1,632	10,113	0,466
MEDIA	6,215	1,698	10,550	0,479
BUQUE PROY	6,224	1,702	10,596	0,480

6. ELECCIÓN CIFRA DE MÉRITO.

Los criterios para la elección de la cifra de mérito más frecuentes y utilizados son los siguientes:

- Coste de construcción mínimo.
- Inversión total mínima.
- Coste de ciclo de vida mínimo.
- Flete requerido mínimo.
- Tasa de recuperación de capital propio máxima.
- Tasa de rentabilidad interna máxima.

En este proyecto se utilizará el criterio de coste de construcción mínimo. Se realizará un cálculo de diferentes alternativas para conseguir el menor coste.

7. CÁLCULO DEL PESO EN ROSCA.

Para calcular el valor aproximado del peso en rosca se dividirá en diferentes partidas:

- Peso de aceros.
- Peso aceros superestructura.
- Peso de maquinaria principal.
- Peso de equipo restante.

- Peso línea de eje.

- Peso de habilitación y equipo.

7.1 CÁLCULO PESO ACERO.

Se calculará de dos formas y se hará la media de los valores obtenidos:

- Formulación matemática: $PS = L^{1.5} * B^{1} * D^{0.5} * k$

$$PS = 276.98^{1.5} * 44.50 * 26.14^{0.5} * 0.03$$

$$PS = 31467.85\ t$$

Esta fórmula tiene en cuenta la importancia en el peso de las dimensiones principales del buque, siendo k una constante que indica las toneladas por metro cúbico.

- Método de Sv.AA. Harvald y J.Juncher: $PS = C_s * (L * B * D + Sup)$

Siendo,

$$C_s = 0.0644 + 0.064 * e^{(-0.5*u-0.1*u^{2.45})}$$

$$u = log\frac{\Delta}{100}$$

$$Sup = 0.8 * B * (1.45 * L - 11)$$

Tenemos todos los valores para hacer este cálculo, siendo el resultado

$$PS = 22607.05\ t$$

Nos quedaremos con el primer valor obtenido, con el fin de usar la misma fórmula matemática para el cálculo de las alternativas.

7.2 CÁLCULO PESO ACEROS SUPERESTRUCTURA.

Puede calcularse por formulación matemática, considerando que la eslora de la superestructura es 1/6 de la eslora del buque, la manga 2 metros menos y el puntal sobre 10 metros (se han tomado mirando el plano de buque base).

$$PSE = Ls^{1.5} * Bs * Ds^{0.5}*k$$

$$PSE = 1.264{,}75\ t$$

7.3 CÁLCULO PESO MAQUINARIA.

En este apartado se incluye la propulsión principal y la maquinaria auxiliar.

7.3.1 PESO MOTOR PRINCIPAL

Para el cálculo de la potencia necesaria se estimará a partir de la fórmula de D.G.M.Watson:

$$BHP = \frac{0.889*\Delta^{2/3}*(40-\frac{Lpp}{61}+400*0.1^2-12*Cb)}{15000-1.81*N*Lpp^{0.5}}*V^3$$

$$PMp = Np * a * (\frac{BHP}{Np * rpm})^b + c * (\frac{BHP}{Np})^d$$

Siendo,

Δ=119731.19 t

Lpp=276.98 m

Cb=0.752

V=19.5 kn.

N, las revoluciones del motor que se tomará de referencia las revoluciones de la base de datos del buque Seri Balhaf N=78 rpm

Np, número de palas, tomaremos Np=5 palas.

a=9.38 b=0.84 c=0.59 d=0.70 valores constantes.

Sustituyendo valores se obtiene el valor de la potencia:

$$BHP = 38.523{,}87$$

$$BKW = 28.727{,}25$$

$$PMp = 2.531{,}89\ t$$

7.3.2 PESO MAQUINARIA Y EQUIPO RESTANTE.

Se considerará que el peso de la maquinaria y del equipo restante será 3% del volumen de la cámara de máquinas y que la eslora es 1/5 de la eslora del buque.

$$PQr = 0.03 * Vcm = 0.03 * (\frac{L}{5} * B * T * Cb)$$

$$PQr = 697{,}46\ t$$

7.3.3 PESO LÍNEA DE EJES FUERA DE CÁMARA DE MÁQUINAS.

Utilizaremos la siguiente fórmula, siendo k número de líneas de eje (k=1 en este proyecto) y Le la eslora de la línea de eje (Le=6 m como valor de referencia).

$$Ple = k * Le * (5 + 0.0164 * Lpp)$$

$$Ple = 57{,}26\ t$$

7.3.4 PESO HABILITACIÓN Y EQUIPO.

Se calculará mediante la siguiente fórmula, siendo $k = 0.36 - 0.53 * 10^{-3} * Lpp$

$$Phe = k * Lpp * B$$

Por tanto, se obtiene que k=0.213 y entonces,

$$Phe = 2.628{,}06\ t$$

7.4 RESULTADO PESO EN ROSCA.

Se presentan las diferentes partidas calculadas y el resultado final del peso en rosca.

Peso en t	
PS	31467,85
PSE	1264,75
PMq	2531,89
PQr	697,46
Ple	57,26
Phe	2628,06
LWT	38647,27

8. CÁLCULO PESO MUERTO.

Se calculará restando el peso en rosca al desplazamiento antes calculado.

$$DWT = \Delta - LWT$$

$$DWT = 119731.19 - 38647.27$$

$$DWT = 81.083{,}92\ t$$

Los pesos más importantes de este punto son la carga útil y los consumos. Para el cálculo de la carga útil tomaremos 0.46 la densidad del gas. Por tanto, se obtiene:

$$Cu = 0.46 * 160000 = 73600\ t$$

Tendríamos un margen para consumos de 7.483,92 t.

9. COSTES.

Se calculará el coste de construcción mínimo, tomando de guía “El

Proyecto Básico del Buque Mercante”. El cálculo del coste de construcción se desglosará de la siguiente manera:

-Coste del material a granel (CMg)

-Coste de los equipos (CEq) y su montaje (CmE)

-Coste de la mano de obra (CMo)

-Costes varios aplicados (CVa)

A continuación se muestra la nomenclatura que se va a utilizar:

- ccs coeficiente de coste ponderado de chapas y perfiles y de las distintas calidades de acero; 1.05<ccs<1.10-1.50.Tomaré 1.10.
- cas coeficiente de aprovechamiento del acero; 1.08<cas<1.15. Tomaré 1.11.
- cem coeficiente de incremento por equipo metálico incluido en la estructura, tecles, escotillas, etc.; 1.03<cem<1.10.Tomaré 1.07.
- ps precio unitario del acero; 850 €/t.
- PS peso del acero estimado anteriormente; 31.467,85 t.
- CEc coste de los equipos de manipulación y contención de la carga. No se utilizará para el cálculo en esta fase inicial.
- CEp coste de los equipos de propulsión y sus auxiliares, montaje incluido.
- Cep coeficiente de coste unitario; 400 €/kw.

- BKW potencia propulsora calculada anteriormente; 28727,25 kw.
- chf coeficiente de coste unitario de la habilitación por tripulante; estimado en 34000 €/trip.
- nch nivel de calidad de la habilitación; 1.10.
- NT número de tripulantes; 40.
- Cer coste del equipo restante instalado.
- chm coste horario medio del astillero; 30 €/h.
- csh coeficiente de horas por unidad de peso; 50 h/t.
- WEr peso del equipo restante $WEr = k * L^{1.3} * B^{0.8} * D^{0.3}$ siendo k=0.03 una constante.
- CMo costes de mano de obra.
- CmM coste de montaje del material.
- CmE coste montaje de equipos.
- CVa costes varios aplicados.
- cva coeficiente de costes varios del astillero referidos al coste de construcción; 0.1 se tomará como valor de referencia.

9.1 COSTE MATERIAL A GRANEL.

$$CMg = ccs * cas * cem * ps * PS$$

$$CMg = 1.10 * 1.11 * 1.07 * 850 * 31467{,}85$$

$$CMg = 34.945.034{,}21€$$

9.2 COSTE DE LOS EQUIPOS Y SU MONTAJE.

$$CEq + CmE = CEc + CEp + CHf + CEr$$

- $CEp = cep * BKW = 400 * 28727{,}25 = 11.490.898{,}84$ €
- $CHf = chf * nch * NT = 34000 * 1.10 * 40 = 1.496.000$ €
- $CEr = \text{cer} * \text{WEr} = 6.500.605{,}02$ €
- $cer = ccs * cas * cem * ps + chm * csh = 1.10 * 1.11 * 1.07 * 850 + 30 * 50 = 2610{,}50$
- $WEr = k * L^{1.3} * B^{0.8} * D^{0.3} = 0.03 * 276.98^{1.3} * 44.50^{0.8} * 26.14^{0.3} = 2490{,}18\ t$

$$CEq + CmE = 19.487.503{,}85\ €$$

9.3 COSTES MANO DE OBRA.

Se incluye sólo el coste de montaje de material CmM, puesto que el coste de montaje de equipos CmE se ha incluido en el apartado 9.2.

$$CMo = CmM = chm * csh * PS$$
$$CMo = 30 * 50 * 31467{,}85$$

$$CMo = 47.201.778{,}4\ €$$

9.4 COSTES VARIOS APLICADOS.

Costes indirectos derivados del proceso de construcción. Pueden ser: Sociedades de Clasificación, ensayos en canal, representación… Se considera que representan un 10% de los costes anteriores.

$$CVa = cva * (CMg + CEq + CmE + CMo)$$

$$CVa = 10.163.431{,}65\ €$$

9.5 RESULTADO COSTES.

Se muestran los datos calculados anteriormente que dan lugar al coste de construcción de la alternativa inicial del proyecto.

CMg	34945034,21
CEq+CmE	19487503,85
Cmo	47201778,4
Cva	10163431,65
CC	111797748,11

$$CC = CMg + CEq + CmE + CMo + CVa$$

$$CC = 111.797.748{,}11\ €$$

10. SELECCIÓN ALTERNATIVA MÁS FAVORABLE.

Para encontrar la alternativa más favorable, se utilizará como cifra de merito el coste de construcción. Se variarán un +-10% la eslora, la manga, y un +-5% el coeficiente de bloque. Se debe fijar el número cúbico para asegurar que la carga entra en el buque y considerar unos rangos en las relaciones de interés. El puntal se calculará en función del número cúbico obtenido en la regresión lineal.

$$D = \frac{LBD}{LB}$$

	L/B	B/D	L/D	T/D
MÁXIMO	6,452	1,824	10,915	0,487
MÍNIMO	5,858	1,632	10,113	0,466
MEDIA	6,215	1,698	10,550	0,479
BUQUE PROY	6,224	1,702	10,596	0,480

LBD (m^3)	324682,40

En el anexo II se muestra las alternativas que dieron válidas según estos criterios. Se ha escogido la que tenía el menor coste de construcción. Se muestra la configuración inicial y la configuración que se obtuvo finalmente.

CONFIGURACIÓN	INICIAL	FINAL
Lpp (m)	277,0	271,3
B (m)	44,5	45,4
D (m)	26,1	26,4
T (m)	12,5	12,3
Δ (t)	119731,2	119484,5
LBD (m3)	324.682,40	324.682,40
Cb	0,752	0,767
Cm	0,992	0,992
Cp	0,759	0,774
BKW	28727,25	28562,00
COSTE	111.797.748,11 €	111.016.632,10 €

Supone un ahorro de 781.116,01 €.

11. NUEVO CÁLCULO DE COEFICIENTES.

$$Fn = \frac{V}{\sqrt{g * Lpp}} = 0.194\ Número\ de\ Froude$$

Para calcular el coeficiente de bloque utilizaré fórmulas de diferentes autores y luego obtendré el valor medio.

- KATSOULIS, siendo f=1.04 para gaseros y Vs la velocidad de servicio 19.5 kn.

$$Cb = 0.8217 * f * Lpp^{0.42} * B^{-0.3072} * T^{0.1721} Vs^{-0.6135}$$

$$Cb = 0{,}694$$

- ALEXANDER, siendo k una constante que obtendré del buque base.

$$Cb = k - \frac{0.5 * V}{(3.28 * Lpp)^{0.5}}$$

Sabiendo del buque BARCELONA KNUTSEN,

$V = 19.5\ kn$

$Lpp = 279\ m$

$Cb = 0.778$

Puede calcularse el valor de la constante k,

$k = 1.10$

Por tanto, para el buque del proyecto y sabiendo el valor d k, se puede obtener el coeficiente de bloque:

$$Cb = 0.773$$

- Fórmula tipo $Cb = K1 - K2 * Fn$

Para calcular el valor de estas constantes utilizaremos los datos de dos buques de la base de datos:

	BARCELONA	MAERSK
V	19,5	20,6
Cb	0,778	0,745
Fn	0,037	0,042

Por tanto el valor de las constantes será:

$$K1 = 1.23 \quad K2 = 2.36$$

Puede obtenerse el coeficiente de bloque ya que ya se ha calculado el número de

Froude:

$$Cb = 0.771$$

Tomaremos el valor medio para el coeficiente de bloque,

$$Cb = 0.745$$

- El coeficiente de bloque al puntal se calcula con el valor medio calculado, D=26.7 m y T=12.5 m.

$$C_{bD} = Cb + C * \frac{D - T}{T} * (1 - Cb)$$

Siendo C=0.3 para formas en U

$$C_{bD} = 0.832$$

- El volumen del casco será,

$$V_h = C_{bD} * L * B * D$$

$$V_h = 270135{,}0\ m^3$$

Para el cálculo del coeficiente de la sección maestra se utilizarán las fórmulas de dos autores:

- KERLEN

$$Cm = 1.006 - 0.0056 * Cb^{-3.56}$$

Utilizando el valor de coeficiente de bloque medio calculado anteriormente.

$$Cm = 0.990$$

- HSVA

$$Cm = \frac{1}{1 + (1 - Cb)^{3.5}}$$

Se obtiene $Cm = 0.992$

Y el valor medio obtenido es Cm=0.991

Una vez calculados el coeficiente de bloque y el de la maestra, podemos obtener el coeficiente prismático longitudinal:

$$C_{pl} = \frac{Cb}{Cm}$$

$$C_{pl} = 0.760$$

Para el coeficiente de flotación,

- SCHNEEKLUTH, para secciones normales:

$$C_f = \frac{1 + 2 * Cb}{3}$$

Obteniéndose: Cf=0.830.

- TORROJA, con valores genéricos por falta de datos para calcular las constantes

$$C_f = 0.248 + 0.778 * Cb$$

$$C_f = 0.828$$

Como puede observarse el valor es muy parecido, se escogerá:

$$C_f = 0.829$$

Podemos obtener un valor orientativo del desplazamiento

$$\Delta = Cb * k * d * L * B * T \cong 116.599{,}36\ t$$

Siendo los valores obtenidos anteriormente y K*d=1.030 t/m^3 la densidad del agua salada añadiendo una corrección por los apéndices del buque. Da un valor algo menor que el calculado antes pero se toma como válido en esta fase del proyecto, son valores aproximados.

A continuación se muestran un resumen de resultados:

CÁLCULOS	
Fn	0,194
Vh (m3)	270135,0
CbD	0,832
Cb	0,745
Cf	0,829
Cm	0,991
Cp	0,752

12. NUEVO CÁLCULO DE PESOS.

Con las nuevas dimensiones se calculará una estimación de pesos ajustada a estos nuevos valores.

12.1 NUEVO PESO EN ROSCA.

Para calcular el valor aproximado del peso en rosca se dividirá en diferentes partidas:

- Peso de aceros.
- Peso aceros superestructura.
- Peso de maquinaria principal.
- Peso de equipo restante.

- Peso línea de eje.

- Peso de habilitación y equipo.

12.1.1 NUEVO PESO ACEROS.

- Formulación matemática: $PS = L^{1.5} * B^{1} * D^{0.5} * k$

$$PS = 271.3^{1.5} * 45.4 * 26.4^{0.5} * 0.03$$

$$PS = 31.242{,}70\ t$$

Esta fórmula tiene en cuenta la importancia en el peso de las dimensiones principales del buque, siendo k una constante que indica las toneladas por metro cúbico.

12.1.2 NUEVO PESO SUPERESTRUCTURA.

Puede calcularse por formulación matemática, considerando que la eslora de la superestructura es 1/6 de la eslora del buque proyecto, la manga 2 metros menos y el puntal sobre 10 metros (se han tomado del plano de buque base).

$$PSE = Ls^{1.5} * Bs * Ds^{0.5} * k$$

$$PSE = 1.251{,}44\ t$$

12.1.3 NUEVO PESO MAQUINARIA.

En este apartado se incluye la propulsión principal y la maquinaria auxiliar.

- MOTOR PRINCIPAL.

Para el cálculo de la potencia necesaria se estimará a partir de la fórmula de D.G.M.Watson:

$$BHP = \frac{0.889*\Delta^{2/3}*(40-\frac{Lpp}{61}+400*0.1^2-12*Cb)}{15000-1.81*N*Lpp^{0.5}}*V^3$$

$$PMp = Np * a * (\frac{BHP}{Np * rpm})^b + c * (\frac{BHP}{Np})^d$$

Siendo,

Δ=116.599,36 t

Lpp=276,8 m

Cb=0,753

V=19.5 kn.

N, las revoluciones del motor que se tomará de referencia las revoluciones de la base de datos del buque Seri Balhaf N=78 rpm

Np, número de palas, tomaremos Np=5 palas.

a=9.38 b=0.84 c=0.59 d=0.70 valores constantes.

Sustituyendo valores se obtiene el valor de la potencia:

$$BHP = 34080{,}38\ HP$$

$$BKW = 25413{,}74\ KW$$

$$PMp = 2.289{,}05\ t$$

- MAQUINARIA Y EQUIPO RESTANTE.

Se considerará que el peso de la maquinaria y del equipo restante será 3% del volumen de la cámara de máquinas y que la eslora es 1/5 de la eslora del buque.

$$PQr = 0.03 * Vcm = 0.03 * (\frac{L}{5} * B * T * Cb)$$

$$PQr = 679{,}22\ t$$

- LÍNEA DE EJES FUERA DE LA CÁMARA DE MÁQUINAS.

Utilizaremos la siguiente fórmula, siendo k número de líneas de eje (k=1 en este proyecto) y Le la eslora de la línea de eje (Le=6 m como valor de referencia).

$$Ple = k * Le * (5 + 0.0164 * Lpp)$$

$$Ple = 56{,}69\ t$$

- HABILITACIÓN Y EQUIPO.

Se calculará mediante la siguiente fórmula, siendo $k = 0.36 - 0.53 * 10^{-3} * Lpp$

$$Phe = k * Lpp * B$$

Por tanto, se obtiene que k= 0,213 y entonces,

$$Phe = 2.662{,}42\ t$$

12.1.4 RESULTADO NUEVO PESO EN ROSCA.

Se presentan las diferentes partidas calculadas y el resultado final del peso en rosca.

PESO en t	
PS	31242,70
PSE	1251,44
PMp	2289,05
PQr	679,22
Ple	56,69
Phe	2662,42
LWT	38181,52

12.2 NUEVO PESO MUERTO.

Se calculará restando el peso en rosca al desplazamiento antes calculado con

$$\Delta = Cb * k * d * L * B * T \cong 116.599{,}36\ t$$

.

$$DWT = \Delta - LWT$$

$$DWT = 116.599{,}36 - 38.181.52$$

$$DWT = 78.417{,}84\ t$$

Los pesos más importantes de este punto son la carga útil y los consumos. Para el cálculo de la carga útil tomaremos 0.46 la densidad del gas. Por tanto, se obtiene:

$$Cu = 0.46 * 160000 = 73.600\ t$$

A continuación se calculará un valor orientativo de los consumos. Más adelante del proyecto se detallará.

- Peso del combustible.

$$Pcomb = Autonomía(h) * BHP * Ce * 10^{-6}$$

Ce consumo específico del motor principal. Para grupos electrógenos, un valor medio de 170 g/BHP (Libro: “Proyecto de buques y artefactos”).

Autonomía de 5000 millas a 19.5 kn de velocidad de servicio.

$$t_{navegación} = \frac{Autonomía}{Velocidad} = 256.41\ h \approx 10.5\ días$$

BHP la potencia calculada anteriormente, 34080,38 hp.

Por tanto el peso del combustible será, $Pcomb = 1.485{,}55\ t$

- Peso del agua dulce.

200 litros por persona y día. 11 días de autonomía aproximadamente y 40 personas a bordo.

$$Pad = 200 * 11 * 40 * 10^{-3}$$

$$Pad = 88\ t$$

- Peso de aceite.

Se suele aproximar al 3-4% del peso del combustible, por tanto:

$$Pac = 0.04 * 1.485{,}55 = 59{,}42\ t$$

Por tanto, en una primera aproximación tenemos que el peso muerto de estas partidas será:

$$DWT = 75.232.97\ t$$

El valor obtenido antes es mayor, se observa que tenemos margen para otros pesos que no hemos contado. (≈3184 t de margen).

13. ESTIMACIÓN POTENCIA PROPULSORA.

13.1 ESTIMACIÓN MEDIANTE FÓRMULA.

Para el cálculo de la potencia necesaria se estimará a partir de la fórmula de D.G.M.Watson:

$$BHP = \frac{0.889*\Delta^{2/3}*(40-\frac{Lpp}{61}+400*0.1^2-12*Cb)}{15000-1.81*N*Lpp^{0.5}}*V^3$$

Siendo,

Δ=116.599,36 t

Lpp=271.3 m

Cb=0.745

V=19.5 kn.

N, las revoluciones del motor que se tomará de referencia las revoluciones de la base de datos del buque Seri Balhaf N=78 rpm

Sustituyendo valores se obtiene el valor de la potencia:

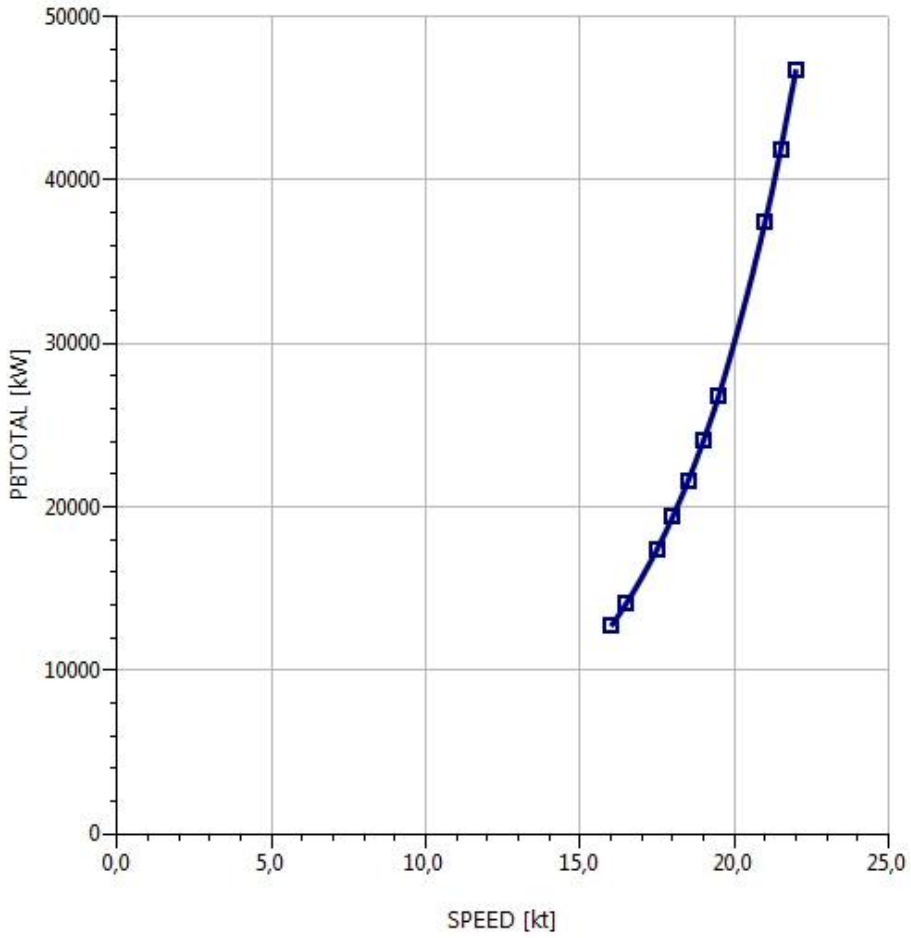
$$BHP = 34.080{,}38HP$$

$$BKW = 25.413{,}74\ KW$$

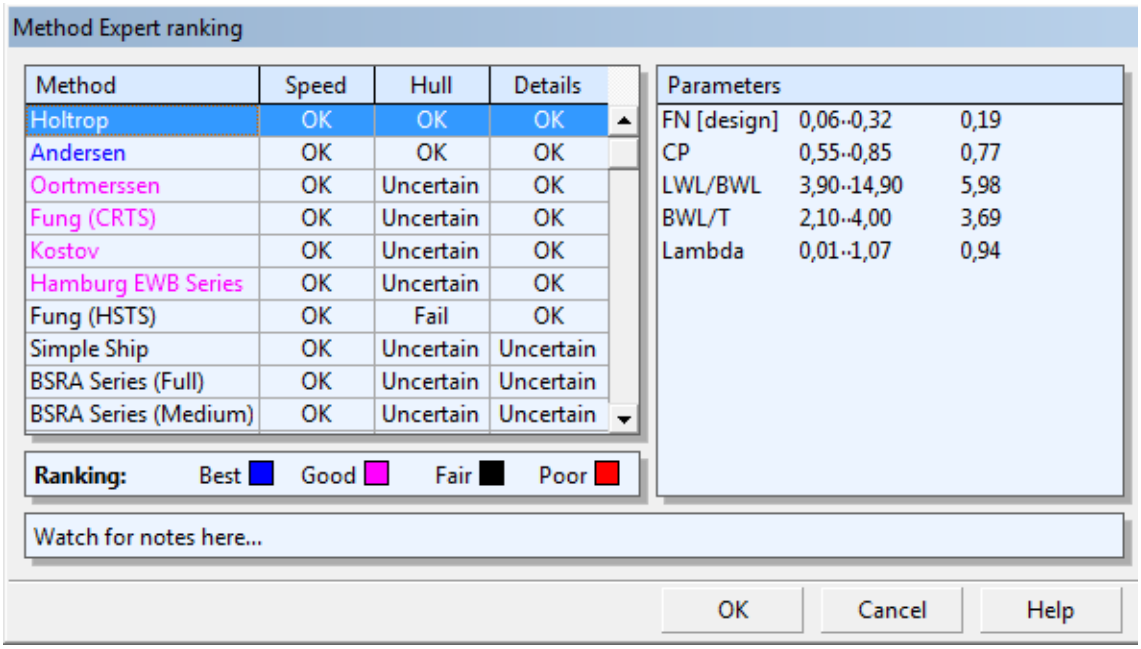
13.2 ESTIMACIÓN MEDIANTE NAVCAD.

Se estimará la potencia necesaria mediante el software de Hydrocomp. Para este primer cuaderno, los valores tomados serán aproximados. Se puede observar que para un primer cálculo la potencia no difiere mucho comparado con lo estimado mediante la fórmula de Watson. Para una velocidad de servicio de 19,5 kn se obtiene una potencia total de 26.845,7 KW.

Esta potencia proporcionada por Navcad es la potencia al freno que necesita la hélice. Esto quiere decir que esta potencia es la que tiene que tener el motor eléctrico que accionará la hélice. Los motores diesel generadores deberán entregar una potencia mayor para satisfacer la demanda del motor eléctrico y la de los demás consumidores del buque.



Se ha utilizado Holtrop, ya que una vez metidos los datos, cumplía los parámetros para realizar un cálculo óptimo.



Se han tomado medidas del buque base BARCELONA KNUTSEN como medidas relacionadas con el bulbo.

Otros valores requeridos para el cálculo los proporciona el software, se deberán cumplir los parámetros para que el cálculo sea acertado. Más adelante del proyecto se calculará la potencia con los datos del buque proyecto.

A continuación se muestra los datos utilizados y en el anexo II los resultados de dicho cálculo.

Vessel drag	Calc	ITTC-78 (CT)
Technique:		Prediction
Prediction:		Holtrop
Reference ship:		
Model LWL:	[m]	
Viscous		
Expansion:		Standard
Friction line:		ITTC-57
Hull form factor:	On	1,299
Speed corr:	Off	
Spray drag corr:	Off	
Corr allowance:		ITTC-78 (v2008)
Roughness [mm]:	Off	
Catamaran		
Interference:	Off	
Added drag		
Appendage:	Off	
Wind:	Off	
Seas:	Off	
Shallow/channel:	Off	
Towed:	Off	
Margin:	Off	

Type	Task
	Right-click to add a task...

Project		
Project ID:	LNG	
Description:	membrana	
Summary		
Scope:	ITTC-78 (CT)	
Configuration:	Monohull	
Chine type:	Round/multiple	
Length on WL:	271,300	m
Displacement:	119484,50	t
Propulsor type:	Propeller	
Count:	1	
Water properties		
Water type:	Salt	
Density:	1026,00	kg/m3
Viscosity:	1,18920e-6	m2/s
Speeds		
Speed [01]	16,00	kt
Speed [02]	16,50	kt
Speed [03]	17,50	kt
Speed [04]	18,00	kt
Speed [05]	18,50	kt
Speed [06]	19,00	kt
Speed [07]	19,50	kt
Speed [08]	21,00	kt
Speed [09]	21,50	kt
Speed [10]	22,00	kt
Design condition		
Design speed:	19,50	kt

Hull		
Configuration:	Monohull	
Chine type:	Round/multiple	
General		
Length on WL:	271,300	m
Max beam on WL:	45,000	m
Max molded draft:	12,300	m
Displacement:	119484,50	t
Wetted surface:	15541,7	m2
Demi-hull spacing:		m
ITTC-78 (CT)		
LCB fwd TR:	135,650	m
LCF fwd TR:	135,650	m
Max section area:	555,1	m2
Waterplane area:	10408,3	m2
Bulb section area:	38,0	m2
Bulb ctr below WL:	7,200	m
Bulb nose fwd TR:	276,300	m
Imm transom area:	0,0	m2
Transom beam WL:	0,000	m
Transom immersion:	0,000	m
Half entrance angle:	35,56	deg
Bow shape factor:	1,0	[WL flow]
Stern shape factor:	1,0	[WL flow]
Planing		
Proj chine length:		m
Proj bottom area:		m2
LCG fwd TR:		m
VCG below WL:		m
Aft station (fwd TR):		m
Deadrise:		deg

Propulsor		
Count:	1	
Propulsor type:	Propeller series	
Propeller type:	FPP	
Propeller series:	B Series	
Propeller sizing:	By total drag	
Reference prop:		
Blade count:	4	
Expanded area ratio:	0,6619	
Propeller diameter:	9000,0	mm
Propeller mean pitch:	7235,0	mm
Hub immersion:	7500,0	mm
Engine/gear		
Engine data:	None defined	
Rated RPM:		RPM
Rated power:		kW
Gear efficiency:	0,970	
Load correction:	On	
Gear ratio:	0,978	
Shaft efficiency:	0,980	
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:	None	
KT multiplier:	1,000	
KQ multiplier:	1,000	
Blade T/C [0.7R]:	0,00	
Roughness:	0,00	mm

14. CÁLCULO DEL FRANCOBORDO.

Se tomará como referencia el Convenio Internacional de líneas de carga. El primer paso es definir el tipo de buque, en este caso lleva sustancias líquidas a granel, por tanto es un buque **TIPO A**.

- FRANCOBORDO TABULAR.

Se escoge el valor más alto de: 96% de la eslora al 85% de puntal o la eslora entre perpendiculares de esa flotación. Para un primer aproximamiento se considerará la eslora entre perpendiculares ya que no tenemos todavía esos valores.

Interpolando en las tablas para buques tipo A se obtiene un francobordo tabular.

$$FBt = 3165\ mm$$

A este valor se le aplicarán las diferentes correcciones.

- CORRECCIÓN POR COEFICIENTE DE BLOQUE.

Para coeficientes de bloque superiores a 0.68, como en este caso, se aplicará el siguiente factor multiplicador para corregirlo.

$$\frac{C_b + 0.68}{1.36} = \frac{0.745 + 0.68}{1.36} = 1.05$$

Por tanto, el francobordo por ahora queda como $FBt = 3323\ mm$

- CORRECCIÓN POR PUNTAL.

Se aplicará la corrección por puntal si éste es superior a Lpp/15. En este caso D= 26.4 m y el ratio Lpp/15=18.09; por tanto el francobordo deberá aumentarse en:

$$\left(D - \frac{Lpp}{15}\right) * R = 2078\, mm$$

Siendo R=250 para esloras superiores a 120 m. En este punto tenemos un francobordo de:

$$FB = 5401\, mm$$

- CORRECCIÓN POR SUPERESTRUCTURA.

Para esloras mayores a 122 m se aplicará una reducción de 1070 mm. Si la superestructura no ocupa toda la eslora se le aplicará un factor de corrección. En este caso, y tomando como referencia que la longitud de la superestructura es 1/6 de la eslora entre perpendiculares, la superestructura es 0.17*Lpp. Para un buque tipo A e interpolando se obtiene el porcentaje que hay que aplicarle a dicha reducción.

$$1070 * 11{,}9\% = 127\, mm$$

Por tanto aplicando este reducción, tenemos que $FB = 5274\, mm$

- CORRECCIÓN POR ARRUFO.

Se considerará que la cubierta no tiene arrufo. Se aplicará una corrección a partir de la tabla de arrufo normal.

	SITUACIÓN	ORDENADA (mm)	FACTOR
MITAD DE POPA	PERPENDICULAR POPA PPP	25*(L/3 + 10)	1
	1/6 L DESDE LA PPP	11,1*(L/3 + 10)	3
	1/3 L DESDE LA PPP	2,8*(L/3 + 10)	3
	CENTRO BUQUE	0	1
MITAD DE PROA	CENTRO BUQUE	0	1
	1/3 L DESDE LA PPR	5,6*(L/3 + 10)	3
	1/6 L DESDE LA PPR	22,2*(L/3 + 10)	3
	PERPENDICULAR PROA PPR	50*(L/3 + 10)	1

Para calcular el defecto de arrufo se utilizará la función de Simpson. Se calculará tanto para popa como para proa y se obtendrá el valor medio.

$$Ypopa = \frac{1 * 25 * \left(\frac{L}{3} + 10\right) + 3 * 11.1 * \left(\frac{L}{3} + 10\right) + 3 * 2.8 * \left(\frac{L}{3} + 10\right) + 1 * 0}{8}$$

$$Yproa = \frac{1 * 50 * \left(\frac{L}{3} + 10\right) + 3 * 22.2 * \left(\frac{L}{3} + 10\right) + 3 * 5.6 * \left(\frac{L}{3} + 10\right) + 1 * 0}{8}$$

A la parte de popa es necesario restar un defecto de arrufo debido a la superestructura.

$$\left(0.75 - \frac{S}{2 * L}\right)$$

Se obtiene unos valores de:

	SITUACIÓN	ORDENADA (mm)	FACTOR	producto
MITAD DE POPA	PERPENDICULAR POPA PPP	25*(L/3 + 10)	1	2510,83
	1/6 L DESDE LA PPP	11,1*(L/3 + 10)	3	3344,43
	1/3 L DESDE LA PPP	2,8*(L/3 + 10)	3	843,64
	CENTRO BUQUE	0	1	0,00
MITAD DE PROA	CENTRO BUQUE	0	1	0,00
	1/3 L DESDE LA PPR	5,6*(L/3 + 10)	3	1687,28
	1/6 L DESDE LA PPR	22,2*(L/3 + 10)	3	6688,86
	PERPENDICULAR PROA PPR	50*(L/3 + 10)	1	5021,67

Para calcular el defecto de arrufo se usará:

$$C_{arrufo} = \frac{Ypopa - \left(0.75 - \frac{S}{2 * L}\right) + Yproa}{2}$$

Siendo S la longitud de la superestructura que se ha aproximado a Lpp/6 y L la eslora que se ha tomado de referencia. Para este primer cuaderno es la eslora entre perpendiculares como ya se ha mencionado al inicio del cálculo.

$$C_{arrufo} = 1256\ mm$$

Por tanto, se aumenta este valor al francobordo y se obtiene el francobordo final geométrico.

$$FB = 6530\ mm$$

El francobordo real es la diferencia entre el puntal y el calado y el resultado es mayor al proporcionado por el convenio de líneas de carga al tratarse de un buque de volumen.

$$FB_{real} = D - T = 14100\ mm$$

14.1 RESULTADOS FRANCOBORDO.

Se muestra en la siguiente tabla los distintos francobordos mínimos calculados según la norma para un calado de 12300 mm.

FRANCOBORDO	milímetros
DE VERANO	6530
TROPICAL	6110
DE INVIERNO	6950
ATLÁNTICO NORTE	6950

15. ESPECIFICACIÓN PRELIMINAR.

15.1 TIPO DE BUQUE.

Este proyecto presenta un buque para transporte de gas licuado. Constará de cuatro tanques, cámara de máquinas y superestructura a popa. En esta especificación se mencionará los aspectos más importantes para tener una idea del buque que se proyectará.

Las características principales del buque son las siguientes, teniendo en cuenta que en esta fase los valores de potencia y peso muerto son aproximados.

Lpp (m)	271,3
B (m)	45,4
D (m)	26,4
T (m)	12,3
Δ (t)	119484,49
DWT	78417,84
LBD (m3)	324682,40
Cb	0,745
BKW	25413,74

El buque constará de una hélice de paso fijo propulsada por un motor eléctrico accionado por motores dual-fuel diesel-eléctrico.

Podrá transportar 160.000 m^3 de gas licuado en cuatro tanques, construidos con una membrana No 96 GTT.

El buque se regirá por la Sociedad de Clasificación Bureau Veritas. Otros reglamentos importantes que deberá cumplir son los siguientes:

- SOLAS, Convenio Internacional para la Seguridad de la Vida Humana en el Mar.
- MARPOL, Convenio Internacional para Prevenir la Contaminación.
- Código CIG, Convenio Internacional para la construcción y equipos de buques que transporten Gases licuados a granel.
- Reglamento Internacional Líneas de Carga 1966.
- IMO, Reglamento Internacional de Arqueo

15.2 DESCRIPCIÓN DEL CASCO.

El casco del buque se realizará con acero naval de prestaciones normales (tensión máxima admisible 235 N/mm^2). La estructura del casco será de tipo longitudinal ya que para barcos con esloras grandes resulta más eficiente frente a la estructura transversal.

Los escantillonados serán calculados de acuerdo con lo exigido por la Sociedad de Clasificación de Bureau Veritas. Cumplirán el mínimo exigido.

Constará de un doble fondo en toda la estructura del casco. Los laterales del doble casco se utilizarán para tanques de lastre. En la zona de proa y popa habrá también un tanque de lastre para asegurar la navegabilidad cuando el buque no lleve carga.
Los cuatro tanques de gas licuado estarán separados entre sí mediante cofferdams para asegurar la estanqueidad de la carga. La estructura de los tanques será del tipo prismático. Llevará un bulbo en proa para disminuir la resistencia por formación de olas, mejorando el rendimiento de la hélice.

15.3 EQUIPO, ARMAMENTO E INSTALACIONES.

Cada tripulante dispondrá de un camarote individual sencillo que constará de:

- Cama de 2000x900 mm con mesilla de noche.
- Televisión.
- Mesa de escritorio con silla.
- Sillón.
- Aseo: ducha, servicio y lavabo.
- Armarios y cajones.

Por otro lado, el Capitán, el Jefe de máquinas y el primer Oficial dispondrán a mayores de una pequeña zona de despacho en el camarote. Las características serán:

- Cama de 2000x1500 con dos mesillas de noche.
- Televisión y zona de minibar.
- Zona de sofá y sillones así como escritorio.
- En la zona de aseo habrá una bañera, servicio y lavabo.
- Armarios y cajones.

A continuación se mencionarán diferentes espacios del buque:

- En el comedor habrá sillas y sillones para toda la tripulación así como televisores.
- La sala de ocio constará de ordenadores, zonas de mesas y zona con proyector.
- La sala de reuniones tendrá elementos para guardar documentación o registros.
- Una zona de gimnasio que constará de: cintas, bicicletas eléctricas, pesas y una zona libre de máquinas.

- Zona de reuniones común con mesas, sillas y ordenador.

- Aseos y vestuarios en zonas comunes.

- Zona de lavandería, donde habrá lavadoras y secadoras para atender a todas las demandas de la tripulación.

- Zona de enfermería con los medios para una atención primaria. Habrá tripulantes formados en primeros auxilios y atención básica.

En la zona de carga se tendrá que considerar:

- Habrá 8 bombas de carga, dos para cada tanque. Se estima 8 horas de llenado (dato tomado del Barcelona Knutsen).

- Los cofferdams son todos compartimentos secos que se calentarán por medio de glycol, para evitar que su temperatura sea demasiado baja al estar en contacto con la carga a -160ºC.

- Los espacios de lastre alrededor de cada tanque, por el costado, se llenarán y vaciarán a través de un conducto en crujía (pipe duct).

- Los espacios de aislamiento de la membrana primaria y secundaria de los tanques estarán bajo una presión controlada mediante nitrógeno. Se recomienda que la presión en el espacio de barrera primaria se mantenga en 0,2 kPa por encima de la presión de la barrera secundaria.

- Las líneas principales de nitrógeno para las barreras primaria y secundaria también están situadas en la cubierta de carga junto con la línea de contra-incendios y la de spray de cubierta.

- Los tanques estarán preparados para contener o menos de un 20% o más de un 70% de su capacidad total, para evitar superficies o aumento de presiones debido al BOG.

- La GCU es la unidad de combustión de gas. Constará de dos quemadores que garanticen la buena combustión del gas excedente que se produce por evaporación en los tanques y del que los motores no puedan absorber.

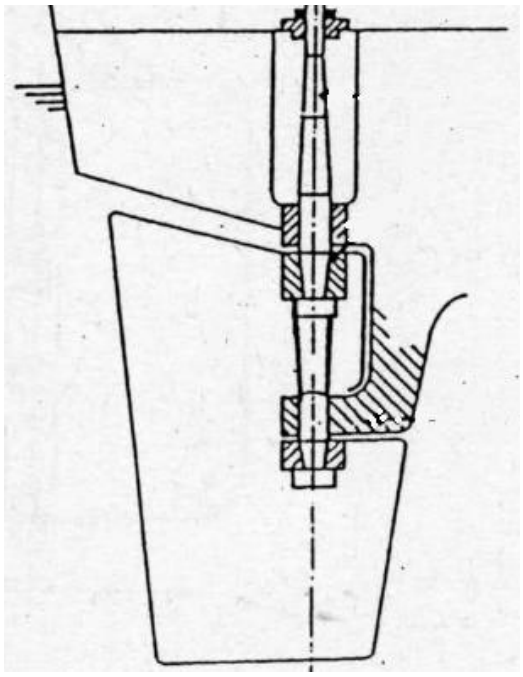
- La instalación eléctrica principal del buque constará de dos redes trifásicas, una para los servicios normales y otra de emergencia. También tendrá un circuito monofásico para los equipos normales, para la habilitación y para el alumbrado. Habrá cuadros eléctricos secundarios donde sea necesario: cocinas, salas de estar…

- En una zona se dispondrá la conexión al cuerpo principal del buque (Conexión a tierra) con los medios de seguridad necesarios: aislamiento, bornes de conexión protegidos, fusibles, lámpara de indicación de fases... El dimensionado de los cables se hará según lo exigido por la Sociedad de clasificación.

15.4 MAQUINARIA AUXILIAR EN CUBIERTA.

El buque tendrá un timón accionado por un servomotor y cumplirá lo requerido por el SOLAS. El servo se dimensionará para que el giro de banda a banda de 70º se produzca en un máximo de 30 segundos con el buque navegando a máxima velocidad y con una sola bomba.

El servo constará de bombas hidráulicas para emergencias, pilotos automáticos y aparatos eléctricos de accionamiento.
El timón será del tipo semi-compensado. Se muestra una imagen a continuación:



El buque constará de una planta generadora de emergencia situada por encima de la cubierta principal cumpliendo lo exigido por los reglamentos. Será totalmente autónoma de la cámara de máquinas.

15.5 INSTALACIÓN PROPULSORA.

Los motores duales (fuel-gas) son generadores de energía eléctrica que alimentan a los motores eléctricos que accionan la hélice y al resto de consumidores del buque.

La potencia necesaria se calculará de una manera más exacta mediante un software en el cuaderno 6. El buque tendrá cuatro motores duales. El buque podrá navegar de forma normal usando tres de los motores.

Constará de dos motores eléctricos que serán los que accionen la hélice. Se elegirá de acuerdo con la demanda de potencia del buque.

Se ha decidido instalar dos motores eléctricos por motivos de seguridad, de esta manera, si se avería uno de los motores eléctricos el buque no perderá el gobierno.
Se necesitará la instalación de una reductora entre los motores y la hélice debido a la diferencia de revoluciones. Con una única línea de ejes.

Se ha decidido instalar los siguientes motores teniendo en cuenta la demanda del buque y la potencia de la base de datos.

- 4 motores 18V50DF con una potencia de 17.550 kW

Funcionarán de forma simultánea tres motores 18V50DF. Teniendo en cuenta el 85% de MCR proporcionarán una potencia de 44.753 kW cubriendo las necesidades eléctricas del buque.

15.6 MAQUINARIA AUXILIAR DE MÁQUINAS.

El buque consta de diferentes sistemas y circuitos, uno muy importante será el sistema contra incendios.

En la zona de la superestructura habrá sistemas de detección de humo con alarma acústica y que utilizará aspersores de agua. Estos detectores se instalarán en cada zona del buque así como en escaleras o vías de evacuación.

En los buques que transporten productos tóxicos o inflamables, deberá instalarse un sistema de aspersores de agua contra incendios en diferentes zonas: partes expuestas de los tanques de carga, pañoles en cubierta. Las descargas del líquido licuado, los manifolds y las áreas de control de sus válvulas, así como cualquier otra área esencial para mantener la seguridad del buque y de la tripulación. El sistema debe ser capaz de cubrir las áreas mencionadas con un régimen uniforme de descarga de agua de 10l/m^2 por minuto para las superficies horizontales, y de 4l/m^2 por minuto para las superficies verticales.

Como protección individual respecto a la seguridad cada tripulante llevará:

- un aparato respiratorio autónomo (que no funcione con oxígeno almacenado).

- indumentaria protectora: botas, guantes y gafas de ajuste seguro, un cabo de rescate de alma de acero con cinturón y una lámpara antideflagrante.

16. CLASS NOTATION.

Se clasificará el buque de acuerdo con Bureau Veritas.

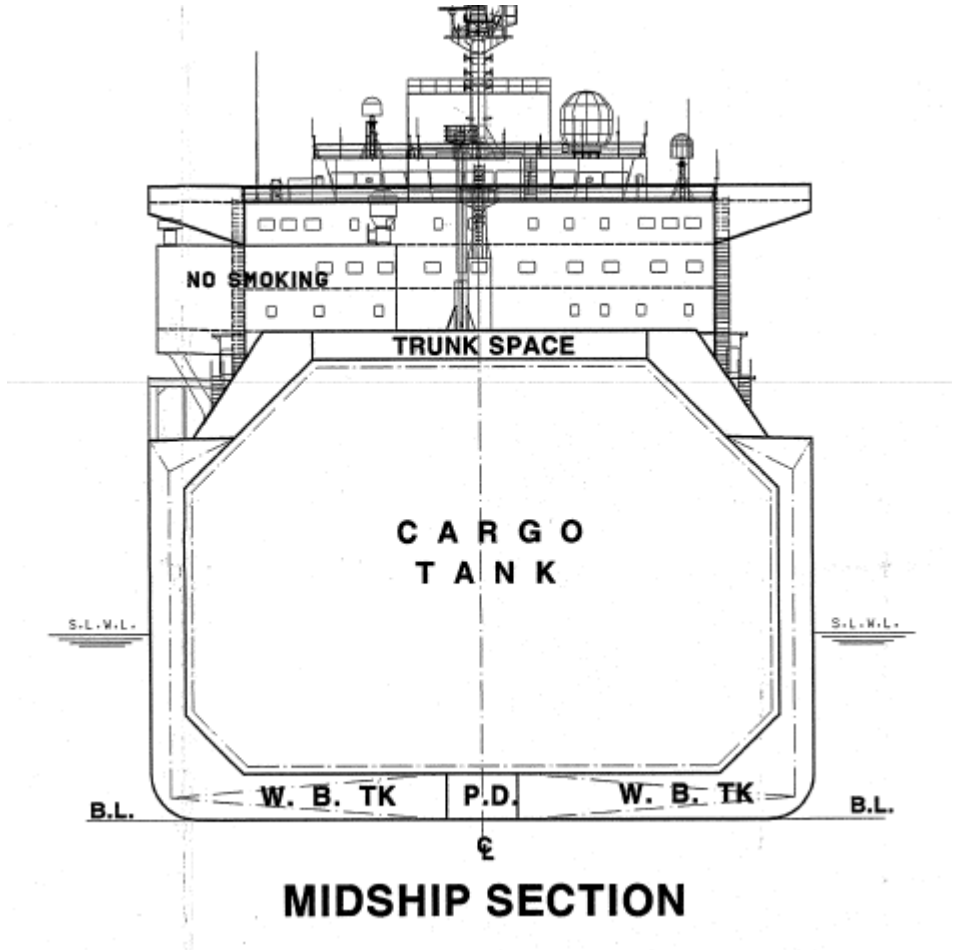
I ✠ HULL ✠ MACH licuefed gas carrier.

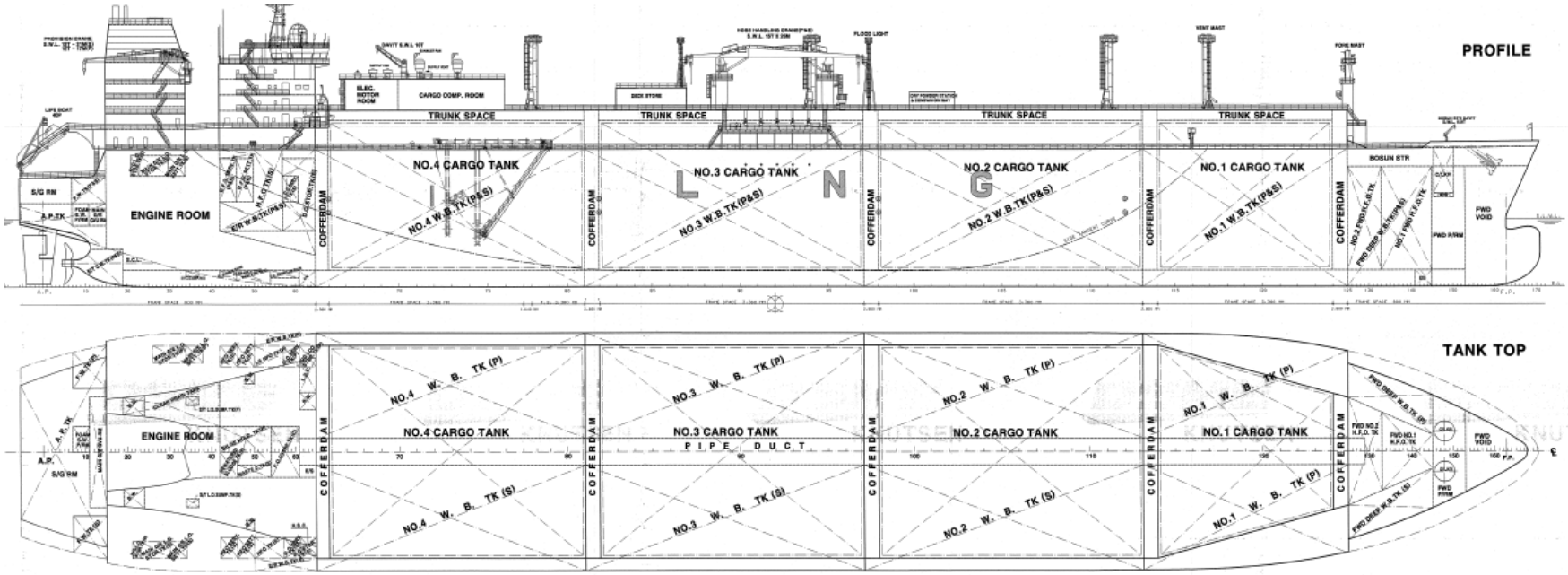
- ✓ AUT-UMS
- ✓ UNESTRICTED NAVIGATION
- ✓ AWT
- ✓ BWE
- ✓ CLEANSHIP
- ✓ COMF-NOISE
- ✓ COMF-VIB
- ✓ IN WATER SURVEY
- ✓ SYSNEQ-1
- ✓ FFS
- ✓ MON-HULL
- ✓ MON-SHAFT

17. DISPOSICIÓN GENERAL BUQUE BASE.

A continuación se muestra la disposición general del buque base Barcelona Knutsen con la finalidad de tener una idea de la disposición del buque proyecto. No están escalados.

Lpp (m)	271,3
B (m)	45,4
D (m)	26,4
T (m)	12,3




PROFILE
TRUNK SPACE
TRUNK SPACE
TRUNK SPACE
TRUNK SPACE
ELEC. MOTOR ROOM
CARGO COMP. ROOM
NO.4 CARGO TANK
NO.3 CARGO TANK
NO.2 CARGO TANK
NO.1 CARGO TANK
L N G
NO.4 W.B.TK(P&S)
NO.3 W.B.TK(P&S)
NO.2 W.B.TK(P&S)
NO.1 W.B.TK(P&S)
ENGINE ROOM
COFFERDAM
COFFERDAM
COFFERDAM
COFFERDAM
BOSUN STR
FWD VOID
FWD PWRM
S/G RM
A.P.TK
TANK TOP
NO.4 W. B. TK (P)
NO.3 W. B. TK (P)
NO.2 W. B. TK (P)
NO.1 W. B. TK (P)
NO.4 CARGO TANK
NO.3 CARGO TANK
PIPE DUCT
NO.2 CARGO TANK
NO.1 CARGO TANK
NO.4 W. B. TK (S)
NO.3 W. B. TK (S)
NO.2 W. B. TK (S)
NO.1 W. B. TK (P)
FWD DEEP W.B.TK (P)
FWD DEEP W.B.TK (S)
ENGINE ROOM
A.P.
S/G RM
COFFERDAM
COFFERDAM
COFFERDAM
COFFERDAM
FWD VOID
FWD PWRM

BIBLIOGRAFÍA

- PROYECTOS DE BUQUES Y ARTEFACTOS→Fernando Junco – EPS – UDC – Ferrol.
- EL PROYECTO BÁSICO DEL BUQUE MERCANTE→Ricardo Alvariño, Juan J. Aspiroz, Manuel Meizoso–FEIN Madrid.
- Material web.

ANEXO I. ALTERNATIVAS

ALTERNATIVA	L	B	D	T
558	271,28	45,39	26,37	12,34
557	271,28	45,39	26,37	12,46
556	271,28	45,39	26,37	12,59
555	271,28	45,39	26,37	12,72

ALTERNATIVA	Cb	Cm	Cp	Δ
558	0,767	0,992	0,774	119484,49
557	0,760	0,991	0,766	119484,49
556	0,752	0,991	0,759	119484,49
555	0,744	0,990	0,752	119484,49

ALTERNATIVA	Fn	BKW	CC	dCC
558	0,194	28562,00	111016632,10	-781116,01
557	0,194	28647,84	111054400,55	-743347,56
556	0,194	28733,68	111092169,00	-705579,11
555	0,194	28819,51	111129937,46	-667810,65

ANEXO II. NAVCAD

Resistance

21 dic 2017 06:27
HydroComp NavCad 2014

Project ID **LNG**
Description **membrana**
File name **LNG.hcnc**

Analysis parameters

Vessel drag		**ITTC-78 (CT)**	**Added drag**	
Technique:	**[Calc] Prediction**		Appendage:	**[Off]**
Prediction:		**Holtrop**	Wind:	**[Off]**
Reference ship:			Seas:	**[Off]**
Model LWL:			Shallow/channel:	**[Off]**
Expansion:		**Standard**	Towed:	**[Off]**
Friction line:		**ITTC-57**	Margin:	**[Off]**
Hull form factor:	**[On] 1,299**		**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 [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T	Lambda
Value	**0,19**	**0,77**	**6,03**	**3,66**	**0,94**
Range	**0,06··0,32**	**0,55··0,85**	**3,90··14,90**	**2,10··4,00**	**0,01··1,07**

Prediction results

	SPEED COEFS			ITTC-78 COEFS					
SPEED [kt]	FN	FV	RN	CF	[CTLT/CF]	CR	dCF	CA	CT
16,00	**0,160**	**0,376**	**1,88e9**	**0,001418**	**1,299**	**0,000122**	**0,000000**	**0,000245**	**0,002209**
16,50	**0,165**	**0,388**	**1,94e9**	**0,001412**	**1,299**	**0,000155**	**0,000000**	**0,000241**	**0,002231**
17,50	**0,175**	**0,411**	**2,05e9**	**0,001403**	**1,299**	**0,000237**	**0,000000**	**0,000232**	**0,002291**
18,00	**0,180**	**0,423**	**2,11e9**	**0,001398**	**1,299**	**0,000287**	**0,000000**	**0,000228**	**0,002331**
18,50	**0,185**	**0,435**	**2,17e9**	**0,001393**	**1,299**	**0,000343**	**0,000000**	**0,000224**	**0,002377**
19,00	**0,189**	**0,447**	**2,23e9**	**0,001389**	**1,299**	**0,000405**	**0,000000**	**0,000220**	**0,002429**
+ 19,50 +	**0,194**	**0,458**	**2,29e9**	**0,001385**	**1,299**	**0,000473**	**0,000000**	**0,000217**	**0,002489**
21,00	**0,209**	**0,494**	**2,46e9**	**0,001373**	**1,299**	**0,000721**	**0,000000**	**0,000205**	**0,002709**
21,50	**0,214**	**0,505**	**2,52e9**	**0,001369**	**1,299**	**0,000815**	**0,000000**	**0,000202**	**0,002795**
22,00	**0,219**	**0,517**	**2,58e9**	**0,001365**	**1,299**	**0,000914**	**0,000000**	**0,000198**	**0,002885**

	RESISTANCE							
SPEED [kt]	RBARE [kN]	RAPP [kN]	RWIND [kN]	RSEAS [kN]	RCHAN [kN]	RTOWED [kN]	RMARGIN [kN]	RTOTAL [kN]
16,00	**1187,49**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1187,49**
16,50	**1275,32**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1275,32**
17,50	**1473,63**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1473,63**
18,00	**1585,93**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1585,93**
18,50	**1708,28**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1708,28**
19,00	**1841,65**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1841,65**
+ 19,50 +	**1987,12**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**1987,12**
21,00	**2508,96**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**2508,96**
21,50	**2713,01**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**2713,01**
22,00	**2932,57**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**2932,57**

	EFFECTIVE POWER			OTHER				
SPEED [kt]	PEBARE [kW]	PETOTAL [kW]	CTLR	CTLT	RBARE/W			
16,00	**9774,3**	**9774,3**	**0,00220**	**0,03980**	**0,00101**			
16,50	**10825,3**	**10825,3**	**0,00279**	**0,04019**	**0,00109**			
17,50	**13266,7**	**13266,7**	**0,00427**	**0,04128**	**0,00126**			
18,00	**14685,7**	**14685,7**	**0,00517**	**0,04200**	**0,00135**			
18,50	**16258,1**	**16258,1**	**0,00617**	**0,04282**	**0,00146**			
19,00	**18001,1**	**18001,1**	**0,00729**	**0,04377**	**0,00157**			
+ 19,50 +	**19934,1**	**19934,1**	**0,00853**	**0,04483**	**0,00170**			
21,00	**27105,1**	**27105,1**	**0,01299**	**0,04881**	**0,00214**			
21,50	**30007,4**	**30007,4**	**0,01468**	**0,05035**	**0,00232**			
22,00	**33190,2**	**33190,2**	**0,01646**	**0,05198**	**0,00250**			

Report ID20171221-1827 HydroComp NavCad 2014 14.02.0029.S1002.539

Resistance

21 dic 2017 06:27
HydroComp NavCad 2014

Project ID	**LNG**
Description	**membrana**
File name	**LNG.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**271,300 m**
Max beam on WL:	[LWL/BWL 6,029]	**45,000 m**
Max molded draft:	[BWL/T 3,659]	**12,300 m**
Displacement:	[CB 0,776]	**119484,50 t**
Wetted surface:	[CS 2,765]	**15541,7 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,500]	**135,650 m**
LCF fwd TR:	[XCF/LWL 0,500]	**135,650 m**
Max section area:	[CX 1,003]	**555,1 m2**
Waterplane area:	[CWP 0,853]	**10408,3 m2**
Bulb section area:		**38,0 m2**
Bulb ctr below WL:		**7,200 m**
Bulb nose fwd TR:		**276,300 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:		**35,56 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:	***9000,0 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

21 dic 2017 06:27
HydroComp NavCad 2014

Project ID **LNG**
Description **membrana**
File name **LNG.hcnc**

Appendage data

General	
Definition:	**Percentage**
Percent of hull drag:	**5,00 %**
Planing influence	
LCE fwd TR:	**0,000 m**
VCE below WL:	**0,000 m**
Shafting	
Count:	**1**
Max prop diameter:	**9000,0 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:	**0**
Rudder location:	**Behind propeller**
Type:	**Balanced foil**
Root chord:	**0,000 m**
Tip chord:	**0,000 m**
Span:	**0,000 m**
T/C ratio:	**0,000**
LE sweep:	**0,00 deg**
Projected area:	**0,0 m2**
Wetted surface:	**0,0 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:	**0,0 m2**
VCE above WL:	**0,000 m**
Profile area:	**0,0 m2**
Superstructure	
Superstructure shape:	**Cargo ship**
Transverse area:	**0,0 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

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HydroComp NavCad 2014

Project ID	**LNG**
Description	**membrana**
File name	**LNG.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

Propulsion

Project ID **LNG**

Analysis parameters

Hull-propulsor interaction		**System analysis**	
Technique:	**[Calc] Prediction**	Cavitation criteria:	**Keller eqn**
Prediction:	**Holtrop**	Analysis type:	**Free run**
Reference ship:		CPP method:	
Max prop diam:	**9000,0 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 [Holtrop]

Parameters	FN [design]	CP	LWL/BWL	BWL/T
Value	**0,19**	**0,77**	**6,03**	**3,66**
Range	**0,06··0,80**	**0,55··0,85**	**3,90··14,90**	**2,10··4,00**

Prediction results [System]

		HULL-PROPULSOR			ENGINE			
SPEED [kt]	PETOTAL [kW]	WFT	THD	EFFR	RPMENG [RPM]	PBPROP [kW]	FUEL [L/h]	LOADENG [%]
16,00	**9774,3**	**0,4994**	**0,2114**	**1,0105**	**62**	**12702,4**	**---**	**0,0**
16,50	**10825,3**	**0,4990**	**0,2114**	**1,0105**	**64**	**14110,6**	**---**	**0,0**
17,50	**13266,7**	**0,4984**	**0,2114**	**1,0105**	**69**	**17432,9**	**---**	**0,0**
18,00	**14685,7**	**0,4981**	**0,2114**	**1,0105**	**71**	**19395,7**	**---**	**0,0**
18,50	**16258,1**	**0,4979**	**0,2114**	**1,0105**	**74**	**21597,3**	**---**	**0,0**
19,00	**18001,1**	**0,4976**	**0,2114**	**1,0105**	**76**	**24068,8**	**---**	**0,0**
+ 19,50 +	**19934,1**	**0,4973**	**0,2114**	**1,0105**	**79**	**26845,7**	**---**	**0,0**
21,00	**27105,1**	**0,4966**	**0,2114**	**1,0105**	**88**	**37455,1**	**---**	**0,0**
21,50	**30007,4**	**0,4964**	**0,2114**	**1,0105**	**91**	**41865,4**	**---**	**0,0**
22,00	**33190,2**	**0,4962**	**0,2114**	**1,0105**	**94**	**46767,3**	**---**	**0,0**

		POWER DELIVERY						
SPEED [kt]	RPMPROP [RPM]	QPROP [kN·m]	QENG [kN·m]	PDPROP [kW]	PSPROP [kW]	PSTOTAL [kW]	PBTOTAL [kW]	TRANSP
16,00	**63**	**1837,61**	**1878,41**	**12074,9**	**12321,3**	**12321,3**	**12702,4**	**759,3**
16,50	**66**	**1972,43**	**2016,23**	**13413,6**	**13687,3**	**13687,3**	**14110,6**	**704,9**
17,50	**70**	**2275,54**	**2326,07**	**16571,7**	**16909,9**	**16909,9**	**17432,9**	**605,1**
18,00	**73**	**2446,46**	**2500,78**	**18437,6**	**18813,9**	**18813,9**	**19395,7**	**559,4**
18,50	**75**	**2632,15**	**2690,60**	**20530,4**	**20949,4**	**20949,4**	**21597,3**	**516,3**
19,00	**78**	**2833,99**	**2896,92**	**22879,8**	**23346,7**	**23346,7**	**24068,8**	**475,9**
+ 19,50 +	**81**	**3053,52**	**3121,33**	**25519,6**	**26040,4**	**26040,4**	**26845,7**	**437,9**
21,00	**90**	**3836,74**	**3921,94**	**35604,9**	**36331,5**	**36331,5**	**37455,1**	**338,0**
21,50	**93**	**4141,65**	**4233,62**	**39797,3**	**40609,5**	**40609,5**	**41865,4**	**309,6**
22,00	**96**	**4469,10**	**4568,34**	**44457,0**	**45364,3**	**45364,3**	**46767,3**	**283,6**

	EFFICIENCY				THRUST			
SPEED [kt]	EFFO	EFFG	EFFOA	MERIT	THRPROP [kN]	DELTHR [kN]		
16,00	**0,5086**	**0,9700**	**0,7933**	**0,59274**	**1505,79**	**1187,48**		
16,50	**0,5073**	**0,9700**	**0,7909**	**0,59387**	**1617,17**	**1275,32**		
17,50	**0,5039**	**0,9700**	**0,7846**	**0,59706**	**1868,64**	**1473,63**		
18,00	**0,5016**	**0,9700**	**0,7806**	**0,59914**	**2011,03**	**1585,92**		
18,50	**0,4990**	**0,9700**	**0,7761**	**0,60151**	**2166,19**	**1708,28**		
19,00	**0,4960**	**0,9700**	**0,7710**	**0,60418**	**2335,31**	**1841,65**		
+ 19,50 +	**0,4927**	**0,9700**	**0,7655**	**0,60711**	**2519,77**	**1987,12**		
21,00	**0,4809**	**0,9700**	**0,7460**	**0,61736**	**3181,49**	**2508,96**		
21,50	**0,4765**	**0,9700**	**0,7389**	**0,62105**	**3440,24**	**2713,01**		
22,00	**0,4720**	**0,9700**	**0,7316**	**0,6248**	**3718,66**	**2932,57**		

Propulsion

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HydroComp NavCad 2014

Project ID **LNG**
Description **membrana**
File name **LNG.hcnc**

Prediction results [Propulsor]

	PROPULSOR COEFS								
SPEED [kt]	J	KT	KQ	KTJ2	KQJ3	CTH	CP	RNPROP	
16,00	**0,4333**	**0,2003**	**0,02716**	**1,067**	**0,33391**	**2,717**	**5,2871**	**6,16e7**	
16,50	**0,4320**	**0,2008**	**0,02722**	**1,0761**	**0,33758**	**2,7403**	**5,3451**	**6,38e7**	
17,50	**0,4284**	**0,2024**	**0,02738**	**1,1028**	**0,34832**	**2,8081**	**5,5151**	**6,83e7**	
18,00	**0,4260**	**0,2034**	**0,02749**	**1,1205**	**0,35552**	**2,8533**	**5,6292**	**7,07e7**	
18,50	**0,4233**	**0,2045**	**0,02761**	**1,1413**	**0,36404**	**2,9064**	**5,7641**	**7,31e7**	
19,00	**0,4202**	**0,2058**	**0,02775**	**1,1653**	**0,37391**	**2,9674**	**5,9203**	**7,57e7**	
+ 19,50 +	**0,4168**	**0,2072**	**0,02790**	**1,1925**	**0,38519**	**3,0366**	**6,0989**	**7,83e7**	
21,00	**0,4049**	**0,2122**	**0,02843**	**1,2945**	**0,42842**	**3,2963**	**6,7834**	**8,69e7**	
21,50	**0,4005**	**0,2140**	**0,02862**	**1,3342**	**0,44562**	**3,3974**	**7,0557**	**8,99e7**	
22,00	**0,3960**	**0,2158**	**0,02882**	**1,3761**	**0,464**	**3,5042**	**7,3468**	**9,31e7**	

	CAVITATION								
SPEED [kt]	SIGMAV	SIGMAN	SIGMA07R	TIPSPEED [m/s]	MINBAR	PRESS [kPa]	CAVAVG [%]	CAVMAX [%]	PITCHFC [mm]
16,00	**20,10**	**3,77**	**0,75**	**29,88**	**0,465**	**35,76**	**2,0**	**2,0**	**5708,7**
16,50	**18,87**	**3,52**	**0,70**	**30,92**	**0,485**	**38,41**	**2,0**	**2,0**	**5703,7**
17,50	**16,74**	**3,07**	**0,61**	**33,12**	**0,529**	**44,38**	**2,4**	**2,4**	**5689,4**
18,00	**15,80**	**2,87**	**0,57**	**34,27**	**0,554**	**47,76**	**2,7**	**2,7**	**5680,2**
18,50	**14,95**	**2,68**	**0,53**	**35,47**	**0,582**	**51,45**	**3,1**	**3,1**	**5669,5**
19,00	**14,15**	**2,50**	**0,50**	**36,71**	**0,612**	**55,46**	**3,6**	**3,6**	**5657,6**
+ 19,50 +	**13,42**	**2,33**	**0,47**	**38,00**	**0,644**	**59,84**	**4,2**	**4,2**	**5644,4**
21,00	**11,54**	**1,89**	**0,38**	**42,20**	**0,761**	**75,56 !!**	**6,9**	**6,9**	**5598,2**
21,50	**11,00**	**1,76**	**0,35**	**43,70**	**0,806**	**81,70 !!**	**8,2**	**8,2**	**5581,4**
22,00	**10,50**	**1,65**	**0,33**	**45,23**	**0,856**	**88,32 !!**	**9,7**	**9,7**	**5564,4**

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Propulsion

21 dic 2017 06:26
HydroComp NavCad 2014

Project ID **LNG**
Description **membrana**
File name **LNG.hcnc**

Hull data

General		
Configuration:		**Monohull**
Chine type:		**Round/multiple**
Length on WL:		**271,300 m**
Max beam on WL:	[LWL/BWL 6,029]	**45,000 m**
Max molded draft:	[BWL/T 3,659]	**12,300 m**
Displacement:	[CB 0,776]	**119484,50 t**
Wetted surface:	[CS 2,765]	**15541,7 m2**

ITTC-78 (CT)		
LCB fwd TR:	[XCB/LWL 0,500]	**135,650 m**
LCF fwd TR:	[XCF/LWL 0,500]	**135,650 m**
Max section area:	[CX 1,003]	**555,1 m2**
Waterplane area:	[CWP 0,853]	**10408,3 m2**
Bulb section area:		**38,0 m2**
Bulb ctr below WL:		**7,200 m**
Bulb nose fwd TR:		**276,300 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:		**35,56 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:	***9000,0 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 total drag**	
Reference prop:		
Blade count:	**4**	
Expanded area ratio:	**0,6619**	**[Size]**
Propeller diameter:	**9000,0 mm**	**[Keep]**
Propeller mean pitch:	[P/D 0,8039] **7235,0 mm**	**[Size]**
Hub immersion:	**7500,0 mm**	

Engine/gear		
Engine data:		
Rated RPM:	**0 RPM**	
Rated power:	**0,0 kW**	
Gear efficiency:	**0,970**	
Load correction:	**On**	
Gear ratio:	**0,978**	**[Size]**
Shaft efficiency:	**0,980**	

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:	**None**
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:	**9000,0 mm**
Design speed:	**19,50 kt**
Reference power:	**0,0 kW**
Design point:	**0,000**
Reference RPM:	**80,0**
Design point:	**1,000**

Propulsion

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HydroComp NavCad 2014

Project ID	**LNG**
Description	**membrana**
File name	**LNG.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. SIGNIFICANT SHIPS

ASIA VISION: LNG carrier for Chevron

Shipbuilder: **Samsung Heavy Industries**
Vessel's name: ***Asia Vision***
Hull No: **1920**
Owner/operator: **Chevron Transport Corporation Ltd.**
Country: **USA**
Designer: **Samsung Heavy Industries**
Country: **Korea**
Model test establishment used: **SSMB**
Flag: **Bahamas**
IMO number: **9606948**
Total number of sister ships already completed (excluding ship presented): **1**
Total number of sister ships still on order: **4**

Asia Vision is the first in the series of six electric-powered LNG carriers for US-based Chevron. The vessel was delivered in September from Samsung Heavy Industries (SHI) with sister vessel *Asia Energy* being delivered in September. A further two vessels will be delivered in 2015 with the last pair scheduled for 2016.

Asia Vision's four centre cargo tanks have a total capacity of 160,000m^3 which uses Gaz Transport & Technigaz's (GTT) Mark III membrane system and will keep the liquefied natural gas to a low temperature of -163°C, with a maximum daily boil-off rate of less than 0.15% of fully loaded cargo volume. The cargo system that has been installed is designed to be capable of loading or discharging the LNG within 12 hours using eight pumps that have been supplied by EBRA International Corporation Cryodynamics Division and have a capacity of 1,850m^3/h.

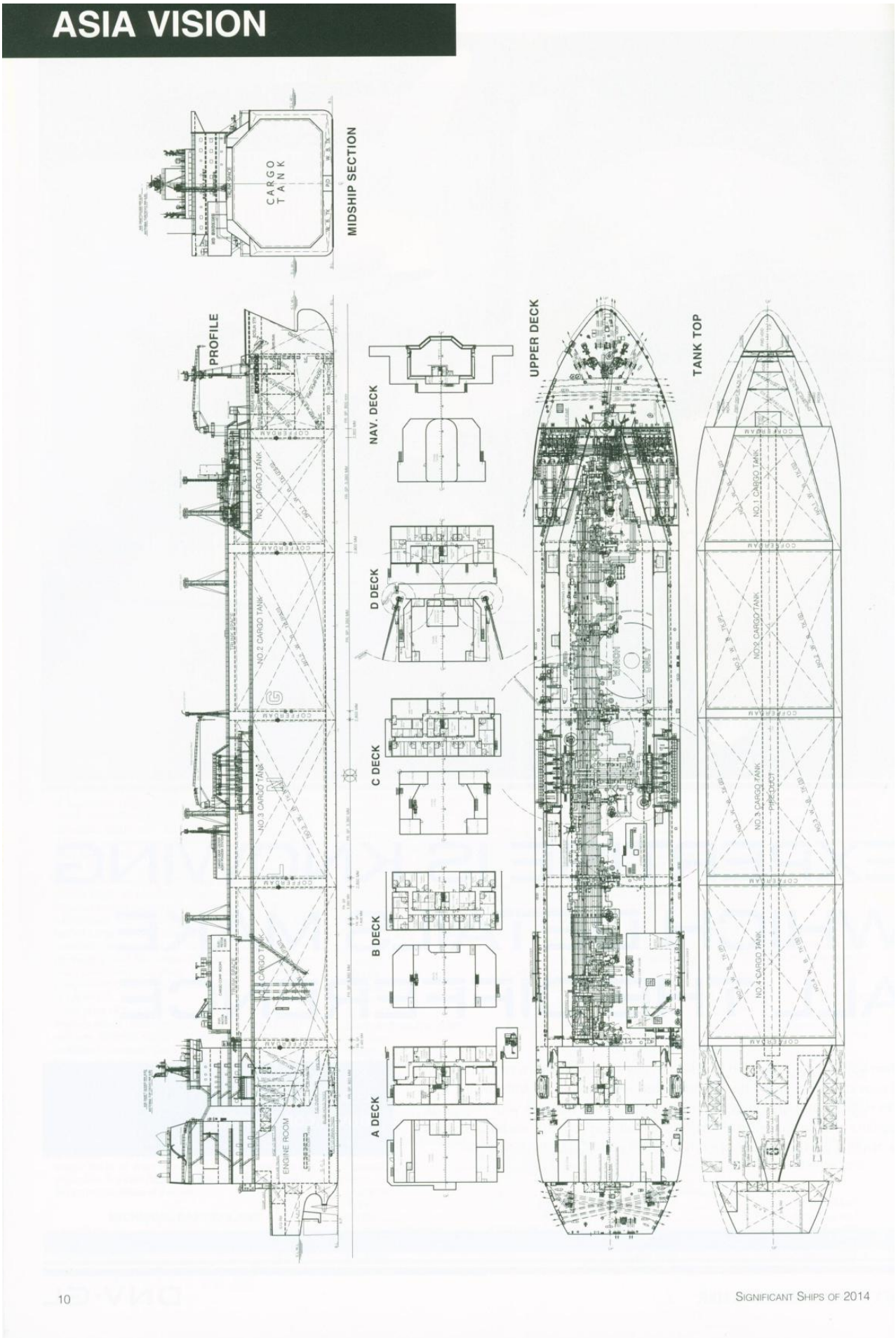
Powering of *Asia Vision* is through the main generator engines, which consist of three sets of Wärtsilä 12V50DF and one Wärtsilä 6L50DF, which are installed in two dedicated spaces in the engine room. The generators have a power output of 11,700kW and 5,850kW, respectively and allow the vessel to have a service speed of 19.5knots. Adding to this an energy saving device has been installed at the aft of the hull to enhance the vessel's powering performance.

The vessel is constructed in accordance with the rules and regulations of ABS classification society as an ocean going electric motor-driven LNG carrier. The design fatigue life is 40 years based on the ABS Rules SFA(40) procedure. A six tier deck house has also been provided for the accommodation of the crew.

TECHNICAL PARTICULARS

Length oa: 285.00m
Length bp: 274.00m
Breadth moulded: 43.40m
Depth moulded
To main deck: 26.40m
Width of double skin
Side: 2.36m
Bottom: 3.1m
Draught
Scantling: 12.75m
Design: 11.50m
Gross: 101,427gt
Deadweight
Design: 75,400dwt
Summer: 82,200dwt
Speed, service: 19.5knots
Cargo capacity
Liquid volume: 160,000m^3
Bunkers
Heavy oil: 4,400m^3
Diesel oil: 1,340m^3
Water ballast: 54,500m^3
Daily fuel consumption
Main engine only: 136tonnes/day
Classification society and notations: ABS +A1 E Liquefied gas carrier, Ship type 2G (membrane tank, Maximum pressure 25kPaG and Minimum Temperature -163°C), SH, SH-DLA, SFA(40), RES, +AMS, DFD, GCu, CRC, +ACCU, UWILD, +APS, ES, SHCM, NIBS, Port, POT, TCM
Main engine
Design: Wärtsilä
Model: 12V50DF, 6L50DF
Manufacturer: Wärtsilä
Number: 3+1
Type of fuel: HFO, MDO, Gas
Output of each engine: 11,700kW/ 5,850kW
Gearboxes
Make: RENK
Model: NDSH-3900
Number: 1
Propeller
Material: Ni-Al-Bronze
Designer/manufacturer: MMG
Number: 1
Fixed/controllable pitch: Fixed
Diameter: 8.6m
Speed: 19.5knots
Boilers
Number: 2
Type: Cylindrical
Make: Alfa Laval
Output, each boiler: 5,000kg/h & 1.0MPa
Cargo cranes/cargo gear
Number: 2
Make: Oriental Precision & Engineering Co., Ltd
Type: Electro-hydraulic driven, cylinder luffing type jib crane
Performance: 10tonnes cargo handling & F.O Hose handling
Other cranes
Number: 2 x provisions crane, 1 x cargo machinery
Make: Oriental Precision & Engineering Co., Ltd
Type: Electro Hydraulic driven, cylinder luffing type jib crane
Performance: 5tonnes, 10tonnes Provisions & Engine part handling 5tonnes cargo machinery maintenance
Mooring equipment
Number: 9 x Windlass (combined type)
Make: Rolls-Royce
Type: Electro-hydraulic driven, low pressure type
Special lifesaving equipment
Number of each and capacity: 1 x 46 persons
Make: Hatecke
Cargo pumps
Number: 8
Type: Centrifugal
Make: EBRA International Corporation Cryodynamics Division
Stainless steel: Aluminium Alloy casting
Capacity: 1,850m^3/h
Water ballast treatment system
Make: Samsung
Complement
Officers: 26
Crew: 14
Bridge control system
Make: Kongsberg
Type: K-Chief 700
Fire detection system
Make: Consilium
Type: Analogue addressable type
Fire extinguishing systems
Cargo holds: Wilhelmsen Technical Solutions/ CO_2
Engine room: Hi-Fog/ Water spray
Radars
Number: 1
Make: Sperry Marine
Model: Radar VisionMaster FT
Contract date: 18 December 2009
Launch/float-out date: 22 July 2013
Delivery date: 28 September 2014

ASIA VISION


MIDSHIP SECTION
CARGO TANK
PROFILE
NAV. DECK
D DECK
C DECK
B DECK
A DECK
UPPER DECK
TANK TOP
ENGINE ROOM
NO.1 CARGO TANK
NO.2 CARGO TANK
NO.3 CARGO TANK
NO.4 CARGO TANK
PIPE DUCT

CORCOVADO LNG: Gas carrier with DSME "shield type structure"

Shipbuilder: ...**Daewoo Shipbuilding & Marine Engineering (DSME)**
Vessel's name:.....***Corcovado LNG***
Hull no: **2297**
Owner/operator: ....**Ocenanus LNG Alpha LLC/ TMS Cardiff Gas Ltd**
Country:.....**Greece**
Designer:.....**Daewoo Shipbuilding & Marine Engineering (DSME)**
Country:.....**Korea**
Flag:.....**Malta**
IMO number: **9636711**
Total number of sister ships already completed (excluding ship presented): **2**
Total number of sister ships on order: **4**

CORCOVADO LNG is the latest 159,800m^3 LNG carrier for TMS Cardiff that utilises the Daewoo Shipbuilding & Marine Engineering (DSME) cargo containment structure that it calls its "shield type structure". This technology has only been applied to LNG regasification vessels to date. The vessel is the first in a series of four to be delivered to the UK-based owner.

The "shield type structure" allows a maximum pressure inside the cargo tank of up to 7bar, which enables it to store more LNG safely over conventional carriers. Traditionally conventional LNG carriers limit the pressure inside the cargo tanks to 2.5bar. The vessel also has a low boil off rate (BOR).

In addition to this *Corcovado LNG* has had further green technologies applied to it; these include a dual-fuel diesel-electric (DFDE) engine, which is a Wärtsilä 9L50DF with a power output of 8,775kW and gives the vessel a service speed of 19.95knots at the design draught of 11.5m. In addition a pre-swirl stator has been added to the propeller to improve the vessel's performance.

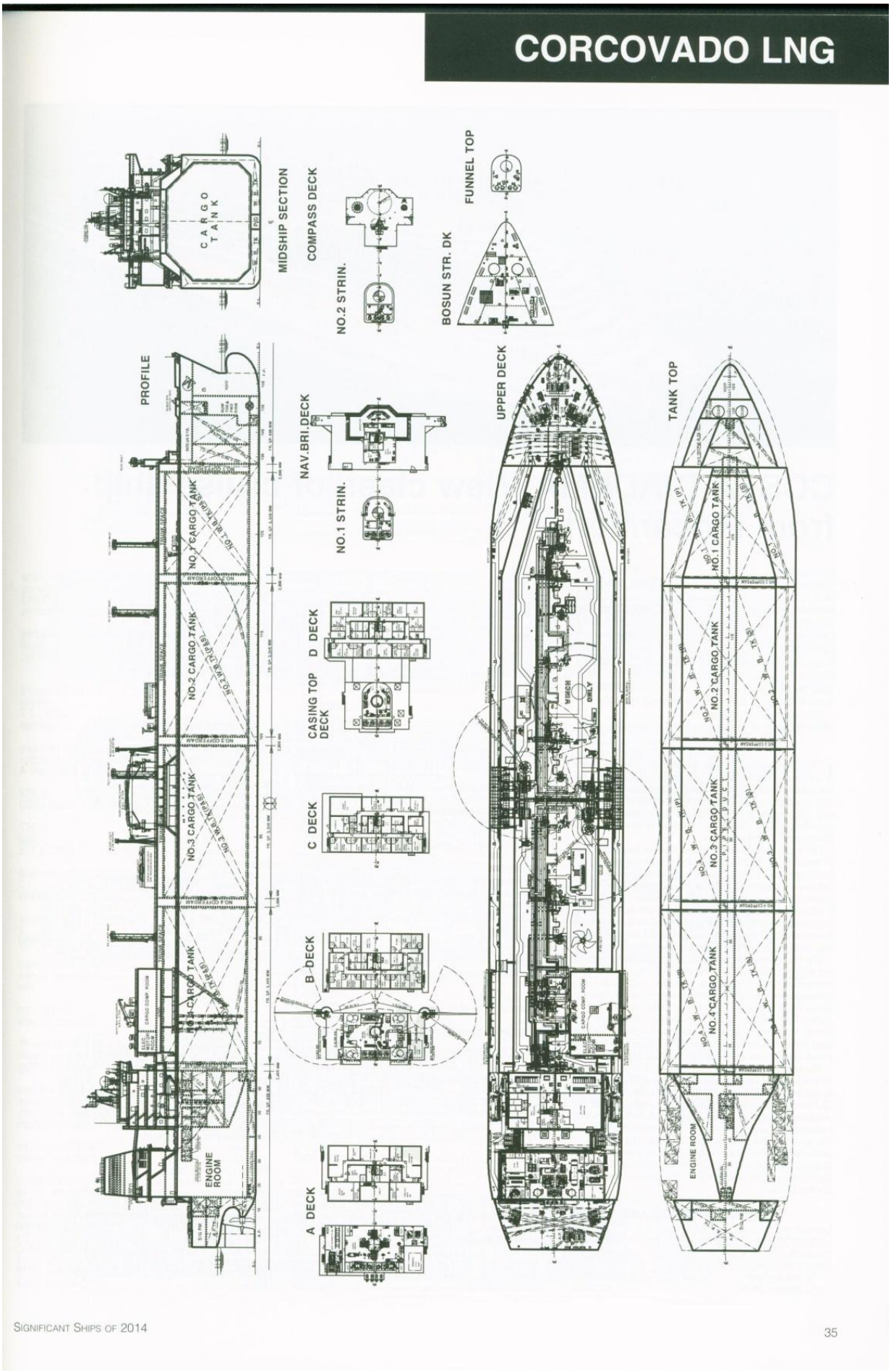
Two NK Ozone ballast water treatment systems have been installed which have a capacity of 3,000m^3/h to help it meet with future ballast water management convention requirements.

The vessel has been ordered to service the spot market and after delivery was sent to operate on the Bonny terminal for the loading of projects for Nigeria LNG.

TECHNICAL PARTICULARS

Length oa: 294.20m
Length bp: 283.20m
Breadth moulded:.....44.00m
Depth moulded
To upper deck: 26.00m
To inner deck:.....31.038m
To trunk decks:.....32.8m
Width of double skin
Side: 2.50m
Bottom:.....3.20m
Draught
Scantling: 12.5m
Design:.....11.5m
Gross: 103,900gt
Displacement: 122,890tonnes
Deadweight
Design:.....78,600dwt
Scantling: 89,600dwt
Speed, service: .....19.95knots at design draught 11.5m
Cargo capacity
Liquid volume:.....160,100m^3
Bunkers
Heavy oil: .....4,600m^3
Diesel oil:.....330m^3
Marine gas oil:.....840m^3
Water ballast:.....57,800m^3
Daily fuel consumption
Main engine only:..... 130.7tonnes/day
Classification society and notations:.....DNV +1A1, Tanker for Liquefied Gas, Ship type 2G (-163°C. 500kg/m^3, 0.35bar), NAUTICUS (Newbuilding), Plus, Coat-PSPC(B), E0, NAUT-OC, CLEAN, TMON, BIS, GAS Fuelled, BWM-T, OPP-F, Recyclable, COMF-V(3)C(3), F-AMC, ECA(SOX-A).
% high-tensile steel used in construction:..5.5%
Main engine
Design:.....Wärtsilä
Model: .....Wärtsilä 9L50DF
Manufacturer:.....Wärtsilä- Hyundai
Number: 4
Type of fuel:.....HFO, MDO, FG
Output of each engine: ....8,775kW x 514rpm
Main propulsion motors
Model: ..... N3 HXC 1000J8
Manufacturer:.....GE Energy
Number: 2
Output of each motor:..... 13, 260kW
Output speed: 651rpm
Gearboxes
Make: .....Renk
Model: NDSH-4060
Number: 1
Output speed: .....26,250kW x 86.9rpm
Propeller
Material: .....Ni-Al-Bronze
Diameter:.....8.6m
Special adaption: .....Pre-Swirl stator
Diesel-driven alternators
Number: 4
Alternator make/type:.....Hyundai Heavy Industries/ HAJ7 243-14P
Output/speed of each set:.....9,389kVA/ 514rpm
Boilers
Number: .....2 x auxiliary boiler, 2 x exhaust gas economiser
Type:.....Auxiliary boiler (vertical, water tube), exhaust gas economiser (smoke tube, forced circulated)
Make:.....Aalborg
Output, each boiler:..... 6,500kg/h, 2,000kg/h
Hose handling cranes
Number: 2
Make: .....DMC
Type:..... 2 x electro-hydraulically driven provision cranes with control stand
Performance:..... 10tonnes x 10m/min/ max working radius: 23.5m
Other cranes
Number: 2
Make: .....DMC
Type:..... 2 x electro-hydraulically driven provision cranes with control stand
Tasks: .....Provision for Engine room in Engine Casing
Performance:...SWL 5tonnes, working radius: max 17m – min: 4.8m
Mooring equipment
Number: .....2 x windlass/ 7 x mooring winch
Make: .....Rolls-Royce
Type:.... Electro-hydraulic, high pressure, non auto-tension
Special lifesaving equipment
Number of each and capacity: .....2 sets 42 persons
Make: .....HLB
Type:.....FRP totally enclosed type/ electric motor driven winch
Cargo pumps
Number: 8
Type:.....Fixed, centrifugal, vertical, submerged, single stage
Make: .....Shinko
Capacity:.....1,850m^3/h
Cargo control system
Make: .....Kongsberg
Type:.....K-Chief 700
Ballast control system
Make: .....Kongsberg
Type:.....K-Chief 700
Water ballast treatment system
Make: .....NK
Capacity:.....6,000m^3/h (2 x 3,000m^3/h)
Complement
Crew:.....14
Bow thrusters
Make: .....Kawasaki
Number: 1
Output: 2,200kW
Bridge control system
Make: .....Furuno
Type:.....FMD-3300
One-man operation: .....Yes
Fire extinguishing systems
Engine room:....NK HIGH Pressure CO_2 & HE Foam fire extinguishing system
Radars
Numbers: 2
Make: .....Furuno
Model: FCR-2829, FCR-2839S
Integrated bridge system
Make: .....Furuno
Model: FMD-3300
Waste disposal plant
Incinerator: .Hyundai-Atlas/MAXI 1500 SL WS
Waste compactor:.....Samjoo Eng/ TT160
Sewage plant: ..... Jonghap Machinery/ Aerob-25N
Contract date:.....28 July 2011
Launch/float-out date: .....20 July 2013
Delivery date: .....3 April 2014

CORCOVADO LNG



SIGNIFICANT SHIPS OF 2014 35

GOLAR ESKIMO: 160,000m^3 LNG carrier

Shipbuilder: ..... **Samsung Heavy Industries**
Vessel's name: ..... ***Golar Eskimo***
Hull No: **SN2024**
Owner/operator: ..... **Golar LNG**
Country: ..... **Norway**
Designer: ..... **Samsung Heavy Industries**
Country: ..... **Korea**
Model test establishment used: ..... **SSMB**
Flag: ..... **Marshall Islands**
IMO number: **9624940**
Total number of sister ships already completed (excluding ship presented): ..... **nil**
Total number of sister ships still on order: ..... **nil**

Golar Eskimo is the latest in LNG carrier designs for Golar LNG that was constructed at Samsung Heavy Industries and delivered to the owner at the end of 2014. The vessel was ordered because of what Golar LNG sees as a continued strong global LNG demand and supply growth that will require a significant amount of new infrastructure, including shipping, over the coming years.

Golar Eskimo features four centre cargo tanks that have a total capacity of 160,000m^3 that have designed by Gaz Transport & Technigaz (GTT), using their membrane system ("Mark III") that will keep the LNG at -163°C with a maximum daily boil-off rate of less than 0.15% of the fully loaded cargo volume. The maximum gas pressure in the tanks is 0.7bar MARVS (Maximum Allowable Relief Valve Setting) above the atmospheric pressure at operating as FSRU.

The cargo handling systems are designed to be capable of loading or discharging the LNG within thirteen hours using eight cargo pumps, supplied by Shinko and have a capacity of 1,750m^3/h. The re-gasification system is located forward of the vessel and consists of three skids.

The vessel has a dual fuel diesel electric engine which will be significantly more efficient than steam turbines thereby reducing fuel costs materially, the company also noted. Three Wärtsilä 12V50DF gensets and one Wärtsilä 6L50DF, are installed in two dedicated spaces in engine room for auxiliary power.

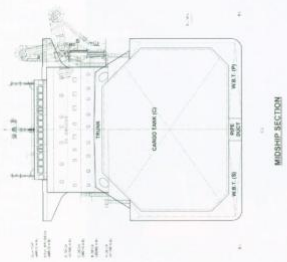
An energy saving device has been installed around the aft body of the hull to improve the vessel's performance. In addition a six tier deckhouse is located at the aft of the vessel to provide accommodation for 38 persons.

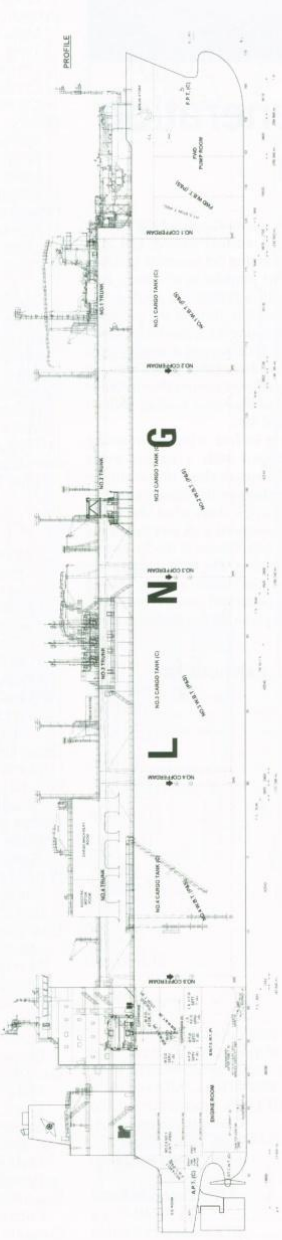
Golar Eskimo is constructed in accordance DNV GL rules and is suitable as an ocean going electric motor driven LNG FSRU (Floating, Storage and Re-gasification Unit).

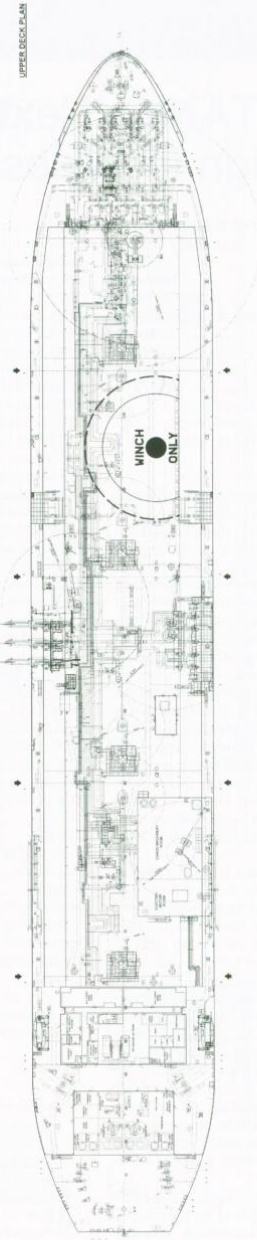
TECHNICAL PARTICULARS

Length oa: 280.5m
Length bp: 269.0m
Breadth moulded: 43.4m
Depth moulded
To main deck: 26.6m
Width of double skin
Side: 2.23m
Bottom: 3.1m
Draught (moulded)
Scantling: 12.75m
Design: 11.728m
Gross: 103,446gt
Deadweight
Design: 75,1910dwt
Summer: 80,040dwt
Speed, service: 19.9knots
Cargo capacity
Liquid volume: ..... 160,660m^3
Bunkers
Heavy oil: ..... 3,140m^3
Diesel oil: ..... 1,640m^3
Water ballast: ..... 53,350m^3
Daily fuel consumption
Main engine only: ..... 144.0tonnes/day including hotel power
Classification, society and notations: ..... DNV +1A1, Tanker for liquefied gas, ship type 2G (membrane tank, maximum pressure 70 kPaG, minimum temperature -1630C and specific gravity 500kg/m^3), NAUTICUS (newbuilding), E0, BIS, TMON, COAT-PSPC(B), NAUT-OC, GASFUELLED, COMF-V(3)C(3), CSA-2, CLEAN, recyclable, REGAS-2
Main engines
Design: ..... Wärtsilä
Model: 12V50DF, 6L50DF
Manufacturer: ..... Wärtsilä-Hyundai
Number: ..... 3 + 1
Type of fuel: ..... HFO or MDO or gas
Output of each engine: . 11,700kW / 5,850kW
Gearboxes
Make: ..... Renk
Model: NDSH-4120
Number: 1
Output speed: ..... 82.5rpm – 87.99rpm
Propellers
Material: ..... Nickel Aluminium Bronze
Designer/manufacturer: ..... Nakashima
Number: 1
Fixed/controllable pitch: ..... Fixed (fixed pitch propeller)
Diameter: 8.6m
Speed: 19.9knots
Diesel driven alternators
Alternator make/type: ..... ABB/AMG 1600, AMG1120
Output/speed of each set: ..... 12,222kVA & 6,111kVA, 514rpm
Boilers
Number: 2
Type: ..... Vertical, cylindrical
Output, each boiler: .....5,000kg/h & 1.0MPa
Cargo cranes/cargo gear
Number: 2
Make: ..... Oriental Precision & Engineering Co., Ltd
Type: ..... Electro-hydraulic driven, cylinder luffing type jib crane
Performance: ..... 5tonnes (SWL) Cargo handling & F.O. hose handling
Other cranes
Number: ..... 2 provision cranes, 1 cargo machinery room crane, 1 service crane for re-gasification unit
Make: ..... Oriental Precision & Engineering Co., Ltd
Type: ..... Electro-hydraulic driven, cylinder luffing type jib crane
Performance: ... 5tonnes (SWL), 10tonnes (SWL) Provisions & engine part handling, 5tonnes (SWL) cargo machinery maintenance, 10tonnes (SWL) service crane for re-gasification unit
Mooring equipment
Number: ..... 2 x Windlass (combined type) + 7 x Mooring winch
Make: ..... FLUTEK-KAWASAKI, Ltd
Type: ..... Electro-hydraulic driven, high pressure type
Special lifesaving equipment
Number of each and capacity: ..... 2 x 48 person each
Make: ..... Hyundai Lifeboat Co., Ltd
Type: ..... Conventional totally enclosed
Cargo tanks
Number: 4
Cargo pumps
Number: 8
Type: ..... Centrifugal
Make: ..... Shinko Ind. Ltd
Stainless steel: ..... Aluminium alloy casting
Capacity (each): ..... 1,750m^3/h
Cargo control system
Make: ..... Kongsberg
Integrated automation system
Make: ..... Kongsberg
Type: ..... IAS
Complement
Officers: 25
Crew: 13
Suez/repair crew: 10
Single/double/other rooms: 36/3/1
Bridge control system
Make: ..... ABB
Is bridge fitted for one-man operation: .....Yes
Fire detection system
Make: ..... Consilium
Type: ..... Addressable type
Fire extinguishing systems
Cargo holds: ..... Wilhelmsen Technical Solution / dry powder
Engine room: ..... Wilhelmsen Technical Solution / high expansion foam
Radars
Number: 2
Make: ..... Furuno
Model(s): ..... FCR-2839SW, FCR-2829W Integrated bridge system
Make: ..... Furuno
Model: FMD-3300
Waste disposal plant
Incinerator
Make: ..... Teamtec
Model: ..... GS500 CABDS
Sewage plant
Make: ..... IL Seung
Model: ISS-43N
Contract date: ..... 8 May 2011
Launch/float date: ..... 3 November 2012
Delivery date: ..... 17 December 2013

GOLAR ESKIMO







ABDELKADER: Tri-fuel DE LNG carrier

Shipbuilder: ..... **Hyundai Heavy Industries Co., Ltd**
Vessel's name: ..... ***Abdelkader***
Hull No: **1876**
Owner/operator: ..... **Mitsui OSK Lines (MOL)**
Country: ..... **Japan**
Designer: .... **Hyundai Heavy Industries Co., Ltd**
Country: ..... **Korea**
Model test establishment used: ..... **Hyundai Maritime Research Institute**
Flag: ..... **Bahamas**
IMO number: **9360922**
Total number of sister ships already completed (excluding ship presented): **1**
Total number of sister ships still on order: **0**

HYUNDAI Heavy Industries Co., Ltd (HHI) delivered the vessel Abdelkader to Mitsui OSK Lines (MOL) on 27 February. The vessel is a 177,000m^3 tri-fuel diesel electric liquefied natural gas (LNG) carrier, which is capable of serving the majority of the Atlantic terminals.

Abdelkader is equipped with four membrane cargo tanks and is designed and constructed as type 2G ship specified in IGC code, suitable for carrying LNG of which vapour pressures are withion the range from atmospheric pressure to 0.25bar g.

The vessel features a continuous deck with trunk/without forecastle and has a bulbous bow, lowered mooring deck, transom stern, open water type stern frame, single propeller driven by two electric motors.

Tank insulation is of GTT Mark III system, which has a 270mm thickness to satisfy the low boil off rate of 0.15% by volume of the total cargo per day. A shore manifold is provided on each of the upper decks between No.2 liquid dome and No.3 vapour dome. A compressor room is arranged in the area in way of No.4 tank.

Cargo discharging is done by eight pumps, two located in each of the tanks that each have a capacity of 1750m^3/hr. The supplementary gas during discharging comes from shore or is produced by an onboard LNG vaporiser to maintain cargo tank pressure. An emergency cargo pump is used when a cargo pump in a tank fails.

One LD compressor and one spray pump is used when the fuel pump is running to supply fuel gas to the engine room under normal sea going conditions. *Abdelkader* has four sets of main tri-feulled engines, two have 50% reversible synchronous motors (each with a power converter and associated transformers, control and excitation system), including one reduction gear (twin input/single output) with one propulsion shaft propeller. The vessel has a redundancy, so that failure of any motor drive auxiliary system shall not result in the loss of propulsion power.

The propulsion system onboard *Abdelkader* is a tri-fuelled diesel electric, capable of burning fuel gas, such as natural boil off gas forced boil off gas (FBOG) and also marine diesel oil (MDO) and heavy fuel oil (HFO). The power generating plant utilises all available natural boil off gas (NBOG) and makes up required power by burning additional MDO, HFO or FBOG. The main diesel engines are also fitted with exhaust gas economisers as a waste heat recovery system.

A gas combustion unit is fitted for periods when the NBOG cannot be burned in the tri-fuel diesel engines or when NBOG consumption is low and the cargo tank pressure rises. The tri-fuel diesel engines are fully compliant with MARPOL Annex VI regulation 13 and the NOx technical code.

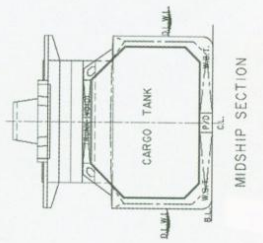
The engine control room and cargo control room contain all facilities to allow for centralised operations of plant and equipment and also allow for unattended operation of the machinery plant under all operational modes.

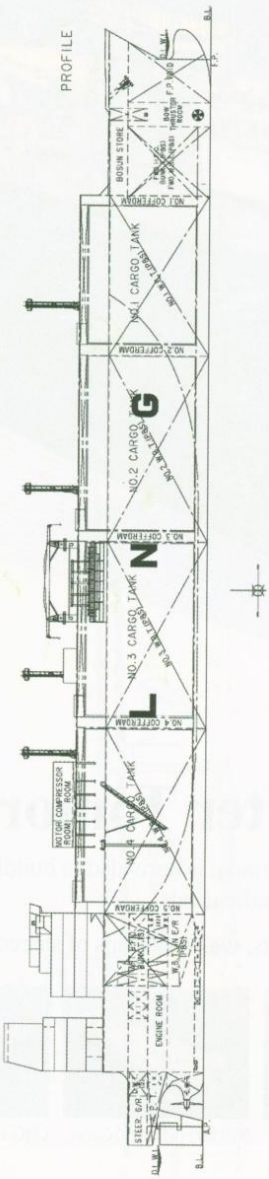
Abdelkaders cargo control room is located in the accommodation deck, where the centralised control of loading, discharging, ballasting and de-ballasting and constant monitoring of the cargo takes place.

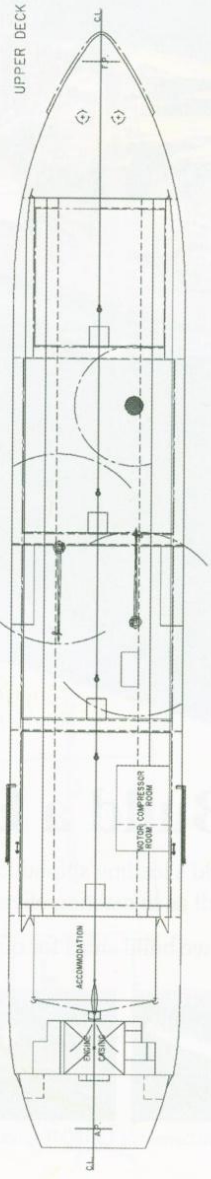
TECHNICAL PARTICULARS

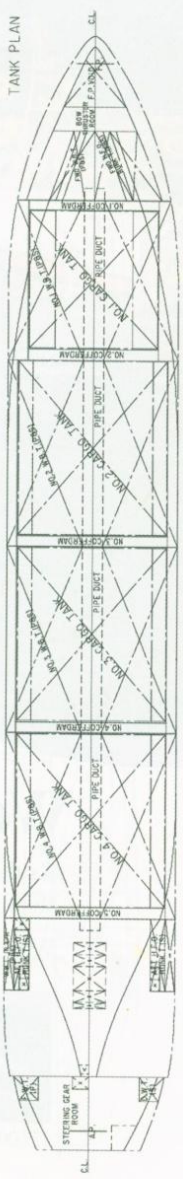
Length oa: 298m
Length bp: 285m
Breadth moulded: 46m
Depth moulded
To main deck: 26.8m
To upper deck: 26.8m
To other decks: 34.6m
Width of double skin
Side: 2.65m
Bottom: 3.3m
Draught
Scantling: 13.0m
Design: 11.9m
Gross: 114,200gt
Deadweight
Design: 87,100dwt
Scantling: 99,700dwt
Speed, service: 19.6knots
Cargo capacity
Liquid volume: ..... 177,400m^3
Bunkers
Heavy oil: ..... 6800m^3
Diesel oil: ..... 480m^3
Water ballast: ..... 65,000m^3
Daily fuel consumption (based on HFO)
Main generator engine: 161tonnes/day
Classification society and notations: ..... Bureau Veritas, BV I +HULL, +MACH, Unrestricted navigation, Liquified gas carrier, +AUT-UMS, +VERISTAR-HULL, SYS-NEQ-1, In water survey, MON-SHAFT
% high tensile steel used in construction: ..... approx. 5%
Main engine
Design: ..... Tri-fuel diesel electric
Model: ..... 2 x 12V50DF 2 x 9L50DF
Manufacturer: ..... Wartsila
Number: 4
Type of fuel used: ..... Fuel gas, HFO or MDO
Output of each engine: ..... 2 x 11,400kW 2 x 8550kW Total 39,900kW
Gearbox
Make: ..... Renk
Model: NDSH-4000
Number: 1
Output speed: 90.6rpm
Propellers
Material: ..... Ni-Al-Bronze
Designer/manufacturer: ..... Hyundai
Number: 1
Fixed/controllable pitch: ..... Fixed
Diameter: 8.6m
Speed: 90.6rpm
Diesel-driven alternators
Number: 4
Engine make/type: ..... Wartsila
Type of fuel: ..... Fuel gas, HFO or MDO
Output/speed of each set: ..... Total 39,900kW
Alternator make/type: ..... Converteam/ synchronous AC generator
Output/speed of each set: ..... 2 x 11,000kW/514rpm 2 x 8250kW/514rpm
Boilers
Number: ..... 2 x auxiliary boiler 2 x exhaust gas economiser
Type: ..... vertical, cylindrical, automatic controlled marine boiler (aux. boiler) Vertical, forced circulating, smoke tube (exhaust gas economiser)
Make: ..... Kangrim
Output, each boiler: ..... 7500kg/h x 10kg/cm^2g saturated steam Exhaust gas 1800kg/h x 10kg/cm^2g saturated steam
Other cranes
Number: ..... 2 x manifold service 2 x provision handling 1 x cargo machinery room service
Make: ..... Oriental Precision Co., Ltd
Type: ..... Electro-hydraulic driven
Performance: ... 5tonnes SWL for manifold and provision handling 6tonnes SWL for cargo machinery room
Mooring equipment
Number: 11
Make: ..... Pusnes
Type: ..... Electro-hydraulic driven
Special lifesaving equipment
Number and capacity: 2
Make: ..... Norsafe
Type: ..... Davit launching type
Cargo tanks
Number: 4
Grades of cargo carried: 1
Stainless steel-structure/piping: ..... SUS 304/SUS 304L
Cargo pumps
Number: 8
Type: ..... Vertical, centrifugal submerged
Make: ..... Ebara
Capacity, each: ..... 1750m^3 x 175mlc
Cargo control system
Make: ..... Converteam
Type: ..... AVC
Bow thruster
Make: ..... Kawasaki
Number: 1
Output, each: 2200kW
Bridge control system
Make: ..... Converteam
Type: ..... Electric propulsion system
One-man operation: ..... Yes
Fire detection system
Make: ..... Consilium
Type: ..... Intelligent addressable type
Fire extinguishing systems
Engine room: ..... NK/High pressure CO_2
Cabins: ..... Sea water + fresh water
Public spaces: ..... Sea water + fresh water
Radars
Number: 3
Make: ..... JRC
Models: LMA-9932-SA JMA-9922-6xA NKE-1087-6
Integrated bridge system
Make: ..... JRC
Model: JAN-901M, JAN-701-CON
Waste disposal plant
Incinerator: ..... Kangrim KFB-73
Sewage plant: ..... Jongjap BIO AEROB-18
Contract date: ..... 06 May 2006
Launch/float-out date: ..... 10 October 2008
Delivery date: ..... 27 February 2010

ABDELKADER









6

SIGNIFICANT SHIPS OF 2010

Barcelona Knutsen: 173,400m^3 LNG carrier from Daewoo

Shipbuilder: ..... **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Vessel name: ..... ***Barcelona Knutsen***
Hull No: **2267**
Owner/Operator: ..... **Knutsen OAS Shipping**
Country: ..... **Norway**
Designer: ..... **DSME**
Country: ..... **Norway**
Model test establishment: ..... **HSVA**
Flag: ..... **NIS**
IMO number: **9401295**
Total number of sister ships already completed (excluding ship presented): **0**
Total number of sister ships still on order: **3**

BARCELONA Knutsen was delivered from Daewoo Shipbuilding and Marine Engineering Co. Ltd to Knutsen OSA Shipping, Norway on 10 February. The vessel has been designed and constructed to meet the requirements of Det Norske Veritas (DNV) with the class notation +1A1 of liquefied Gas, Ship Type 2G(0.25bar -163°C, 500kg/m^3), Nauticus(Newbuilding), Plus-2, E0, Naut-OC, F-A, CLEAN, Gas Fuelled, RP, TMON, BIS.

Four centre cargo tanks have a total capacity of 173,400m^3 and have been designed by Gaz Transport & Technigaz (GTT) using its membrane system (GT NO 96 E-2) that will keep the liquefied natural gas (LNG) at a low temperature of -163°C with the maximum daily boil-off rate of less than 0.145% of fully loaded cargo volume.

Design fatigue life of hull structure is 40 years based on North Atlantic trading. The deck house is six tiers which is located aft of the vessel, providing accommodation for 46 persons including the Suez Crew. Care has also been taken in reducing the noise and vibration levels in this area.

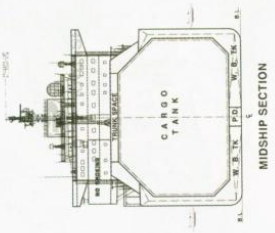
The cargo handling systems onboard the *Barcelona Knutsen* have been designed to be capable of loading or discharging the LNG within 13 hours using eight cargo pumps with a capacity of 1900m^3/h and four stripping/spray pumps. There is also vapour cargo handling equipment that comprises of two high duty compressors, two low duty compressors, one main vaporiser, one forcing vaporiser and one warm-up heater arranged in the cargo machinery room.

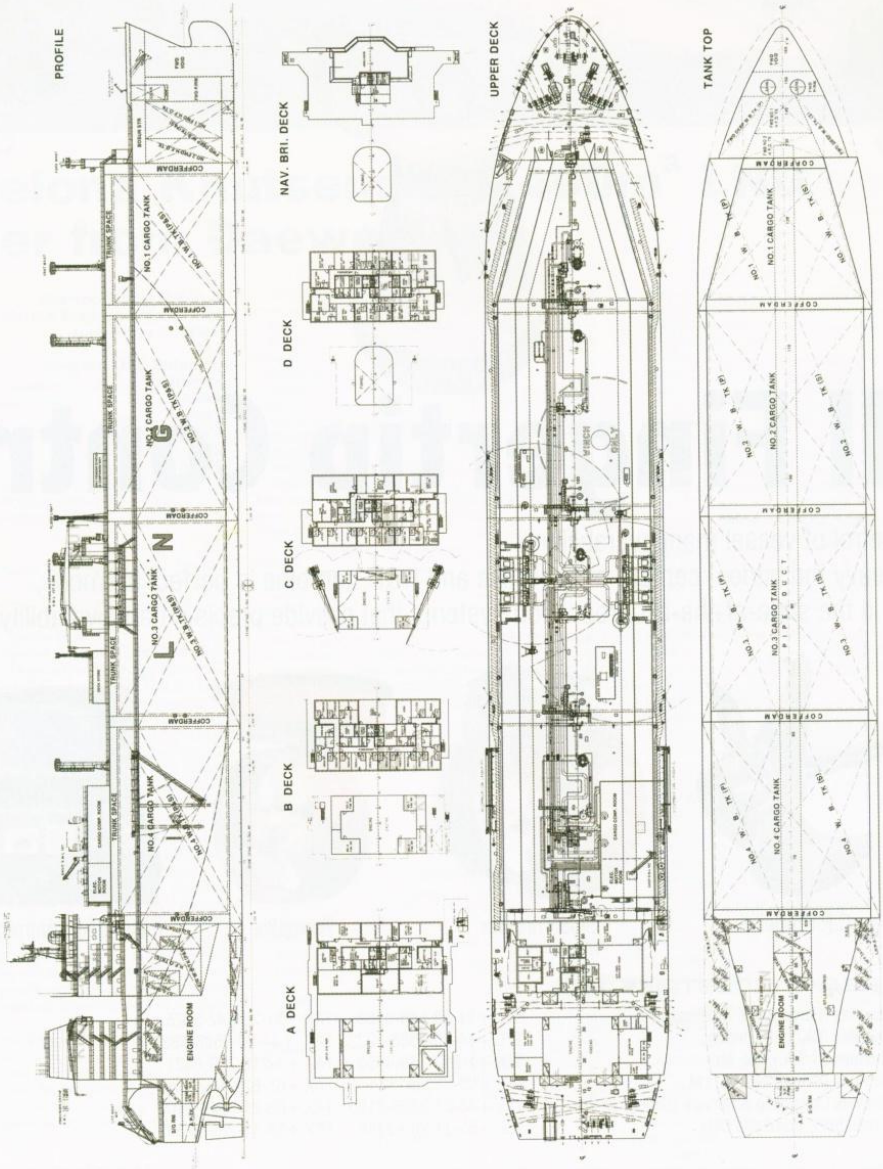
The bridge has been designed for optimum operational safety, efficiency and takes advantage of the current technology and rational navigational methods that are on the market. For one-man bridge operations the system is a modular workstation arrangement, meeting all design and equipment layout requirements in accordance with DNV's notation NAUT-OC.

TECHNICAL PARTICULARS

Length oa: 290.0m
Length bp: 279.0m
Breadth moulded: 45.8m
Depth moulded
To upper decks: 26.5m
Width of double skin
Side: 2.21m
Bottom: 3.2m
Draught
Scantling: 12.9m
Design: 11.95m
Gross: 110,920gt
Displacement: 131,72tonnes
Lightweight: 33,79tonnes
Deadweight
Design: 86,92dwt
Scantling: 97,93dwt
Block co-efficient: ..... 0.778 @ scantling draught
Speed, service: 19.5knots
Cargo capacity
Liquid volume: ..... 173,650m^3
Bunkers
Heavy oil: ..... 5670m^3
Diesel oil: ..... 530m^3
Water ballast: ..... 57,86m^3
Daily fuel consumption
Main engine only: 144.3tonnes/day
Classification: ..... DNV, +1A1, Tanker for Liquefied Gas, Ship type 2G(0.25bar, -163°C, 500kg/m^3), NAUTICUS(Newbuilding), PLUS-2, E0, NAUT-OC, F-A, CLEAN, GAS FUELLED, RP, TMON, BIS.
Main engines
Design: ..... Wartsila
Model: ..... 12V50DF x 3 sets 9L50DF x 1 set
Manufacturer: ..... Wartsila
Number: ..... 4 sets
Type of fuel: ..... HFO/MDO/FUEL GAS
Output of engine: ..... 11,400kW x 3 sets 8550kW x 1 set
Gearboxes
Make: ..... Kawasaki Heavy Industries Ltd
Model: M1H-190/67
Number: ..... 2 sets
Output speed each: 13,240kW
Propellers
Material: ..... Ni-Al-Bronze
Designer/Manufacturer: ..... DSME/Mecklenburger Metallguss GmbH
Number: ..... 2 sets
Fixed/Controllable pitch: ..... FPP
Diameter: 7.8m
Speed: 77.8m
Special adaptations: ..... Manufacturing tolerance – Class S of ISO 484/1 & Surface finish – Class S of ISO 484/1
Main-engine driven alternators
Number: ..... 4 sets
Make/Type: .. Converteam/M4HXD 253-71 x 3 sets, M4HXD 253-58 x 1 set/ self excited, brushless
Output/Speed of each set: ..... 11,000kW at 514rpm (M4HXD 253-71), 8250kW at 514rpm (M4HXD 253-58)
Boilers
Number: ..... 2 sets
Type: ..... Verical water tube
Make: ..... Aalborg
Output, each boiler: 6000kg/h
Cargo cranes/cargo gear
Number: 2
Type: ..... Dregen
Type: ..... Electro-hydraulic driven, single jib, cylinder luffing
Performance: SWL12tonnes
Other Cranes
Number: 2
Make: ..... Dregen
Type: .... Electro-hydraulically driven, single jib, cylinder luffing
Tasks: ..... Provision and engine spare parts handling
Performance: ..... 12tonnes SWL
Mooring equipment
Number: 2
Make: ..... Rolls-Royce Marine
Type: ..... Hydraulic
Special lifesaving equipment
Number or each and capacity: ..... 1 x 40 persons
Make: ..... Schat-Harding Equipment
Type: ..... Freefall launching type
Cargo tanks
Number: 4
Cargo pumps
Number: 8
Type: ..... Centri., vertical, submerged, single stage, direct built-in el-motor driven
Make: ..... Shinko Industries ltd
Capacity: ..... 1900m^3 x 160mLC
Cargo control system
Make: ..... Emerson
Type: ..... Radar beam type for cargo tank level gauging
Ballast control system
Make: ..... Hanla IMS
Type: ..... Electro-Pneumatic
Complement
Officers: 19
Crew: 21
Suez/Repair crew: 6
Fire detection system
Make: ..... Autronica fire and safety
Type: ..... Autosafe
Fire extinguishing systems
Cargo holds: ..... Wilhelmsen/Dry powder
Engine room: ..... Wilhelmsen/ High Exp. Foam system
Radars
Number: 2
Make: ..... JRC
Model: JMA-9132-SA, JMA-9122-6XA
Waste disposal plant
Incinerator: ..... Teamtec GS500CS
Waste compactor: ..... Metos IMCIP400
Sewage plant: ..... Evac JMC-BIO AEROB-18
Contract date: ..... 29 June 2006
Launch/float-out date: ..... 16 May 2009
Delivery date: ..... 10 February 2010

BARCELONA KNUTSEN





BERGE EVERETT: Daewoo LNG tanker

Shipbuilder: Daewoo Shipbuilding & Marine Engineering Co Ltd (DSME), Korea
Vessel's name: *Berge Everett*
Hull number: 2212
Owner/operator: Bergesen dy, ASA, Norway
Designer: Daewoo Shipbuilding & Marine Engineering Co Ltd, Korea
Flag: Norway
Total number of sister ships already completed: 1
Total number of sister ships still on order: 1

THE leading positions held in the LNG market by Norwegian owner Bergesen, and shipbuilder Daewoo, is demonstrated by their combined involvement in the construction of *Berge Everett*, another example of the Korean company's circa 140,000m^3 capacity, specialist Type 2G gas carrier design, introduced for worldwide trading in a rapidly expanding fuel distribution network. A number of factors required consideration in the development of this class of vessel, many of which relate to parameters existing at loading and discharging terminals, where positions of mooring equipment, fenders, gangway and manifolds are of particular importance.

In addition, in order to ensure an even keel ballast arrival condition with peak tanks empty, and allowing consumables at 50% maximum capacity and three days reserve, the disposition and quantity of water ballast carried has necessitated careful study. The layout is also arranged to enable the vessel to discharge at the Everett (Boston, USA) terminal where an air draught restriction of 41.2m from the ballast waterline is enforced.

Within a double-hull structure there are four cargo tanks separated by cofferdams, and which extend above the upper deck to form a trunk. These are constructed to the Gaz Transport NO96 E-2 membrane system which uses Invar stainless steel sheet with a nickel content of 36%, for primary and secondary barriers, with perlite granules in plywood boxes inserted between them, and between the secondary barrier and the shell. This system, together with hull scantlings and cargo pumps, is suitable for the carriage of cargo of maximum specific gravity 0.50 at -163°C, and maximum boil-off rate 0.15% cargo volume. Underdeck passageways in the trunk deck space provide fore and aft access, and a duct keel in the double bottom carries pipes and cables.

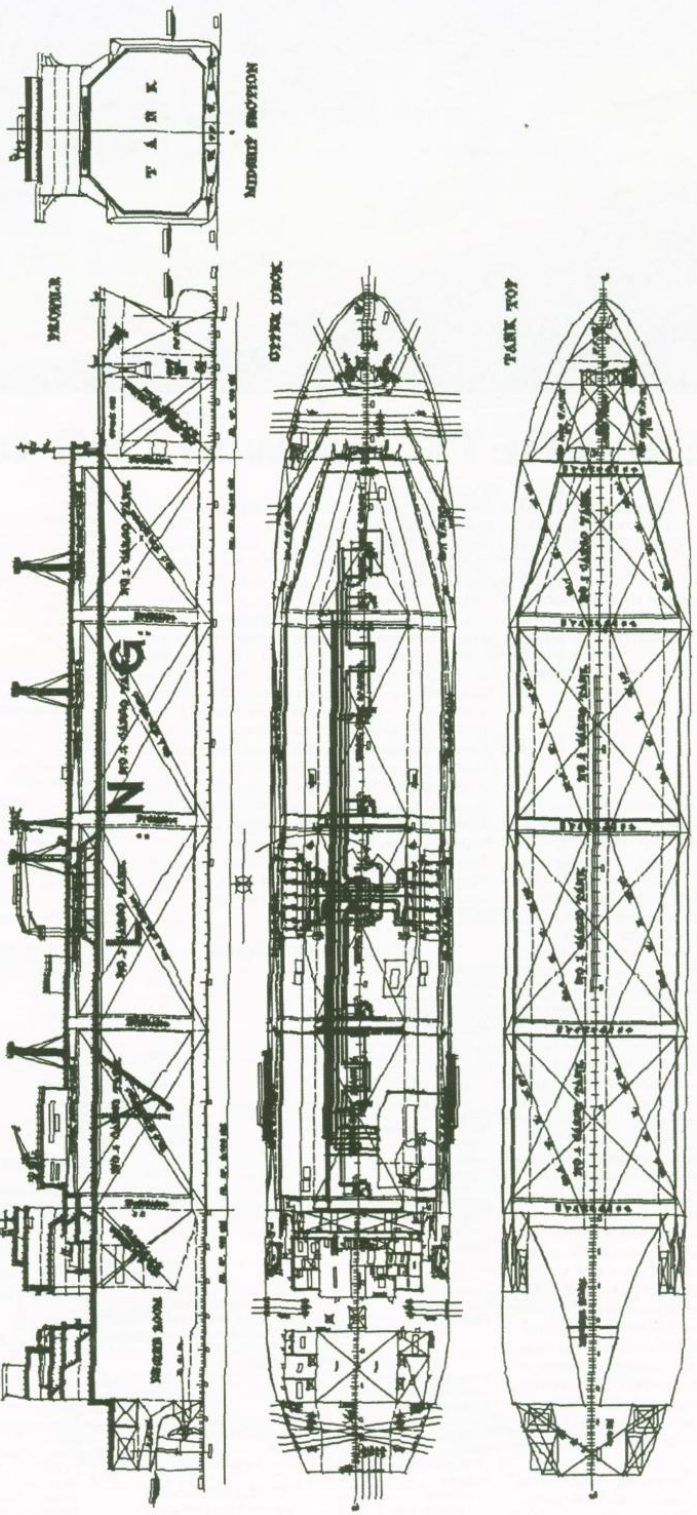
Cargo handling is by means of eight Ebara, aluminium alloy, submerged, centrifugal electric pumps, each with a duty of 1700m^3/h and together capable of discharging a full cargo in 12 hours. Other equipment forming part of the cargo system includes high- and low-duty compressors, main and forcing vaporisers, and boil-off/warm-up heaters. Heavy-fuel tanks are contained within the double hull and have a capacity for 13,000 nautical miles steaming at 90% MCR, allowing five days margin without the use of boil-off gas.

Although Daewoo is looking at the use of alternatives to the 'conventional' steam turbine propulsion system, it is this which has been adopted for *Berge Everett*, in the form of a Kawasaki cross-compound unit developing 36,690shp (26,985kW) at 88rev/min. This drives a five-bladed, FP propeller for a service speed of 19.50knots at 90% MCR. Two Mitsubishi steam-turbine-driven, 3450kW alternators are the main source of electrical power, supplemented by a Rolls-Royce/Bergen-driven diesel-alternator set of similar output. The two boilers are arranged for dual-fuel burning, and each produce 56tonnes/h. Brunvoll supplied the 1600kW bow thruster which provides manoeuvring aid to the semi-balanced rudder, fitted in an open-water sternframe. Accommodation is arranged for 43 persons in the main superstructure aft, with the living quarters completely separate from the engine and funnel casings.

TECHNICAL PARTICULARS

Length, oa	277.00m
Length, bp	266.00m
Breadth, moulded	43.40m
Depth, moulded to upper deck	26.00m
Width of double skin	
side	2.11m
bottom	3.20m
Draught	
design	11.40m
scantling	12.10m
Gross	93,844gt
Displacement	107,000tonnes
Lightweight	29,600tonnes
Deadweight	
design	70,300dwt
scantling	77,400dwt
Speed, service at 90% MCR	19.50knots
Cargo capacity	
liquid volume	138,000m^3
Bunkers	
heavy oil	6000m^3
diesel oil	500m^3
Water ballast	52,400m^3
Fuel consumption	168.80tonnes/day
Classification	Det Norske Veritas 1A1, Tanker for Liquefied Gas, Ship type 2G (-163°C, 500kg/m^3, 0.25bar), NAUTICUS Newbuilding, PLUS-1, EO, W1-OC, LCS (S10)
Percentage of high-tensile steel used in construction	Nil
Steam turbines	
Design	Cross-compound impulse
Manufacturer	Kawasaki Heavy Industries
Number	1
Output/speed	26,985kW/88rev/min
Propeller	
Material	Nickel-aluminium-bronze
Designer/manufacturer	Hyundai Heavy Industries
Number	1
Pitch	Fixed
Diameter	8500mm
Speed	88rev/min
Steam-turbine-driven alternators	
Number	2
Make/type	Mitsubishi Heavy Industries/multi-stage
Output/speed	2 x 3450kW/1800rev/min
Diesel-driven alternators	
Number	1
Make/type	Rolls-Royce Bergen/-
Output/speed	3450kW/720rev/min
Boilers	
Number	2
Type	Vertical, 2-drum, water tube
Make	Mitsubishi Heavy Industries
Output	2 x 56tonnes/h
Hose-handling cranes	
Number	2
Make	Shinyong-TTS
Type	Electro-hydraulic
Performance	2 x 12tonnes swl
Mooring equipment	
Make	Rolls-Royce
Type	Electro-hydraulic
Cargo tanks	
Number	4
Grades of cargo carried	LNG
Stainless steel	Structure and piping
Cargo pumps	
Number	8
Type	Submerged electrical centrifugal
Make	Ebara
Material	Aluminium alloy
Capacity	8 x 1700m^3/h
Ballast control system	
Make	Honeywell
Type	TPS (total plant solution)
Complement	
Officers	13
Crew	19
Supernumaries/spare	5
Suez crew	6
Rooms	35 x single; 1 x double; 1 x six
Bow thruster	
Make	Brunvoll
Number	1
Ouput	1600kW
Bridge control system	
Make	Kawasaki
One man operation	Yes
Fire detection system	
Make	Kongsberg
Type	BS-100 addressable
Fire extinguishing systems	
Engineroom	CO_2
Make	Unitor
Cabins/public spaces	Sea water and portable
Make	Unitor
Radars	
Number	2
Make	KMSS (Kongsberg)
Models	Autocargo 2000
Integrated bridge system	
Make	KMSS (Kongsberg)
Model	Databridge 10
Waste disposal plant	
Incinerator	
Make	Teamtec
Model	GS500C
Sewage plant	
Make	Janghap
Model	A-25
Contract date	18 December 2000
Launch/float-out date	31 August 2002
Delivery date	17 June 2003

BERGE EVERETT



BRITISH EMERALD: LNG tanker with dual-fuel/diesel-electric propulsion

Shipbuilder:...Hyundai Heavy Industries Co Ltd, (HHI), Korea
Vessel's name: ...*British Emerald*
Hull number: ...1777
IMO number:...9333591
Owner:...BP Shipping Ltd, UK
Designer:...Hyundai Heavy Industries Co Ltd, Korea
Model test establishment used: ..SSPA, Sweden
Flag: ...Isle of Man
Total number of sister ships already completed:...Nil
Total number of sister ships still on order: ...5

BRITISH Emerald's reign as the largest LNG carrier in the world, at 155,000m³, was short-lived (as can be seen by other entrants in this year's *Significant Ships*); nevertheless, this lead vessel of BP's new Gem class is of special interest because of its 'green' credentials, and for introducing - for this owner - an innovative propulsion system (the first dual-fuel/diesel LNG tanker was *Gaz de France Energy*, presented in our 2004 review). The use of dual-fuel marine engines is not new, but its combination here in a diesel-electric configuration (DFDE) brings a new dimension into the selection of gas-ship machinery, previously dominated by the steam turbine.

The machinery installation here is centred on four Wärtsilä type 50DF main engines: two 12-cylinder vee-type units and two with nine cylinders in line, of 11,400kW and 8550kW output, which are connected, respectively, to Converteam alternators producing 11,000kW/8250kW. These are, perhaps uniquely, each positioned directly above the propulsion motors in the two enginerooms included for redundancy purposes, and supply the ship's main electrical requirements, as well as powering two 14,860kW propulsion motors, connected via a Renk twin-input/single-output reduction gearbox to a five-bladed propeller producing a service speed of 20knots.

The main engines can operate on conventional diesel fuel or, on a loaded voyage, on boil-off gas from the cargo which is heated up and delivered as fuel gas by low duty compressors. Comparison between DFDE and similar steam-propelled gas carriers is understood to show that the latter, burning oil and gas, produced 530tonnes of CO_2 and 7tonnes SO_x daily, whilst the DFDE vessel, burning only gas, emitted just 386tonnes of CO_2.

British Emerald has a flat, single-deck, with sunken mooring deck aft, and a double-skin hull containing four membrane-type cargo tanks separated by cofferdams, and constructed in accordance with the GTT Mk III containment system for carrying cargoes at cryogenic temperatures of -163°C. Tank insulation is 270mm thick to satisfy a low boil-off rate of 0.15% by volume of total cargo per day. The tanks extend above the upper deck and are enclosed in a trunk which provides access passages fore and aft.

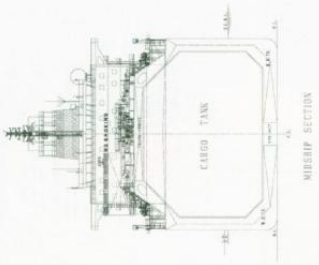
A shore manifold is arranged P&S between tanks 2 and 3 and a compressor room is situated on the starboard side of the trunk. Cargo is loaded by shore pumps, with unloading handled by having two Ebara 1800m³/h electric, submerged pumps in each tank.

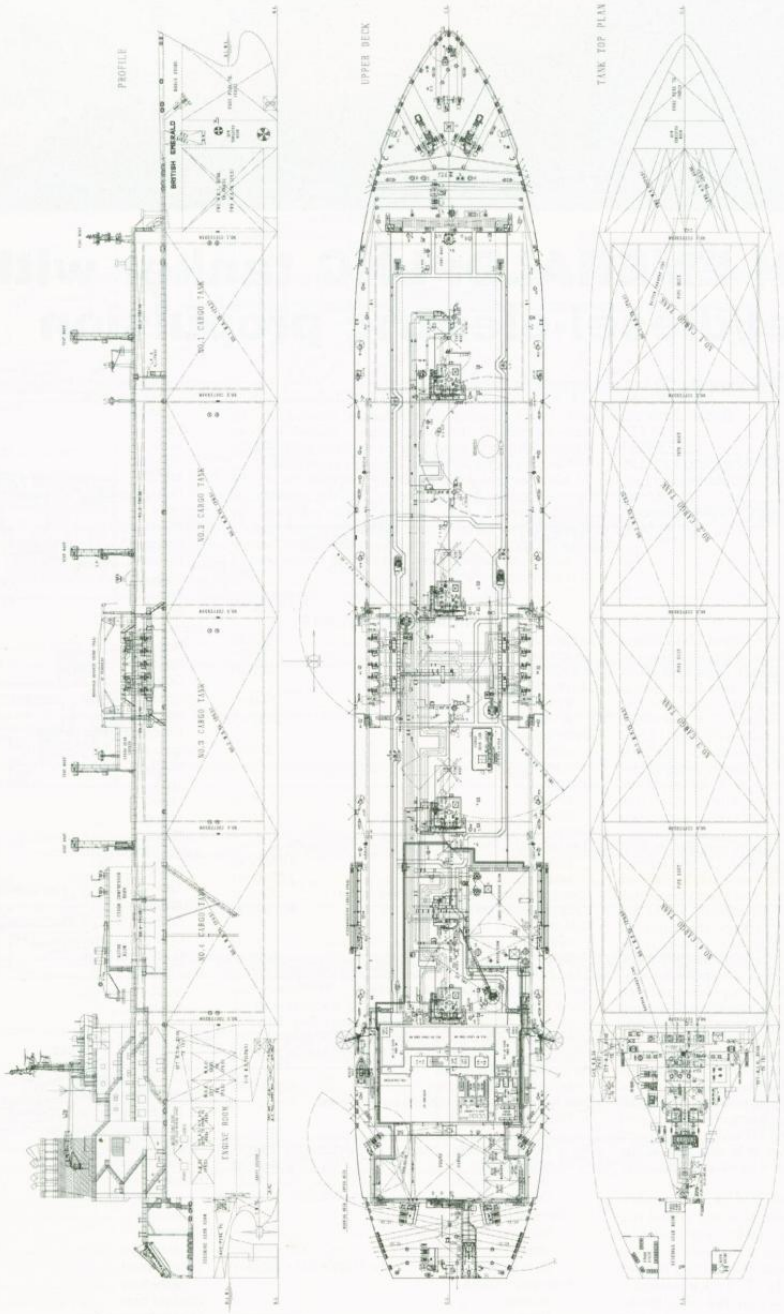
Other features included in the specification are the new technology of 'cold ironing' facilities to allow the vessel to accept shore power whilst in port, and the application of external paint colours proven to reduce solar energy absorption, resulting in less natural heating of cargo and consequently minimising production of boil-off gases.

TECHNICAL PARTICULARS

Length, oa ...280.00m
Length, bp...275.00m
Breadth, moulded ...44.20m
Depth, moulded
to main deck...26.00m
to trunk deck...33.09m
Width of double skin
side ...2.76m
bottom...3.20m
Draught
design ...11.47m
scantling ...12.20m
Gross...102,000gt
Deadweight
design ...76,600dwt
scantling...84,300dwt
Speed, service, MCR with 15% sea margin ...20knots
Cargo capacity, liquid volume...155,000m³
Bunkers
heavy oil ...nil
diesel oil...6600m³
Water ballast ...59,000m³
Fuel consumption (diesel oil equivalent).....143.3tonnes/day
Classification .....Lloyd's Register of Shipping, +100A1 Liquefied Gas Tanker, Ship Type 2G, SG 0.5, 0.25bar g, -163°C, *IWS ShipRight(SDA), L1, EP, +LMC, UMS, ICC, NAV
Percentage of high tensile steel used in construction ...approx 2%
Dual fuel diesel electric (DFDE) power system
Main engines
Design ...Wärtsilä
Number/models.....2 x 12V50DF/2 x 9L50DF
Manufacturer ...Wärtsilä
Type of fuel used.....Boil-off gas/MDO
Output, each engine.....2 x 11,400kW/2 x 8550kW
Alternators
Number...4
Make ...Converteam
Output, each unit .....2 x 11,000kW/2 x 8250kW
Propulsion motors
Number...2
Make ...Converteam
Output, each unit ...2 x 14,860kW
Frequency converters
Number/type...2/synchronous
Make ...Converteam
Gearbox
Make ...Renk
Number ...1
Model.....NDSH-4000 (twin input/single output)
Output speed.....720 rev/min (input)/90.6rev/min (output)
Propeller
Material ...Nickel-aluminium-bronze
Designer/Manufacturer...Hyundai
Number ...1
Pitch ...Fixed
Diameter ...8600mm
Speed...90.6rev/min
Boiler
Number ...1
Make ...KangRim Heavy Industries
Output ...15,000kg/h
Cargo tanks
Number ...4
Grades of cargo carried ...LNG
Cargo pumps
Number ...8
Type ...Vertical, submerged, centrifugal
Make...Ebara
Material ...Stainless steel
Capacity ...8 x 1800m³/h
Ballast/cargo control systems
Make...Converteam
Type ...Integrated automation system
Complement
Officers...22
Crew...11
Suez/repair crew...6
Bow thruster
Number ...1
Make ...Brunvoll
Output...2000kW
Bridge control system
Make ...Furuno
One man operation ...Yes
Fire detection system
Make/type ...Consilium CS 3000
Fire extinguishing systems
Cargo area ...Unitor/dry powder
Engineroom ...Unitor/high-pressure CO_2
Radars
Number/make...2 x Furuno
Models...FAR-2837SW/ FAR-2827W
Incinerator
Make/type...Hyundai/MAXI 150SL-1 WS
Sewage plant
Make/type...Jonghap/BIO AEROB-25
Contract date...April 2004
Launch/float-out date...July 2006
Delivery date...5 July 2007

BRITISH EMERALD





BRITISH TRADER: advanced LNG tanker

Shipbuilder:..... Samsung Heavy Industries Co Ltd, Korea
Vessel's name:..... *British Trader*
Hull number:..... 1380
Owner/operator:..... BP Shipping, UK
Designer:..... Samsung Heavy Industries Co Ltd, Korea
Model test establishment used:..... SSPA, Sweden
Flag:..... Isle of Man
Total number of sister ships already completed:..... Nil
Total number of sister ships still on order:..... 2

BRITISH TRADER has been constructed in accordance with the Gaz Transport & Technigas Mark III cargo containment system for the carriage of LNG cargoes at cryogenic temperature (-163°C) and atmospheric pressure. Within a double hull, which has been designed to last for a period of not less than 40 years, there are four cargo tanks, encased in a primary membrane of 1.2mm-thick corrugated, SUS 304L grade, stainless steel plates, and a secondary membrane of triplex glass wool. Insulation is made up of 270mm reinforced polyurethane foam, and the system allows the daily boil-off gas rate to be restricted to 0.15% of the total cargo volume.

Two 1700m³/h cargo pumps are fitted in each tank, capable of completely discharging the cargo in 12 hours, following pre-cooling by LNG spray. Two 8000m³/h, low-duty, and two 26,000m³ high-duty compressors are installed, together with four spray pumps: a 550m³/h emergency cargo pump, two warming-up heaters, an LNG vaporiser, forcing vaporiser, a 14,000Nm³/h inert-gas generator and two 90Nm³/h nitrogen generators.

The machinery installation is centred on a Kawasaki cross-compound steam turbine, supplied with steam from boilers which burn fuel oil or boil-off gas, or a combination of both. This drives a six-bladed propeller for a service speed of 20.10knots. Electrical power is produced by two 3450kW steam-turbine driven alternators, with a similar-sized diesel set as stand-by. A 2500kW thruster is fitted at the bow.

British Trader is equipped with a 'centralised administration and control centre', with integrated automation system (IAS) and shipboard management system (SMS), which serves as a central command station for carrying out cargo and ballasting operations, and monitoring and remotely controlling the propulsion plant. Also installed is a one-man bridge system complying with Lloyd's Register's NAV1/IBS notation, an ECDIS, a manoeuvring simulator, GMDSS console, voyage data recorder, and automatic identification system.

Other features of note included in the specification are a ballast water exchange system which uses sequential empty/refill procedures to complete the operation in under 30hours. The diesel-alternator engine has a low NOx emission, and there is an emergency operation for water ballast leakage, a CO_2 blowing agent for the insulation system, and all paint complies with environmental requirements.

TECHNICAL PARTICULARS

Length, oa..... 278.80m
Length, bp..... 266.00m
Breadth, moulded..... 42.60m
Depth, moulded
- to main deck..... 26.00m
- to trunk deck..... 32.70m

Width of double skin
- side..... 2.30m
- bottom..... 3.40m

Draught
- design..... 11.35m
- scantling..... 12.30m

Air draught (approx)..... 50.00m above base
Displacement, at 12.30m..... 107,300tonnes
Lightweight..... 29,800tonnes
Deadweight
- design..... 68,100dwt
- scantling..... 77,500dwt

Speed, service.. 20.10knots at 85% MCR with 15% sea margin

Cargo capacity
- liquid volume..... 138,200m³

Bunkers
- heavy oil..... 7700m³
- diesel oil..... 400m³

Water ballast..... 54,800m³
Fuel consumption..... 170.90tonnes/day
Classification..... Lloyd's Register of Shipping +100A1 Liquefied Gas Tanker, Ship Type 2G, Methane (LNG) in Membrane Tanks. Maximum vapour pressure 0.25bar, minimum temperature minus 163°C/ ShipRight (SDA), IWS, L1, + LMC, UMS, CCS, ICC, NAV1, IBS, with descriptive notes ShipRight (FDA, CM, HCM, SEA(HSS-4), SEA (VDR-4), PMS(CM), SCM), Part high-tensile steel, ETA
Percentage of high-tensile steel used in construction..... 2.3%

Steam turbine
- Design..... Cross-compound impulse turbine
- Manufacturer..... Kawasaki Heavy Industries
- Number..... 1
- Output..... 39,500shp MCR/33,580shp NCR at 85.3rev/min

Gearbox
- Make..... Kawasaki Heavy Industries
- Model..... UA-400
- Number..... 1
- Output speed..... 90rev/min MCR

Propeller
- Manufacturer..... Mitsubishi Heavy Industries
- Number..... 1
- Pitch..... Fixed
- Diameter..... 8250mm
- Speed..... 90rev/min MCR

Steam-turbine driven alternators
- Number..... 2
- Make/type..... Shinko/multi-stage
- Output..... 2 x 3450kW/1800rev/min

Diesel-driven alternator
- Number..... 1
- Engine make..... Wärtsilä
- Output/speed..... 3600kW/720rev/min
- Alternator make..... ABB
- Output/speed..... 3450kW/720rev/min

Boilers
- Number..... 2
- Type..... Water tube, forced draught
- Maker..... Kawasaki Heavy Industries
- Output..... 2 x 65tonnes/h

Mooring equipment
- Make..... Kocks
- Type..... Self-contained hydraulic

Cargo tanks
- Number..... 4
- Stainless steel..... Structure and piping

Cargo pumps
- Number..... 8
- Type..... Submerged electric
- Make..... Ebara International
- Capacity..... 8 x 1700m³

Cargo and bridge control systems
- Type..... Integrated with IAS

Complement
- Officers..... 22
- Crew..... 11
- Suez/repair crew..... 6

Bow thruster
- Make..... Kawasaki Heavy Industries
- Number..... 1
- Output..... 2500kW

Fire detection system
- Make..... Consilium
- Type..... Analogue addressable

Fire extinguishing system
- On deck..... Dry powder
- Make..... NK
- Engineroom..... CO_2
- Cabins/public spaces..... Sea water

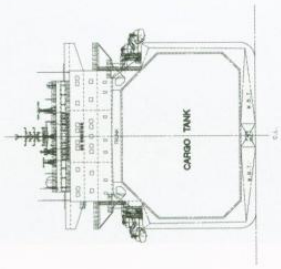
Radars
- Number..... 2
- Make..... Kongsberg
- Model..... 2 x DB10

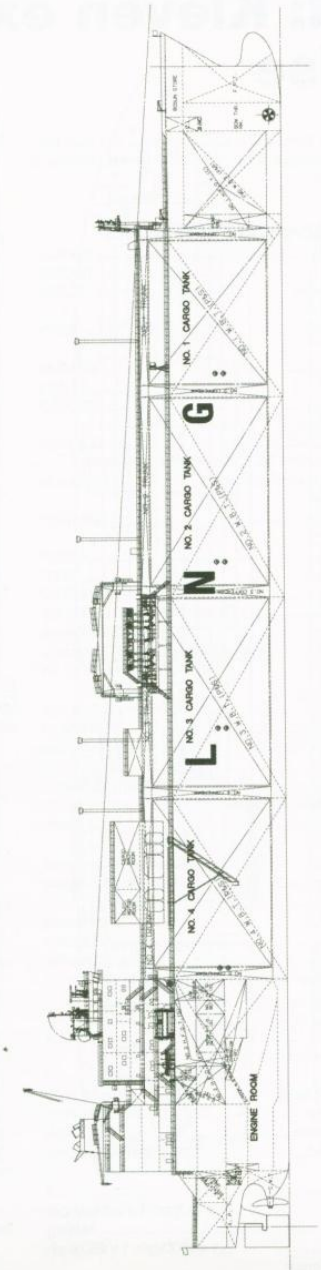
Satellite navigation systems
- Number..... 2 x DGPS
- Make..... Leica
- Model..... MX412

Waste disposal systems
- Incinerator
  - Make..... TeamTec
  - Model..... OGS400C
- Waste compactor
  - Make..... Hackman Metos
  - Model..... Orwak 5030
- Waste shredder/crusher
  - Make..... Bin Systems
  - Model..... F515

Contract date..... 20 July 2000
Launch/float-out date..... 9 December 2001
Delivery date..... 15 November 2002

BRITISH TRADER





EXPRESS: LNG re-gasification vessel from Daewoo

Shipbuilder: **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Vessel's name: ***Express***
Hull No: **2263**
Owner/Operator: **EXMAR**
Country: **Belgium**
Designer: **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Model test establishment used: **SSPA**
Flag: **Belgium**
Total number of sister ships already completed (excluding ship presented): **1**
Total number of sister ships still on order: **3**

Express, a 74,700dwt LNGRV (liquefied natural gas – re-gasification vessel) was delivered by Daewoo Shipbuilding & Marine Engineering Co. Ltd. (DSME) to EXMAR Marine NV of Belgium on May 11, 2009. *Express* is jointly owned by EXMAR and US company Excelerate Energy and is on a 25-year charter to Excelerate Energy. At the time of delivery *Express* was the fourth LNGRV in EXMAR's fleet.

LGNRVs are independent of shore-based re-gasification facilities, being capable of re-gasifying LNG onboard and delivering it directly into the distribution system. *Express* can discharge re-gasified liquid natural gas through a high pressure shore manifold connection or to a subsea pipeline through an internal turret arrangement connected to an offshore mooring buoy. The vessel can also operate as a conventional LNG vessel discharging to a shore-based re-gasification facility.

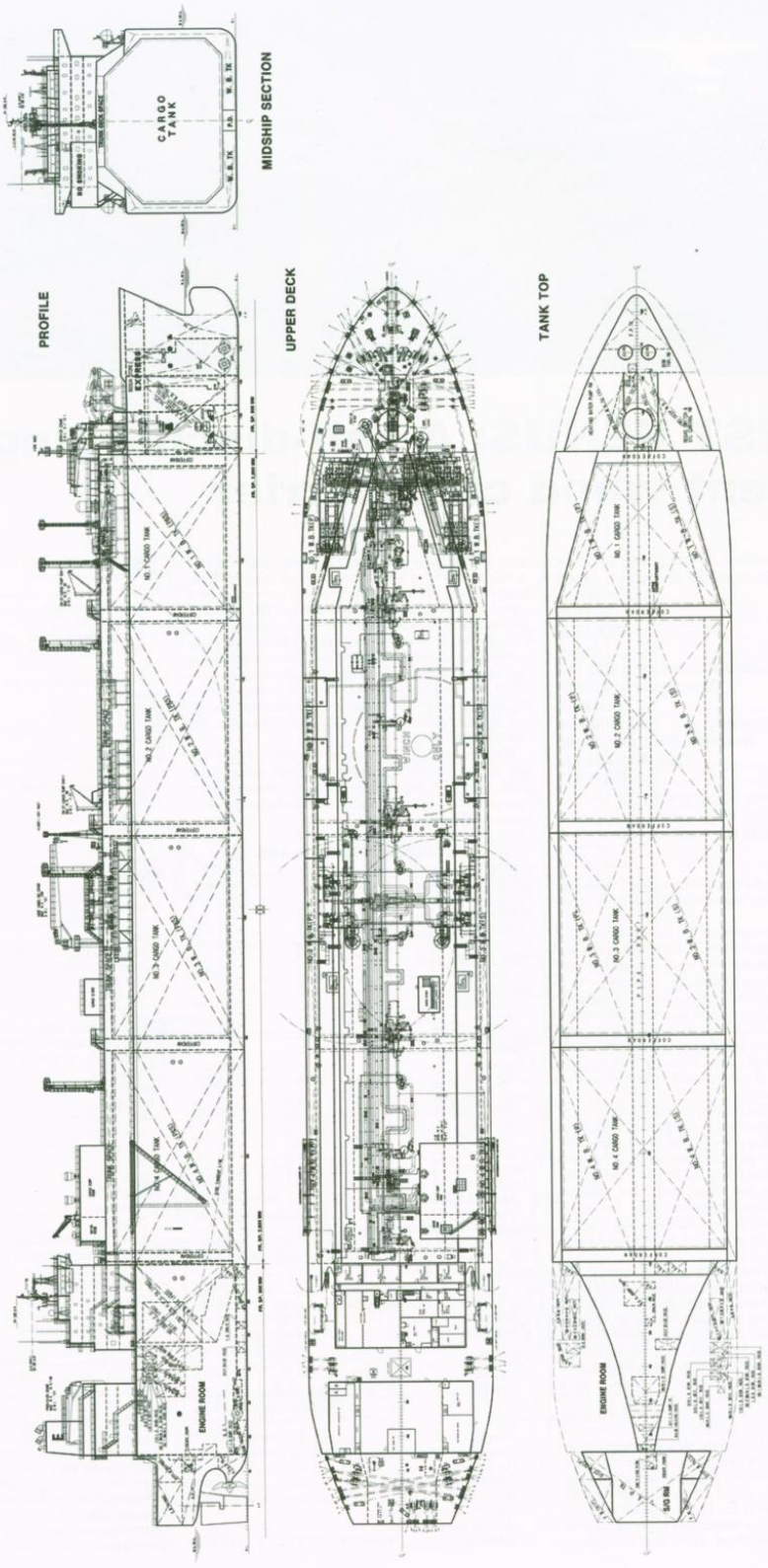
Express has a continuous upper deck with aft sunken deck, a raked stem with bulbous bow and a submerged turret unloading system, a transom stern with open water type stern frame, a semi balanced rudder and a fixed pitch propeller driven by a cross compound type marine steam turbine. The cargo area is of the double-hull type with a double bottom. Cofferdams are located at forward and after part of cargo area and between cargo tanks. Cargo is carried in four centre cargo tanks with the Gaz Transport & Technigaz membrane containment system ("GT NO 96 E-2").

The re-gasification plant, consisting of a number of high pressure pumps, vaporisers, heaters and other equipment is provided in way of No. 1 cargo tank. A SCR (Selective Catalytic NOx Reduction) system is provided for two main boilers and one auxiliary boiler in order to reduce the NOx level.

TECHNICAL PARTICULARS

Length oa: 291.0m
Length bp: 280.0m
Breadth moulded: 43.4m
Depth moulded
to main deck: 26.0m
to upper deck: 32.95m
Width of double skin
side: 2.211m
bottom: 3.2m
Draught
scantling: 12.4m
design: 11.6m
Gross: 100,300gt
Displacement: 117,300tonnes
Deadweight:
Design: 74,700dwt
Scantling: 83,200dwt
Speed, service: 19.2knots
(90% MCR with 21% sea margin)
Cargo capacity:
Liquid volume: 151,000m^3
Bunkers:
Heavy oil: 5906m^3
Diesel oil: 480m^3
Water ballast: 55,000m^3
Daily fuel consumption:
Main engine only: 170.3tonnes/day
Classification society and notations: Bureau Veritas; I +HULL +MACH, Liquefied gas carrier/LNG, Ship Type 2G (membrane tank, 0.25 bar -163C, 500kg/m3), unrestricted navigation, +VeriSTAR Hull, AUT-UMS, +SYS-NEQ-1, SPM/STL, INWATERSURVEY, MON-SHAFT,
% high tensile steel used in contrustion: 0.2%
Main engine:
Design: Cross compound, marine steam turbine
Model: UA 360
Manufacturer: KHI
Number: 1
Output: MCR: 26,480kW/88rev/min
Gearbox:
Make: KHI
Number: 1
Output speed: 88rev/min
Propeller:
Material: Ni-Al-Bronze
Designer/Manufacturer: Hyundai
Number: 1
Fixed/Controllable pitch: Fixed
Diameter: 8.5m
Speed (NCR): 85rev/min
Special adaptations: Class I of ISO 484/1 and class S of ISO 484/1
Turbine driven alternators:
Number: 3
Turbine make/type: MHI/Multi-stage high efficiency turbine AT42CT
Alternator make/type: HHI/Self-excited, brushless
Output/speed of each set: 3700kW/1800rev/min
Diesel-driven alternators:
Number: 1
Engine make/type: Wartsila 12V32DF / 4-stroke, dual fuel burning
Type of fuel: MDO/Fuel gas
Output: 4020kW
Boilers
Number: 2
Type: Vertical, 2-drum, water tube type
Make: MHI
Output, each boiler: 71,000kg/hour x 6.03MPa
Cargo cranes:
Number: 2
Make: TTS Marine Crane AS
Type: Electro-hydraulically driven
Performance: 12tonnes (SWL) x 12m/min.
Other cranes
Number: 2
Make: TTS Marine Crane AS
Type: Electro-hydraulically driven,
Tasks: Engine spare part & provision handling
Performance: 12tonnes (SWL) x 10m/min.
Mooring equipment
Number: 2 windlasses + 7 mooring winches
Make: TTS KOCKS GMBH
Type: Electro-hydraulically driven, high pressure type
Special lifesaving equipment:
Number of each and capacity: 2 x 40persons
Make: UMOE Schart-Harding
Type: Totally enclosed type (FRP)
Cargo tanks
Number: 4
Stainless steel: SUS 316L for cargo system
Cargo pumps
Number: 8
Type: Cryogenic centrifugal
Make: Ebara
Materials: Aluminium alloy casing and impeller
Capacity (each): 1700m^3/h
Cargo control system
Make: Honeywell
Type: Central computerised system
Ballast control system
Make: Honeywell
Type: Central computerised system
Complement
Officers: 18
Crew: 15
Bow thrusters:
Make: Brunvoll As
Number: 2
Output (each): 1500kW
Stern thrusters:
Make: Brunvoll As
Number: 1
Output: 2000kW
Submerged Turret Unloading (STL)
Make: Advanced Production & Loading AS
Number: 1
Capacity: Approx. 500 MMSCFD
Bridge control system
Make: KHI
Type: UA 360
Is bridge fitted for one-man operation? Yes
Fire detection system
Make: Consilium
Type: Addressable
Fire extinguishing systems
Cargo holds: None
Engine room: High expansion foam system / Kashiwa
Cabins: Portable fire extinguishing system
Public spaces: Portable fire extinguishing system
Radars
Number: X-band(one set) & S-band(one set)
Make: SAM Electronics
Model(s): Chart radar 1100
Integrated bridge system:
Make: SAM Electronics
Model: Chart pilot 1100
Waste disposal plant
Incinerator: Kangrim KEI-70SDA
Sewage plant: Jonghap AER0B-18
Contract date: 10 January 2006
Launch/float-out date: 21 June 2008
Delivery date: 11 May 2009

EXPRESS


MIDSHIP SECTION
CARGO TANK
PROFILE
UPPER DECK
TANK TOP
ENGINE ROOM

FERNANDO TAPIAS: Daewoo-built LNG tanker for Spanish owner

Shipbuilder:.....Daewoo Shipbuilding & Marine Engineering Co Ltd, Korea
Vessel's name:.....*Fernando Tapias*
Hull number:.....2205
Owner/operator:.....Naviera F Tapias Gas SA, Spain
Designer:.....Daewoo Shipbuilding & Marine Engineering Co Ltd, Korea
Flag:.....Spain
Total number of sister ships already completed:.....Nil
Total number of sister ships still on order:.....1

FERNANDO TAPIAS has been built for the transportation of liquefied natural gas (LNG), and special attention has been paid in her design to the facilities at loading and discharging berths worldwide, to ensure compatibility of mooring arrangements, fender contact areas, gangway and manifold positions, and other aspects. Laid out with a continuous single deck, and a sunken aft deck, the vessel has four cargo tanks, constructed on the Gaz Transport membrane system (GT No 96 E-2), positioned in a double-hull configuration which is extended above the deck to form a trunk.

Gas is maintained at a temperature of -163°C with a maximum boil-off rate of less than 0.15% fully loaded cargo volume. Primary/secondary barriers of 36% nickel-steel (Invar) alloy are fitted in the cargo tanks, with plywood boxes filled with expanded pearlite forming primary/secondary insulation. Underdeck passageways in the trunk deck space provide fore and aft access, and a duct keel in the double bottom serves as a pipe and cable passage.

The cargo handling systems are designed to load/discharge cargo within 12hours, using two sets of 1700m³/h pumps and one stripping/spray pump in each tank, forming a complete assembly within a 'tripod mast' construction with Saab radar beam-type level gauges, and all fittings and pipes. Vapour handling equipment such as two high-duty compressors, two low-duty compressors, one main and one forcing vaporiser, and two boil-off/warm-up heaters, are arranged in the cargo machinery room.

The main propulsion unit is a Kawasaki UA-360 cross-compound steam turbine, developing 36,000shp at 88rev/min (behind the gearbox). The unit has high- and low-pressure turbines, double-reduction gearing, main condenser, and astern turbine. Two dual-fuel boilers supply steam for the main turbine, steam auxiliaries, and turbo-generators. Two of the latter are installed for electrical power together with one diesel-powered set. Each develops a similar output of 3450kW. Current is transmitted to three switchboards (main, cargo, and emergency) located in separate rooms. An integrated automation system is fitted, and control and monitoring is carried out from the cargo and engine control rooms.

Accommodation and navigation spaces are arranged right aft, with the latter designed for optimum operational safety around a modular workstation, fitted for one-man operation, and meeting all design and layout requirements of the BV notation +SYS-NEQ-1.

TECHNICAL PARTICULARS

Length, oa.....298.00m
Length, bp.....268.80m
Breadth, moulded.....43.40m
Depth, moulded
- to main deck.....26.00m
- to trunk deck.....32.75m

Width of double skin
- side.....2.21m
- bottom.....3.20m

Gross.....94,822gt
Deadweight
- design.....72,367dwt
- scantling.....79,364dwt

Draught
- design.....11.42m
- scantling.....12.12m

Speed, service (90% MCR: 21% sea margin)...19.50 knots
Cargo capacity
- liquid volume.....140,627m³

Bunkers
- heavy fuel.....6004m³
- diesel oil.....502m³

Water ballast.....53,108m³
Fuel consumption
- main engine only.....165.60tonnes/day

Classification.....Bureau Veritas, I + Hull, + MACH, Liquefied Natural Gas Carrier, Ship Type 2G, (membrane tank, 0.25bar, -163°C, 500kg/m³), unrestricted navigation, + VeriSTAR-HULL, AUT-IMS, AUT-PORT, +SYS-NEQ-1, In Water Survey, MON-SHAFT

Percentage of high-tensile steel used in construction.....Nil

Steam turbine
- Design.....Cross-compound impulse turbine
- Manufacturer.....Kawasaki Heavy Industries
- Model.....UA-360
- Number.....1
- Output.....MCR: 36,000shp/88rev/min NCR: 32,400shp/85rev/min

Propeller
- Material.....Cunial
- Manufacturer.....Lips
- Number.....1
- Pitch.....Fixed
- Diameter.....8500mm
- Speed.....88rev/min (MCR)

Steam-turbine driven alternators
- Number.....2
- Turbine make.....Mitsubishi Heavy Industries
- Type.....Multi-stage
- Alternator make.....Hyundai Heavy Industries
- Output.....2 x 3450kW/1800rev/min

Diesel-driven alternator
- Number.....1
- Engine make.....Ssangyong Heavy Industries
- Alternator make.....Hyundai Heavy Industries
- Output.....1 x 3450kW/720rev/min

Boilers
- Number.....2 plus 1 low-pressure steam generator
- Type.....2 x vertical two-drum 1 x horizontal tubular
- Makers.....Mitsubishi Heavy Industries and Donghwa Entec
- Output.....2 x 56tonnes/h; 1 x 6.5tonnes/h

Hose-handling cranes
- Number.....2
- Make/type.....Hydralift/electro-hydraulic
- Capacity.....2 x 12tonnes

Mooring equipment
- Number.....2 x mooring winch/windlass, 7 x mooring winch
- Make.....Kocks
- Type.....High-pressure hydraulic

Cargo tanks
- Number.....4
- Product range.....LNG
- Coated tanks.....No
- Stainless steel.....No

Cargo pumps
- Number.....8
- Type.....Submerged electrical
- Make.....Ebara International
- Capacity.....8 x 1700m³/h

Cargo control system
- Type.....Integrated automation system
- Make.....Honeywell Korea

Ballast pumps
- Make.....Shinko
- Type.....Electric vertical centrifugal

Complement
- Officers.....21
- Crew.....16
- Repair/Suez crew.....6

Bow thruster
- Make.....Brunvoll
- Number.....1
- Output.....1 x 1600kW

Bridge control system
- Make.....STN Atlas
- One man operation.....Yes

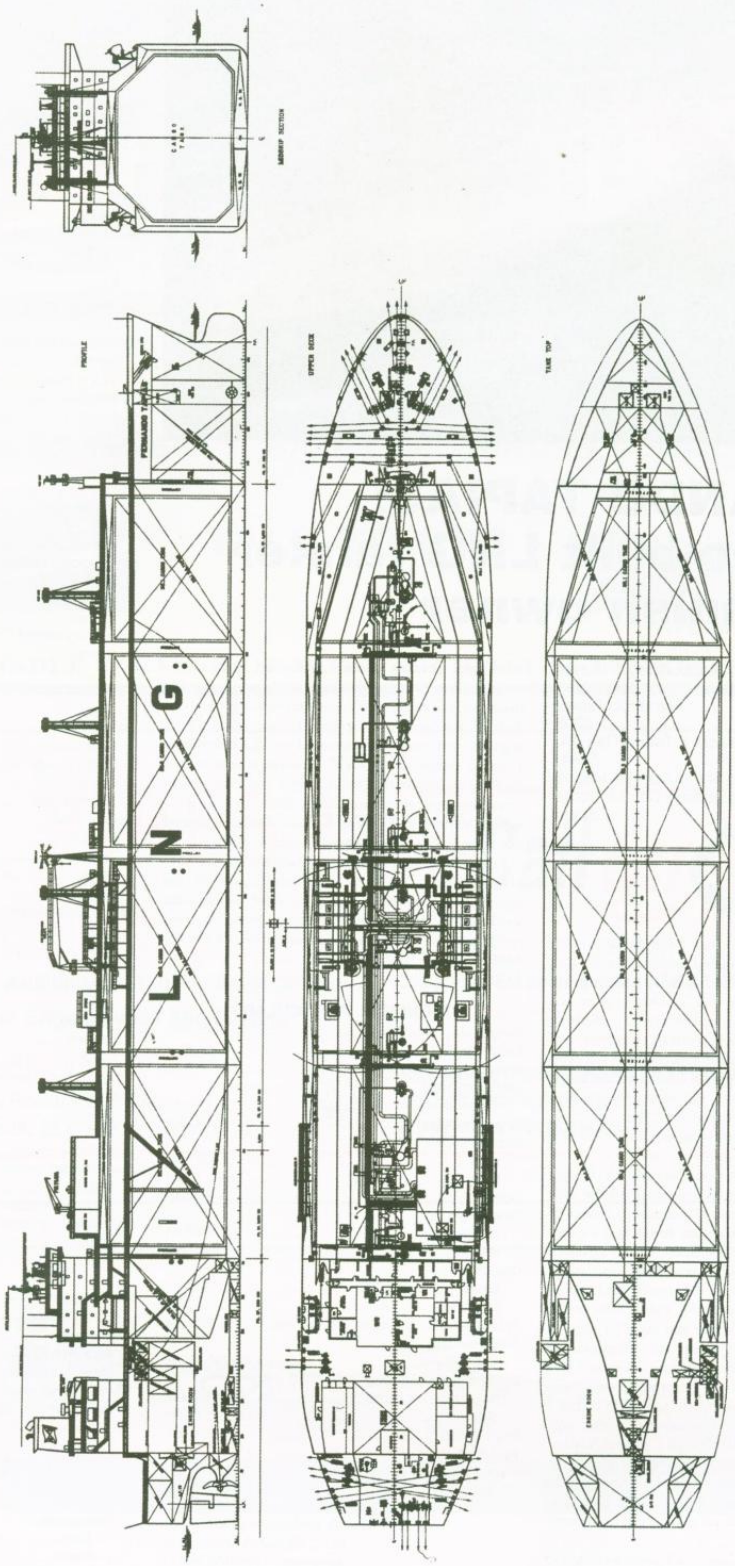
Fire detection systems
- Make.....Consilium
- Type.....25 heat detectors; 6 flame detectors; 235 smoke detectors

Fire extinguishing systems
- Cargo spaces.....Dry powder, water spray, nitrogen
- Make.....NK Fire Protection
- Engineroom.....High-expansion foam
- Make.....Kashiwa

Waste disposal plant
- Incinerator
  - Make.....Hyundai-Atlas
  - Model.....Maxi T150 SL W/S
- Waste compactor
  - Make.....Metos Marine
  - Model.....Uson UP-10
- Sewage plant
  - Make.....Jong-Hap
  - Model.....AEROB-18

Contract date.....31 March 2000
Launch/float-out date.....3 November 2001
Delivery date.....30 September 2002

FERNANDO TAPIAS



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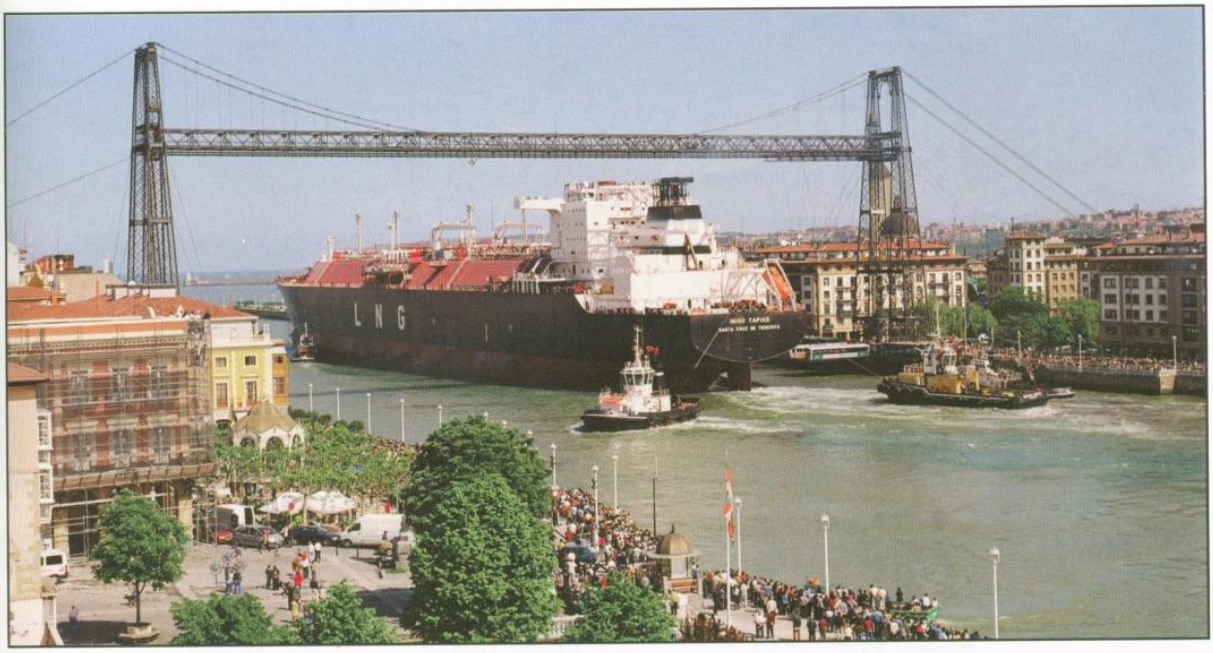
SIGNIFICANT SHIPS OF



INIGO TAPIAS: satisfying Spain's increasing LNG requirements

Shipbuilder:.....IZAR (Astillero Sestao, Bilbao), Spain
Vessel's name:.....*Inigo Tapias*
Hull number:.....319
Owner/operator:.....Naviera F Tapias SA, Spain
Designer:.....IZAR
Model test establishment used:.....MARIN, The Netherlands
Flag:.....Spain
Total number of sister ships already completed:.....Nil
Total number of sister ships still on order:.....4 (*contract shared with IZAR (Puerto Real)*

A PROJECTED 50% increase in Spain's consumption of gas has initiated this contract, for vessels equalling in capacity the largest yet built, which re-introduces construction of LNG tankers into the country's shipyards after a lapse of more than 30 years. Although designed to load/unload at all the world's current terminals, *Inigo Tapias* will normally be employed transporting gas from Trinidad and Tobago to Spain, with hull form, propulsion and power systems, developed for maximum energy economy on what is virtually a liner service. To this end, Schneekluth wake-equalising ducts have been fitted at the stern, in front of a five-bladed FP propeller, in an arrangement claimed to reduce power requirements by 1.50%.

The proven reliability of steam turbine propulsion, along with the ability of that system to burn boil-off gases in the boilers, is demonstrated by the fitting of a conventional (for this type of vessel) machinery installation centred upon a Kawasaki package, comprising a main propulsion turbine developing 28,000kW at 83rev/min, two 3150kW turbo-generators, main feed pump turbines, and reversible double-reduction gearing, all assembled at the shipbuilder's Ferrol works. A 3150kW diesel-alternator set is installed and an 1800kW electric bow thruster is fitted. The two Mitsubishi boilers each have an output of 65,000kg/h and are arranged to burn heavy oil, boil-off gas, or a combination of both.

Inigo Tapias is a single-deck vessel with sunken aft deck, and all accommodation and navigating spaces aft, built with principal dimensions which differ slightly from those of other, similar sized vessels (see *Significant Ships of 2002*), resulting in a slightly longer, narrower hull form. This is in order to meet a beam restriction on the building berth at the Sestao yard. The machinery casings and accommodation are not integrated, in order to minimise vibration transmission, and the design satisfies the requirements of a Type 2G tanker suitable for the carriage of liquid natural gas of SG 0.46 at -163°C. Maximum boil off rate is 0.15% cargo volume.

The four cargo tanks, which extend above the deck to form a trunk, are built within a complete double-hull structure with integral spaces utilised as water ballast tanks, in accordance with a Gaz Transport/Technigas NO96-E2 membrane technique, using Invar stainless steel sheet with a 36% nickel content for the primary and secondary barriers. Between these, and the secondary barrier/shell, perlite granules in plywood boxes are inserted.

The cargo handling systems can discharge the vessel in 12 hours using two 1700m^3/h electric submerged pumps, and one 50m^3/h stripping pump, in each tank, supplemented by a 530m^3/h emergency cargo pump. Each tank has a liquid manifold; vapour manifold; stripping manifold and cooling manifold, with the liquid pipelines running to the bottom of the tanks and the vapour line connected at the top. Included in the cargo systems are 2 x 30,000m^3/h high-duty, and 2 x 8000m^3/h low-duty, compressors; two 23,000kg/h main heaters and 1 x 20,000kg/h LNG vaporiser. The forcing vaporiser capacity is 6950kg/h; the inert gas generator is rated at 15,000Nm^3/h and the two nitrogen generators each produce 120Nm^3/h.

TECHNICAL PARTICULARS

Length, oa.....284.40m
Length, bp.....271.00m
Breadth, moulded.....42.50m
Depth, moulded
- to main deck.....25.40m
- to trunk deck.....32.20m

Width of double skin.....-
Gross.....93,450gt
Draught
- design.....11.40m
- scantling.....12.30m

Deadweight
- design.....68,200dwt

Speed
- service.....19.50knots
- ballast trial, at 90% MCR.....21.00knots

Cargo capacity
- liquid volume (100% full).....138,000m^3
- liquid volume (98.5% full).....135,930m^3

Bunker capacity.....-
Water ballast.....-
Classification.....Lloyd's Register of Shipping, +100A1, Liquefied Gas Tanker, Ship Type 2G, Methane in Membrane Tanks, Max. Pressure 0.25bar, Min Temperature -163°C, +LMC, UMS, PORT, SDA, IWS, SCM, LI, FDA, NAV1, IBS, ES, TCM, CCS

Main engine
Steam turbine
- Design.....Cross-compound impulse
- Manufacturer.....Kawasaki Heavy Industries
- Model.....-
- Number.....1
- Output.....28,000kW/83rev/min

Gearbox
- Make.....Kawasaki
- Type.....Double-reduction

Propeller
- Manufacturer.....Navalips
- Number of blades.....5
- Number.....1
- Pitch.....Fixed
- Diameter.....8700mm
- Speed.....83rev/min

Steam-turbine-driven alternators
- Number.....2
- Output.....2 x 3150kW

Diesel-driven alternator
- Number.....1
- Output.....1 x 3150kW

Boilers
- Number.....2 x water tube, dual fuel
- Make.....Mitsubishi Heavy Industries
- Output.....2 x 65,000kg/h

Hose-handling cranes
- Number.....2
- Duty.....2 x 12tonnes swl

Cargo tanks
- Number.....4 x membrane type
- Design.....Gaz Transport/Technigas
- Type.....NO96-E2
- Product range.....LNG
- Coated tanks.....No
- Stainless steel.....No

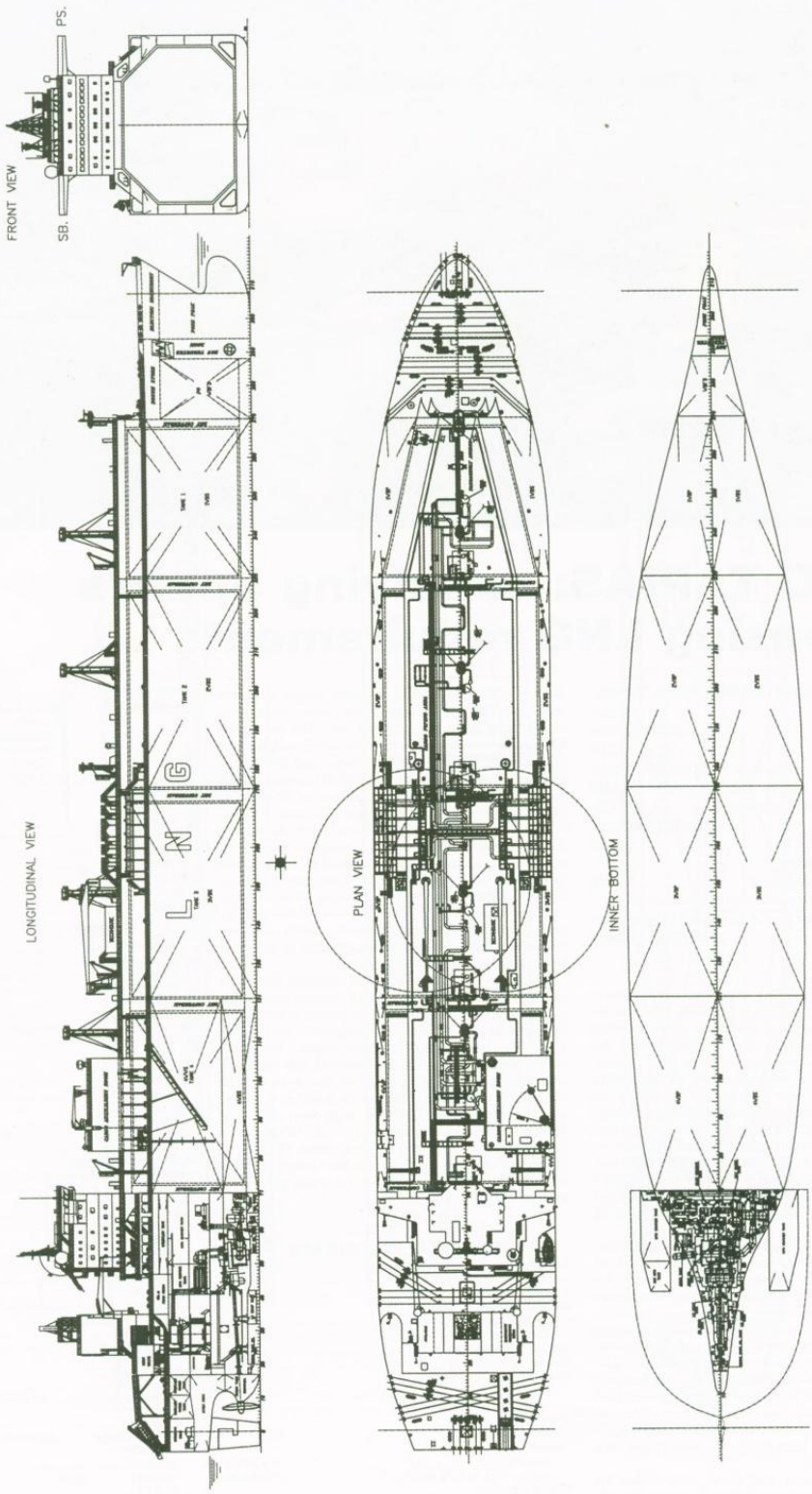
Cargo pumps
- Number.....8
- Type.....Electric submerged
- Make.....-
- Capacity.....8 x 1700m^3/h 4 x 450m^3/h, stripping

Ballast pumps
- Make.....-
- Capacity.....3 x 2500m^3/h; 1 x 350m^3/h ejector; 1 x 200m^3/h ejector

Complement.....-
Stern appendage.....Schneekluth wake-equalising ducts
Bow thruster
- Make.....-
- Number.....1
- Output.....1 x 1800kW

Contract date.....-
Launch/float-out date.....-
Delivery date.....1 August 2003

INIGO TAPIAS



MAERSK QATAR: 145,600m³ LNG carrier for RasGas project

Shipbuilder: Samsung Heavy Industries Co Ltd, Korea
Vessel's name: *Maersk Qatar*
Hull number: 1562
IMO number: 9321732
Owner/operator: AP Möller-Maersk Group, Denmark
Designer: Samsung Heavy Industries Co Ltd, Korea
Model test establishment used: Samsung Ship Model Basin, Korea
Flag: Danish International Shipping Register
Total number of sister ships already completed: 11 (different owners)
Total number of sister ships still on order: 7

THE diversity of the Möller-Maersk Group is difficult to measure, but some idea of its extent is demonstrated in this edition of *Significant Ships* where four of this leading owner's newbuildings are featured, including the largest container ship in the world, together with this vessel - one of the largest LNG tankers in service, alongside two 'baby-size' box ships. Equally, Samsung can point to its own varied output, and a rise to becoming a world leader in LNG carrier design in just seven years since delivering the first ship of this type.

Maersk Qatar is a development of Samsung's standard design, which conforms closely to what has become an industry 'norm', offering around 140,000m³ capacity. In fact, *Maersk Qatar*, with some slight 'tweaking' of length and beam over earlier ships, will load nearly 6000m³ more than that, in its operations on the RasGas project.

The design features a double-skin hull with side spaces joined with top and bottom wing tanks arranged to carry water ballast. These enclose four individual cargo tanks, separated by cofferdams, and constructed in accordance with the Gaz Transport and Technigas (GTT) Mk 3 containment system for the carriage of LNG cargoes at cryogenic temperatures (-163°C).

These tanks extend above the upper deck and are enclosed in a trunk which also provides access passages forward and aft. The containment system, which is designed to limit the daily boil-off rate to 0.15% cargo volume, is complemented by three Ebara 1700m³/h electric submersible pumps, capable of discharging cargo in 12 hours, following pre-cooling by LNG spray.

Despite the fact that its does hold contracts for both low-speed diesel and diesel-electric-powered LNG tankers, Samsung has retained the 'traditional' steam turbine propulsion system for *Maersk Qatar*. This makes use of a Kawasaki UA400, cross-compound, direct-reversible, impulse-type unit developing 29,050kW and driving an FP propeller at 90rev/min for a service speed of 20.6knots. A double-reduction, articulated gearbox is integrated with the main turbine. Two 3450kW steam turbine-driven alternators are installed, and there is also a diesel set with the same output. Steam is produced in two watertube boilers arranged to burn either oil fuel or boil-off gases.

TECHNICAL PARTICULARS

Length, oa: approx 283.00m
Length, bp: approx 270.00m
Breadth, moulded: 43.40m
Depth, moulded
- to main (upper) deck: 26.00m
- to trunk deck: 32.80m

Width of double skin
- side: 2.53m
- bottom: 3.10m

Draught
- design: 11.40m
- summer: 12.00m
- scantling: 12.40m

Gross: 96,508gt
Displacement (design): 102,000tonnes
Lightweight: 30,740tonnes
Deadweight
- design: 71,450dwt
- summer: 77,450dwt
- scantling: 81,450dwt

Block coefficient (design): 0.745
Speed, service, 85% MCR, design draught: 20.60knots
Cargo capacity: 145,600m³
Bunkers
- heavy oil: 7490m³
- diesel oil: 440m³

Water ballast: 57,000m³
Fuel consumption, main engine: 171.7/tonnes/day
Classification: American Bureau of Shipping, +A1, E, Liquefied Gas Carrier, Ship Type 2G (Membrane Tank, max pressure 25kPaG, min temp -163°C, SG 500kg/m³), SH, SH-DLA, SHCM, SFA (40) +AMS, +ACCU, UWILD, PMS including CMS, NIBS, HM3+R with Descriptive Note: 'Slam Warning, Hull Girder Stress, Full VDM'

Percentage of high-tensile steel used in construction: approx 13%
Main engine
- Design: direct reversible steam turbine
- Model: UA-400
- Manufacturer: Kawasaki Heavy Industries
- Number: 1
- Output: 29,050kW

Main boilers
- Number: 2
- Type: Water tube
- Manufacturer: Kawasaki Heavy Industries
- Output: 2 x 66tonnes/h

Gearbox
- Make: Kawasaki Heavy Industries
- Type: double-reduction, articulated
- Number: 1
- Output speed: 90rev/min

Propeller
- Material: Nickel-aluminium-bronze
- Designer/manufacturer: Samsung/Nakashima
- Number: 1
- Pitch: Fixed
- Diameter: 8600mm
- Speed: 90rev/min

Steam-turbine driven alternators
- Number: 2
- Make/type: Mitsubishi/AT42CT-B
- Output/speed: 2 x 3450kW/1800rev/min

Diesel-driven alternator
- Number: 1
- Engine make/type: STX-MAN/8L32/40H
- Type of fuel: MDO
- Output/speed: 3664kW/720rev/min
- Alternator type: Nishishiba
- Output/speed: 3450kW/720rev/min

Cargo tanks
- Number: 4 x IMO Type 2 membrane (GTT Mk 3 system)

Cargo pumps
- Number: 8
- Type: submerged electric
- Make: Ebara
- Capacity: 8 x 1700m³/h

Custody transfer system: Saab Rosemount
Integrated automation system: Kongsberg Maritime
Complement: 41 plus 6 Suez crew
Bow thruster
- Make: Kawasaki Heavy Industries
- Number: 1
- Output: 2500kW

Bridge control system
- Make: Kawasaki
- Type: part of main turbine installation

Fire detection system
- Make: Consilium Marine
- Type: CS 3000

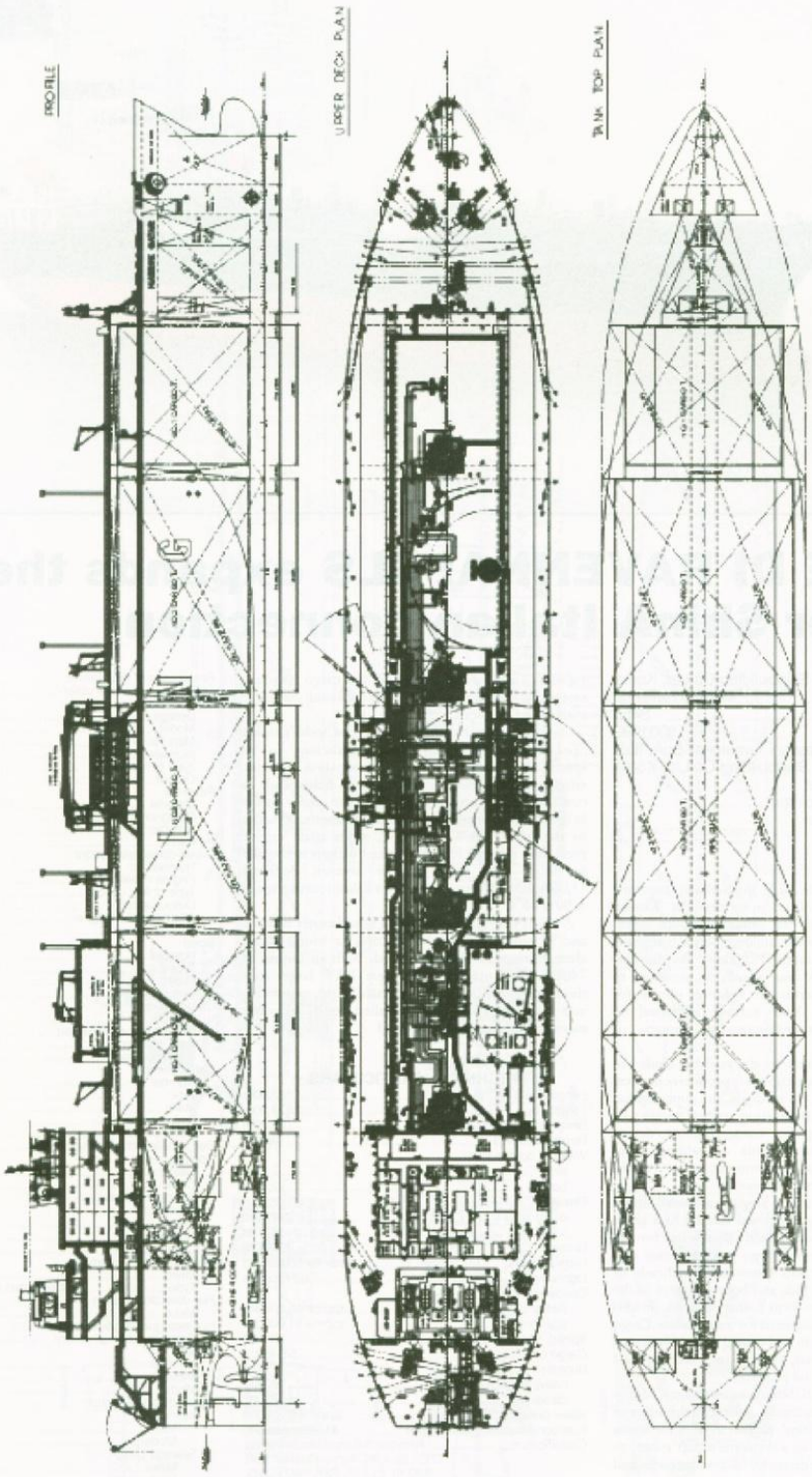
Fire extinguishing system
- Engineroom: High-pressure CO_2
- Make: Unitor

Radars
- Number: 2
- Make: Kongsberg
- Model: DB 1028

Integrated bridge system
- Make: Kongsberg
- Model: SEAMAP 1021

Contract date: 29 October 2003
Launch/float-out date: 9 July 2005
Delivery date: 15 April 2006

MAERSK QATAR



Methane Julia Louise: Tri-fuelled diesel-electric LNG carrier from SHI

Shipbuilder: **Samsung Heavy Industries Co., Ltd**
Vessel name: ***Methane Julia Louise***
Hull No: **HN1745**
Owner/operator: **BG LNG services**
Country: **United Kingdom**
Designer: **Samsung Heavy Industries Co., Ltd**
Country: **Republic of Korea**
Model test establishment used: **SSMB (Samsung Ship Model Basin)**
Flag: **Bermuda**
IMO number: **9412880**
Total number of sister ships already completed (excluding ship presented): **3**
Total number of sister ships still on order: **Nil**

Methane Julia Louise is a 170,000m^3 class liquefied natural gas (LNG) carrier that uses Gaz Transport & Technigas' Mark III membrane. It is equipped with four dual fuel engines and electric motors driving twin propellers and rudders. The service speed of *Methane Julia Louise* is 19.5knots with 6% savings in propulsion power. *Methane Julia Louise* was delivered to its owner BG LNG Services on 19 April.

The technology of the Samsung tip advanced raked propeller (STAR) concept was, applied to the vessel, which helps not only the vessel's speed but also its vibration performance. In addition, Samsung has added its Samsung vibration & energy reduction (SAVER) fins, which have been adopted around the aft of the vessels body. The potential vibration reduction of the fin is between 30-40%.

The cargo system has also been reinforced more than usual for LNG carriers, due to the design taking into account the vessel's operational route and the weather conditions that it will endure. Most of the upper areas of the cargo tanks have reinforced Rib application. Also, the corner areas for the upper part of the cargo tanks have been fitted with wedge material, which can provide reinforcement against internal sloshing pressure.

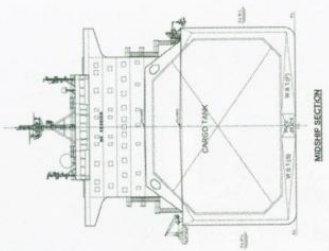
Methane Julia Louise is also equipped with a re-liquefaction plant based on a N2 cycling system, which is integrated with the gas management system of the duel fuel engines. The system is capable of liquefying 2.5tonnes of boil off gas per hour providing greater flexibility in managing boil off gas at sea as well as delivering more cargo at the end of the voyage.

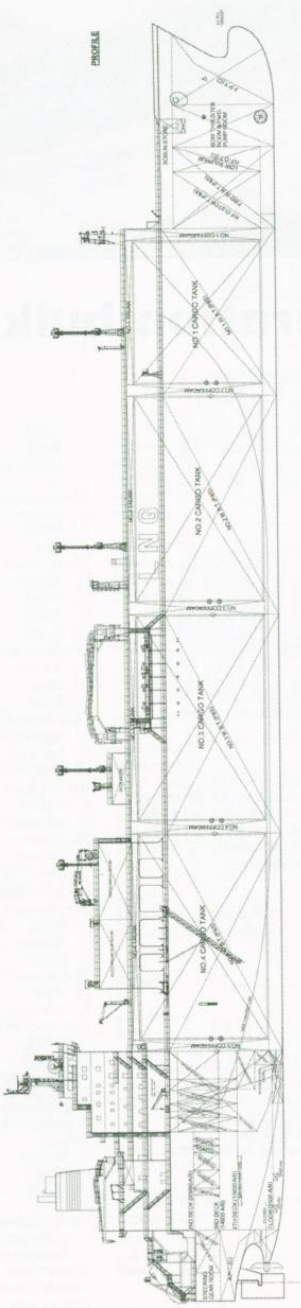
An integrated automation system has been adopted which gives centralised and integrated control and monitoring features of all major systems onboard, which allows intuitive operation even in critical circumstances. The integrated navigation system has an integrated system for collision avoidance, route planning and monitoring, and other navigational systems.

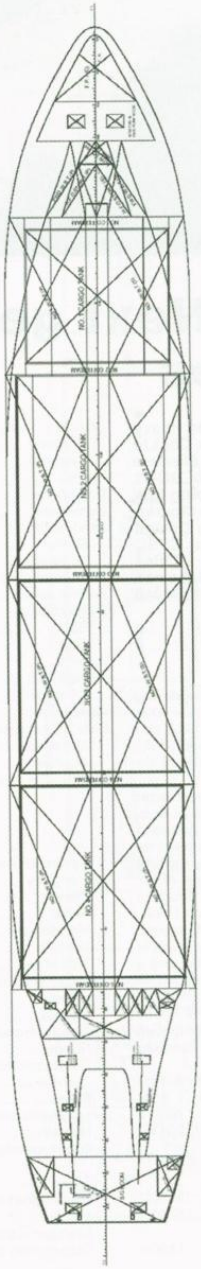
TECHNICAL PARTICULARS

Length oa: 291.06m
Length bp: 279.00m
Breadth moulded
To main deck: 45.00m
To upper deck: 26.00m
To other decks: 34.25m
Width of double skin
Side: 2.48m
Bottom: 3.20m
Draught
Scantling: 12.5m
Summer: 11.9m
Design: 11.5m
Gross: 109,004gt
Displacement: 119,094tonnes (at Tsummer)
Lightweight: 32,968tonnes
Deadweight
Design: 81,621dwt
Scantling: 86,125dwt
Block co-efficient: 0.7721 (at Tdesign)
Speed, service: 19.75knots
Cargo capacity
Liquid volume: 170,723m^3
Bunkers
Heavy oil: 5259m^3
Diesel oil: 824m^3
Water ballast: 62,933m^3
Daily fuel consumption
Main engine only: 124.9tonnes/day
Classification: ABS, ✠ A1 E, Liquefied Gas Carrier, Ship type 2G(Membrane tank, Maximum pressure 25kPaG and minimum Temperature -163°C, Specific gravity 500kg/m^3), SH, FL(40), SH-DLA, SHCM, SFA(40), ✠AMS, NBL, ✠ACCU, UWILD, PMS including CMS, R2 without centralised fresh water cooling system
% high tensile steel used in construction: Approx. 20%
Main engine
Design: 25,000kW
Model: 3 x 12V50DF 1 x 6L50DF
Manufacturer: Wartsila
Number: 4
Type of Fuel: BOG, HFO, MDO
Output of each engine: 11,400kW at MCR(12V50DF) 5700kW at MCR(6L50DF)
Propulsion motors
Number: 2
Make: Converteam
Model: N3HXC 1000
Output/speed of each set: 12,700kW/675rpm
Gearboxes
Make: Renk
Model: RSH-2000
Number: 2
Output speed: 86rpm
Propellers
Material: Ni-Al-Bronze
Designer/Manufacturer: Nakashima
Number: 2
Fixed/Controllable pitch: Fixed pitch
Speed: 86rpm
Main-engine driven
Number: 4
Make/Type: Coverteam/M4HXD 253-58
Output/speed of each set: 11,000kW/514rpm 5500kW/514rpm
Boilers
Number: 2
Type: oil fired, vertical, forced draft, marine boiler
Make: Aalborg
Output, each boiler: 5000kg/h
Cargo cranes/cargo gear
Number: 2
Make: MacGregor
Type: Self contained elctro-hydraulic single jib
Performance: SWL5tonnes
Other cranes
Number: 3
Make: MacGregor
Type: Self contained electro-hydraulic single jib
Tasks: 2 for handling of provisions and engine parts One for handling of cargo machinery room equipment
Performance: 1 x 5tonnes at port side 1 x 10tonnes at starboard side 1 x 5tonnes at cargo machinery room
Mooring equipment
Number: 2 x windlasses 7 x winches
Make: TTS Kocks
Type: Self contained electro-hydraulic (high pressure)
Special lifesaving equipment
Number: 1 x 42 persons
Make: Schat-Harding
Type: Totally enclosed free-fall
Cargo tanks
Number: 4
Density: 470kg/m^3 for general design, 500kg/m^3 for hull scantling, containment
Temperature: min -163°C
Pressure: -10mbar to 250mbar gauge
Coated tanks: GTT MarkIII
Stainless steel: SUS316 and SUS316L
Cargo pumps
Number: 8
Type: Centrifugal, single stage, submerged, electric motor driven
Make: EBARA
Stainless steel: Aluminium alloy
Capacity: 1750m^3/h x 160mlc
Re-liquefaction plant
Number: 1
Type: N2 cycling system
Capacity: Full re-liqefication of 2500kg/hr boil off gas
Make: Hamworthy
Integrated automation system
Make/Type: Kongsberg K-Chief700
Bow thrusters
Make: Kawasaki Heavy Industries
Number/Output: 1 x 2500kW
Bridge control system
Make: Coverteam
Type: ARW
One-man operation: Yes
Fire detection system
Make/Type: Consilium Marine/Addressable type
Fire extinguishing systems
Cargo holds: Wilhelmsen/Dry powder Iljinand/water spray
Engine room: Wilhelmsen/High expansion foam NK/CO_2
Radars
Number: 3
Make: Furuno
Model: FAR-2827W (X-Band)/ FAR-2837SW (S-Band)
Inegrated bridge system
Make/Model: Furuno/FEA-2107
Waste disposal plant
Incinerator: Hyundai-Atlas Maxi NG100SL
Sewage plant: DVZ DVZ-SKA-30
Contract date: 26 December 2006
Launch/float-out date: 21 February 2009
Delivery date: 19 April 2010-10-27

METHANE JULIA LOUISE







SERI BALHAF: Mitsubishi's first dual-fuel diesel-electric LNG tanker

Shipbuilder: ..... **Mitsubishi Heavy Industries, Ltd.Nagasaki Shipyard & Machinery Works, Japan**
Vessel's name: ..... ***Seri Balhaf***
Hull No: **2223**
Owner/Operator: ..... **MISC Berhad**
Country: ..... **Malaysia**
Designer: ... **Mitsubishi Heavy Industries, Ltd.**
Country: ..... **Japan**
Model test establishment used: ..... **MHI Nagasaki R&D Center, Japan**
Flag: ..... **Malaysia**
IMO number: **9331660**
Total number of sister ships already completed (excluding ship presented): ..... **Nil**
Total number of sister ships still on order: **1**

Seri Balhaf is the largest Japanese-built LNG Tanker to feature the Gaz Transport & Technigaz membrane cargo containment system (GTT No.96E 2F) and electric propulsion motors with a Dual Fuel Engine (DFE) system. This results in improved fuel efficiency for the main propulsion system, supplemented by the high propulsive performance achieved by using a refined hull form developed using CFD (Computational Fluid Dynamics).

The principal dimensions of the membrane tanks were optimised taking into account the requirements of LNG terminals world-wide, with particular attention given to major Japanese, Korean and Taiwanese terminals. Cargo tank dimensions were determined to minimise sloshing dynamic loads.

The water ballast tanks adjacent to No.2 & 3 cargo tanks are divided into two pairs to facilitate safe ballast water exchange by the displacement method whilst remaining within the vessel's designed longitudinal strength parameters. The ballast exchange is automated by Mitsubishi Heavy Industries' ABE (Automatic Ballast Exchange) system.

One fuel gas pump of submerged type is provided in each of No.2 & 3 cargo tanks. Where natural boil-off is inadequate for vessel needs forced boil-off gas is supplied using cargo LNG transferred by fuel gas pump or spray pump from cargo tanks.

The propulsion plant consists of two electric propulsion motors and four Wärtsilä dual fuel engines (3 x 12V50DF plus 1 x 6L50DF). These dual fuel engines can run in MDO mode, burning diesel oil only, and in gas mode, burning mainly gas with diesel oil as a pilot fuel. In the gas mode the engines can use forced boil-off gas supplied as described above or natural boil-off gas generated in the cargo tanks. The natural boil-off gas is transferred to the engine room through a low duty gas compressor installed in the cargo machinery room.

The engines are arranged in two separate machinery spaces, each with independent fuel systems, seawater cooling systems, fresh water cooling systems, ventilation systems, and fire detection devices.

Two ABB AMZ 1120MS08 LSF electric propulsion motors drive one propeller through a Renk NDSH-3920 reduction gear. Each electric propulsion motor has independent feeder circuits and is operated individually. A gas combustion unit in the engine casing burns surplus boil-off gas where the amount of natural boil-off gas exceeds vessel requirements.

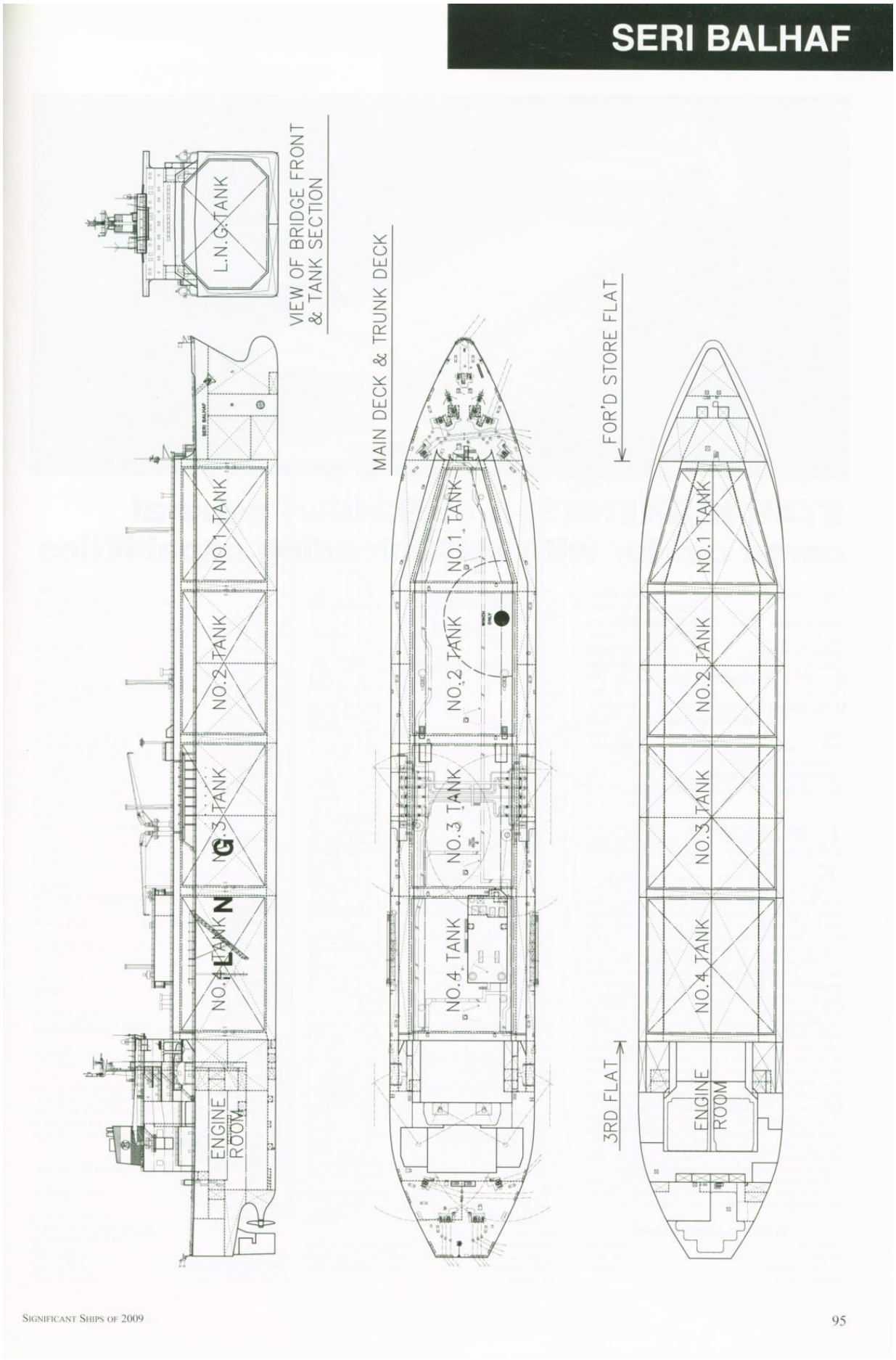
A Mitsubishi Heavy Industries DCS (Distributed control system) is provided to facilitate monitoring and control of the principal machinery and the equipment in the engine and cargo handling areas from the centralised control room.

Seri Balhaf and her sister ship, *Seri Balqis*, have been chartered to lift Yemen LNG cargoes for 20 years, plus further options.

TECHNICAL PARTICULARS

Length oa: 294.6m
Length bp: 281.6m
Breadth moulded: ..... 46.5 m
Depth moulded to upper deck: ..... 25.8 m
Width of double skin:
side: ..... 2.36m approx.
bottom: ..... 3/1m approx.
Draught:
scantling: 12.40m
design: 11.15m
Gross: 107,633gt
Deadweight, scantling: 91,201dwt
Speed, service: ..... 19.5knots at 100% MCR
Cargo capacity:
Liquid volume: ..... 157,720m^3 (100% at -163 degrees C)
Bunkers:
Diesel oil: ..... 2600m^3
Water ballast: ..... 57,900 m^3
Daily fuel consumption:
Main engine only: 129tonnes/day
Classification society and notations: ..... Bureau Veritas I, +Hull, +Mach Liquefied Gas Carrier/ LNG, +Unrestricted navigation, +AUT-UMS, +VeriStar-Hull, Mon-Shaft, Inwatersurvey
Main generator engines:
Design & manufacturer: ..... Wärtsilä
Model: ..... 12V50DF and 6L50DF
Number: ..... 3 x 12V50DF + 1 x 6L50DF
Type of fuel: ..... MDO and Natural Gas
Output of each engine: ..... 3 x 11,400kW + 1 x 5700kW
Propulsion Electric Motor:
Design & manufacturer: ..... ABB
Number & model: ..... 2 x AMZ 1120MS08 LSF
Gearbox:
Make: ..... Renk
Number & model: ..... 1 x NDSH-3920
Output: ..... 24,750kW x 78.0rev/min
Propeller:
Material: ..... Nickel aluminum bronze
Designer/Manufacturer: ..... Mitsubishi Heavy Industries, Ltd.
Fixed/Controllable pitch: ..... 1 x Fixed
Diameter: 9.0m
Speed: 78.0rev/min
Exhaust-gas scrubbing equipment:
Manufacturer: ..... Aalborg Industries K.K.
Type: ... Mono-pressure, forced circulation, fin tube type
Boiler:
Number & type: ..... 1 x Cylindrical type
Make: ..... Aalborg Industries K.K.
Output, each boiler: 9000kg/h
Mooring equipment
Number: ..... 2 x mooring winch/windlass, 7 x Mooring winch
Make: ..... Friedrich Kocks GmbH
Type: ..... Electro-hydraulic
Special lifesaving equipment:
Number of each and capacity: ..... 2 x 44 persons
Make: ..... Hyundai Life boats Co., Ltd.
Type: ..... FRP enclosed type lifeboat
Cargo tanks:
Number: 4
Grades of cargo carried: ..... LNG
Cargo pumps:
Number: 8
Type: ..... Electric motor driven centrifugal submerged
Make: ..... Ebara Corporation
Capacity (each): ..... 1850m^3/h / 170tonnes/h
Cargo control system:
Make: ..... Mitsubishi Heavy Industries, Ltd.
Type: ..... Distributed Control System
Ballast control system:
Make: ..... Mitsubishi Heavy Industries, Ltd.
Type: ..... Automatic Ballast Exchange system
Complement:
Officers: 12
Crew: 19
Supernumaries/Spare: 5
Suez/Repair Crew: 4
Bow thrusters:
Make: ..... Kawasaki Heavy Industries, Ltd.
Number & ouput: ..... 1 x 2000kW
Fire detection system:
Make: ..... Autronica A/S
Fire extinguishing systems:
Cargo holds: ..... Dry powder
Engine room: ..... CO_2
Radars:
Number & make: ..... 2 x Japan Radio Co., Ltd.
Models: ..... 1 x X-band with ARPA, 1 x S-band with ARPA
Integrated bridge:
Make: ..... Japan Radio Co., Ltd.
Waste disposal plant
Incinerator: ..... Sunflame Co., Ltd.
Sewage plant: ..... Taiko Kikai Industries Co., Ltd
Contract date: ..... 23 July 2004
Launch/float-out date: ..... 16 February 2008
Delivery date: ..... 1 January 2009

SERI BALHAF


VIEW OF BRIDGE FRONT & TANK SECTION
L.N.G. TANK
NO.1 TANK
NO.2 TANK
NO.3 TANK
NO.4 TANK
ENGINE ROOM
MAIN DECK & TRUNK DECK
FOR'D STORE FLAT
3RD FLAT

SOYO: Eco-friendly LNG carrier

Shipbuilder: Samsung Heavy Industries Co., Ltd
Vessel's name: *Soyo*
Hull No: HN1810
Owner/operator: MiNT/ Teekay
Designer: Samsung Heavy Industries Co., Ltd
Country: Korea
Model test establishment used: Samsung Ship Model Basin
Flag: Bahamas
IMO number: 9475208
Total number of sister ships already completed (excluding ship presented): nil
Total number of sister ships still on order: 3

Soyo is the first vessel in a series of four latest energy efficient liquefied natural gas (LNG) carriers to be delivered to global shipping operator Teekay. *Soyo* was delivered from Korean shipyard Samsung Heavy Industries in July.

The vessel features optimal terminal compatibility, for most of the worldwide LNG terminals with maximum cargo capacity. It also features higher criteria for vibration and noise compared with IMO A.468 & ISO 6954, with stability of structure (Satisfied North Atlantic base) and 40 years fatigue life based on the North Atlantic trading route. Adding to this the vessel has ES notation for Environmental Safety.

Soyo features a SAVER fin that enhances the vessels efficiency by creating better flow of water to the propeller. The SAVER fin's main purpose is to enhance the vessel's energy efficiency through the reduction of the vessel's power. The vessel's power performance will be improved by the pressure recovery effect on the aft body of the hull through flow control, on the aft body, which will be induced by the SAVER fin. Additionally, the SAVER fin has a positive effect on vibration performance.

Adding to the vessel's green credentials the vessel has been fitted with three Wärtsilä-Hyundai 12V50DF and one 6L50DF engines that lowers the vessels NOx and SOx emissions. The Wärtsilä 50DF engine can operate with duel fuel (gas fuel mode and liquid fuel mode). Because the emissions (NOx and SOx) level in gas fuel mode is very low, this vessel can meet the IMO Tier II guidance with gas fuel operation without any additioanl system.

TECHNICAL PARTICULARS

Length oa: 285.357m
Length bp: 274m
Breadth moulded: 43.4m
Depth moulded
- To main deck: 26.4m
- To upper deck: 26.4m
- To other decks: 33.82m (trunk deck)

Width of double skin
- Side: 2.36m
- Bottom: 3.1m

Draught
- Scantling: 12.75m
- Summer: 12.15m
- Design: 11.75m

Gross: 100,723m
Displacement: 113,021tonnes (at Tsummer)
Lightweight: 30,163tonnes
Deadweight
- Design: 78,697dwt
- Scantling: 82,857dwt

Block co-efficient (at Tdeisgn): 0.7595
Speed, service: 21knots
Cargo capacity
- Liquid volume: 160,518m^3

Bunkers
- Heavy oil: 4762m^3
- Diesel oil: 1490m^3
- Water ballast: 54,993m^3

Tankers - percentage segregated ballast 100%
Daily fuel consumption
Main propulsion with 2000kW Hotel load: 142tonnes/day
Classification society and notations: ABS,✠A1 E, Liquefied gas carrier, Ship type 2G (membrane tank, Maximum pressure 25kPaG and minimum Temperature -163°C), SH, SH-DLA, SFA(40), RES,✠AMS, DFD, GCU, CRC,✠ACCU, UWILD, ✠APS, ES, SHCM, NIBS, PORT, POT, TCM

Main engines
- Model: 3 x 12V50DF 1 x 6L50DF
- Manufacturer: Wärtsilä-Hyundai Engine Company
- Number: 4
- Type of fuel used: Boil off gas, HFO, MGO
- Output of each engine: 11,400kW (12V50DF) 5700kW (6L50DF)

Gearboxes
- Make: Renk
- Model: NDSH-3900
- Number: 1
- Output speed: abt. 87rpm

Propellers
- Material: Ni-Al-Bronze
- Designer/Manufacturer: MMG
- Number: 1
- Fixed/controllable pitch: Fixed
- Diameter: 8.6m
- Speed: 87rpm

Boilers
- Number: 2
- Type: Oil fired marine boiler
- Make: Kangrim Heavy Industries
- Output, each boiler: 5000kg/h x 1MPa

Cargo cranes
- Number: 2
- Make: Oriental Precision
- Type: Electro-hydraulic driven, cylinder luffing type jib crane
- Performance: SWL 15tonnes

Other cranes
- Number: 3
- Make: Oriental Precision
- Type: Electro-hydraulic driven, cylinder luffing type jib crane
- Tasks: Provsiions & engine room equipment handling, CMR handling
- Performance: SWL 10tonnes

Mooring equipment
- Number: 5860
- Make: Rolls-Royce
- Type: Low pressure hydraulic driven

Cargo pumps
- Number: 8 (2 set for each cargo tank)
- Type: Centrifugal, single stage, submerged
- Make: Ebara
- Capacity: 1850m^3/h x 155mlc

Cargo control system
- Make: Seil-Seres
- Type: Hydraulic remote control system

Ballast control system
- Make: Seil-Seres
- Type: Hydraulic remote control system

Complement
- Officers: 26

Crew 14

Bow thrusters
- Make: Kawasaki
- Number: 1
- Output: 2000kW

Bridge control system
- Make: Furuno
- Type: Piano type console
- One-man operation: Yes

Fire detection system
- Make: Consilium
- Type: CS3000

Fire extinguishing systems
- Cargo area deck space: Dry powder system/ Wilhelmsen
- Engine room: High expansion foam/ Wilhelmsen
- Cabins: Sea water fire extinguishing system

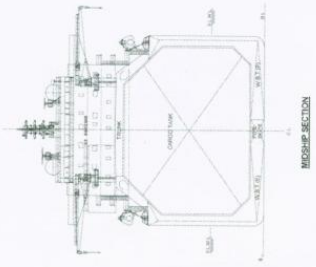
Radars
- Number: 2
- Make: Furuno
- Model: FAR-2827W FAR-2827SW

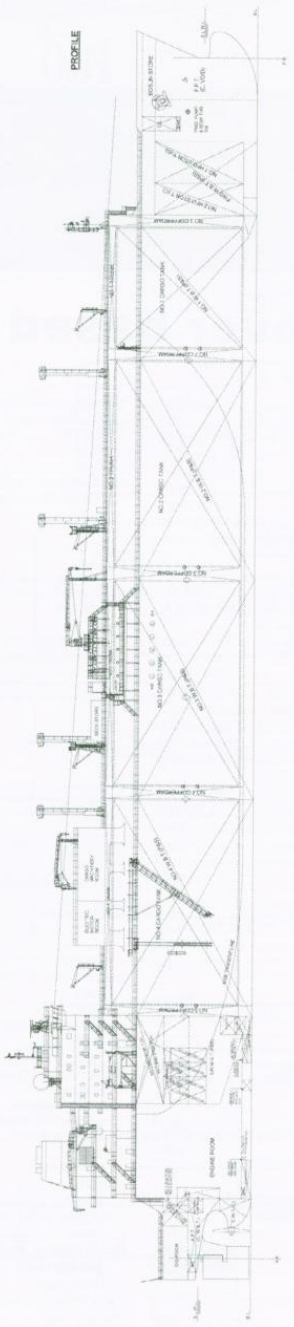
Integrated bridge system
- Make: Furuno
- Model: FEA-2807

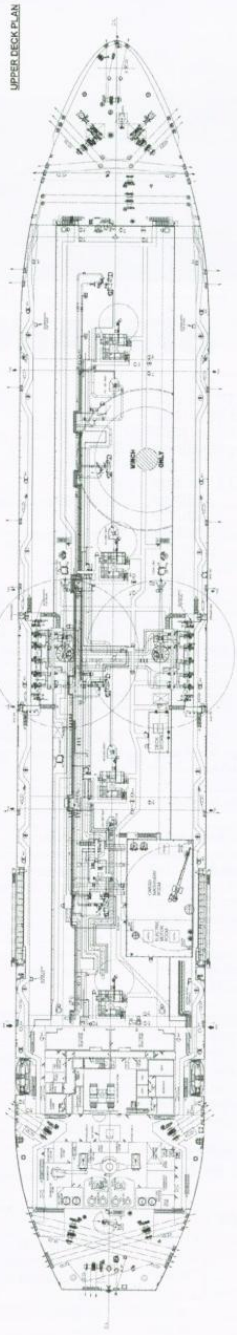
Waste disposal plant
- Incinerator: Hyundai Atlas/ Maxi 1500SL WS
- Sewage plant: Hamworthy/ ST3A-C

Contract date: 18 December 2007
Launch/float-out date: 10 October 2010
Delivery date: 29 July 2011

SOYO







TRINITY ARROW: Imabari Group delivers its first LNG carrier

Shipbuilder: **Imabari Shipbuilding Co Ltd (Koyo Dockyard), Japan**
Vessel's name: ***Trinity Arrow***
Hull number: **2258**
IMO number: **9319404**
Owner/operator: **Cypress Maritime (Panama SA, Panama/K Line LNG Shipping UK Ltd, UK**
Designer: **Imabari Group (Koyo Dockyard), Japan**
Model test establishment used: **Shipbuilding Research Centre of Japan, Japan**
Flag: **Panama**
Total number of sister ships already completed: **Nil**
Total number of sister ships still on order: **2**

IMABARI Shipbuilding Group's first LNG tanker is understood to be the largest capacity vessel of this type yet built in Japan. Although conforming to the traditional 'membrane-type' gas tanker layout with four cargo spaces, each containing an independent trapezoidal cargo tank which extends into a trunk above the upper deck, the design is unusual: in a departure from the norm, No 1 tank is of horizontally trapezoidal shape. It is claimed that this is the first time the arrangement has been used, and that it brings benefits of increased cargo capacity and, by virtue of its shape, allows an improved hull form to be developed, leading to better propulsive performance and reduced fuel consumption.

Because *Trinity Arrow* is intended for worldwide trading rather than long term operation on a specific route, Imabari sought to ensure compatability with most major LNG terminals in its design. This features a complete double-hull structure with cargo tank divisional bulkheads forming cofferdams heated by circulating glycol water to keep the temperature above +5°C, to suit the physical properties of the steel, in accordance with the IGC code.

A GTT Mk III cargo containment system has been adopted. This has a primary barrier of 1.2mm SUS membrane with orthogonal corrugations, and a secondary barrier of Triplex membrane, sandwiched between first and second glass fibre reinforced polyurethane foam layers. The insulation has a total thickness of 270mm, which allows an LNG boil off less than 0.15% each day to be maintained during a voyage.

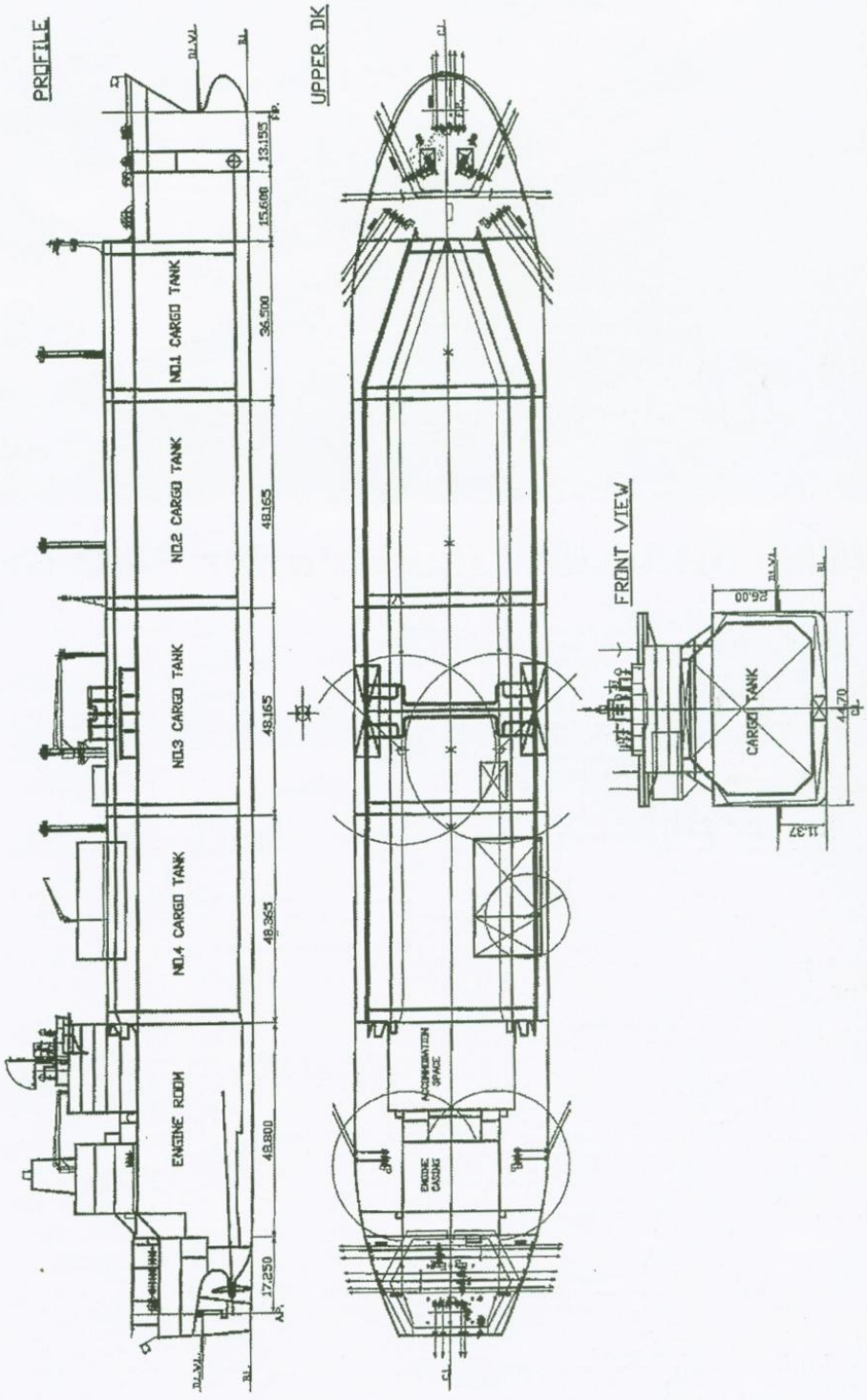
Each cargo tank is fitted with two 1700m³/h Shinko submerged cargo pumps, and one 50m³/h cargo stripping/spray pump. A further cargo pump of 550m³/h is provided for emergency use. Cargo control is carried out from the bridge, allowing full observation and monitoring of all operations, which are handled through port and starboard, midship manifolds. An automatic ballast exchange system is installed for use at sea, taking into consideration the strength, stability and safety aspects of the procedure, in accordance with IMO requirement A868(20). As is the current trend, separate bunker tanks are provided for holding low-sulphur fuel, for use in sulphur emission control areas (SECAs).

Trinity Arrow is fitted with a Kawasaki UA-400 turbine, supplied with steam from two water tube boilers arranged to burn heavy oil and boil-off gas. This installation develops a maximum continuous rating of 29,420kW at 81rev/min, and drives a fixed pitch propeller through a double-reduction, tandem articulated gearbox integrated with the main turbine, for a service speed of 19.50knots when running at 80% full power. Three Nishishiba 3250kW alternators are fitted, two driven by Shinko steam turbine prime movers, and one connected to a Yanmar diesel engine, to satisfy electrical requirements.

TECHNICAL PARTICULARS

Length, oa 289.00m
Length, bp 276.00m
Breadth, moulded 44.70m
Depth, moulded
  to trunk deck 33.12m
  to upper deck 26.00m
Width of double skin
  side 2.51m
  bottom 3.20m
Draught
  design 11.37m
  scantling 12.60m
Gross 101,080gt
Deadweight
  design 72,318dwt
  scantling 85,511dwt
Speed, service at 80% MCR 19.50knots
Cargo capacity, liquid volume 154,982m³
Bunkers
  heavy oil 6460m³
  diesel oil 700m³
Water ballast 56,780m³
Fuel consumption 161tonnes/day
Classification ..... Lloyd's Register +100A1, Liquefied Gas Tanker, Ship Type 2G, Membrane (LNG) in Membrane Tanks, Max Vapour Pressure 0.25bar, Minimum Temperature -163°C, ShipRight (SDA, FDA plus CM), *IWS, L1, +LMC, UMS, NAV 1, IBS, ICC
Percentage of high tensile steel used in construction 10.30%
Percentage of stainless steel used 0.10%
Main engine
  Design ..... Direct reversible steam turbine
  Manufacturer ..... Kawasaki Heavy Industries
  Model UA-400
  Number 1
  Output, MCR 29,420kW/81rev/min
  Output, NCR 26,480kW/78.2rev/min
Main boilers
  Number 2
  Manufacturer ..... Kawasaki Heavy Industries
  Type ..... UME LL153 watertube
  Output, max ..... 2 x 66,000kg/h
Gearbox
  Type ..... Tandem, articulated, double reduction, integrated with main turbine
Propeller
  Material ..... Nickel-aluminium-bronze
  Designer/manufacturer ..... Mitsubishi Heavy Industries
  Number 1
  Pitch ..... Fixed
  Diameter 8800mm
Steam turbine-driven alternators
  Number 2
  Turbine manufacturer ..... Shinko
  Alternator make ..... Nishishiba
  Output/speed ..... 2 x 3250kW/1800rev/min
Diesel-driven alternator
  Number 1
  Engine make ..... Yanmar
  Type of fuel used ..... Diesel/marine gas oil
  Output/speed 3404kW/720rev/min
  Alternator make ..... Nishishiba
  Output/speed 3250kW/720rev/min
Cargo tanks
  Number ..... 4 x IMO type 2G membrane type: GTT Mk III system
Cargo pumps
  Number 8
  Type ..... vertical submerged
  Make ..... Shinko
  Capacity ..... 8 x 1700m³/h
Ballast/cargo control systems
  Make ..... Kokogawa
  Type ..... Integrated automation system
Complement
  Officers 11
  Crew 18
  Supernumaries 6
  Suez crew 6
Bow thruster
  Make ..... Kawasaki Heavy Industries
  Number 1
  Output 2200kW
Bridge control system
  Make ..... Japan Radio Co
  Type ..... Integrated automation system
  One man operation ..... Yes
Fire detection system
  Make ..... Nippon Nahuyo
  Type FF-1515-4
Fire extinguishing system
  Cargo area (deck) ..... Unitor, dry powder
  Engineroom ..... Kashiwa, high expansion foam
Radars
  Number 2
  Types ..... 1 x JMA-922M9XA, LX-band
  1 x JMA-932MSA, S-band
  Make ..... Japan Radio Co
Integrated bridge system
  Make ..... Japan Radio Co
Waste disposal plant
  Incinerator ..... Sunflame DSV 600 SA1
  Waste compactor ..... Electrolux
  Sewage plant ..... Taiko Kikai SBT-65
Contract date ..... 3 August 2004
Launch/float-out date ..... 17 August 2006
Delivery date ..... 31 March 2008

TRINITY ARROW



WOODSIDE ROGERS: Electric driven LNG carrier

Shipbuilder: ....**Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Vessel's name: ....***Woodside Rogers***
Hull No: **2288**
Owner/operator: ....**Maran Gas**
Country: ....**Greece**
Designer: ....**Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Country: ....**Korea**
Model test establishment used: ....**SSPA**
Flag: ....**Greece**
IMO number: **9627485**
Total number of sister ships already completed (excluding ship presented): ....**nil**
Total number of sister ships still on order: **7**

MARAN Gas took delivery of its first electrically driven LNG carrier, *Woodside Rogers*, in July that was constructed by Daewoo Shipbuilding & Marine Engineering Co. Ltd. (DSME). It is the first of seven of these state-of-the-art LNG carriers that are scheduled for delivery between 2013 and 2015.

Woodside Rogers is equipped with a GE system comprising of four 9.85Mva generators, main and cargo switchboards, four transformers, two converters, two 13.26MW motors and remote control. The electric drive system is supported by four tri-fuel Wärtsilä 9L50DF engines, which are installed in two dedicated spaces within the engine room with a steel partition wall and, where necessary, openings to be provided for access and maintenance.

The four centre cargo tanks have a total capacity of 159,760m^3 and were designed by Gaz Transport & Technigaz (GTT) membrane system ("GT NO 96-GW"). The tanks will keep the LNG at a temperature of -163°C and have a daily boil-off rate of less than 0.125% of the fully loaded cargo volume.

The vessel has a continuous upper deck with an aft sunken deck, a raked stem with bulbous bow, a transom stern with open water type stern frame, one semi spade type rudder and one fixed-pitch propeller driven by electric propulsion motors through reduction gears.

The cargo handling systems have been designed to be capable of loading or discharging the LNG within 13 hours, using eight cargo pumps with a capacity of 1,850m^3/h and four stripping/spray pumps.

Vapour cargo handling equipment such as two high duty compressors, two low duty compressors (i.e., one for 2-stage & the other for 4-stage), one main vaporiser, one forcing vaporiser and one gas heater have been installed in cargo the machinery room.

The design fatigue life of the longitudinal stiffener connections to the transverse webs/bulkheads and critical details in cargo area have been designed to meet with the Rule requirement or the DNV PLUS notation for a minimum of 40 years on the basis of worldwide wave environment.

A six tiers deckhouse is located at the aft providing accommodation for 51 persons including Suez crews. Special attention has been paid to the vibration levels in living areas, which have been minimised at normal operating condition.

The bridge is designed for optimum operational safety and efficiency, taking advantages of current technology and rational navigational methods. The bridge can be operated under normal conditions by one person and the system comprises a modular workstation arrangement, meeting all design and equipment layout requirements in accordance with DNV notation NAUT-OC.

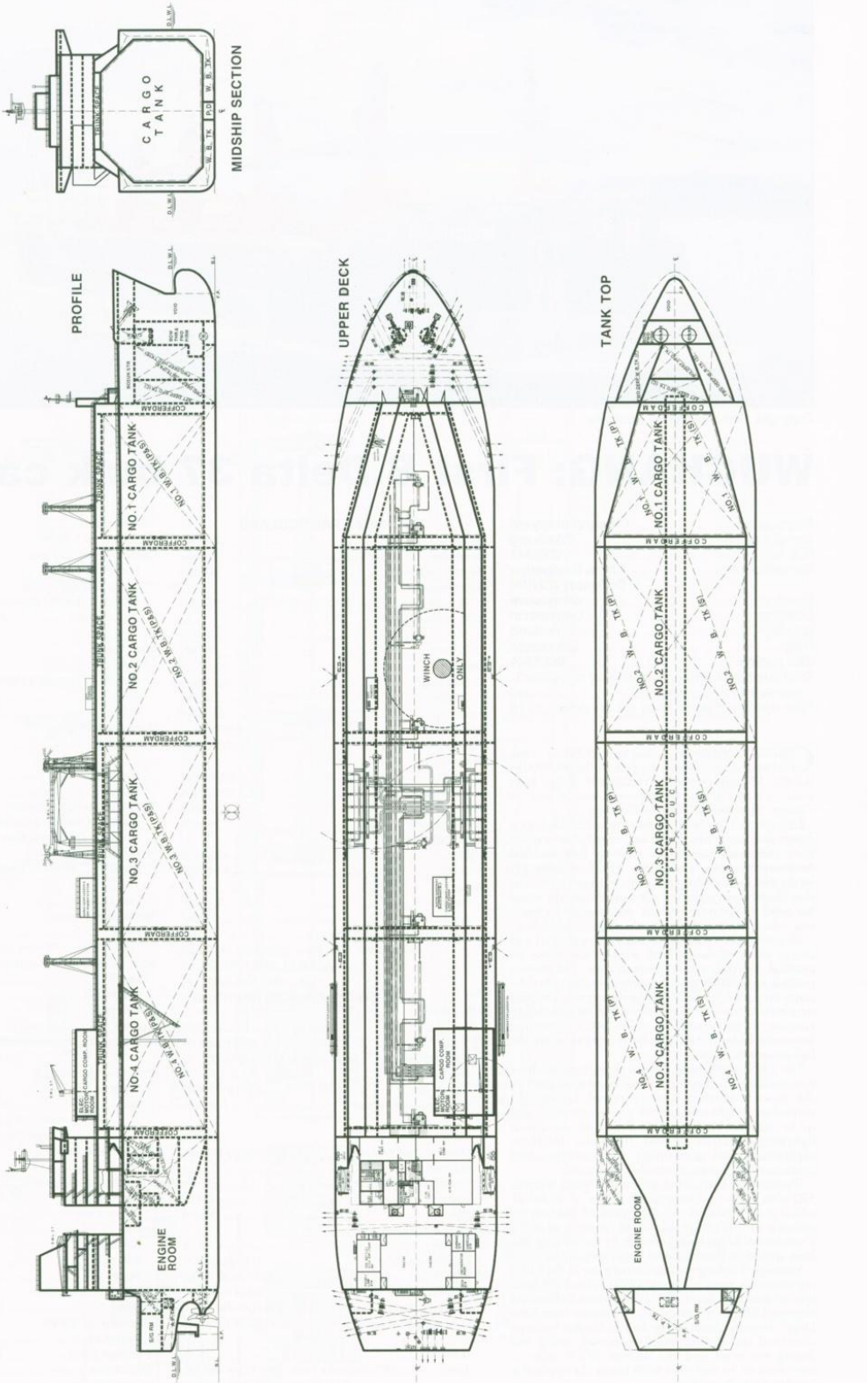
TECHNICAL PARTICULARS

Length oa: 294.20m
Length bp: 283.20m
Breadth moulded: 44.00m
Depth moulded
To main deck: 26.00m
Width of double skin
Side: 2.51m
Bottom: 3.20m
Draught
Scantling: 12.50m
Design: 11.50m
Gross: 103,670gt
Deadweight
Design: 78,000dwt
Scantling: 89,000dwt
Speed, service: 19.9knots
Cargo capacity
Liquid volume: ....159,760m^3
Bunkers
Heavy oil: ....5,000m^3
Diesel oil: ....520m^3
Water ballast: ....56,800m^3
Daily fuel consumption
Maine engine & auxiliaries: 140.2tonnes/day
Classification society and notations: ....DNV +1A1, Tanker for Liquefied Gas Ship type 2G 9-163°C, 500kg/m^3, 0.25bar, Nauticus (Newbuilding), Plus, COAT-2, E0, NAUT-OC, F-AMC, TMON, CLEAN, OPP-F, Gas Fuelled, BIS

Main engine
Design: ....Wärstilä
Model: 9L50DF
Manufacturer: ....HHI-Wärtsilä
Number: 4
Type of fuel: ....HFO, MDO, Gas
Output of each engine: 8,865kW
Gearbox
Make: ....Renk
Model: NDSH-4060
Number: 1
Propeller
Material: ....Ni-Al-Bronze
Designer/manufacturer: ....DSME-Samwoo
Number: 1
Fixed/controllable pitch: ....Fixed
Diameter: 8.6m
Speed: 19.9knots
Boilers
Number: 2
Type: ....Vertical, water drum
Make: ....Alfa Laval- Aalborg
Output, each boiler: ....6,500kg/h at 7bar

Cargo cranes/cargo gear
Number: 2
Make: ....Oriental
Type: ....Electro-hydraulic luffing jib
Performance: 10tonnes
Other cranes
Number: 2
Make: ....Oriental
Type: ....Electro-hydraulic, luffing jib
Performance: 10tonnes
Mooring equipment
Number: ....2 x windlass
8 x mooring winches
Make: ....Fukushima
Type: ....Electro-hydraulic, low pressure
Special lifesaving equipment
Number of each and capacity: ....2 x 40 persons
Make: ....Hyundai Lifeboat
Type: ....Conventional totally enclosed
Cargo tanks
Number: 4
Cargo containment system: ....GTT NO 96-GW
Boil off rate: ....0.125% per day
Cargo pumps
Number: 8
Type: ....Centrifugal
Make: ....Shinko
Material: ....Aluminium
Cargo control system
Make: ....Kongsberg
Type: ....IAS
Ballast control system
Make: ....Kongsberg
Type: ....IAS
Water ballast treatment system
Make: ....NK
Capacity: ....6,000m^3/h
Complement
Crew: 19
Bow thruster
Make: ....Kawasaki Heavy Industries
Number: 1
Output: 2,200kW
Bridge control system
Make: ....GE
One-man operation: ....Yes
Fire detection system
Make: ....Consilium
Type: ....Smoke detection type
Fire extinguishing system
Engine room: ....Kashiwa/ High expansion foam
Radars
Number: 2
Make: ....JRC
Integrated bridge system
Make: ....JRC
Model: JAN-901
Contract date: ....24 June 2008
Launch/float-out date: ....2 Sept 2012
Delivery date: ....1 July 2013

WOODSIDE ROGERS



SIGNIFICANT SHIPS OF 2013 109

LNG BONNY II: 177,000m^3 class LNG carrier

Shipbuilder: ..... **Hyundai Heavy Industries**
Vessel's name: ..... ***LNG Bonny II***
Hull No: **2636**
Owner/Operator: ..... **Bonny Gas Transport Limited**
Country: ..... **Bermuda**
Designer: ..... **Hyundai Heavy Industries**
Country: ..... **Republic of Korea**
Model test establishment used: ..... **SSPA**
Flag: ..... **Bermuda**
IMO number: **9692002**
Total number of sister ships already completed (excluding ship presented): ..... **None**
Total number of sister ships still on order: ..... **None**

LNG BONNY II is the 177,000m^3 class LNG carrier that was delivered from HHI to BGT. The vessel's design is intended to reduce waste energy and emissions and it has been fitted with the latest in energy saving features.

The ship has an overall length of 299.5m, width of 46m and depth 26.5 m with a design draught of 11.97 m. It has four membrane LNG tanks. To handle the cargo the vessel is fitted with eight vertical centrifugal submerged EBARA pumps that have 2,000m^3/h capacity each. They are controlled with ICAS type Yokogawa-made ballast and control system in the cargo control room.

The vessel has four pairs of water ballast tanks which incorporated into the double hull and double bottomed structure. *LNG Bonny II* is propelled by twin screw propellers which are driven by electric motors with a service speed of 19.75 knots at design draught when running at maximum propulsion power of 2 x 12,310 kW with 20% sea margin burning less fuel of about 133.6 tonnes per day.

The ship is compliant with IMO's Energy Efficiency Design Index (EEDI) as certified by the Classification Society's compliance letter and with IMO Tier II rules. The vessel has been built according to the latest SOLAS / MARPOL requirements and its design offers economical operation, is safe and environmentally friendly.

TECHNICAL PARTICULARS

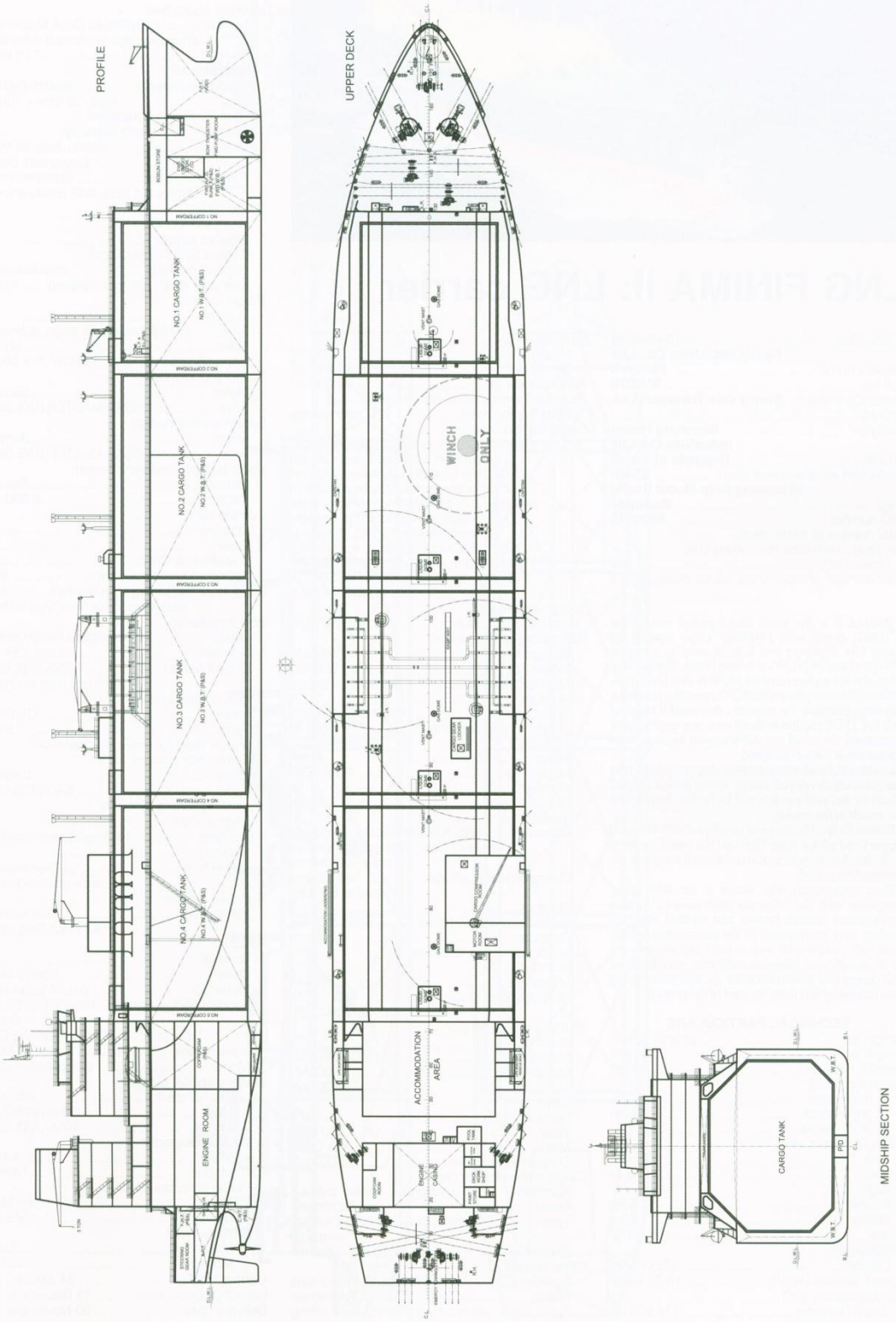
Length oa: ..... About 299.5m
Length bp: 286.3m
Breadth moulded: 46m
Depth moulded
To upper deck: 26.5m

Width of double skin
Side: 2.527m
Bottom: 3.3m
Draught
Scantling: 12.97m
Design: 11.97m

Gross: 115,995gt
Deadweight
Design: 87,711dwt
Scantling: 89,970dwt
Speed, service (-- %MCR output): ..... 19.75 knots at maximum propulsion power
Cargo capacity (m^3)
Liquid volume: ..... 176,800m^3
Bunkers (m^3)
Heavy oil: ..... 4,050m^3
Diesel oil: ..... 1,350m^3
Water ballast (m^3): ..... 61,800m^3
Daily fuel consumption (tonnes/day)
Main engine only: ..... 133.6 tonnes/day

Classification society and notations: ..... LR +100A1 Liquefied Gas Tanker Type 2G, Methane (LNG) in Membrane Tanks, Maximum Vapour Pressure 0.35 bar g, Minimum Temperature Minus 163°C, ShipRight(SDA, ACS(B)), *IWS, LI, ECO(BWT, IHM), +LMC, UMS, ICC, NAV1 IBS with descriptive notes "ShipRight (BWMP(T), CM,FDA plus(40, WW), SERS, SCM)"
Main engine(s)
Design: ..... Four stroke, single acting, trunk piston, turbocharged, intercooled, constant speed, non-reversible, dual fuel burning.
Model: ..... Wärtsilä 8L50DF
Manufacturer: ..... Wärtsilä Hyundai Engine Company
Number: 5
Type of fuel (eg, HFO or MDO) : ..... HFO / MGO / Gas
Output of each engine: 7,800kW
Propulsion Motor(s)
Make: ..... GE
Model: ..... N3 HXC 1000 J8
Number: 2
Output speed: ..... 583 RPM
Gearbox(es)
Make: ..... RENK
Model: RSH-1950
Number: 2
Output speed: ..... 68 RPM
Propeller(s)
Material: ..... Ni-Al-Bronze
Designer/Manufacturer: ..... HHI-EMD
Number: 2
Fixed/Controllable pitch: : ..... FPP
Diameter: 8.4M
Speed: 68rpm
Main-engine driven alternators
Number: 5
Make/type: ..... Nil
Output/speed of each set: ..... 7,530 kW / 514 RPM
Boilers
Number: 2
Type: ..... Automatic, forced draft, marine boiler
Make: ..... SAACKE
Output, each boiler: ..... 7.5 ton/h x 7 kg/cm^{2}G
Economisers x 4
Type: ... Vertical, forced circulating, smoke tube
Make: ..... SAACKE
Output, each economiser: .... About 1.0 ton/h x 7 kg/cm^{2}G
Cargo cranes/cargo gear x 2
Make: ..... DMC
Type: ..... Electro-hydraulic
Performance: ..... 5 tons S.W.L. x 2sets(P&S)
Cranes x 1
Make: ..... DMC
Type: ..... Electro-hydraulic
Tasks: ..... Machinery room service crane
Performance: ..... 7 ton S.W.L. x 1 set
Other cranes x 2
Make: ..... DMC
Type: ..... Electro-hydraulic
Tasks: ..... Provision crane
Performance: ..... 5 ton S.W.L. x 2 sets (P&S)
Mooring equipment
Number: ..... 2 windlass, 9 mooring winches
Make: ..... TTS Marine GMBH
Type (electric/hydraulic/steam): ..... Electric, step-less control
Special lifesaving equipment
Number of each and capacity: ..... 2 sets, 60 persons
Make: ..... HLB
Type: ..... Conventional
Cargo tanks x 4
Grades of cargo carried: ..... LNG
Containment system: ..... Prefabricated insulation panel, membrane sheets
Cargo pumps x 8 sets
Type : ..... Vertical centrifugal, submerged
Make : ..... EBARA
Capacity (each) : ..... 2,000 m^3/h x 165 mlc
Cargo and Ballast control system
Make : ..... Yokogawa
Type : ..... ICAS
Water ballast treatment system
Make : ..... HHI
Capacity : ..... 6,000 m^3/h
Complement
Officers: 30
Crew: 15
Suez/Repair Crew: 6
Single/double/other rooms: ..... 46 single rooms
Bow thruster
Make: ..... HHI-EMD
Number: 1
Output (each): 3,000kW
Bridge control system
Make: ..... Sperry Marine
Type: ..... Auto-pilot(Sperry Marine), ECDIS(Sperry Marine)
Is bridge fitted for one-man operation? ..... No.
Fire detection system
Make: ..... Consilium
Type: ..... Addressable type (smoke, heat, flame)
Fire extinguishing systems
Cargo tank deck: ..... Make/Type: NK / Dry chemical powder
Engine room: ..... Make/Type: NK / High expansion foam
Cargo compressor room: ... Make/Type: NK / High pressure CO_2
Cabins: ... Make/Type: NK / Sea water hydrant
Public spaces: ..... Make/Type: NK / Sea water hydrant
Radars
Number: ..... 1 S-band, 2 X-band
Make: ..... Sperry Marine
Model(s) : ..... ARPA RADAR
Integrated bridge system: ..... Yes
If yes, make: ..... Sperry Marine
Model: ..... IBS
Waste disposal plant
Waste handled: .....
Incinerator
Make: ..... HMMCO
Model: ..... MAXI 1500SL WS(Double door)
Sewage plant
Make: ..... Ilseung
Model: ISS-60N
Contract date: ..... 14 December 2012

LNG BONNY II


PROFILE
UPPER DECK
NO.1 CARGO TANK
NO.2 CARGO TANK
NO.3 CARGO TANK
NO.4 CARGO TANK
WINCH ONLY
ACCOMMODATION AREA
ENGINE ROOM
CARGO TANK
MIDSHIP SECTION

LNG FINIMA II: LNG carrier

Shipbuilder: ..... **Samsung Heavy Industries Co., Ltd.**
Vessel's name: ..... ***Finima II***
Hull No: **SN2076**
Owner/Operator: .... **Bonny Gas Transport Ltd.**
Country: ..... -
Designer: ..... **Samsung Heavy Industries Co. Ltd.**
Country: ..... **Republic of Korea**
Model test establishment used: ..... **SSMB (Samsung Ship Model Basin)**
Flag: ..... **Bermuda**
IMO number: **9690145**
Total number of sister ships already completed (excluding ship presented): ..... **Nil**
Total number of sister ships still on order: **3**

FINIMA II is the world first liquefied natural gas (LNG) carrier with 174,000m^3 cargo capacity for Bonny Gas Transport and is to be used to transport LNG produced by NLNG at Bonny Island, Nigeria. This vessel acts as a replacement for NLNG's first LNG train.

Finima II is compliant with BGT's operating profile for non-stop operation. For example, this vessel is installed with five TFDE engines so that if even one engine is not operational, the vessel can still transport its cargo to its destination at the service speed.

In addition, by adopting the twin skeg propulsion type and SHI's self-developed energy saving devices, its fuel efficiency and performance will be higher than similar size vessels in the market.

Finima II's specification was developed with technical support and advice from Shell and the vessel has been built with Braemar's technical assistance throughout the construction period.

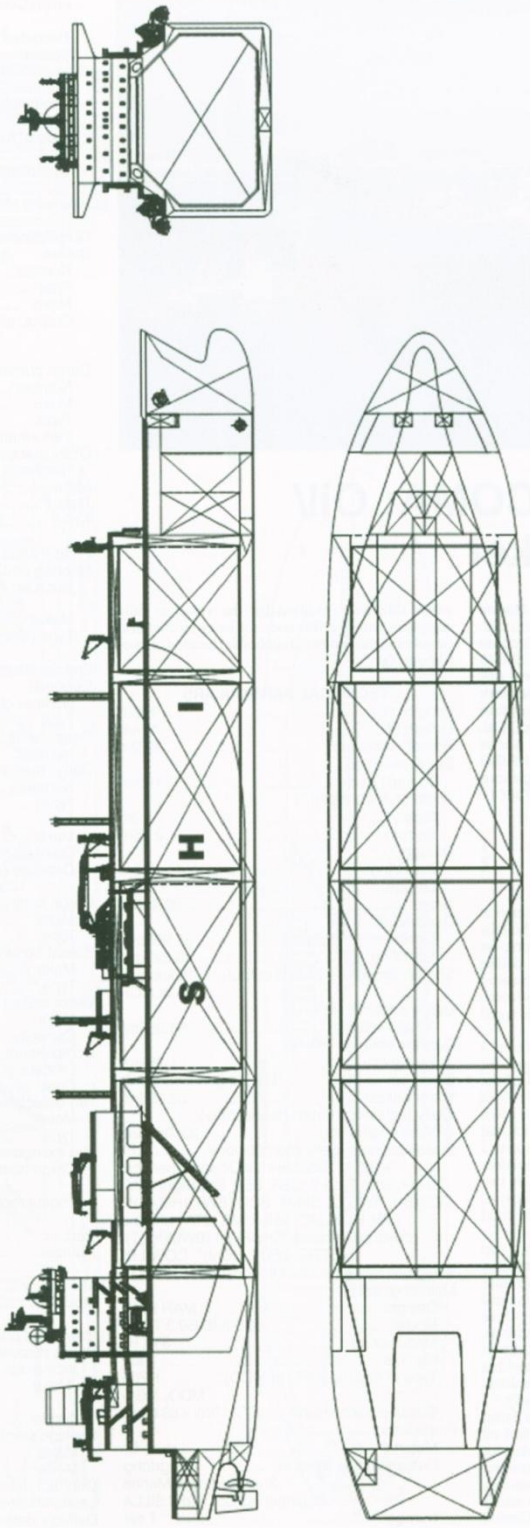
Most importantly, this vessel is the first vessel compliant with the Nigerian government's content development project. Proven and verified Nigerian vendors have participated in the construction of the vessel with components such as paint and anodes used for its completion. Nigerian engineers were involved with design and construction for the first time having been trained by SHI from the start of the project.

TECHNICAL PARTICULARS

Length oa: ..... approx. 293m
Length bp: 280m
Breadth moulded: 47.8m
Depth moulded
To main deck: 26.2m
To upper deck: 26.2m
To other decks: ..... Nil
Width of double skin
Side: 2.56m
Bottom: ..... 3.2 m
Draught
Scantling: 12.65m
Design: 11.65m
Gross: 116,600gt
Deadweight
Design: ..... 87,000 dwt
Speed, service (MPP): ..... 19.75 knots
Cargo capacity (m^3)
Liquid volume: ..... 174,900 m^3

Bunkers (m^3)
Heavy oil: ..... 3,900 m^3
Diesel oil: ..... 1,250 m^3
Water ballast (m^3): ..... 64,000 m^3
Daily fuel consumption (tonnes/day)
Main engine only: 121.3tonnes/day
Classification society and notations: ..... Bureau Veritas I, ✠ HULL, ✠ MACH, Liquefied Gas Carrier/ LNG, Ship type 2G (Methane (LNG) in membrane tanks, Maximum vapour pressure 0.35bar, Minimum temperature -163deg), Unrestricted navigation, ✠ VeriSTAR-HULL DFL 40 years, CPS(WBT), INWATERSURVEY, ✠ AUT-IMS, ✠ SYS-NEQ-1, ✠ SYS-IBS, MON-SHAFT, CLEANSHIP, BWT, GREEN PASSPORT, LI-HG-S3, ERS-S
% high-tensile steel used in construction: ..... approx. 10%
Main generator engine(s)
Design: ..... Wärtsilä
Model: 8L50DF
Manufacturer: ..... Wärtsilä Licensee
Number: 5
Type of fuel: ..... HFO, MDO and gas
Output of each engine: ..... 7,800 kW
Gearbox(es)
Make: ..... Renk
Model: RSH-1950
Number: 2
Output speed: ..... 77.8 rpm
Propeller(s)
Material: ..... Hub & blade: Nickel aluminium bronze / Cap : Manganese bronze or Ni – Al bronze
Designer/Manufacturer: ..... Nakashima Propeller Co. Ltd.
Number: 2
Fixed/Controllable pitch: ..... FPP
Diameter: 8,200mm
Main-engine driven alternators
Number: 5
Make/type: ..... GE Energy / B183X14
Output/speed of each set: ..... 8,367 KVA (7,530 Kw) / 514 rpm
WHRS turbo generator
Number: 1
Make/type: ..... SHINKO / RG65-5
Output/speed of each set: ..... 2,300kW / 1,800 rpm
Boilers
Number: 2
Type: ..... OS 5,000 kg/h
Make: ..... Alfa Laval
Output, each boiler: ..... 5,000 kg/h
Cargo cranes/cargo gear
Number: ..... Cargo machinery crane 1
Make: ..... Techflower
Type: ..... Electro-hydraulic cylinder luffing, single jib
Performance: ..... 5ton @ 13.5m, 12m/min
Other cranes
Number: ..... Provision Crane 2 sets
Make: ..... Techflower
Type: ..... electro-hydraulic cylinder luffing
Tasks: ..... provision crane
Performance: .... 5 ton @20m, 12m/min / 5 ton @20m, 12m/min
Mooring equipment
Number: ..... Hydraulic Deck Machinery, 8 drums(except combined windlasses)
Make: ..... TTS Marine
Type (electric/ hydraulic/steam): ..... electro-hydraulic type, 30 tons x 15M/min
Special lifesaving equipment
Number of each and capacity: 2
Make: ..... Jiansu Jiaoyan Marine Equipment Co. Ltd.
Type: ..... Conventional fire protected type, 60P, totally enclosed
Cargo tanks
Number: 4
Product range: ..... LNG
Coated tanks – make and type of coating: ..... membrane tank
Stainless steel – structure/piping: ..... Applied
Cargo pumps
Number: 8
Type: ..... Centrifugal, single stage, submerged
Make: ..... SHINKO
Capacity (each): ..... 1,950m^3 /h x 160 mlc
Cargo control system
Make: ..... Samsung
Type: ..... SSAS-MASTER (IAS Grade)
Ballast control system
Make: ..... Samsung
Type: ..... SSAS-MASTER (IAS Grade)
Water ballast Treatment System
Make: ..... Samsung
Capacity: ..... 6,000 m^3 /h
Complement
Officers: 16
Crew: 22
Suez/Repair Crew: 6
Single/double/other rooms: 39/6/1
Stern appendages/special rudders: ..... Semi-balanced streamline type with bulb
Bow thruster(s)
Make: ..... Kawasaki Heavy Industry
Number: ..... 1 set, CPP type
Output (each): ..... 2,500kW (6,600V), Air to air heat exchanger
Bridge control system
Make: ..... GE Energy
Type: ..... BUK-C
Is bridge fitted for one-man operation? ..... Yes
Fire detection system
Make: ..... Consilium
Type: ..... SALWICO Cargo
Fire extinguishing systems
Engine room: .....
Make/Type: ..... NK/High Expansion Foam
Cabins: .....
Make/Type: ..... Sea water fire extinguishing system
Public spaces: .....
Make/Type: ..... Sea water fire extinguishing system
Radars
Number: 3
Make: ..... Sperry Marine
Model(s): ..... VisionMaster Radar
Integrated bridge system: Yes (ECDIS/Conning Display/ Route Planning/CAMS
If yes, make: ..... Sperry Marine
Model: ..... VisionMaster ECDIS
Waste disposal plant
Waste handled: ..... Incinerator
Make: 1,000,000KCAL/H
Model: ..... MAXI 1200 SL 2S
Waste compactor
Make: ..... METOS
Model: UBP-30S
Waste shredder/crusher
Make: ..... Uson Marine
Model: UMS-2530
Sewage plant
Make: ..... Ilseung
Model: ISS-60N
Contract date: ..... 24 January 2013
Launch/float-out date: ..... 13 December 2014
Delivery date: ..... 30 November 2015

LNG FINIMA II



MARAN GAS ACHILLES: LNG carrier

Shipbuilder: ..... **Hyundai Samho Heavy Industries**
Vessel's name: ..... ***Maran Gas Achilles***
Hull No: **S689**
Owner/Operator: ..... **Maran Gas**
Country: ..... **Greece**
Designer: .. **Hyundai Samho Heavy Industries**
Country: ..... **Republic of Korea**
Model test establishment used: ..... **Hyundai Maritime Research Institute (HMRI)**
Flag: ..... **Greece**
IMO number: **9682588**
Total number of sister ships still on order: **5**

MARAN GAS ACHILLES is the first vessel in the series of 174K (TFDE-Twin Screw) LNG carriers ordered by Maran Gas Maritime. The vessel will be delivered from Hyundai Samho Heavy Industries (HSHI) around the end of December 2015.

The vessel is designed and constructed as a type 2G ship specified in the IGC code, suitable for carrying LNG for which vapour pressures are between atmospheric pressure up to 0.25 bar.

Maran Gas Achilles is the first twin screw propeller LNG vessel to be driven by an electric motor with a bulbous bow, sunken stern deck, transom stern and two rudders built at HSHI shipyard.

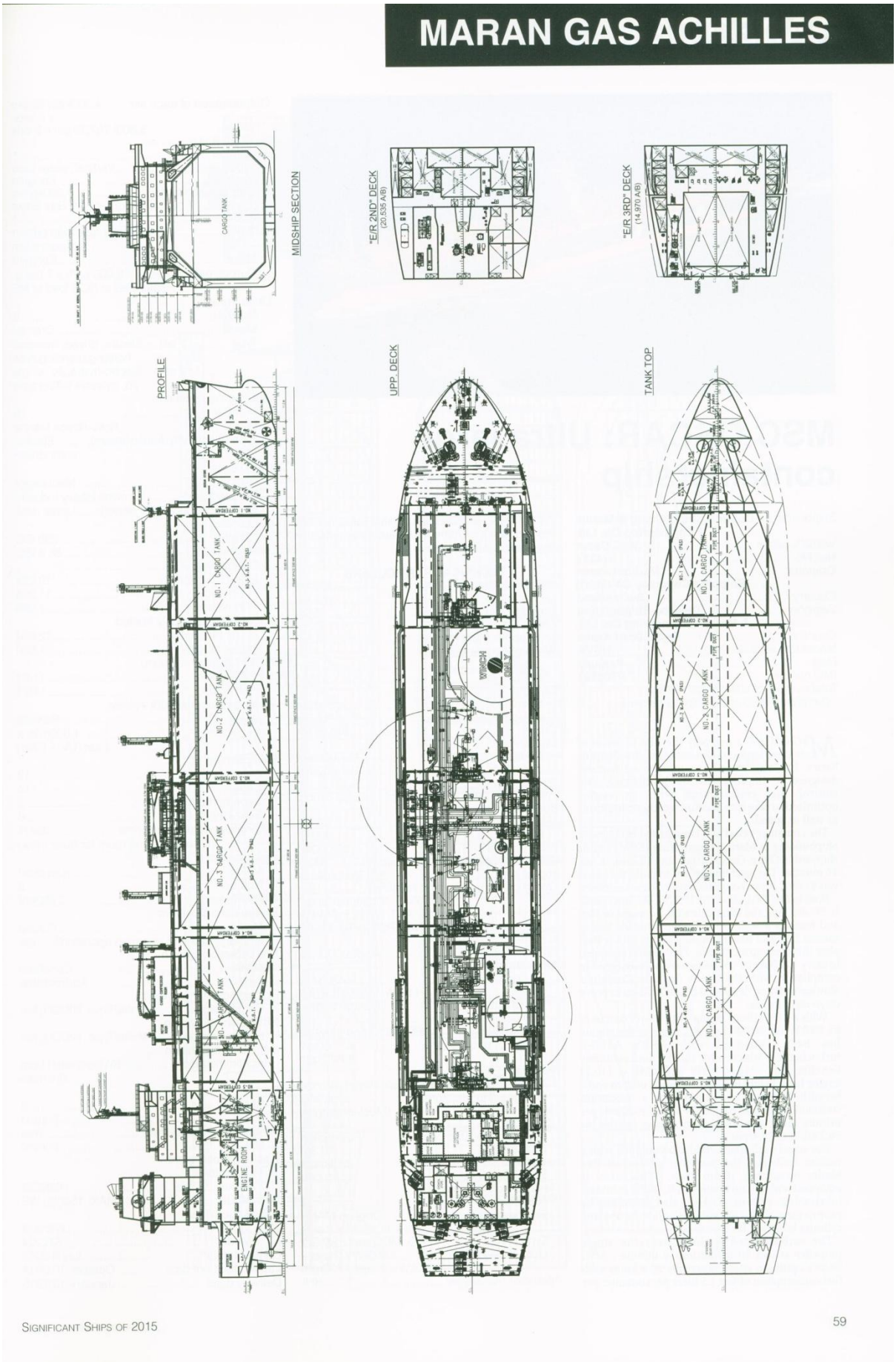
A PBCF (Propeller Boss Cap Fin) has been fitted as an energy saving device. The propeller blades have been changed from five to three in order to increase its efficiency. Moreover, Hi-Rudder (twisted rudder with bulb) and a twisted skeg are installed to increase propulsion efficiency. It is estimated that the application of the aforementioned features have increased the overall efficiency by a total of 5% compared to the previous LNG carrier.

In addition to the class notation for redundancy, the vessel complies with the buyer's 'Propulsion Redundancy Design Intent' (PRDI) as follows: "The arrangement shall not allow for single failure that can lead to total loss of propulsion, steering, power or other critical safety function."

The cargo area consists of a double deck, double hull and cofferdams which are located forward and aft of the cargo area and between cargo tanks with double bottoms. There are four cargo tanks with Gaz-Transport & Technigaz (GTT) MARK III membrane systems with a boil-off rate of ≤ 0.09% per laden day.

TECHNICAL PARTICULARS

Length oa: 290m
Length bp: 284m
Breadth moulded: 46.40m
Depth moulded
To main deck: 26.40m
To upper deck: 26.40m
To other decks: ..... 20.535m (2nd deck)
Width of double skin
Side: 46.40m
Bottom: ..... 3.20m (above base line)
Draught
Scantling: ..... 12.60m (moulded)
Design: ..... 11.60m (moulded)
Gross: 113680gt
Displacement: ..... 128,190gt (at scantling draught)
Lightweight: ..... 34,500gt (Estimated)
Deadweight
Design: 82,583dwt
Scantling: 93,690dwt
Block co-efficient ..... 0.7517 (at scantling draught)
Speed, service: .. 19.50knots (MPP with 20% SM)
Cargo capacity (m^3)
Liquid volume: ..... 174,078.4m^3
Bunkers (m^3)
Heavy oil: ..... 5025.3m^3
Diesel oil: ..... 1078.8m^3
Water ballast (m^3): ..... 58768.8m^3
Classification society and notations: ..... Lloyd's Register of Shipping+100A1 Liquefied Gas Tanker, Ship Type 2G, Methane(LNG) in Membrane tanks, Maximum S.G. 0.5, Maximum vapour pressure 0.25bar, Minimum temperature minus 163, ShipRight(ACS(B), SDA, FDA plus(40, WW), CM), *IWS, LI, +LMC, UMS, NAV1, PSMRL, ECO(BWT, IHM, P), with the descriptive notes "Part Higher Tensile Steel, ShipRight(SERS, MPMS, MCM, SCM).
% high-tensile steel used in construction: 5.56%
Main engine(s)
Design: ..... Wärtsilä
Model: 8L50DF, 12V50DF
Manufacturer: ..... Wärtsilä -Hyundai Engine Company
Number: ..... 8L50DF X 2 sets, 12V50DF X 2 sets
Type of fuel: ..... HFO, MDO, MGO, LNG
Output of each engine: ..... 8L50DF- 7,800kW X 514rpm, 12V50DF- 11,700kW X 514rpm
Gearbox(es) x 2 sets
Make: ..... Renk
Model: RSH-2000
Output speed: ..... 68 rpm
Propeller(s) x 2
Material: ..... Ni.Al.Bronze
Designer/Manufacturer: ..... HHI-EMD
Fixed/Controllable pitch: ..... Fixed pitch
Diameter: ..... 8.5 m
Speed: ..... 68 rpm
Special adaptations: ..... Hyundai Hi-Fin
Main-engine driven alternators x 2
Make/type: ..... GE POWER CONVERSION
Output/speed of each set: ..... 11,700KW / 540RPM
Diesel-driven alternators x 4
Alternator make/type: ..... HHI-EES / HAJ7 245-149, HAJ7 213-149
Output/speed of each set: ..... 11,340KW AT 514 RPM / 7,560KW AT 514 RPM
Boilers x 2 sets
Type: ..... Small oil fired boiler
Make: ..... Alfa Laval
Output, each boiler: .... 7,500 kg/h X 10 barg
Cargo cranes/cargo gear x 2 sets
Make: ..... Oriental
Type: ..... Electric-Hydraulic
Performance:
- Capacity: 10ton
- Working Radius: Max.25m~Min.6.7m
Other cranes x 3 sets
Make: ..... Oriental
Type: ..... Electric-Hydraulic
Performance: ..... Cargo Machinery Room Service Crane
- Capacity : ..... 5 ton Working Radius : Max.24m~Min.5.6m
Provision Crane (PORT)
- Capacity : 5 ton Working Radius : Max.17m ~ Min.4.6m
Provision Crane (STBD):
- Capacity : ..... 5 ton Working Radius : Max.18.5m~Min.5.0m
Mooring equipment x 9 sets
Make: ..... Fukushima
Type (electric/hydraulic/steam): ..... Electric -Hydraulic
Special lifesaving equipment
Number of each and capacity: ..... 2 sets, 50 persons
Make: ..... Hyundai Lifeboats
Type: ..... Davit Launched Type
Cargo tanks x 4
Grades of cargo carried: ..... LNG
Product range (Mole%): ..... Nitrogen – 0.006~1.2, Methane – 86.7~100, Ethane – 0.01~10.4,
Propane: ..... 0.0~3.69,
Butane: ..... 0.0~1.5,
Pentane and Heavier: ..... 0.00~0.05
Coated tanks – make and type of coating: ..... Membrane Type
Stainless steel – structure/piping: ..... /ASTM A312 Gr.TP316L
Cargo pumps x 8 sets
Type: ..... Vertical, centrifugal, electric motor driven, submerged
Maker: ..... Shinko
Stainless steel: ..... Ball bearing
Capacity (each): ..... 1,800 m^3/h x 165 mlc
Cargo control system
Make: ..... KSB Seil-Seres
Type: ..... Electro-hydraulic remote control system
Ballast control system
Make: ..... KSB Seil-Seres
Type: ..... Electro-hydraulic remote control system
Water ballast treatment system ..... NK
Capacity: NK-O3-300
Stern appendages/special rudders: .... Hyundai Hi-rudder (twisted rudder)
Bow thruster(s) x 1 set ..... Kawasaki
Output (each): 354kN
Bridge control system ..... Kwant Controls
Type: ..... BUK-B
Is bridge fitted for one-man operation? ..... YES
Fire detection system
Make: ..... Consilium
Type: ..... SALWICO FDS
Fire extinguishing systems
Engine room: .....
Make/Type: ..... NOVEC
Cabins: .....
Make/Type: ..... Portable Fire Extinguisher
Public spaces: .....
Make/Type: ..... Portable Fire Extinguisher
Radars x 3
Make: ..... JRC
Model(s) NO.1&2X-Band Radar: JMR-9225-7X3
S-BAND : JMR-9282-S
Waste disposal plant
Incinerator ..... Teamtec
Model: GS1000CRSX
Waste compactor ..... METOS
Model: IP500
Waste shredder/crusher ..... METOS
Model: UMS-2530
Sewage plant ..... Jong hap
Model: ..... JMC-BIO AEROB-25N
Contract date: ..... 20 December 2012
Launch/float-out date: ..... 4 February 2015
Delivery date: ..... 14 December 2015


MARAN GAS ACHILLES
MIDSHIP SECTION
CARGO TANK
"E/R 2ND" DECK
(20,535 A/B)
"E/R 3RD" DECK
(14,970 A/B)
PROFILE
UPP. DECK
TANK TOP
NO.1 CARGO TANK
NO.2 CARGO TANK
NO.3 CARGO TANK
NO.4 CARGO TANK
ENGINE ROOM
SIGNIFICANT SHIPS OF 2015
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