UNIVERSIDADE DA CORUÑA

Escola Politécnica Superior

Trabajo Fin de Máster
CURSO 2017/18

PETROLERO DE CRUDO DE 300.000 TPM

Máster en Ingeniería Naval y Oceánica

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Cuaderno I

ANTEPROYECTO DEL BUQUE

Escola Politécnica Superior
UNIVERSIDADE DA CORUÑA

DEPARTAMENTO DE INGENIERÍA NAVAL Y OCEÁNICA

TRABAJO FIN DE MASTER EN INGENIERIA NAVAL Y OCEÁNICA

CURSO 2016-2017

PROYECTO 17-33

TIPO DE BUQUE: Petrolero de crudo de 300.000 TPM.

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

CARACTERÍSTICAS DE LA CARGA: Crudo y calefacción de tanques.

VELOCIDAD Y AUTONOMÍA: 15 nudos a la velocidad de servicio, 85% MCR y 15% MM.

SISTEMAS Y EQUIPOS DE CARGA / DESCARGA: Bombas en cámara de bombas.

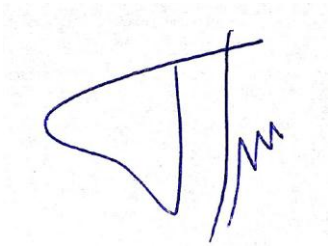
PROPULSIÓN: Motor diésel lento.

TRIPULACIÓN Y PASAJE: 35 tripulantes en camarotes individuales.

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

Ferrol, Febrero de 2017

ALUMNO: D. Pedro Carro Allegue



Fernando Junco Ocampo

CUADERNO I:

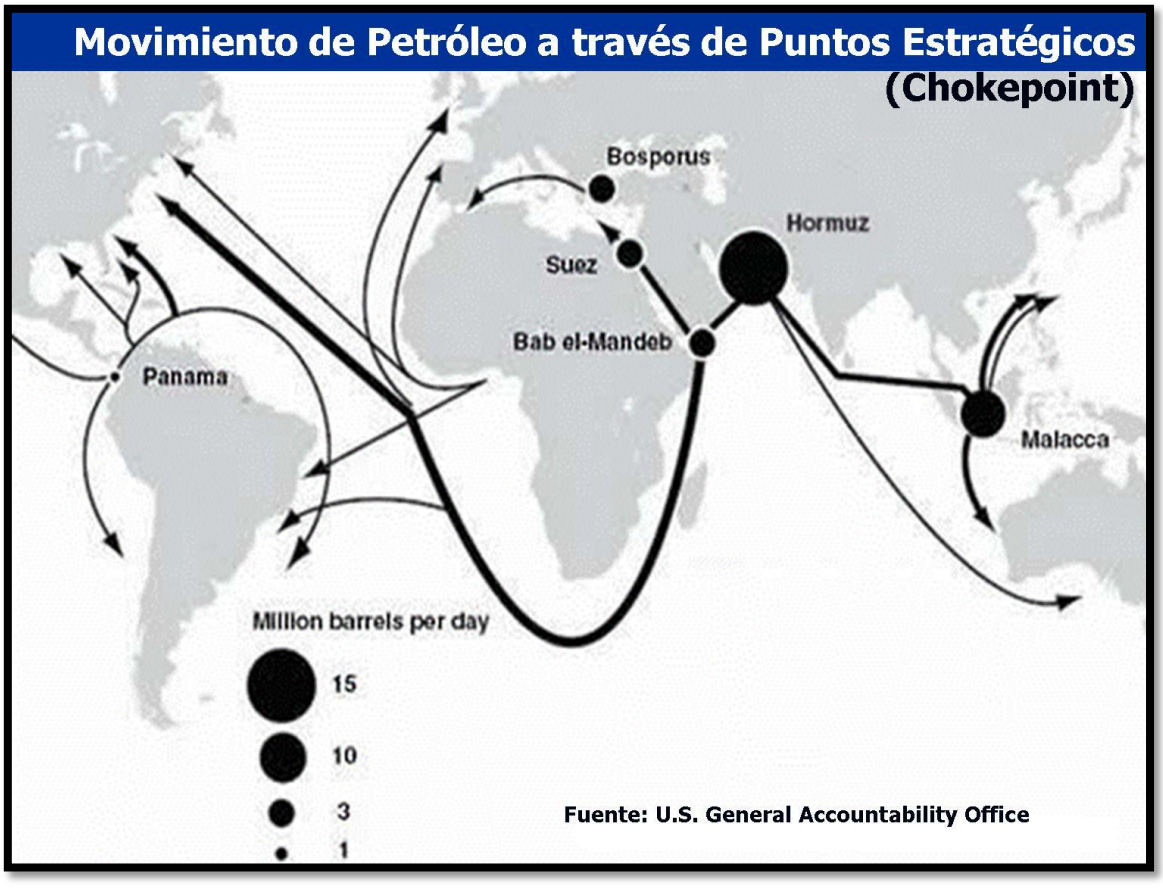
ANTEPROYECTO DEL BUQUE

ÍNDICE:

1. INTRODUCCIÓN A LOS PETROLEROS Y AL TRANSPORTE DE CRUDO.

La producción mundial de petróleo se acerca actualmente a lANEos 3.000 millones de toneladas, de los que una cuarta parte es producida por Oriente Medio y la mitad de esta cantidad es exportada a Europa occidental por la llamada ruta de los petroleros.

El papel del transporte en la industria petrolera es considerable: Europa Occidental importa el 97% de sus necesidades, principalmente de África y de Oriente Medio y Japón el 100%.



En el mundo del petróleo los oleoductos y los buques tanqueros son los medios por excelencia para el transporte del crudo. El paso inmediato al descubrimiento y explotación de un yacimiento es su traslado hacia los centros de refinación o a los puertos de embarque con destino a exportación.

1.1 Descripción general de un petrolero.

Un petrolero es un buque diseñado para el transporte de crudo o productos derivados del petróleo.

Actualmente casi todos los petroleros en construcción son del tipo de doble casco, en detrimento de los más antiguos diseños de un solo casco (monocasco), debido a que son menos sensibles a sufrir daños y provocar vertidos en accidentes de colisión con otros buques o encallamiento.

1.2 Diferencias con otros buques de carga.

Las diferencias básicas entre un buque de carga corriente y un petrolero son:

- Resistencia estructural:

En un buque normal la carga es soportada por las cubiertas en el espacio de las bodegas; en un petrolero gravita sobre el fondo, forro exterior y mamparos. Además, en aguas agitadas se producen fuerzas de inercia que actúan sobre los costados y mamparos. La estructura del petrolero debe de ser más resistente que otros barcos.

- Estanqueidad al petróleo:

Los tanques de carga deben ser estancos al petróleo y sobre todo a los gases producidos por él, que al mezclarse con el aire hacen una mezcla explosiva. Debe de evitarse que circuitos eléctricos pasen por los tanques o cámara de bombas.

- Variación del volumen de la carga:

La carga aumenta su volumen 1% por cada 10º C de incremento de la temperatura. Si el tanque se llena mucho, al calentarse rebosaría. Y si se llena poco se tendrá un cargamento móvil que reduce la estabilidad y el espacio libre se llena de gases explosivos.

- Sistema de bombas de carga y descarga de petróleo:

La cámara de bombas suele estar a popa de los tanques de carga, para trasiego de la carga. Son bombas de gran capacidad y son movidas por vapor o motor eléctrico.

- Ventilación:

Se producen vapores de petróleo en los cóferdams y cámara de bombas, son más pesados que el aire y es necesario expulsarlos de estos espacios.

1.3 Situación actual de los petroleros.

El aumento de la flota petrolera mundial y la tendencia al gigantismo de la década de los 70 evidenciaron la contaminación del medio ambiente marino.

En 1971, las operaciones de lavado de tanques en navegación, lastre sucio arrojado directamente al mar, accidentes, operaciones en terminales y otras, representaron alrededor de 1.400.000 toneladas.

Desde 1967, la IMCO (Inter-Governmental Maritime Consultative Organization) adoptó medidas para luchar contra la contaminación. Esencialmente, se trató de frenar la carrera hacia el gigantismo y el petrolero de un solo tanque, fomentados ambos por la búsqueda de la mayor rentabilidad en la explotación y la obtención de buques más simples y baratos, suprimiendo los mamparos en la zona de carga. Cuanto mayor son los petroleros, peores son las consecuencias en caso de accidente, además son de más difícil maniobra y remolque, por lo que se acrecientan los riesgos.

Actualmente se construyen petroleros con doble casco y con tanques de lastre separados, lo que elimina el problema de tratamiento de mezclas oleosas, que quedan reducidas a las propias del lavado con crudo de los espacios de carga.

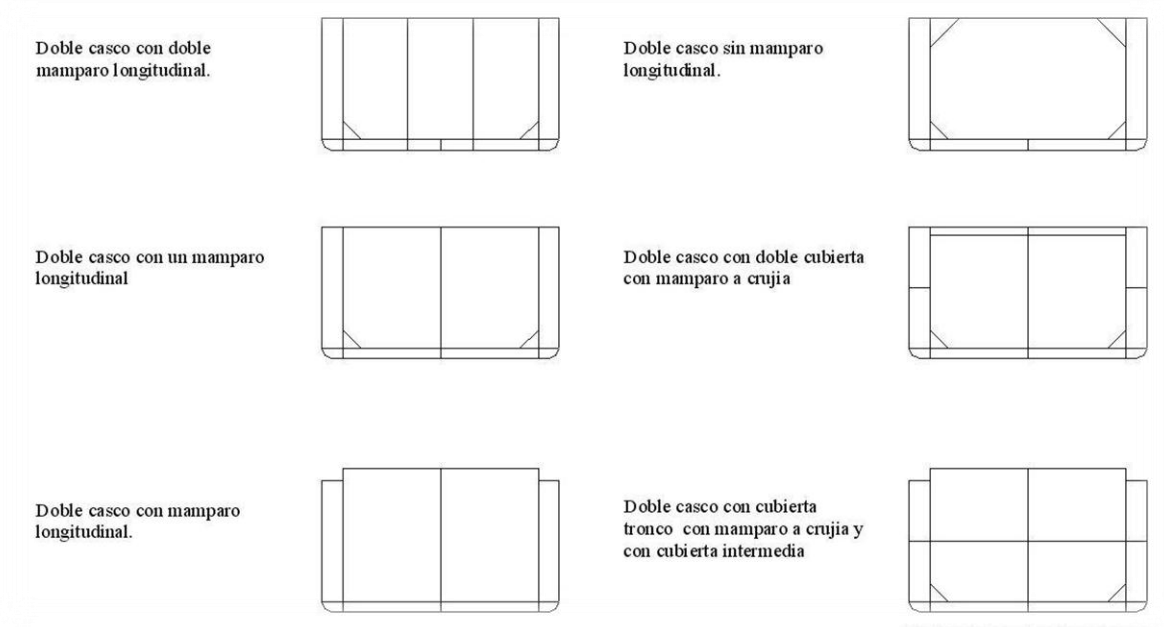
El descubrimiento de que el propio crudo era el mejor fluido para limpiar no sólo el crudo residual, sino también las incrustaciones que se originan en los tanques de carga al cabo de un cierto tiempo de explotación, fue presentado como primicia en la conferencia MARPOL-78.

También es obligatorio que el petrolero disponga de equipos de gas inerte.

- Características generales que deben cumplir las nuevas construcciones:

Los petroleros de nueva construcción tendrán que llevar protegidos los tanques de carga, con tanques de lastre o espacios que no sean tanques de carga o combustible. Es decir, contarán con doble casco. Opcionalmente se podrá plantear el proyecto del buque con cubierta intermedia.

"Lloyd´s Register" sugiere las siguientes secciones maestras en el diseño de nuevos petroleros:



Los cargamentos de un petrolero se dividen en:

a) pesados o sucios (crudos, asfalto, fuel-oil)

b) ligeros o limpios (gasolinas de automóvil, aviación, etiladas, etc.)

Si se transporta de crudo, fuel-oil y, en general, productos de gran viscosidad, hay que calentar los tanques para dar fluidez a la carga y facilitar la descarga. El llenado y vaciado se hace por el fondo.

El lastrado se realizaba llenando con agua los tanques de carga, actualmente en los buques de nueva construcción llevan tanques de lastre separados.

Como complemento de los tanques de carga están los tanques de decantación "Slop" destinados a retener los residuos de las mezclas generadas por el lavado de los tanques con crudo. Normalmente se dispone de dos, situados a popa de los de carga.

La cámara de bombas de carga está situada a popa de la cántara, las bombas suelen ser turbo-bombas accionadas con vapor o bombas accionadas con motor eléctrico.

Si la propulsión es Diesel, se suelen incorporar una o dos calderas de mecheros para alimentar las turbo-bombas de carga y calefacción de tanques.

Cuando se vacían los tanques, éstos se llenan con vapores de petróleo y gases explosivos. Para eliminarlos se emplea el equipo de gas inerte. El gas inerte se obtiene por tratamiento de los gases de escape de los motores auxiliares, el gas inerte es básicamente CO2.

Cuando el buque va a ser sometido a alguna inspección o reparación en sus tanques de carga, es preciso desgasificar los tanques. Esta operación se lleva a cabo en la estación desgasificadora y la forma de efectuarla es la siguiente: se vacía el tanque, se inyecta vapor durante 5 horas con los tanques bien cerrados, luego se abre el tanque, y al liberarse el vapor arrastra a los gases. Después se llenan los tanques de agua hasta que rebosen por la tapa, el agua arrastra los gases en grandes burbujas. Más tarde se vacía el tanque y se ventila con aire durante uno o dos días, hasta que no haya gases y se pueda bajar al tanque con seguridad.

La autonomía es una variable que pivota en función del tipo de tráfico al que se va a destinar el buque. No será la misma para un petrolero Maxi-Suez, para un tráfico Europa-Golfo Pérsico que atraviesa el canal de Suez, que otro de más de 150.000 t que deba hacer el mismo viaje por la ruta del Cabo de Buena Esperanza.

Todos llevan doble casco y doble fondo, salvo los que llevan el sistema de cubierta intermedia, que pueden no llevar doble fondo.

El doble fondo hace que se eleve el centro de gravedad esto ha traido como consecuencia que se dieran problemas de inestabilidad en el momento de efectuar la carga para los petroleros doble casco, doble fondo sin mamparo longitudinal.

1.4 Operaciones en un buque petrolero

Los petroleros son buques potencialmente peligrosos debido a la carga que llevan y a las cantidades que transportan. Cada vez que se hunde un petrolero cargado se producen grandes catástrofes medioambientales.

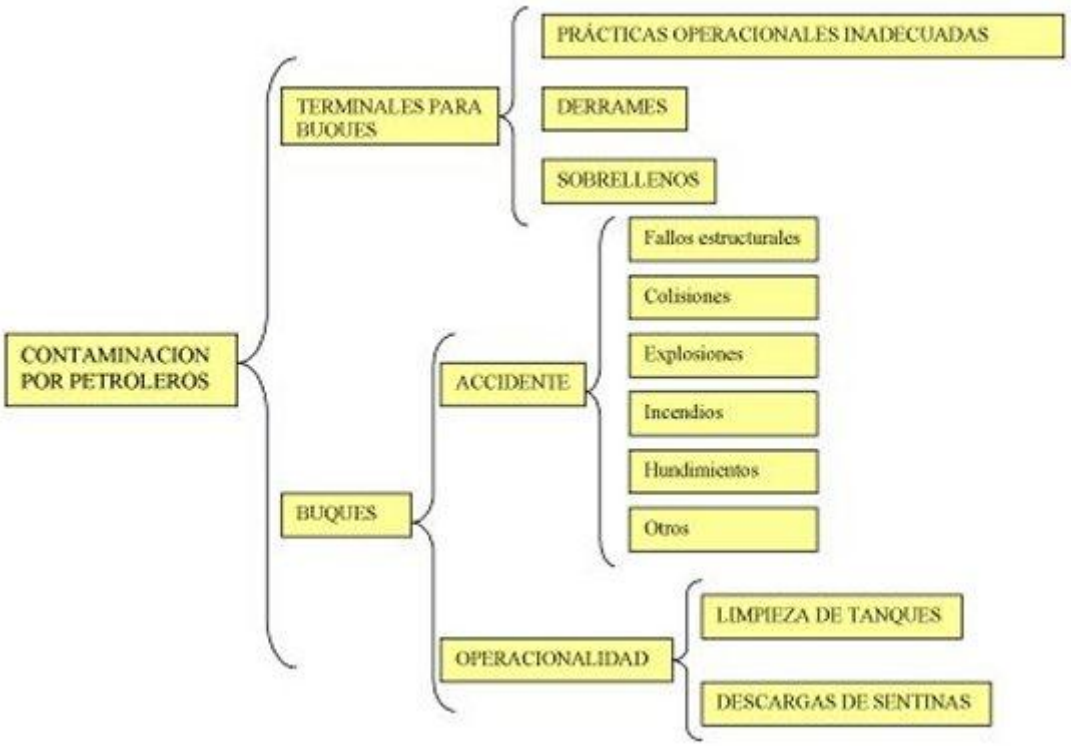
También, en funcionamiento operativo los petroleros contaminan, por lo que se promovieron convenios en el ámbito de la IMO (International Maritime Organization) y otros para tratar de reducir en lo posible la contaminación del medio marino.

Por este motivo, la lucha contra la contaminación condiciona el diseño de las nuevas construcciones de los buques en general, y de los petroleros en particular, por ser buques potencialmente de alto riesgo.

La IMO en los años 50 del pasado siglo promulgó el primer convenio internacional para la prevención de la contaminación del mar por hidrocarburos, que obligó a montar en los buques separadores de agua-aceites procedentes de las descargas de sentinas.

Los buques de nueva construcción deberán de llevar doble casco y tanques de lastre segregado.

Principales factores de contaminación por petroleros:



- Limpieza de tanques (principio operacional):

El proceso de limpieza de tanques constituía un foco de contaminación en el funcionamiento operacional del petrolero.

Se ha tratado de minimizar la contaminación adoptando los tanques de lastre segregado y lavado con crudo, pudiendo hacer de vez en cuando un aclarado con agua salada caliente.

Actualmente en los buques de nueva construcción se emplea el método siguiente:

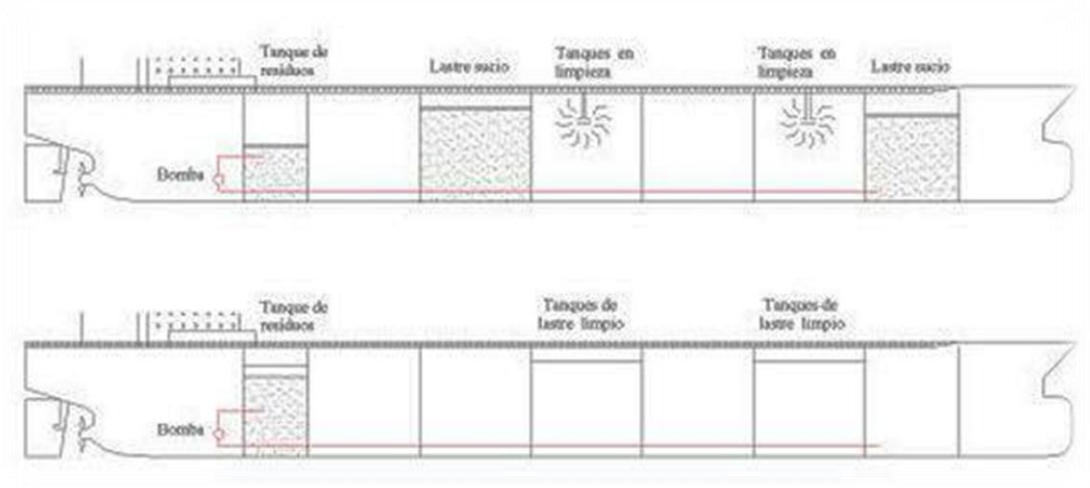
El buque parte de la terminal de descarga en situación de lastre separado. En una fase determinada de la travesía se realiza la limpieza de tanques con crudo. Las máquinas para lavado con crudo, que van fijas en el interior de los tanques de carga, deberán de cubrir con su acción el total de la superficie interna de los tanques. La mezcla de crudo y residuos se bombea a los tanques de decantación que, en este caso concreto, hacen de tanques almacén de residuos. La mezcla resultante se completa con crudo en la terminal de carga, (es decir en el viaje de carga, los tanques de

decantación Slop van con carga también) y se descarga en la refinería. Este proceso de llenar el tanque de decantación con carga y mezclarla con los residuos se llama Load on Top (cargar encima). La refinería absorbe sin problemas la pequeña contaminación arrastrada.

El sistema que se viene empleando en los petroleros anteriores, sin doble casco y con lastre en los tanques de carga, es el siguiente:

Después de realizar la descarga, y teniendo que realizar el trayecto de vuelta vacíos, es necesario lastrar el buque. Para ello se llenan algunos tanques de carga con agua del mar (lastre sucio). En los tanques de carga vacíos se puede efectuar el lavado con agua del mar caliente. Todos los lavados de los tanques se envían al tanque de residuos a popa (tanque de decantación o slop tank). En los tanques de lastre sucio el agua salada limpia debajo del crudo flotante se devuelve directamente al mar y los residuos aceitosos que quedaron en el tanque se bombean al tanque de residuos. Se llenan ahora con lastre los tanques que se habían lavado (lastre limpio). Toda el agua contaminada y el crudo se mantienen en el tanque de residuos y se le da tiempo al crudo para que se separe del agua. Después, el agua bajo el petróleo se bombea al mar. Ya en puerto, en la terminal de carga, el petróleo se carga encima del petróleo del tanque de residuos.

Ejemplo de petrolero que utiliza el sistema de limpieza de tanques con agua caliente y sistema anticontaminación “Load on top”:



Los petróleos crudos originan una gran cantidad de sedimentos (pueden constituir hasta 0,5% del total de la carga), formados por arcillas, fangos, láminas de óxido y arena que, junto con las parafinas, se depositan en toda la estructura del tanque.

Las ventajas del lavado con crudo son:

- ✓ Muy escasa contaminación del mar.
- ✓ Es un método económico (al descargar la mayor parte de los residuos se reducen las mermas).
- ✓ Operacionalmente más sencillo (el achique de tanques y su apurado final se efectúa mejor y en menos tiempo al no haber residuos que obstruyan las groeras).
- ✓ Material (el equipo empleado en el viaje queda reducido).
- ✓ Conservación (disminuye la corrosión al disminuir el empleo de agua salada y el porcentaje de oxigeno).

En la actualidad, con los buques con tanques de lastre segregados, la contaminación es prácticamente inexistente al eliminarse las operaciones de enjuague (con agua) para lastre limpio. Éstas solo se efectuarán en casos excepcionales de inspección o reparación.

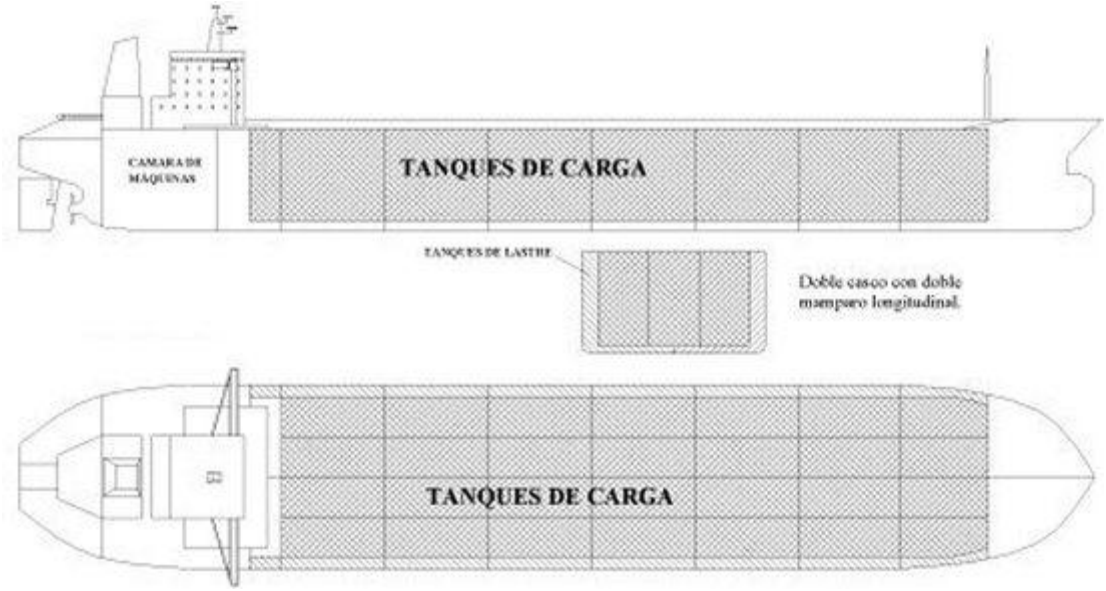
Las técnicas del proceso de lavado son dos:

1) Lavado en una etapa; que consiste en lavar el tanque en su totalidad, hasta que quede limpio, de forma continuada y sin interrupciones. Para ello el tanque debe estar seco, no permitiéndose acumulaciones de líquido en el plan durante el proceso de lavado.

2) Lavado en dos o más etapas; consiste en efectuar la operación con interrupciones durante el tiempo que dura la descarga de tanques a limpiar, aprovechando las zonas del mismo que quedan libres de crudo para efectuar el lavado. Se recomienda la utilización de máquinas programables, minimizando así los costes.

A continuación se muestra un moderno petrolero de 300.000 toneladas con doble casco, doble fondo y dos mamparos longitudinales en el espacio de carga. Se puede apreciar el gran volumen de carga en relación con el espacio de cámara de máquinas. La limpieza de tanques normalmente es con crudo, aunque existe el equipo necesario para hacerlo con agua de mar. El espacio del doble casco y doble fondo sirve como tanques de lastre segregado. Los tanques Slop tienen la doble misión de tanque de carga y

tanque de decantación, para separar el agua del petróleo cuando se efectúa el lavado de tanques con agua.



- <u>El gas inerte</u>:

El gas inerte es un gas o mezcla de gases en la que el contenido de oxígeno es tan bajo que es imposible la combustión. Este gas se puede obtener de la combustión de una caldera, de la exhaustación de un motor, desde un generador independiente o desde un tanque de almacenamiento.

El principal cometido del gas inerte es proporcionar protección contra explosiones en los tanques al desplazar al aire de los mismos (con su contenido de 21% de oxigeno). El gas inerte también se utiliza para ventilar tanques de carga y/o evitar condiciones de sobrepresión o vacío.

Antes de ser distribuido a los tanques, el gas inerte tiene que ser primeramente enfriado y purificado, ya que hay que eliminar las partículas sólidas y corrosivas como el azufre.

Se dice que un tanque es inerte cuando el contenido de oxígeno de su espacio libre es inferior al 8%.

En el proceso de descarga, el buque llegará con la planta de gas inerte chequeada y los tanques inertizados. El suministro de gas inerte se iniciará inmediatamente antes de comenzar la descarga con objeto de subir la presión en tanques.

En ningún momento se dejará que entre aire en el tanque, para ello siempre se mantendrá una presión positiva en el tanque. Antes de comenzar la limpieza de tanques se asegurará que el porcentaje de oxígeno sea inferior al 5%.

Las operaciones de lavado se interrumpirán si falla la planta de gas inerte, si el porcentaje de oxígeno es superior al 5%, o si la presión en el tanque es inferior a la atmosférica.

1.5 Clasificación de los petroleros.

Podemos agrupar los buques petroleros según su capacidad de transporte e idoneidad para cada tráfico:

- Shuttle Tanker (lanzaderas): Son buques especializados que repiten continuamente el trayecto de ida y vuelta, desde pozo (instalación offshore), a la refinería en tierra donde descarga el crudo para su tratamiento.

Su tamaño no es excesivamente grande 80.000 a 200.000 TPM, pero cuentan con gran capacidad de maniobra, posicionamiento dinámico y equipamiento para realizar la carga de crudo en el mar.

- Coastal Tanker (Costeros): Se trata de buques de hasta 16.500 DWT. Por lo general son utilizados en trayectos costeros, cortos y/o cautivos. Pueden transportar petróleo crudo o derivados.

- General Porpouse Tanker (Multipropósito): Desde 16.500 DWT hasta 25.000 DWT. Operan en tráficos diversos. Transportan petróleo crudo o derivados.

- Handy Size Tanker: Se trata de buques de 25.000 a 45.000 TPM, ejemplos de áreas de operación son el Caribe, costa Este de los Estados Unidos, Mediterráneo y Norte de Europa. Pueden transportar petróleo crudo o derivados.

- Panamax: Su tonelaje puede variar entre los 55.000 DWT hasta los 80.000 DWT. En otros términos, poseen una capacidad que oscila entre los 350.000 y los 500.000 barriles de petróleo. El nombre de este módulo se debe a que, originalmente, las dimensiones de estos buques, cumplían con las máximas permitidas para su tránsito por el Canal de Panamá (unos 274 m de eslora, poco más de 32 m de manga y entre 12 y 13 m de calado).

- Aframax: Derivados de la "Average Freight Rate Assessment", se acepta un rango de entre 75.000 y 120.000 TPM. Sus tráficos habituales incluyen cargamentos entre puertos ubicados en áreas como el Caribe, el mar Mediterráneo o el Golfo Pérsico.

- Suezmax: Sus módulos van desde las 120.000 hasta los 200.000 TPM. En sus orígenes su nombre estaba vinculado a que el módulo con su mayor carga cumplía con las máximas dimensiones permitidas para el tránsito por el canal de Suez, aunque hoy en día navegan por este canal buques de hasta 300.000 TPM.

- V.L.C.C. (Very Large Crude Carrier)**:** Con pesos muertos desde 200.000 hasta 320.000 TPM. En promedio, transportan dos millones de barriles. Por sus dimensiones se trata de buques que operan por lo general en terminales mar adentro.

- U.L.C.C. (Ultra Large Crude Carrier): Son todos aquellos cuya capacidad de carga supere las 320.000 TPM.

Estos superpetroleros aparecen en el mercado a finales de los años ’60. Debido a su gran tamaño son muy limitados para operar en aguas restringidas.

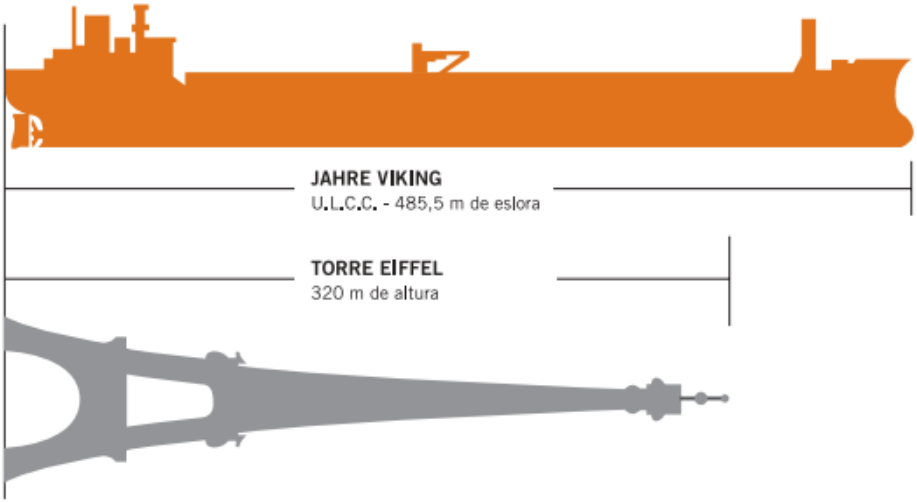
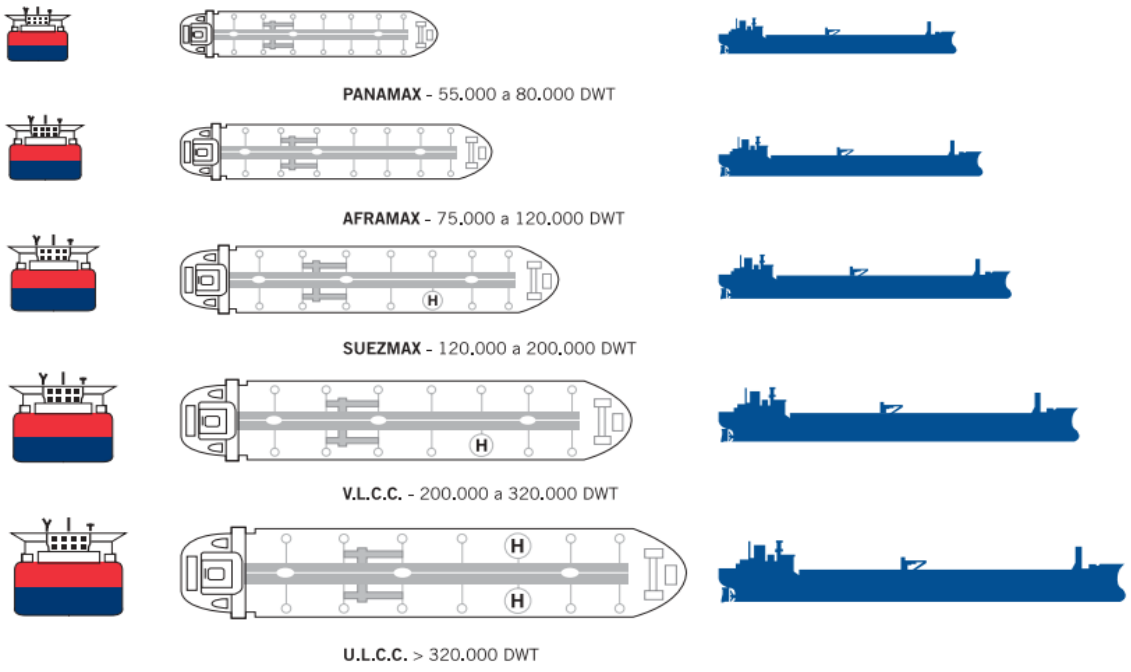


Tabla comparativa entre los diferentes tipos de petroleros:

CLASIFICACION DE PETROLEROS POR TAMAÑO					
CLASE	TAMAÑO DWT	CLASIFICACION	TAMAÑO DWT	PRECIO NUEVO	PRECIO USADO
General Purpose tanker	10,000–24,999	Product tanker	10,000–60,000	$43M	$42.5M
Medium Range tanker	25,000–44,999	Panamax	60,000–80,000		
LR1 (Large Range1)	45,000–79,999	Aframax	80,000–120,000	$58M	$60.7M
LR2 (Large Range2)	80,000–159,999	Suezmax	120,000–200,000		
VLCC (Very Large Crude Carrier)	160,000–319,999	VLCC	200,000–320,000	$120M	$116M
ULCC (Ultra Large Crude Carrier)	320,000–549,999	Ultra Large Crude Carrier	320,000–550,000		



2 OBJETIVOS Y ALCANCE DEL PROYECTO.

El buque correspondiente a nuestro proyecto, es un buque petrolero (VLCC) destinado al transporte de crudo.

Cuyos requisitos principales son los siguientes:

Tipo de buque	Petrolero de transporte de crudo
Peso Muerto(DWT)	300.000 TPM
Clasificación y reglamentos	DNV, SOLAS, MARPOL
Velocidad de servicio	15 knots a 85% MCR y 15% MM
Propulsión	Motor diesel lento
Tripulación	35 tripulantes

Consideraremos además, que nuestro barco operará desde el Golfo Pérsico, donde se producirá la extracción y posterior transporte hacia Europa (España).

De este modo, para realizar dicho trayecto, tenemos dos opciones, una de ellas es bordear toda la costa Africana, y la segunda opción es utilizar el canal de Suez.

Obviamente la opción más económica es la del canal de Suez (como podemos ver en la imagen anterior), por lo tanto, debemos conocer más en detalle las limitaciones que nos puede imponer el paso del buque por el canal en nuestro dimensionamiento del buque.

2.1 Limitaciones impuestas por el canal de Suez.

Su longitud es de 163 km entre Puerto Saíd (en la ribera mediterránea) y Suez (en la costa del mar Rojo). Permite acortar la ruta del comercio marítimo entre Europa y el sur de Asia, pues evita tener que rodear el continente africano.

El canal permite el paso de barcos hasta 20 metros de calado aunque posee una profundidad media de 24 metros después de la última ampliación.

La manga del canal esta entre los 280 y los 345 metros en su superficie, aunque debido a su forma de trapecio las restricciones de la manga máxima permitida viene en función del calado, siendo la manga máxima permitida para aquellos buques que calen 20 metros y teniendo un valor máximo de 74.676 metros.

La altura máxima es de 66 metros por encima del nivel del agua, esto es producto del obstáculo que representa el Puente del Canal de Suez con 70 metros de altura. Estas dimensiones citadas limitan el tamaño de los buques que deben construirse para pasar este canal.

No obstante, algunos petroleros que lleguen al canal a plena carga exceden el calado máximo permitido, y por lo tanto, deben transferir parte de su carga a otros buques o a un oleoducto antes de ingresar al Canal de Suez. De manera que descargan parte de su carga hasta conseguir un calado de 20 metros con el cual cruzan el canal, y al llegar al otro extremo vuelven a cargar toda la carga anteriormente descargada para así proseguir su viaje.

2.2 Autonomía.

Puesto que es conocida la ruta que efectuará el buque a lo largo de su vida, podemos establecer la autonomía que este deberá tener.

Nuestro buque tendrá una ruta que será desde el Golfo Pérsico hasta un puerto español, estableceremos por ejemplo el puerto de Algeciras. La distancia que tendrá que recorrer entre salida y destino será de unas 5100 millas náuticas aproximadamente.

A esta distancia le aplicaremos un margen de seguridad de un 25% por posibles emergencias y obtendremos nuestra autonomía.

$$Autonomía = 1{,}25 \cdot 5100 = 6.375$$

Nuestro buque tendrá 6.500 millas náuticas de autonomía.

3 BASE DE DATOS.

La base de datos a utilizar está compuesta por 20 petroleros de crudo con unas dimensiones y un DWT similares al que queremos diseñar.

A partir de esta base de datos, consideraremos una primera aproximación, en función de una serie de gráficas y regresiones que nos darán unos primeros valores de dimensionamiento.

En la siguiente tabla, podremos ver los buques utilizados en nuestra base de datos, así como las características principales con las que vamos a tratar de cada buque.

En el ‘’ANEXO I’’ podemos ver una ficha de cada buque que pertenece a la base de datos, en la cual podremos observar sus características principales y una pequeña descripción del mismo.

	Nombre del buque	Fuente	Lt (m)	Lpp(m)	Bmáx(m)	D(m)	T(m)	DWT(ton)	Δ(ton)	Capacidad (m3)	V(knots)	Año	L/B	L/D	B/T	T/D	B/D	L/T	Froude	Cb
1	Andromeda Voyager	Significant Ships	333	320	60	30,5	22,56	320500	364900	357900	16,2	2005	5,333	10,492	2,660	0,740	1,967	14,184	0,1459	0,8219
2	British Progress	Significant Ships	334	320	58	31,26	22,5	304400	348817	341100	15	2000	5,517	10,237	2,578	0,720	1,855	14,222	0,1349	0,8149
3	Crown Unity	Significant Ships	330,27	314	58	31	22,2	300000	342998	345096	14,7	1995	5,414	10,129	2,613	0,716	1,871	14,144	0,1329	0,8277
4	Front Century	Significant Ships	335	320	58	31	22,7	311000		350060	15,74	1998	5,517	10,323	2,555	0,732	1,871	14,097	0,1413	
5	Harad	Significant Ships	333,3	319	58	31,25	22,5	303100	350900	350100	16,4	2002	5,500	10,208	2,578	0,720	1,856	14,178	0,1476	0,8224
6	Limburg	Significant Ships	332	320	58	31	22	299364	341097	347593	15,8	2000	5,517	10,323	2,636	0,710	1,871	14,545	0,1425	0,815
7	Murex	Significant Ships	332	320	58	31	22	298300	341100	345000	15,5	1995	5,517	10,323	2,636	0,710	1,871	14,545	0,1398	0,815
8	Raphael	Significant Ships	335	320	58	31	22,7	309600		349600	15,2	2000	5,517	10,323	2,555	0,732	1,871	14,097	0,1365	
9	Stena Victory	Significant Ships	333,49	320	70	25,6	19	312600		358500	16,3	2001	4,571	12,500	3,684	0,742	2,734	16,842	0,1467	
10	Universal Queen	Significant Ships	333	324	60	36,56	21	309400	352410	353181	15,6	2005	5,400	8,862	2,857	0,574	1,641	15,429	0,1405	0,8422
11	Yukong Navigator	Significant Ships	329	315	51,2	30,4	22,45	277798		330647	15	1995	6,152	10,362	2,281	0,738	1,684	14,031	0,1359	
12	Utik	Significant Ships	332	320	58	31	22	299497		347593	15,3	2001	5,517	10,323	2,636	0,710	1,871	14,545	0,1380	
13	BW Lotus	Significant Ships	332	320	60	30,5	22,5	320141		355000	16,1	2011	5,333	10,492	2,667	0,738	1,967	14,222	0,1452	
14	Brightoil Glory	Significant Ships	333	319	60	30,4	22,6	319743	364560	353626	16,4	2012	5,317	10,493	2,655	0,743	1,974	14,115	0,1477	0,8222
15	Samco Amazon	Significant Ships	333,08	319	60	30,4	22,6	314250	364000	352500	16,6	2011	5,317	10,493	2,655	0,743	1,974	14,115	0,1495	0,821
16	Ubud	Significant Ships	330	316,6	60	28,9	20,4	279999	339317	328458	16,1	2000	5,277	10,955	2,941	0,706	2,076	15,520	0,1456	0,8543
17	C. Galaxy	Significant Ships	336	324	60	29,6	22	316400	364500	347000	16	2009	5,400	10,946	2,727	0,743	2,027	14,727	0,1434	0,8315
18	Dar Salwa	Significant Ships	333	320	60	30,5	22,5	319760	363849	358484	16,2	2010	5,333	10,492	2,667	0,738	1,967	14,222	0,1459	0,8217
19	Eagle Vancouver	Significant Ships	333	320	60	30,5	22,5	319580		357000	15,8	2013	5,333	10,492	2,667	0,738	1,967	14,222	0,1423	
20	Sifa	Significant Ships	333	319	60	30,4	22,6	316400	364465	351200	15,5	2011	5,317	10,493	2,655	0,743	1,974	14,115	0,1396	0,822

4 ESTIMACIÓN DE LAS DIMENSIONES PRINCIPALES.

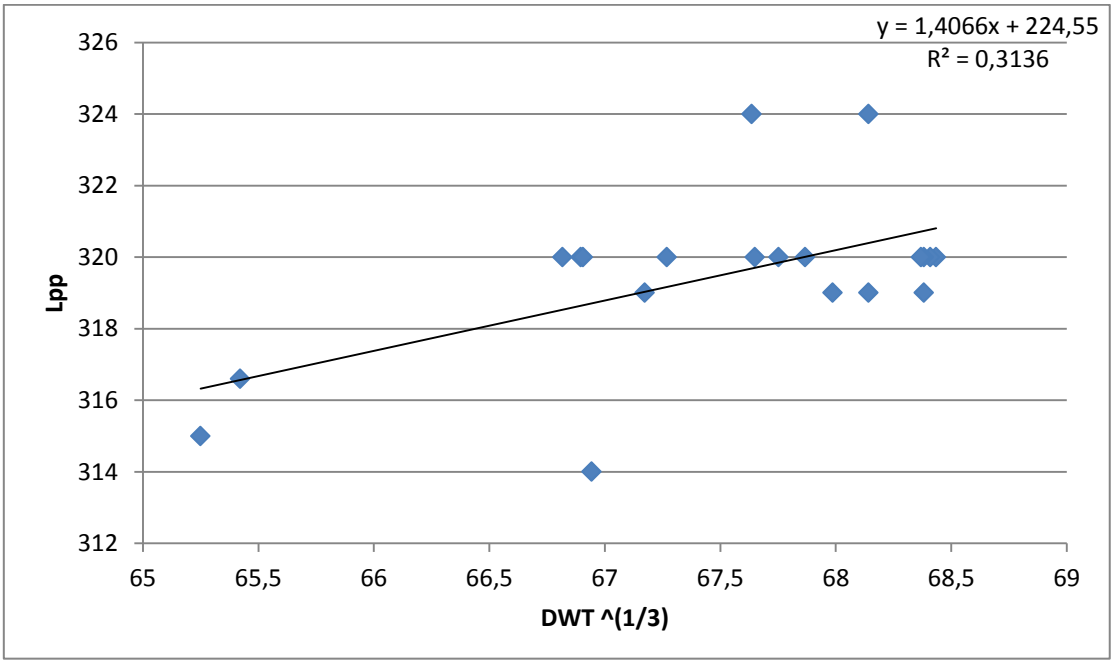
En este apartado nos dedicaremos a la obtención y definición de las características principales, así como de definir las relaciones entre ellas, a partir de la base de datos anteriormente mostrada.

Para la definición de estas dimensiones preliminares, lo que haremos serán unas gráficas y las correspondientes regresiones, con el fin de determinar un valor aproximado de dicha dimensión.

4.1 Por rectas de regresión.

4.1.1 Definición de la eslora entre perpendiculares (Lpp).

La calcularemos haciendo una regresión, con los buques de la base de datos, entre $Lpp/DWT^{1/3}$.

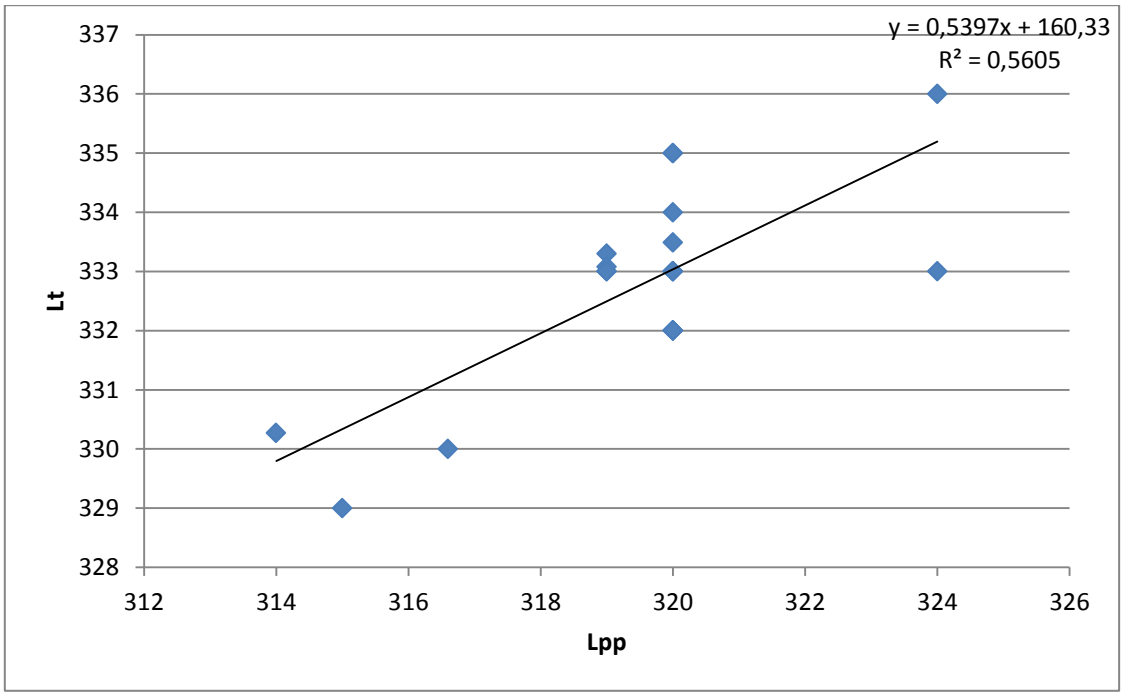


Por tanto, para nuestro valor de DWT:

Lpp = 318.7 metros

4.1.2 Definición de la eslora total (Lt).

En este caso haremos una regresión de Lt/Lpp



Por tanto, usando el valor de la eslora entre perpendiculares obtenida en el apartado anterior, obtendremos:

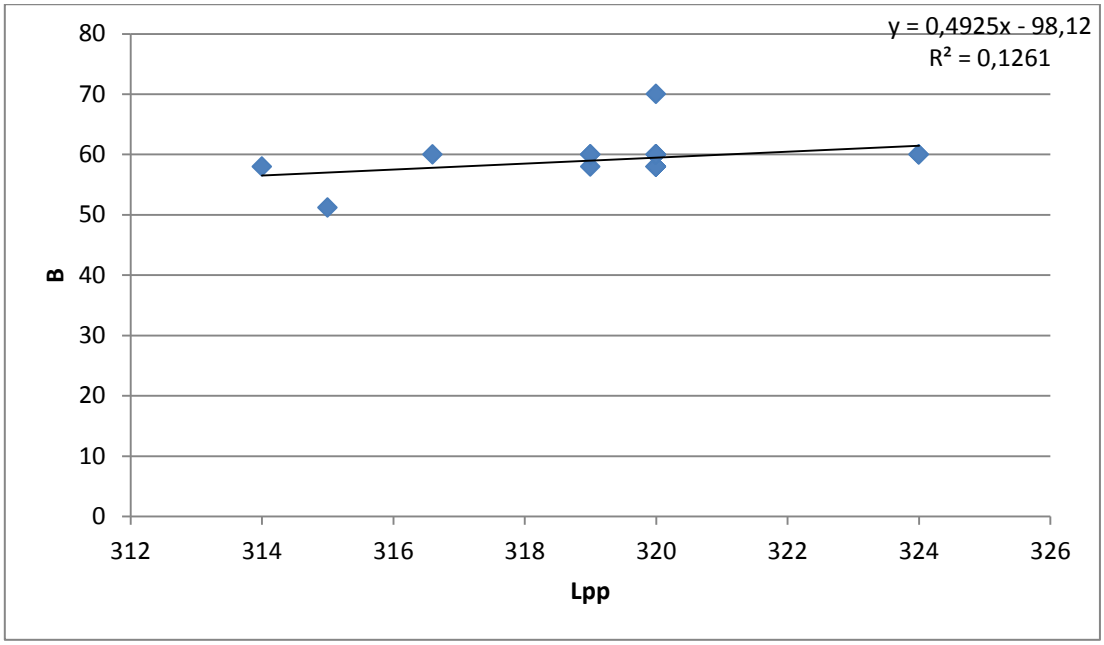
Lt = 332.3 metros

4.1.3 Definición de la manga (B).

Para la estimación de la manga, haremos dos regresiones diferentes, y luego haremos una media entre ellas para obtener un valor bastante fiable.

La primera regresión será una regresión con respecto a la eslora entre perpendiculares obtenida en las regresiones anteriores, y la segunda regresión será en función del número adimensional (Lpp/B) con respecto a la eslora entre perpendiculares calculada en el apartado anterior.

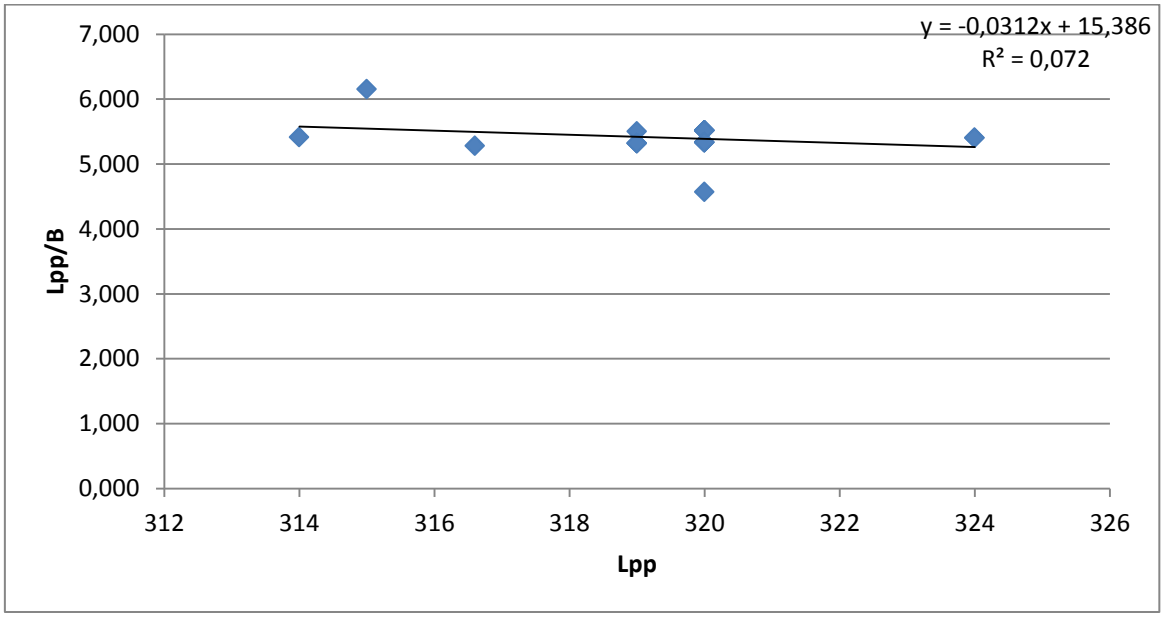
- 1ª regresión: B/Lpp:



De esta regresión obtenemos un valor de B como el siguiente:

$$B = 58.9 \text{ m}$$

- 2ª regresión: (Lpp/B)/Lpp:



De aquí obtenemos un valor del parámetro adimensional Lpp/B:

$$Lpp/B = 5,442248$$

Y con este valor y nuestro Lpp ya calculado anteriormente obtenemos el valor de B:

$$B = 58.6 \text{ m}$$

Debido a que ninguna de las dos regresiones son especialmente buenas, haremos una media de los dos valores obtenidos en las regresiones para tener un valor más aproximado.

$$B = \frac{58.6 + 58.9}{2}$$

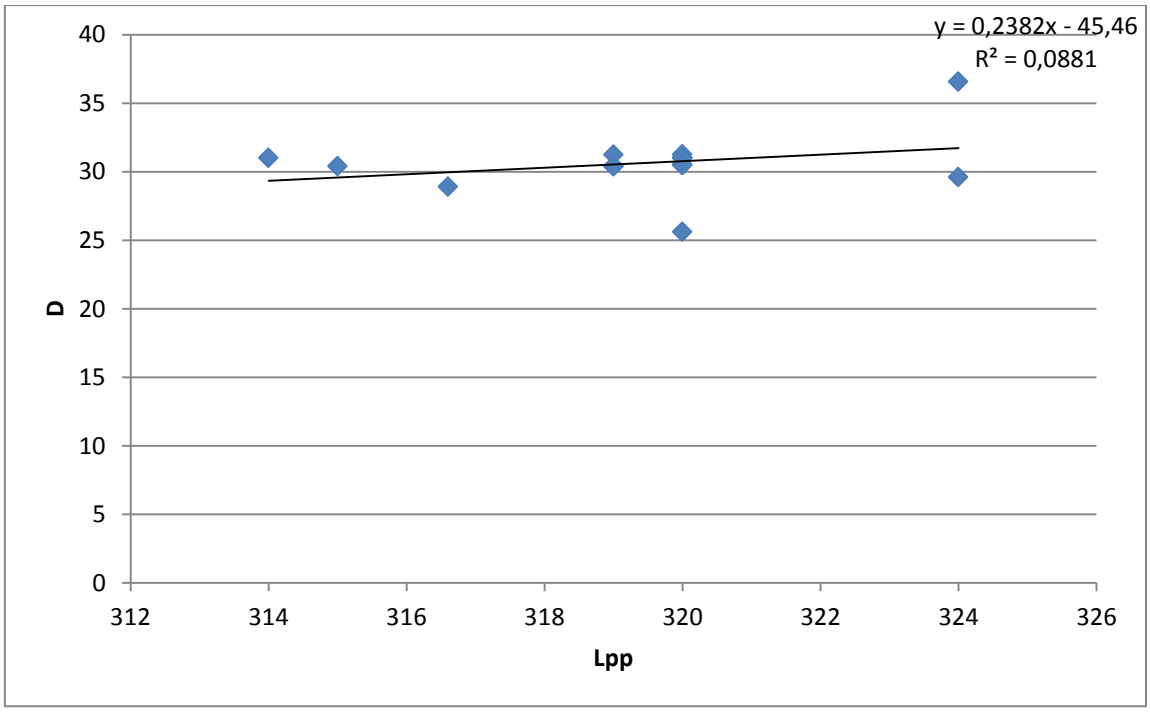
B = 58.75 metros

4.1.4 Definición del puntal (D).

Para la estimación del puntal, haremos el mismo procedimiento que para la manga, haremos dos regresiones, y luego una media de los valores obtenidos.

Para la primera regresión utilizaremos la eslora entre perpendiculares, y para la segunda el parámetro adimensional Lpp/D.

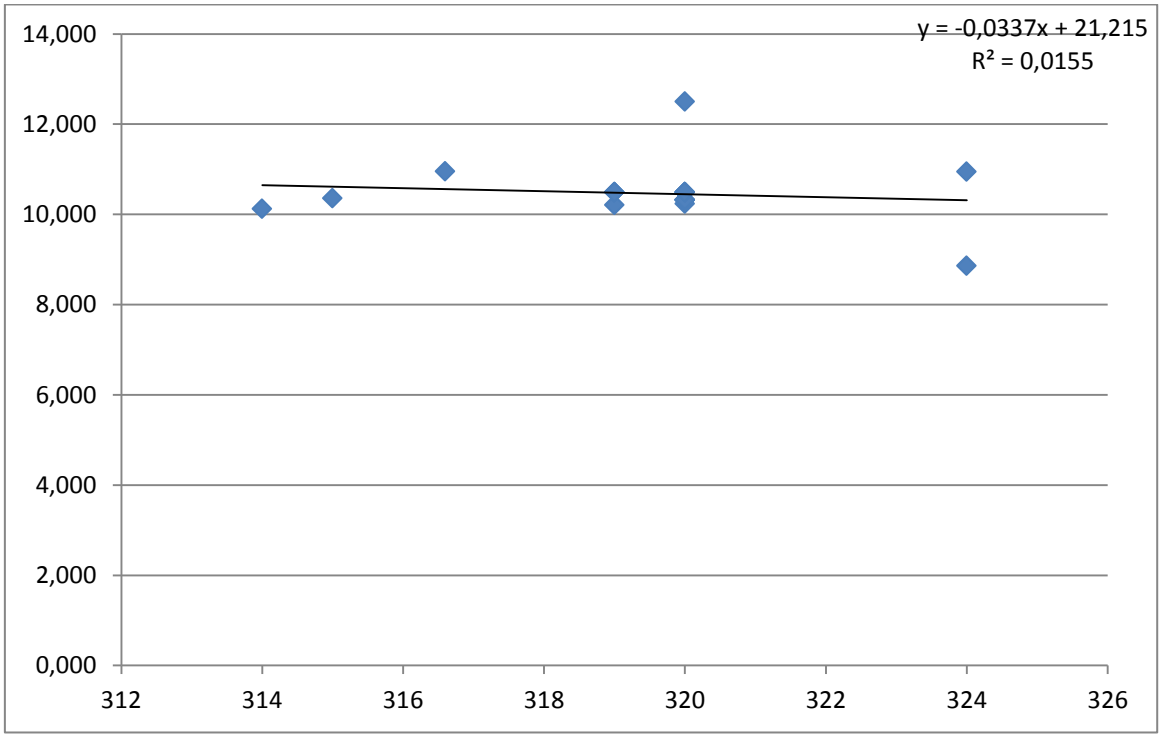
- 1ª regresión: D/Lpp:



De esta regresión obtenemos el siguiente valor de puntal:

$$D = 30.5 \text{ m}$$

- 2ª regresión: (Lpp/D)/Lpp:



De aquí obtenemos un valor del parámetro adimensional Lpp/D:

$$Lpp/D = 10{,}474473$$

Y con este valor y nuestro Lpp ya calculado anteriormente obtenemos el valor de D:

$$D = 30.4 \text{ m}$$

Debido a que ninguna de las dos regresiones son especialmente buenas, haremos una media de los dos valores obtenidos en las regresiones para tener un valor más aproximado.

$$D = \frac{30.4 + 30.5}{2}$$

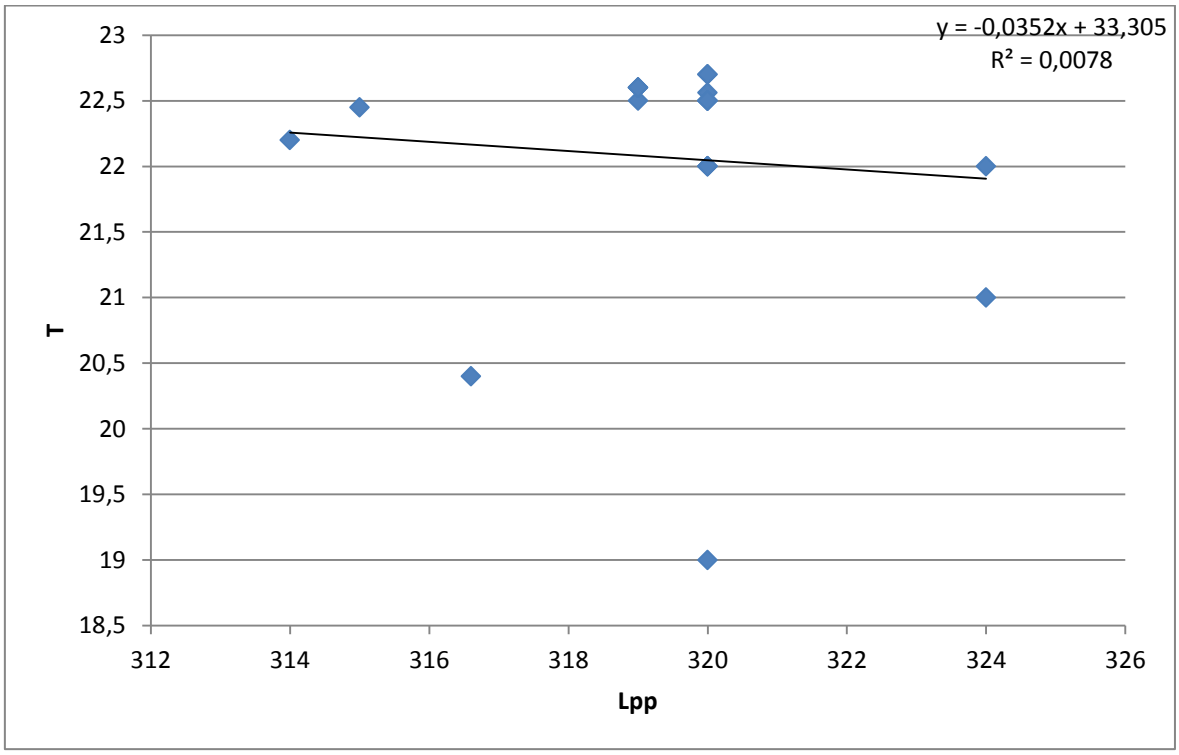
D = 30.45 metros

4.1.5 Definición del calado (T).

Igual que para la definición de la manga y del puntal, haremos dos regresiones y luego calcularemos la media de los dos datos obtenidos.

Como en las dos anteriores regresiones, primero utilizaremos el valor de la eslora entre perpendiculares de la primera regresión y luego el parámetro adimensional Lpp/T.

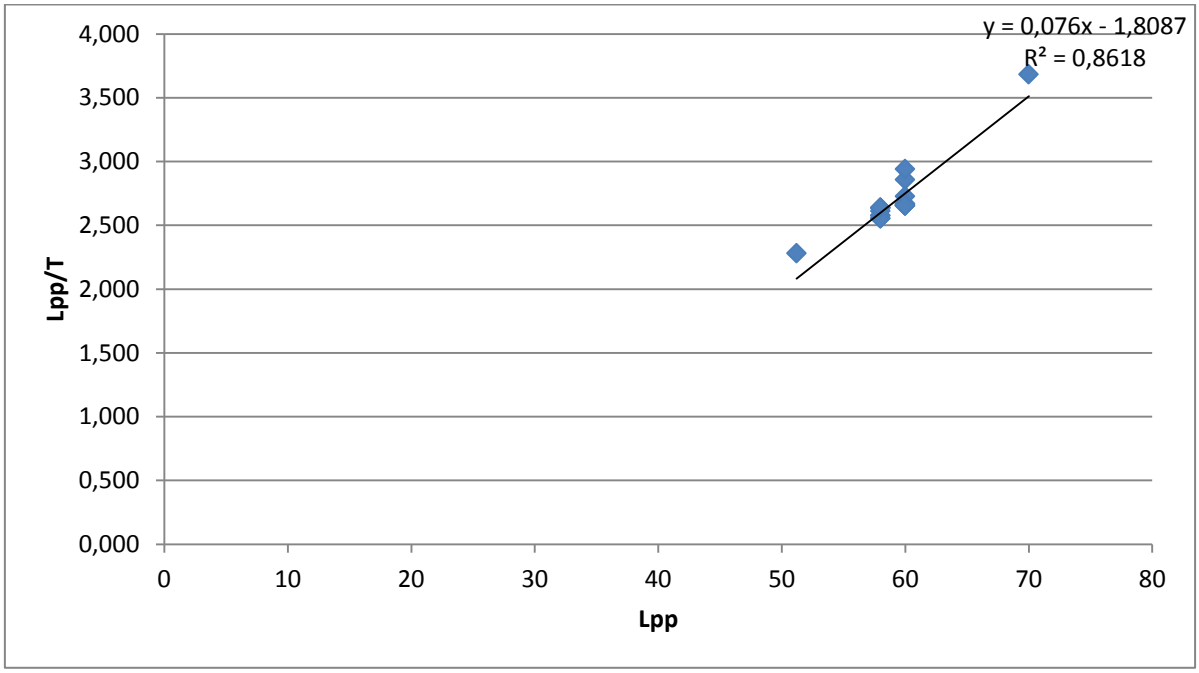
- 1ª regresión: T/Lpp:



De esta regresión obtenemos el siguiente valor:

T = 22.1 m

- 2ª regresión: (Lpp/T)/Lpp:



De esta regresión obtenemos el siguiente valor:

$$T = 22.1 \text{ m}$$

Debido a que por las dos regresiones obtenemos el mismo valor, nuestra aproximación final del calado es:

T = 22.1 metros

4.1.6 Estimación del coeficiente de bloque (Cb).

Para la regresión del coeficiente de bloque, la haremos en función del número de Froude de cada buque. Por lo tanto, lo primero que haremos será calcular el nº de Froude de nuestro buque.

La fórmula a aplicar es la siguiente:

$$Fn = \sqrt{\left(\frac{(v \cdot 0.5144)^2}{g \cdot L}\right)}$$

En la cual los datos a introducir son los siguientes:

- v = 15 knots

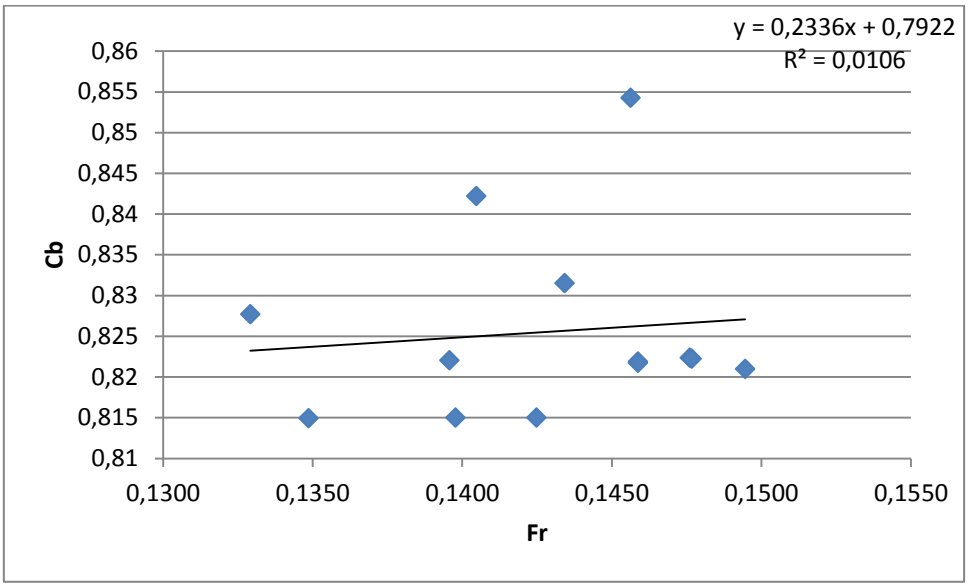
- L = 318.7 metros

- g, es la aceleración de la gravedad, que la tomaremos como 9.81 m/s^2.

Para nuestro buque el número de Froude tomará el valor de:

Fn = 0.138

Ahora realizamos la regresión mencionada anteriormente:



Por lo tanto nuestro Cb tendrá un valor, de acuerdo con esta regresión, de:

Cb = 0.824

4.1.7 Relación entre las dimensiones principales.

Una vez realizadas las primeras aproximaciones de las dimensiones principales de nuestro proyecto tenemos:

	Lpp (m)	Lt (m)	B (m)	D (m)	T (m)	Cb
Dimensiones	318.70	332.30	58.75	30.45	22.10	0.824

A partir de estas dimensiones, podemos establecer una serie de parámetros adimensionales bastante importantes, simplemente relacionándolos entre si.

Lpp/B	B/T	B/D	T/D	Lpp/D	Lpp/T
5,425	2,658	1,929	0,726	10,466	14,421

- Relación L/B: un valor de L/B alto disminuirá la resistencia al avance, por lo que habrá que montar un motor propulsor más pequeño con el ahorro que eso supone tanto en el equipo como en el consumo de combustible. Por contrapartida, el aumento de este parámetro nos conducirá a un mayor peso de acero, lo que conllevará a un aumento del precio.

- Relación de B/T y B/D: un valor alto conllevará a una mayor estabilidad inicial por formas ya que al aumentar la manga tendremos un mayor KM, por contrapartida conllevará a un aumento de la resistencia al avance del buque. Por lo general, se buscará una relación lo más baja posible para reducir la resistencia al avance. y solo se considerará un valor alto, si existen unas condiciones de estabilidad muy exigentes.

- Relación T/D: simplemente nos proporciona información referente al francobordo.

- Relación L/D: Esta relación nos da información acerca de la resistencia del buque sobre todo a su resistencia a la flexión. La importancia de esta relación es tal que está limitada para los buques en un valor máximo de 15 que no se podrá superar por considerarse, en tal caso, al buque como peligroso.

4.2 Por formulación.

Para este apartado, nos basaremos en la formulación que aparece en el libro “El proyecto básico del buque mercante”. Y usaremos también algunas fórmulas sacadas del libro “Proyectos de buques y artefactos”, del profesor de la Universidad de La Coruña Fernando Junco Ocampo.

- Eslora entre perpendiculares (Lpp):

Según "El proyecto básico del buque mercante, la podemos definir en función de los miles de toneladas de DWT (WPM'), como:

$$L_{pp} = e^{[3.92-9.36\cdot10^{-5}\cdot WPM'+0.33\cdot\ln(WPM')]}$$

Lpp = 321.87 m

- Manga (B):

$$B = 38.8 + 0.068 \cdot WPM' - \left(\frac{430.8}{WPM'}\right)$$

B = 57.76 m

- Puntal (D):

$$D = 14.77 + 0.055 \cdot WPM'$$

D = 31.27 m

- Calado de francobordo (T):

$$T = e^{[1.39+3.81\cdot10^{-4}\cdot WPM'+0.276\cdot\ln(WPM')]}$$

T = 21.73 m

4.3 Cálculo de las dimensiones por medio del GetxoNAVAL.

El programa "GetxoNaval" es una versión adaptada y reprogramada, para ejecutarse on-line, del programa "Arqnaval", incluido en el libro "El Proyecto básico del buque mercante" de los autores R. Alvariño, J.J. Azpíroz y M. Meizoso, publicado por El Fondo Editorial de Ingeniería Naval, del C.O.I.N..

Introduciendo el tipo de buque (petrolero de crudo), y las toneladas de peso muerto (300.000 TPM), nos da unos valores aproximados de nuestras dimensiones principales.

Dimensiones	Valores
Eslora Lpp (m)	323,00
Manga (m)	57,80
Puntal (m)	31,20
Calado verano(m)	21,80
C. Bloque	0,84
V.Servicio(nudos)	15,30
Potencia Propulsora(Kw)	30300
RPM Propulsor(es)	60
Arqueo Bruto GT	172.000
Arqueo Bruto Compensado CGT	46.200

4.4 Dimensiones finales.

Las dimensiones obtenidas en los apartados anteriores no son más que unos valores aproximados.

Para determinar los valores de las dimensiones finales, haremos una media con todos los valores anteriormente obtenidos.

Si en algún apartado nos da un valor muy diferente al obtenido por otros métodos, simplemente lo eliminaremos, y haremos la media sin contar con ese valor determinado.

	L	B	D	T	Cb
Regresión	318,7	58,75	30,45	22,1	0,824
Formulación	321,87	57,76	31,27	21,73	-
Getxo naval	323	57,8	31,2	21,8	0,84
∑	963,57	174,31	92,92	65,63	1,664
Media	321,19	58,10	30,97	21,88	0,832

Si estos valores, los redondeamos hacia arriba, obtenemos nuestros valores definitivos:

- L_{pp} = 321.5 m

- B = 58.5 m

- D = 31 m

- T = 21.88 m

- Cb = 0.83

4.5 Relaciones dimensionales.

En este apartado, comprobaremos que las relaciones adimensionales de nuestro buque están dentro de los intervalos de nuestra base de datos.

	Intervalos de la base de datos		Valores de nuestro buque
	Valores mínimos	Valores máximos	
L/B	4,571	6,152	5,496
L/D	8,862	12,500	10,371
B/T	2,281	3,684	2,674
T/D	0,574	0,743	0,706
B/D	1,641	2,734	1,887
L/T	14,031	16,842	14,694

Como podemos observar, todas las relaciones están dentro de los intervalos marcados, por lo que se consideran válidos para una primera aproximación.

5 COMPROBACIÓN DEL FRANCOBORDO.

A continuación, usaremos de nuevo el programa "GetxoNaval", y con él calcularemos una aproximación del francobordo, y sacaremos así el calado máximo del buque, y lo compararemos con el que habíamos obtenido anteriormente.

Simplemente introduciendo nuestras dimensiones previamente calculadas, y dejando en blanco los datos que aún desconocemos (el programa los estimará adoptando valores medios normales para el tipo y tamaño del buque), obtenemos del programa la siguiente tabla:

Resultados	Francobordo(m)	Calado (m)
Tipo A	7,222	23,811
Tipo B	8,985	22,047
Tipo B-60	7,959	23,073
Cubertada madera	8,768	22,264
Altura mínima proa	6,257	

Para nuestro buque, que es del "Tipo A", tenemos los siguientes valores:

- Francobordo (m) = 7.22

- Calado (m) = 23.811

Si los comparamos con los datos que habíamos calculado anteriormente, podemos comprobar que nuestro calado es menor (21.88 m), por lo tanto cumplimos de sobras con los requerimientos de francobordo.

6 PREDICCIÓN PRELIMINAR DE LA POTENCIA PROPULSORA.

Para una primera aproximación de la potencia propulsora, nos basaremos simplemente en la fórmula de Watson, con los datos obtenidos anteriormente:

$$BHP = (0.889 \cdot \frac{\Delta^{\frac{2}{3}}\left(40 - \left(\frac{L}{61}\right) + 400\,(K-1)^2 - 12C_B\right)}{15000 - 1.81\,N\sqrt{L}}\,V^3$$

En donde:

- V, es la velocidad en nudos (15 knots)

- $\Delta = C_B \cdot L \cdot B \cdot T \cdot 1.025$

$$\Delta = 0.83 \cdot 321.5 \cdot 58.5 \cdot 21.88 \cdot 1.025 = 350095.17\ ton$$

- K, es la constante de Alexander, que se obtiene como:

$$C_B = K - \left(0.5\left(\frac{V}{\sqrt{3.28 \cdot L}}\right)\right)$$

$$K = 1.0609$$

- N, son las rpm del motor, siguiendo los datos de un buque base, tomaremos 85.

BHP ≈ 32000 HP

BKW ≈ 23862,39 KW

7 ELECCIÓN DE LA CIFRA DE MÉRITO.

En este apartado, y partiendo de las dimensiones preliminares anteriormente calculadas, generaremos una serie de alternativas y seleccionaremos la más favorable, que será simplemente la que conlleve un menor coste de construcción.

Las dimensiones preliminares que hemos calculado son las siguientes:

- L_{pp} = 321.5 m

- T = 21.88 m

- B = 58.5 m

- Cb = 0.83

- D = 31 m

7.1 Aproximación de pesos del buque.

Con estas dimensiones preliminares, calculamos el valor del desplazamiento y el peso en rosca con dichas dimensiones para conocer el peso muerto asociado a estas dimensiones preliminares:

$$\Delta = \mathrm{PR} + \mathrm{PM}$$

- El desplazamiento (Δ) lo calculamos como:

$$\Delta = (L \cdot B \cdot T \cdot Cb) \cdot 1.025$$

Δ = 350095.16 ton

- El Peso en Rosca (PR) lo podemos descomponer en:

$$\mathrm{PR} = \mathrm{Pestructura} + \mathrm{Pmaquinaria} + \mathrm{Pequipos\ restantes}$$

- Peso estructura según "El proyecto básico del buque mercante":

$$\mathrm{Pestructura} = 0.0685\ \mathrm{Lpp}^{1.7}\mathrm{B}^{0.102}\mathrm{D}^{0.886}$$

Pestructura = 39764.42 ton

- Peso equipos restantes :

$$\text{Pequipos restantes} = Ke \cdot Lpp \cdot B$$

En donde:

$$Ke \text{ (para petroleros)} = 0.36 - 0.53 \cdot 10^{-3} \cdot Lpp$$

Por tanto:

$$\underline{\text{Pequipos restantes} = 3566.04 \text{ ton}}$$

- Peso de la maquinaria:

Este peso, lo desglosaremos a su vez en :

- Peso del motor (para una hélice) :

$$P_{motor} = a\left(\frac{BKW}{rev}\right)^{b} + c(BKW)^{d}$$

Siendo :

$$a = 9.38 \; ; \; b = 0.84 \; ; \; c = 0.59 \; ; \; d = 0.7$$

$$P_{motor} = \; 1752.79 \; ton$$

- Peso de otros elementos :

$$P_{otros} = k_m \cdot MCO^{0.7}$$

En donde podemos tomar :

$$k_m = 0.72$$

$$MCO = BKW = 23862{,}39 \text{ KW}$$

$$P_{otros} = \; 835.1 \; ton$$

- Peso línea de ejes fuera de cámara de máquinas :

$$P_{Línea\ ejes} = N_e \cdot \; L_e(5 + 0.0164 \cdot L)$$

Siendo :

N_e número de ejes, en nuestro caso 1.

L_e es la longitud del eje, tomaremos el valor de un buque referencia (L_e = 8 m)

$$P_{Línea\ de\ ejes} = 82.18\ ton$$

Haciendo un sumatorio de estos tres factores, tenemos el peso de nuestra maquinaria :

$$P_{maq} = P_{motor} + P_{otros} + P_{Línea\ ejes}$$

$$P_{maq} = 2670.05\ ton$$

Por tanto el Peso en Rosca del buque, será la suma de los tres valores obtenidos:

$$PR = P_{estructura} + P_{equipos\ restantes} + P_{maquinaria}$$

PR = 46000.51 ton

A este valor le aplicamos un margen del 6 %:

PR' = 48760.54 ton

Con el valor del desplazamiento (Δ) y del Peso en Rosca (PR'), podemos sacar el valor de nuestro Peso Muerto (PM):

$$PM = \Delta - PR'$$

PM = 301334.61 ton

7.2 Desglose de los costes.

En este apartado estamos buscando establecer un valor para una cifra de mérito concreta.

En nuestro caso, la cifra de mérito será el menor coste de construcción para el astillero.

Por ello, primero evaluaremos de forma empírica, a partir de una serie de fórmulas, el precio más o menos aproximado de los costes totales de construcción de un buque.

El coste total de la construcción lo podemos expresar como:

$$CC = CMg + (CEq + Cem) + CMo + CVa$$

En donde:

CC: coste total de construcción.

CMg: costo de los materiales a granel.

CEq: costo de los equipos del buque.

Cem: costo montaje de los equipos

CMo: costo de la mano de obra.

CVa: otros costos del astillero.

- Costos de materiales a granel:

$$CMg = ccs \cdot cas \cdot cem \cdot ps \cdot WST$$

WST: representa el peso de aceros del buque.

ccs: representa el coeficiente ponderado de las chapas y perfiles de distintas calidades de acero

$$1.05 < ccs < 1.10$$

Tomamos el valor de ccs = 1.10

cas: representa el coeficiente de aprovechamiento del acero en relación con el pedido de materiales peso bruto/peso neto.

$$1.08 < cas < 1.15$$

Tomamos el valor de cas = 1.12

cem: representa el coeficiente de incremento por equipo metálico incluido en la estructura tales como tecle, registros escotilla, barandillas, etc.

$$1.03 < cem < 1.10$$

Tomamos el valor de cem = 1.07

ps: representa el precio unitario del acero para referencia. Conjunto de chapas y perfiles de distintas calidades

ps = 700 euro/tonelada, para acero de calidad normal grado A

- Costo de los equipos (CEq) y de su montaje (Cme):

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

CEc: representa el coste de los equipos de manipulación de la carga, montaje incluido.

CEp: representa el coste de los equipos de propulsión, de sus auxiliares y su montaje

$$CEp = cep \cdot PB$$

cep: representa el coeficiente de coste por unidad de potencia de los equipos de propulsión y de sus auxiliares

$$300 < cep < 400 \text{ euro/kilowatio}$$

Tomamos cep =400

PB: representa la potencia propulsora total en KW (23862,39)

CHf: representa el coste de la habilitación y fonda incluido su montaje

$$CHf = chf \cdot nch \cdot NT$$

chf: representa el coeficiente de coste unitario de la habilitación por tripulante.

$$chf = 32000/35000 \text{ euro/tripulante}$$

Tomamos chf = 34000

nch: representa el coeficiente de nivel de calidad de la habilitación.

$$0.90 < nch < 1.20$$

Tomamos nch =1.05

NT: representa el número de tripulantes, que en nuestro caso es de 35.

CEr: representa el coste del equipo restante incluido su montaje.

$$CEr = cpe \cdot pst \cdot WEr$$

cpe: coeficiente de comparación del coste del equipo restante con el coste del acero.

$$1.25 < cpe < 1.35$$

pst: engloba todos los coeficientes del acero y representa el coste unitario del acero montado en cada castillo.

WEr: peso del equipo restante.

- Costo de la mano de obra (CMo):

$$CMo = CMm + Cme$$

CMm: representa el costo de la mano de obra de montaje del material a granel

$$\boldsymbol{CMm = chm \cdot csh \cdot WST}$$

chm: representa el costo horario medio del Astillero

$$21/25 < chm < 30/40 \text{ euros/hora}$$

$$\text{Tomamos } chm = 40$$

csh: representa el coeficiente de horas por unidad de peso. Este ratio está directamente relacionado con la capacidad productiva del Astillero.

$$20/30 < csh < 80/100 \text{ horas/tonelada}$$

$$\text{Tomamos } csh = 80$$

WST: representa el peso de acero del buque.

CMe representa el costo de la mano de obra de montaje de los equipos e instalaciones del buque, no lo tenemos en cuenta porque no lo conocemos.

- Costes varios aplicados, CVa:

$$CVa = cva \cdot CC$$

$$0.05 < cva < 0.10$$

Tomamos cva = 0.1

7.3 Generación de alternativas y elección de la cifra de mérito.

Para la generación de las alternativas, utilizaremos la potente herramienta de "Microsoft Excel" denominada "Solver", con el objetivo de evaluar una serie de alternativas a la inicial con el fin de que, variando ligeramente las dimensiones preliminares, consigamos optimizar estas para una cifra de mérito concreta, en nuestro caso el menor coste de construcción para el astillero.

Recordemos nuestras dimensiones preliminares:

	Lpp (m)	B (m)	D (m)	T (m)	Cb
Dimensiones	321.5	58.5	31	21.88	0.83

Estas dimensiones las haremos variar en $\pm$10%, excepto la eslora que la variaremos en un $\pm$5%, para la generación de las alternativas, de forma que no nos queden unas dimensiones excesivamente diferentes a las preliminares.

De esta forma, las dimensiones finales deberán estar comprendidas entre:

	MÁXIMO (m)	MÍNIMO (m)
L	337,575	305,425
B	64,35	52,65
D	34,1	27,9
T	24,068	19,692

Ahora debemos definir las restricciones que le debemos introducir al programa de cálculo:

- La primera restricción nos la determina nuestra RPA y es el peso muerto (TPM):

TPM = 300.000 ton

- La segunda restricción, serán unos intervalos en los que deben encontrarse las relaciones adimensionales siguientes, de forma que no nos salga un tipo de barco demasiado atípico:

	MÍNIMO	MÁXIMO
L/B	4,571	6,152
L/D	8,862	12,500
B/T	2,281	3,684
T/D	0,574	0,743
B/D	1,641	2,734
L/T	14,031	16,842

Una vez definidos los anteriores parámetros, ejecutamos el programa de cálculo, del cual obtendremos nuestras dimensiones principales optimizadas en función de nuestra cifra de mérito (Mínimo Coste de Construcción).

Cuyas dimensiones principales son las siguientes:

L_{pp} = 305.425 m

B = 62.95 m

D = 27.9 m

T = 20.74 m

Cb = 0.83

Con las dimensiones preliminares anteriormente calculadas el coste total de construcción es de:

Coste total (€)	192212402,1

Con las dimensiones obtenidas con el "Solver", el Coste de Construcción es:

Coste total (€)	163554530,9

Lo que supone un ahorro de unos 28657871.2€ para el astillero.

Ahora redondearemos los valores obtenidos, y tendremos nuestras dimensiones finales:

L_{pp} = 305.5 m

B = 63 m

D = 28 m

T = 20.8 m

Cb = 0.83

Durante la espiral de proyecto, hemos observado que con estas dimensiones iremos muy justos en cuanto a capacidad de carga como de lastre, por tanto se ha optado por dar dos metros más de puntal al barco, de forma que podamos cumplir holgadamente con la capacidad de carga y lastres requeridos.

Por tanto, las dimensiones finales de nuestro buque serán:

L_{pp} = 305.5 m

B = 63 m

D = 30 m

T = 20.8 m

Cb = 0.83

8 COMPROBACIÓN DEL FRANCOBORDO.

En este apartado, haremos una nueva estimación preliminar con el programa "Getxo Naval", para comprobar que se cumple con el francobordo mínimo, como ya hemos hecho anteriormente con las dimensiones preliminares.

Para nuestro buque, que es del "Tipo A", tenemos los siguientes valores:

- Francobordo (m) = 7.618

- Calado (m) = 22.412

Si los comparamos con nuestros valores, podemos comprobar que nuestro calado es menor (20.8 m), por lo tanto cumplimos de sobras con los requerimientos de francobordo.

9 PREDICCIÓN DE LA POTENCIA.

En este apartado, apoyados en el software de cálculo "NavCad", haremos una primera predicción, muy preliminar, de potencia de nuestro buque.

Una de las primeras características de las que depende la potencia es de la existencia o no de un bulbo de proa.

Los buques que suelen llevar bulbo de proa, se encuentran dentro de los siguientes intervalos:

$$0.65 < Cb < 0.815$$

Nuestro C_B es de 0.83, por lo que según esto no necesitaremos bulbo.

$$5.5 < (Lpp/B) < 7$$

En nuestro caso Lpp/B = 4.85 que tampoco entra en el rango.

$$0.24 < Fn < 0.57$$

Nuestro número de Froude lo podemos definir como:

$$Fn = \sqrt{\frac{v^2}{g \cdot L}}$$

En donde:

"v" es la velocidad en m/s (7.76 m/s)

"g" es la fuerza de la gravedad (9.81 m/s^2)

"L" es la eslora (317.72 m)

Por tanto:

$$Fn = 0{,}1382$$

Por tanto en este caso tampoco es aconsejable el uso de bulbo.

$$Cb \cdot B / Lpp < 0.135$$

En nuestro caso este valor será 0,171 por tanto tampoco es aconsejable el uso de bulbo.

Dado que en ninguno de los casos anteriores nos aconseja el uso de bulbo de proa, para esta primera aproximación de la potencia propulsora, no usaremos bulbo.

Antes de la realización de la predicción de potencia, debemos definir una serie de parámetros que serán necesarios introducir en el software de cálculo. Estos parámetros son los siguientes:

- Margen de mar = 15%

- Eslora en la flotación (L_{fl}):

La podemos definir aproximadamente como:

$$L_{fl} = 1{,}04 \cdot L_{pp}$$

$$L_{fl} = 317{,}72\ m$$

- Desplazamiento (Δ):

$$\Delta = L \cdot B \cdot T \cdot C_B \cdot 1.025$$

$$\Delta = 339595{,}93\ ton$$

- Coeficientes:

Coeficiente de bloque (C_B):

Ya está calculado anteriormente, y tomará el valor de:

$$C_B = 0.83$$

Coeficiente de la maestra (C_m):

Según la fórmula del HSVA:

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

$$\mathrm{Cm} = 0.998$$

Coeficiente prismático (C_p):

Para el coeficiente prismático es necesario conocer los dos coeficientes anteriores, este se calculará de la siguiente forma:

$$C_p = \frac{\mathrm{Cb}}{\mathrm{Cm}}$$

$$C_p = 0.832$$

Coeficiente de la flotación (C_{fl}):

Lo podemos expresar como:

$$C_{fl} = \frac{1 + 2 \cdot C_B}{3}$$

$$C_{fl} = 0{,}887$$

- Área de la flotación (A_{fl}):

$$A_{fl} = C_{fl} \cdot L_{fl} \cdot B$$

$$A_{fl} = \ 17747{,}84\ m^2$$

- Área de la maestra (A_m):

$$A_m = C_m \cdot B \cdot T$$

$$A_m = \ 1303{,}98\ m^2$$

- Superficie mojada (S_m):

La podemos aproximar con la siguiente expresión:

$$S_m = L_{fl}(2 \cdot T + B) \cdot C_m^{0.5} \cdot \Big(0.453 + 0.4425 \cdot C_B - 0.2862 \cdot C_m - 0.003467 \cdot \frac{B}{T} + \\ +0.3696 \cdot C_{fl}\Big) + 2.38 \cdot \frac{ABT}{C_B}$$

En donde "ABT" es el área transversal del bulbo, y ya que como hemos dicho anteriormente que no usaríamos bulbo lo tomaremos como 0.

Por tanto la superficie mojada valdrá:

$$S_m = \ 27579{,}605\ m^2$$

Ahora que ya tenemos calculados los parámetros necesarios para introducir en el "NavCad", procedemos a realizar la predicción de potencia.

Una vez introducidos los datos, el software no vuelca un fichero en el que podemos observar la potencia requerida para una velocidad de servicio determinada.

Para nuestra velocidad de servicio que son 15 nudos, la potencia será:

	RESISTANCE AND EFFECTIVE POWER								
SPEED [kt]	RBARE [kN]	RAPP [kN]	RWIND [kN]	RSEAS [kN]	RCHAN [kN]	RMARGIN [kN]	RTOTAL [kN]	PEBARE [kW]	PETOTAL [kW]
12,50	1578,51	78,93	0,00	0,00	0,00	236,78	1894,21	10150,7	12180,8
13,00	1699,41	84,97	0,00	0,00	0,00	254,91	2039,29	11365,2	13638,3
13,50	1825,64	91,28	0,00	0,00	0,00	273,85	2190,76	12679,0	15214,9
14,00	1957,77	97,89	0,00	0,00	0,00	293,67	2349,33	14100,3	16920,4
14,50	2096,57	104,83	0,00	0,00	0,00	314,49	2515,88	15639,2	18767,1
+ 15,00 +	2242,99	112,15	0,00	0,00	0,00	336,45	2691,59	17308,4	20770,1
15,50	2398,25	119,91	0,00	0,00	0,00	359,74	2877,90	19123,3	22948,0
16,00	2563,79	128,19	0,00	0,00	0,00	384,57	3076,55	21102,9	25323,4
16,50	2741,38	137,07	0,00	0,00	0,00	411,21	3289,66	23269,8	27923,7
17,00	2933,08	146,65	0,00	0,00	0,00	439,96	3519,69	25651,4	30781,7

$$\underline{\boldsymbol{BKW = 20770,1\ KW}}$$

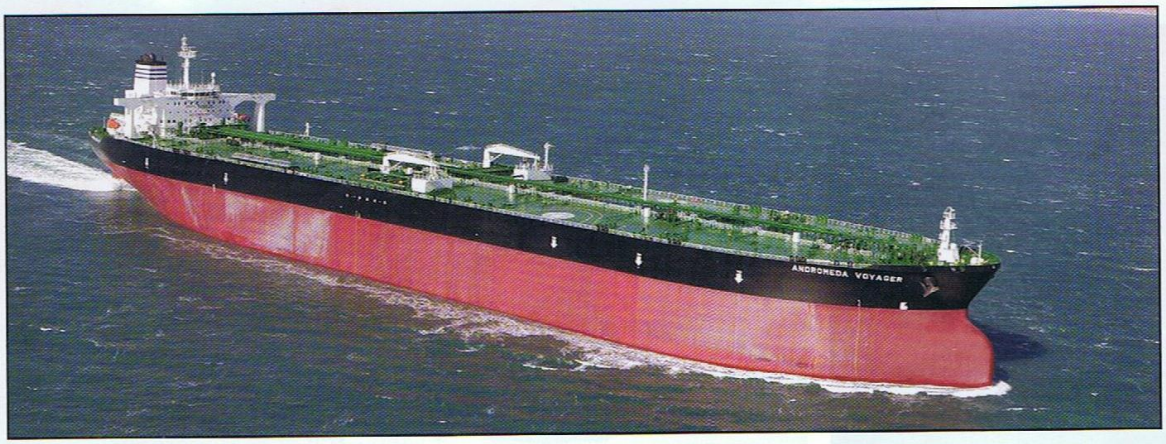
$$\underline{\boldsymbol{BHP = 28239,48\ HP}}$$

10 BIBLIOGRAFÍA.

- "El proyecto básico del buque mercante", Alvariño, R; Aspiroz, J; y Meizoso , M.
- "Proyectos de buques y artefactos", Fernando Junco.
- Revistas de "Significant Ships",
- Apuntes de la asignatura de Proyectos (ITN)
- Apuntes de la asignatura de Métodos computacionales aplicados al proyecto (GAN)
- Diverso material web.

ANEXO I:

BUQUES BASE DE DATOS



ANDROMEDA VOYAGER: DSME's latest version of the VLCC tanker

Shipbuilder: ..... Daewoo Shipbuilding & Marine Engineering Co Ltd (DSME), Korea
Vessel's name: ..... *Andromeda Voyager*
Hull No: 5261
Owner/operator: ..... Kristen Navigation Inc, Greece
Designer: ..... DSME, Korea
Model test establishment used: ..... SSPA, Sweden
Flag: ..... Bahamas
Total number of sister ships already completed: ..... Nil
Total number of sister ships still on order: 2

THE standardisation of modern ship types to suit perceived market requirements has resulted in a great deal of commonality of design features, and nowhere is this more evident than amongst the examples of very large crude carriers (VLCCs) which are regularly reviewed in *Significant Ships*. Daewoo's latest version of this still popular class of vessel shows few variations from other, similar designs produced over the years and, relatively speaking, offers only modest differences in technical particulars.

What the Okpo shipyard has included in this VLCC series, however, is a new hull and structural design philosophy aimed at producing 'stronger safer ships', complying with all the latest international safety and environmental regulations. Cargo tanks are located within a double-hull configuration in which the side-tank width is 3.4m compared with the minimum Marpol 13F values of 2m. Structurally, cross-ties have been included to improve fatigue characteristics to the extent that the hull's fatigue life generally, is guaranteed for 30 years, and longitudinal stiffeners' end connections in the cargo area for 40 years, in accordance with ABS Safehull Phase A requirements.

Mild steel content has been increased to 70% (high-tensile steel accounting for 30%) and the proportion of T-bar longitudinals from 60% to 92%, to provide innovative fatigue strength in place of inverted angle stiffeners. Notably, a light coloured anti-abrasive epoxy paint of 300microns thickness has been applied in the ballast tanks to allow easier detection of leaks and corrosion, and good access arrangements have been fitted to longitudinal bulkheads in cargo and water ballast tanks.

Andromeda Voyager is a flush-decked vessel without forecastle, but having a sunken mooring deck aft, a raked stem with bulbous bow, and a transom stern over a semi-balanced rudder and open water sternframe. The double hull surrounds a cargo space divided by two longitudinal, and transverse bulkheads into five pairs of side tanks and five centre tanks. The wing tanks within the double hull are joined with centrally divided bottom tanks to form six L-shaped ballast tanks, and a pair of slop tanks is arranged aft of the cargo tanks.

Three cargo grades can be handled simultaneously with double-valve segregation, using three Shinko 5500m³/h steam turbine-driven pumps. Cargo and ballast operations are controlled from a central console made by Saab, and bridge control includes the facility for one man operation, featuring a Kongsberg Maritime C20 installation and a JRC integrated bridge system.

The main engine was supplied by Hyundai Heavy Industries, and is a MAN B&W 6S90MC-C unit developing 29,340kW at 76rev/min MCR. When operating at 90% full power and allowing a sea margin of 15%, a service speed of 16.20knots is achieved. Electrical supply is from three Wärtsilä/Hyundai 1200kW diesel-alternator sets, and steam is generated from two 40,000kg/h watertube boilers.

TECHNICAL PARTICULARS

Length, oa 333.00m
Length, bp 320.00m
Breadth, moulded 60.00m
Depth, moulded, to upper deck 30.50m
Width of double skin
- side 3.40m
- bottom 3.00m

Gross 160,808gt
Draught
- design 21.00m
- scantling 22.56m

Displacement
- design 337,000tonnes
- scantling 364,900tonnes

Lightweight (approx) 44,000tonnes
Deadweight (approx)
- design 292,600dwt
- scantling 320,500dwt

Speed, service, 90% MCR, 15% sea margin 16.20knots
Cargo capacity 357,900m³
Bunkers
- heavy oil 8500m³
- diesel oil 400m³

Water ballast 102,100m³
Fuel consumption, main engine only 105tonnes/day
Classification ..... American Bureau of Shipping +A1(E), RW, Crude Oil/Product Carrier, +AMS, +ACCU, VEC, HM2+R, SH/ FL(30), SHCM, RES, ESP, With descriptive notes UWILD, SPM
Percentage of high-tensile steel used in construction 30%
Main engine
- Design ..... MAN B&W
- Model 6S90MC-C
- Manufacturer ..... Hyundai Heavy Industries
- Number 1
- Type of fuel used ..... HFO
- Output/speed 29,340kW/76rev/min

Propeller
- Material ..... Nickel-aluminium-bronze
- Designer/manufacturer ..... DSME/Hyundai
- Number 1
- Pitch ..... Fixed
- Diameter 9900mm
- Speed 73.40rev/min

Diesel-driven alternators
- Number 3
- Engine make/type Wärtsilä/8L20C
- Type of fuel used ..... HFO
- Output/speed 1200kW/900rev/min
- Alternator make ..... Hyundai

Boilers
- Number 2
- Type ..... vertical, watertube
- Make ..... Mitsubishi Heavy Industries
- Output ..... 2 x 40,000kg/h

Mooring equipment
- Make ..... Oriental-Fukushima
- Type ..... Electro-hydraulic

Cargo tanks
- Number 15
- Grades of cargo carried 3
- Product range ..... Crude oil
- Coated tanks ..... 2 x tar-free epoxy (200microns); 2 x anti-abrasive epoxy (300microns) in ballast tanks

Cargo pumps
- Number 3
- Type ..... vertical steam turbine
- Make ..... Shinko
- Capacity, each pump ..... 3 x 5500m³/h

Cargo control system
- Make ..... Saab
- Type ..... includes radar tank sounding

Ballast control system
- Make ..... SF-Control
- Type ..... Electro-pneumatic

Complement
- Officers 11
- Crew 22
- Supernumaries 1
- Suez crew 6

Bridge control system
- Make ..... Kongsberg Maritime
- Type ..... C 20
- One man operation ..... Yes, without notation

Fire detection systyem
- Make ..... Consilium
- Type C-300

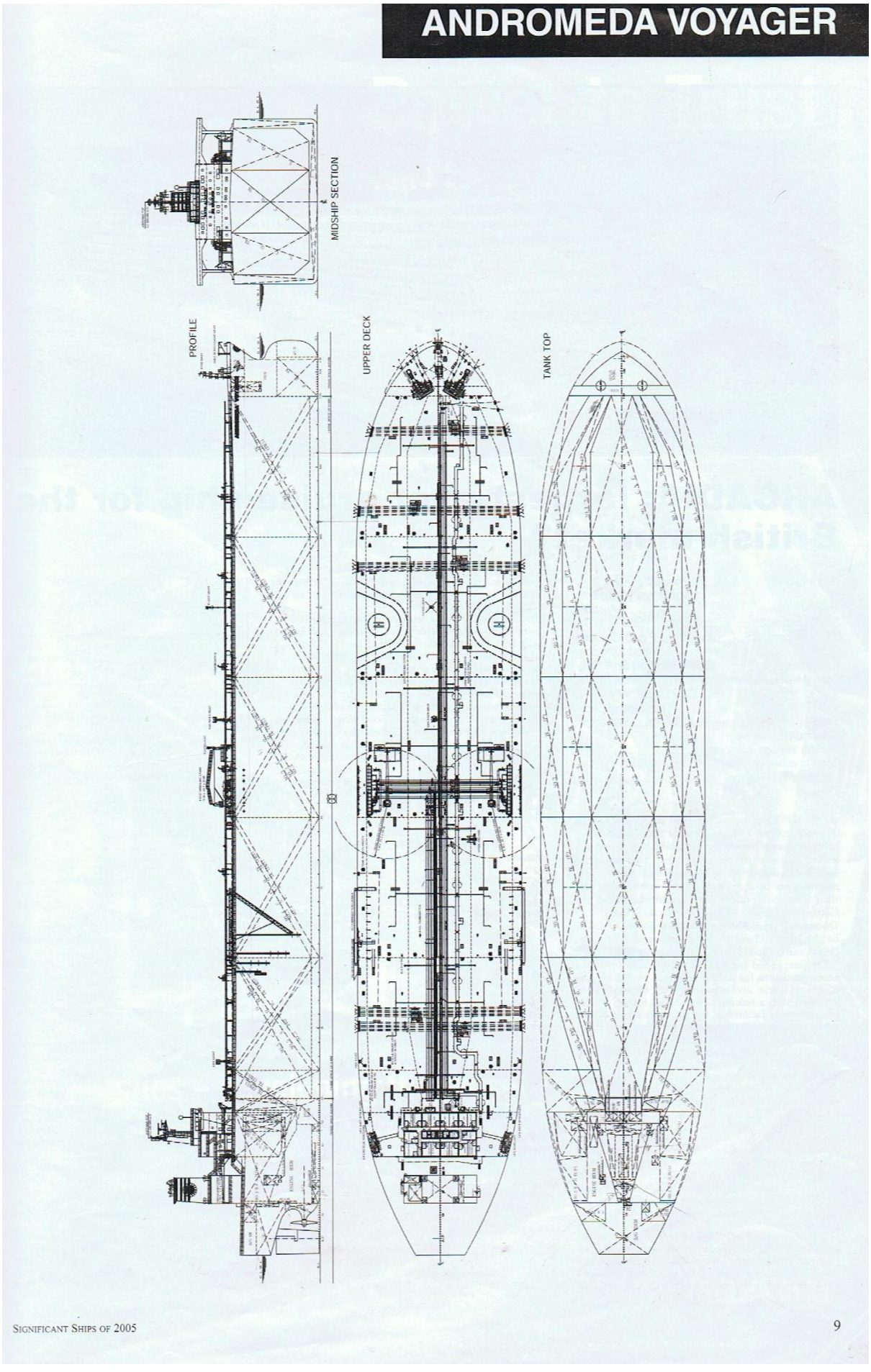
Fire extinguishing systems
- Engineroom ..... high-expansion foam
- Make ..... Kawasaki

Radars
- Number 2
- Make ..... JRC
- Models ..... JMA-9933 SA (S-band), JMA-9923 &XA (X-band)

Integrated bridge system
- Make ..... JRC
- Model ..... JAN-701 CON (Conning Display)/JAN-701 EOR (ECDIS)

Waste disposal plant
- Incinerator
  - Make ..... Teamtec Golar
  - Model ..... GS 1200C

Contract date ..... 27 January 2001
Launch/float-out date ..... 27 November 2004
Delivery date ..... January 2005


ANDROMEDA VOYAGER
MIDSHIP SECTION
PROFILE
UPPER DECK
TANK TOP
SIGNIFICANT SHIPS OF 2005
9

BW LOTUS: Chinese-built VLCC for BW Fleet Management

Shipbuilder: ..... **Bohai Shipbuilding Heavy Industry Co., Ltd.**
Vessel's name: ..... ***BW Lotus***
Hull no: **BH5189**
Owner/operator: ..... **BW Fleet Management**
Country: ..... **Singapore**
Flag: ..... **Hong Kong**
IMO number: **9385037**
Total number of sister ships already completed (excluding ship presented): **1**
Total number of sister ships still on order: ..... **nil**

BW Lotus is the first in a series of two very large crude carriers (VLCCs) for BW Fleet Management. The vessel was delivered from Chinese Bohai Shipbuilding Heavy Industries Co., Ltd at the beginning of 2011. Its sister vessel *BW Peony* was delivered a few months afterwards.

The 320,141dwt *BW Lotus* is the largest VLCC to be delivered from a Chinese shipyard and is the first delivery for BW from Bohai shipyard of a VLCC. The vessel has been specifically tailored to customer requirements. The hull form takes advantage of the vessels double skin configuration and has particularly fine lines aft of the vessel, which gives the vessel a smooth flow through water. *BW Lotus* also features a shrunken deck at the aft end allowing for more space for machinery and giving better protection against pirates.

The vessel is fitted with Pusnes hydraulic windlasses with large disc brakes. This type of windlass is a first for BW as previously the company has opted for standard drum brakes to install on its vessels. The mooring winches are also of Pusnes type. The steering gear is of Wuhan-Kawasaki design, and both the hose handling and provision cranes have been supplied by MacGregor Nanjing.

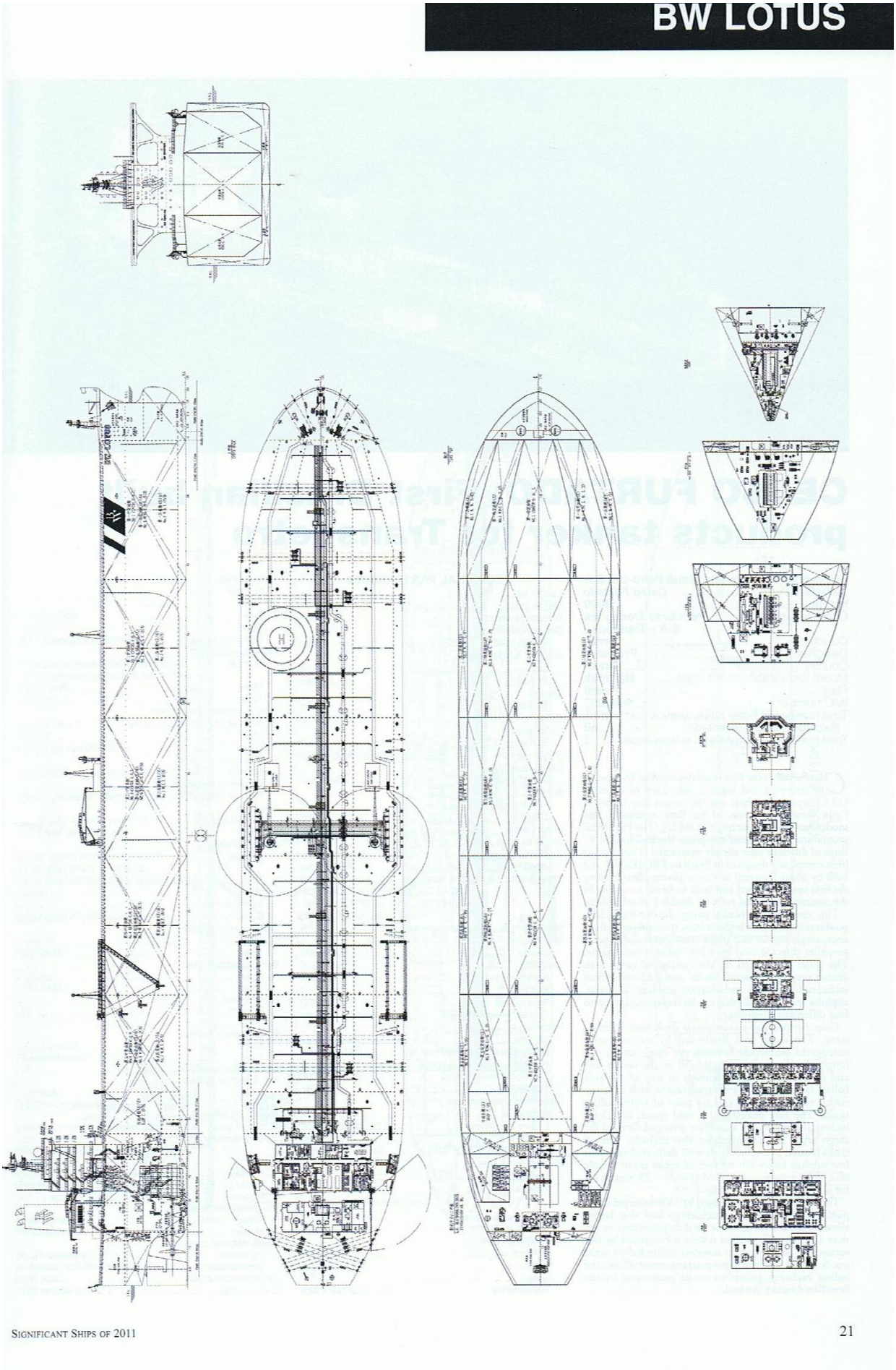
BW Lotus has a cargo capacity of 355,000m^3 that is carried in its arrangement of 15 cargo tanks. To handle the cargo the vessel is fitted with three Shinko KV500-2 cargo pumps that have a 5500m^3/h capacity each. Emerson Saab remote gauges transmit levels in the cargo control station, and independent Emerson high level alarms and sound when levels are reached. Temperatures and inert gas pressures are monitored by three sensors in each of the cargo and slop tanks, located in the upper, mid-level and bottom.

A Wärtsilä 7RTA84D powers the vessel, with a power output of 26,460kW at 74.4rpm, giving the vessel a speed of 16knots. In addition the vessel is fitted with a Tei Greens exhaust gas economiser and a 1200kW steam turbine generator, which is intended to be the single power generating unit while at sea. The advantage of this system means that the vessel can lower its diesel generator usage, which in turn reduces maintenance, fuel consumption and emissions. The electrical power is supplied by the turbo alternator and two Wärtsilä-driven generator sets, which are backed up by a cummins/Donghyun emergency generator.

The vessels are DNV classed with the following class notations: +1A1 Tanker for Oil ESP SPM EO VCS-2 TMON CLEAN LCS-DC. The vessel will operate on worldwide trade and will mainly carry crude oil.

TECHNICAL PARTICULARS

Length oa: 332m
Length bp: 320m
Breadth moulded: 60m
Depth moulded
  To main deck: 30.50m
Draught
  Scantling: 22.50m
  Design: 21m
Gross: 166,414gt
Displacement: 337,468tonnes
Lightweight: 46,149tonnes
Deadweight
  Design: 291,318dwt
  Scantling: 320,141dwt
Speed, service: ..... 16.1knots @ 90%MCR
Cargo capacity
  Liquid volume: ..... 355,000m^3
Bunkers
  Heavy oil: ..... 8567m^3
  Diesel oil: ..... 353m^3
Water ballast: ..... 107,000m^3
Tankers – percentage segregated ballast: 100%
Daily fuel consumption
  Main engine only: 105tonnes/day
  Auxiliaries: 5tonnes/day
Classification society and notations: ..... ✠1A1 CSR Tanker for oil, ESP, E0, LCS-DC, VCS-2, CLEAN, BIS, TMON
% high-tensile steel used in construction: 35%
Roll-stabilisation equipment: ..... Bilge keel
Main engines
  Model: ..... Sulter 7RTA84T-D
  Manufacturer: ..... Dalian Marine Diesel Co Ltd
  Number: 1
  Type of fuel: ..... HFO
  Output of each engine: ..... 29,400kW x 76rpm
Propellers
  Material: ..... Ni-Al-Bronze
  Number: 1
  Fixed/controllable pitch: ..... Fixed
  Diameter: 10m
Diesel-driven alternators
  Number: 2
  Engine make/type: ..... Wärtsilä W1050 6L20DS
  Type of fuel used: ..... HFO
Exhaust-gas scrubbing equipment
  Manufacturer: ..... Tei Greens UK
  Type: OVM1822
  On main engines: ..... Yes
Boilers
  Number: 2
  Type: ..... Mission TMD
  Make: ..... Aalborg
Cargo cranes/ cargo gear
  Number: 2
  Make: ..... MacGregor
  Type: 20tonnes/ 20m
Other cranes
  Number: 2
  Make: ..... MacGregor
  Type: 10tonnes/18m, 5tonnes/22m
Mooring equipment
  Make: ..... Aker Kvaerner
  Type: ..... Hydraulic
Special life saving equipment
  Number of each and capacity: 42
  Make: ..... Hai Hong Boat Making Co Ltd
Cargo tanks
  Number: ..... 15 + 2 slop tanks
  Grades of cargo carried: ..... Crude oil
  Product range: ..... Crude
Cargo pumps
  Number: 3
  Type: KV500-2
  Make: ..... Shinko – Japan
  Capacity: ..... 5500m^3/h
Cargo control system
  Make: ..... Nakakita
  Type: U-3P-7000
Ballast control system
  Make: ..... Nakakita
  Type: U-3P-7000
Complement
  Officers: 9
  Crew: 15
Bridge control system
  Make: ..... Chinese made
  One-man operation: ..... Yes
Fire detection system
  Make: ..... Apollo
Fire extinguishing systems
  Cargo hold: ..... Inert gas & foam/ NK Korea SCH-8EA-12
  Engine room: ..... Foam/ NK Korea SCH-8EA-12
Radars
  Number: 2
  Make: ..... Tokyo Keiki Inc
Waste disposal plant
  Incinerator: ..... CSSC Nan Jing Lu Zhou Machine Co Ltd/ GS1200C
  Sewage plant: ..... Sasakura/ SD-4A
Launch/ float-out date: ..... 4 January 2010
Delivery date: ..... 5 January 2011


BW LOTUS
SIGNIFICANT SHIPS OF 2011
21

BRITISH PROGRESS: 304,400dwt crude oil tanker

Shipbuilder:..Samsung Heavy Industries Co, ...Korea
Vessel's name: .....*British Progress*
Hull number: 1242
Owner/operator: .....BP Shipping Ltd, UK
Designer: ....Samsung Heavy Industries Co, ...Korea
Flag: .....Isle of Man
Total number of sister ships already completed:.....-
Total number of sister ships still on order:.....-

THIS series of Samsung VLCCs is of flush-decked design with two longitudinal bulkheads and associated transverse divisions forming a cargo space made up of five centre, and five pairs of side tanks (plus two slop tanks at the aft end). These are enclosed within a double-hull structure which contains five tanks P&S, utilised as segregated water ballast capacity in compliance with MARPOL 13F and OPA 90 regulations.

The width of the side and bottom spaces formed by this arrangement is such as to allow easy access for maintenance in accordance with the owner's operating policies. These include coating the interior of all ballast tanks with two coats of light-colour, tar-free epoxy for early identification of corrosion problems.

Features of the design are the extension of the double-hull concept into the engineroom in the form of a cofferdam protecting the heavy oil tanks P&S, and compliance with Lloyd's Register ShipRight Structural Design Assessment (SDA), and Fatigue Design Assessment (FDA) levels 2 and 3. The purpose of these procedures is to ensure high design integrity and a long lifespan, set for critical areas at 40 years. As a follow-up to these design investigations, hull stress monitoring in accordance with Lloyd's LR-SEA notation has been installed, together with a voyage data recorder registering voyage parameters.

Three grades of cargo can be handled simultaneously using three Shinko vertical, centrifugal steam turbine-driven pumps, each with a capacity of 5600m³/h, and fitted in a pumproom at the forward end of the engineroom. The 15 cargo tanks have been coated internally on the bottoms only, and are equipped with a Samgong-Danfoss electric/hydraulic valve control system which also serves the ballast tanks.

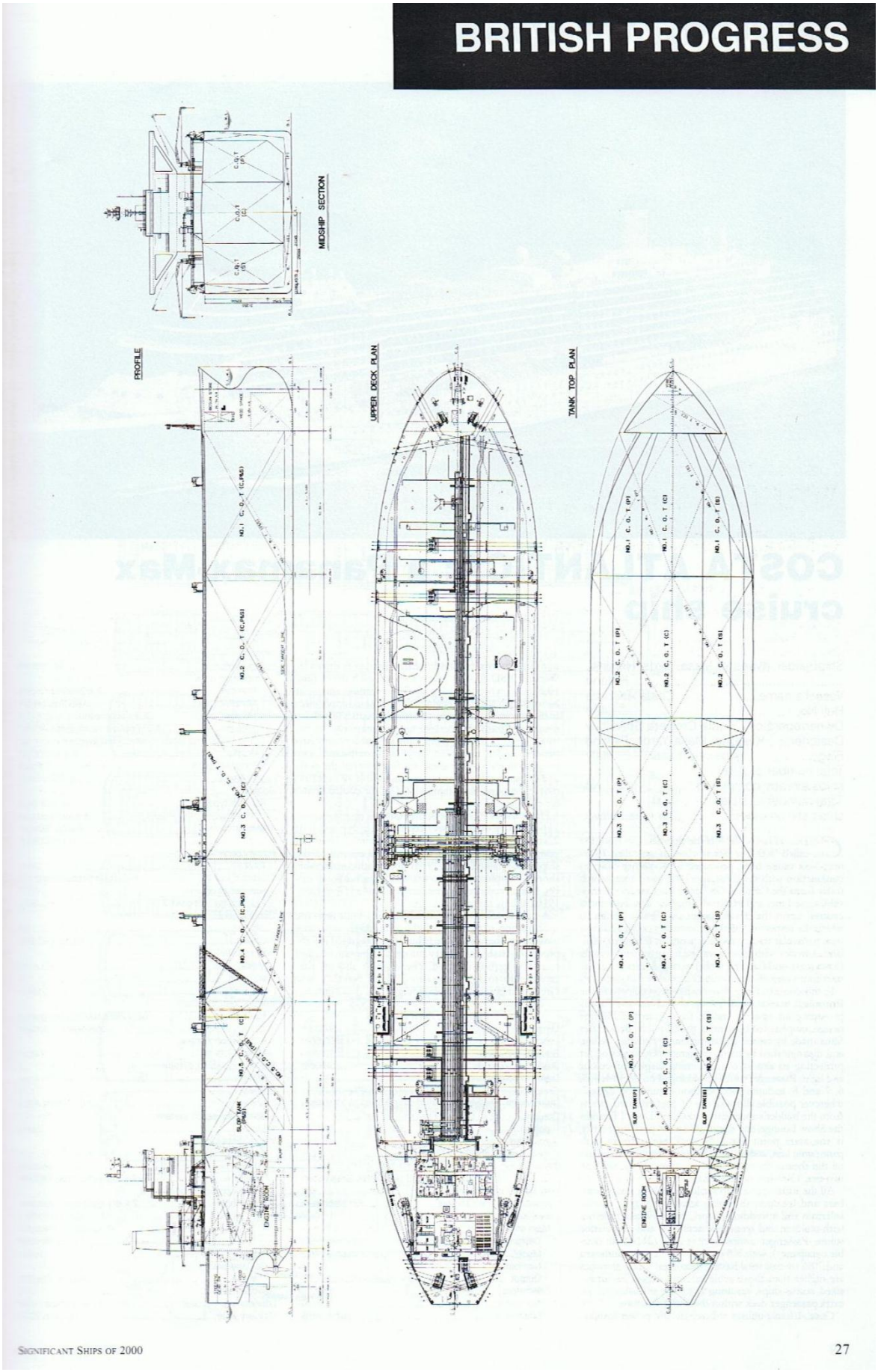
Cargo tank monitoring uses a Saab TankRadar installation and an independent overfill alarm is also fitted. Gas sampling of the ballast spaces is carried out using a Consilium system, and crude-oil tank washing and inert-gas arrangements are included. To allow for future lightering operations, a vapour recovery line to the manifold has been installed.

The main engine is a Samsung-built MAN B&W 7S80MC unit with an MCR rating of 34,650bhp at 79rev/min, directly coupled to a FP propeller. When operating at 86.5% of this rating, and allowing a sea margin of 20%, service speed is 15knots and fuel consumption 86.1tonnes/day. Three Ssangyong/Hyundai 1300kW diesel-alternators sets supply electrical power, and steam is generated by a 90tonnes/h water tube boiler and a 2.8tonnes/h economiser. Operations within the engineroom are controlled by a Lyngsø-Marine remote system, with the same company providing the alarms and monitors.

The accommodation block is set right aft, separated from the engineroom and funnel casing and equipped to serve 17 officers and 19 crew occupying single rooms, except for three double-berth cabins. A closed-circuit television system views the areas around the cargo manifold and mooring equipment, and a computer-based shipboard management system with LAN (local area network) is fitted.

PRINCIPAL PARTICULARS

Length, oa.....334.00m
Length, bp.....320.00m
Breadth, moulded.....58.00m
Depth, moulded to main deck.....31.25m
Gross.....159,000gt
Deadweight
  design.....301,440dwt
  scantling.....304,400dwt
Draught
  design.....22.30m
  scantling.....22.50m
Speed, service at 86.50%MCR, 20% sea margin.....15.00knots
Cargo capacity
  liquid volume.....341,100m³
Bunkers
  heavy oil.....7650m³
  diesel oil.....450m³
Water ballast.....108,000m³
Fuel consumption
  main engine only.....86.10tonnes/day
Classification.....Lloyd's Register of Shipping +1A1, ...Double Hull Tanker, ShipRight(SDA, FDA), ...+LMC, NAV 1, UMS, CCS, COW, IGS, SBT, IWS, IBS
Percentage of high-tensile steel used in construction.....35%
Main engine
  Design.....MAN B&W
  Model.....7S80MC
  Manufacturer.....Samsung
  Number.....1
  Output.....34,650bhp/79rev/min
Propeller
  Material.....Nickel-aluminium-bronze
  Manufacturer.....Hyundai
  Number.....1
  Diameter.....9800mm
Pitch.....Fixed
  Speed.....79rev/min
Diesel-driven alternators
  Number.....3
  Engine make/type.....Ssangyong/-
  Alternator make/type.....Hyundai/-
  Output.....3 x 1300kW
Boilers
  Number.....2
  Make/type.....1 x Mitsubishi water tube .....1 x TEI economiser
  Output.....1 x 90tonnes/h, 1 x 2.8tonnes/h
Mooring equipment
  Number.....2 x windlass; .....8 x mooring winch
  Make.....Pusnes
  Type.....High-pressure hydraulic
Cargo tanks
  Number.....15 plus 2 slop
  Grades.....3
  Product range.....Crude oil
  Coated tanks.....Bottom only
  Type of coating.....-
Cargo pumps
  Number.....3
  Type.....Vertical centrifugal
  Manufacturer.....Shinko
  Capacity.....3 x 5600m³/h
Cargo/ballast control system
  Manufacturer.....Samgong-Danfoss
  Type.....Electric/hydraulic
Pumproom
  Number.....1
  Position.....Forward of engineroom
Complement
  Officers.....17
  Crew.....14
  Rooms.....25 x single; 3 x double
Fire detection system
  Manufacturer.....Consilium
  Type.....Addressable
Fire extinguishing system
  Cargo deck.....Foam
  Engineroom.....High-pressure CO_2
  Manufacturer.....NK Protection
Radars.....-
Satellite navigation system
  Manufacturer.....Litton Marine/Furuno
Computers on ship
  Type.....LAN system
  Number.....7
Waste disposal system
  Incinerator
    Manufacturer.....TeamTec
    Model.....OGS 400C
  Sewage treatment plant
    Manufacturer.....Sasakura
    Model.....ST-4A
Contract date.....-
Launch/float-out date.....January 2000
Delivery date.....June 2000


BRITISH PROGRESS
MIDSHIP SECTION
PROFILE
UPPER DECK PLAN
TANK TOP PLAN
SIGNIFICANT SHIPS OF 2000
27

Ship represented in photo is *Brightoil Galaxy*, sister ship of *Brightoil Glory*

BRIGHTOIL GLORY: first 318,000dwt tanker for Brightoil

Shipbuilder: **Hyundai Heavy Industries**
Vessel's name: ***Brightoil Glory***
Hull No: **2587**
Owner/operator: **Brightoil**
Country: **Hong Kong**
Designer: **HHI**
Country: **Korea**
Model test establishment used: **HMRI**
Flag: **Hong Kong**
IMO number: **9602631**
Total number of sister ships already completed (excluding ship presented): **2**
Total number of sister ships still on order: **2**

WITH a designed capacity of 318,000dwt, *Brightoil Glory* was constructed by Hyundai Heavy Industries for Brightoil and delivered in July. The Group currently owns five very large crude carriers (VLCCs), with delivery of two more VLCCs in 2012 and the last two of the series expected in 2013.

Upon delivery of all five vessels by the first half of 2013, the Group will boast a sizable marine fleet with a total capacity that exceeds 2,000,000 dwt. The fleet will be able to carry approximately 20,000,000tonnes of oil each year.

Brightoil Glory's fuel oil tanks are constructed with a double hull structure to protect the fuel oil tanks from external damage. The vessel has five pairs of side cargo oil tanks, five centre cargo oil tanks and one pair of slop tanks with double bottom and double side structure, five pairs of water ballast tanks and peak tanks.

A unique feature of *Brightoil Glory* is that it is able to load and discharge three different kinds of cargo oils simultaneously without contamination. This is achieved by a blending facility that has been installed onboard that allows for the mixing of different cargo oils whilst in transport. The cargo pump system has a maximum unloading rate of 15,000m³/h with three main cargo pumps, which are driven by three 3-stage steam turbines.

The vessel is powered by a Hyundai - B&W 6S90ME-C8.2 engine with MCR of 30,423kW at 75.6rpm, enabling it to sail at a service speed of 16.4knots at design draft when running at 90% MCR with a 15% sea margin. As the engine is electronically controlled it is expected that the vessel will burn less fuel and will see a fuel consumption level of around 108.8tonnes per day by adopting this form of propulsion.

Brightoil Glory is equipped with the highly advanced navigation system which supports integrated bridge operation such as route planning, manoeuvring for collision and grounding avoidance and navigation monitoring. It is classed by Lloyd's Register of Shipping, +100A1 Double hull oil Tanker, CSR, ESP, ShipRight (CM, ACS(B)), *IWS, LI, DSPM4, +LMC, IGS, UMS, COW(LR), ShipRight (BWMP(S), SCM).

TECHNICAL PARTICULARS

Length oa: 333m
Length bp: 319m
Breadth moulded: 60m
Depth moulded
- To main deck: 30.4m
- To upper deck: 30.4m
- To other decks: 27.654m

Width of double skin
- Side: 3.4m
- Bottom: 3.00m

Draught
- Scantling: 22.60m
- Design: 21.00m

Gross: 161,269gt
Deadweight
- Design: 291,061dwt
- Scantling: 319,743dwt

Speed, service: 16.4knots
Cargo capacity
- Liquid volume: 353,626m³

Bunkers
- Heavy oil: 8,397m³
- Diesel oil: 599m³

Water ballast: 97,983m³
Daily fuel consumption
- Main engine only: 108.8tonnes/day
- Auxiliaries: 4.67tonnes/day

Main engine
- Design: 2-stroke
- Model: 6S90ME-C8.2
- Manufacturer: Hyundai
- Number: 1
- Type of fuel: HFO, MDO, MGO
- Output of each engine: 30,423kW

Propellers
- Material: Ni-Al-bronze
- Designer/manufacturer: Hyundai
- Number: 1
- Fixed/controllable pitch: Fixed
- Diameter: 10.1m

Diesel-driven alternators
- Number: 3
- Engine make/type: Hyundai 6H21/32
- Type of fuel: HFO, MDO, MGO
- Output, speed of each set: 1,277kW x 900rpm
- Alternator make/type: Hyundai HFC7 566-84K
- Output, speed of each set: 1,200kW x 900rpm

Boilers
- Number: 2
- Type: Mission OL
- Make: Aalborg
- Output, each boiler: 45,000kg/h

Hose handling crane
- Number: 2
- Make: Oriental
- Type: Single jib crane with self-contained hydraulic power unit
- Performance: SWL 20tonnes x 7m

Provision handling crane
- Number: 2
- Make: Oriental
- Type: Single jib crane with self-contained hydraulic power unit
- Performance: SWL 10/3tonnes x 4m

Mooring equipment
- Number: 2 x combined windlass/mooring winch, 8 x mooring winches
- Make: TTS Marine
- Type: Electro-hydraulic, high pressure

Special lifesaving equipment
- Number or each and capacity: 2 x 30persons
- Make: Hyundai Lifeboat
- Type: Conventional

Cargo tanks
- Number: 15 cargo tanks + 2 slop tanks
- Stainless steel: Piping ERW steel

Cargo pumps
- Number: 3
- Type: Vertical centrifugal single stage
- Make: Hyundai
- Capacity: 5,000m³/h x 150mTH

Cargo control system
- Make: Ace Valve
- Type: Hydraulic operated valves/ piano type control console

Ballast control system
- Make: Ace Valves
- Type: Hydraulic operated valves/ piano type control console

Complement
- Officers: 12
- Crew: 18

Bridge control system
- Make: Kongsberg
- Type: Autochief C20

Fire detection system
- Make: Tyco Marine
- Type: T2000

Fire extinguishing system
- Engine room: NK/ High expansion foam
- Cabins/public spaces: Seawater, portable extinguishers

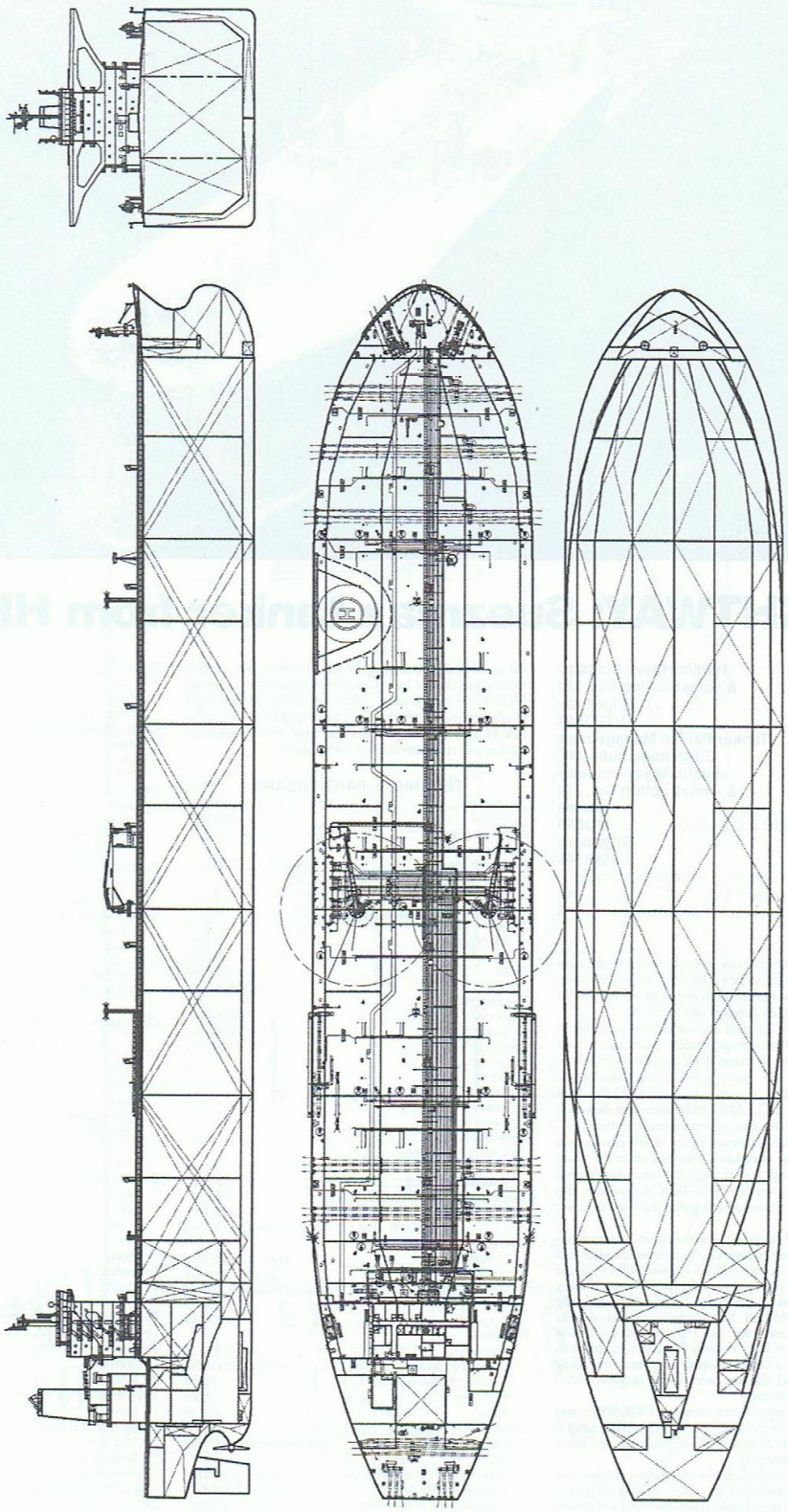
Radars
- Number: 2
- Make: JRC
- Models: JMA-9132-SA, JMA-9122-6XA

Integrated bridge system
- Make: JRC
- Model: JAN-901B

Waste disposal plant
- Incinerator: HMMCO/ MAXI 1500SL WS
- Sewage plant: Il Seung ISS-35N

Contract date: 31 August 2010
Launch/float-out date: 20 July 2012
Delivery date: 26 November 2012

BRIGHTOIL GLORY



SIGNIFICANT SHIPS OF 2012 29

CROWN UNITY Hyundai-built 300,000dwt VLCC

Shipbuilder:	**Hyundai Heavy Industries Co Ltd, Korea,**
Vessel's name:	***Crown Unity***
Owner/operator:	**Maritime Overseas Corp, USA**
Designer:	**Hyundai Heavy Industries Co Ltd, Korea,**
Flag:	**Panama**
Total number of sister ships already completed:	**Nil**
Total number of sister ships still on order:	**1**

HYUNDAI has considerable experience with VLCC construction, both single- and double-hull types, and, in 1993, added its 'double-vee' structure (see *New Wisdom, Significant Ships of 1993*) to the many design variants then being offered in answer to the controversies surrounding tanker construction and safety. That arrangement was developed to suit a particular owner's requirements, and for *Crown Unity,* the yard has reverted to a more conventional design, nevertheless fully compliant with the latest Marpol (3F), and United States NVIC 2-90 regulations for double-hull tankers.

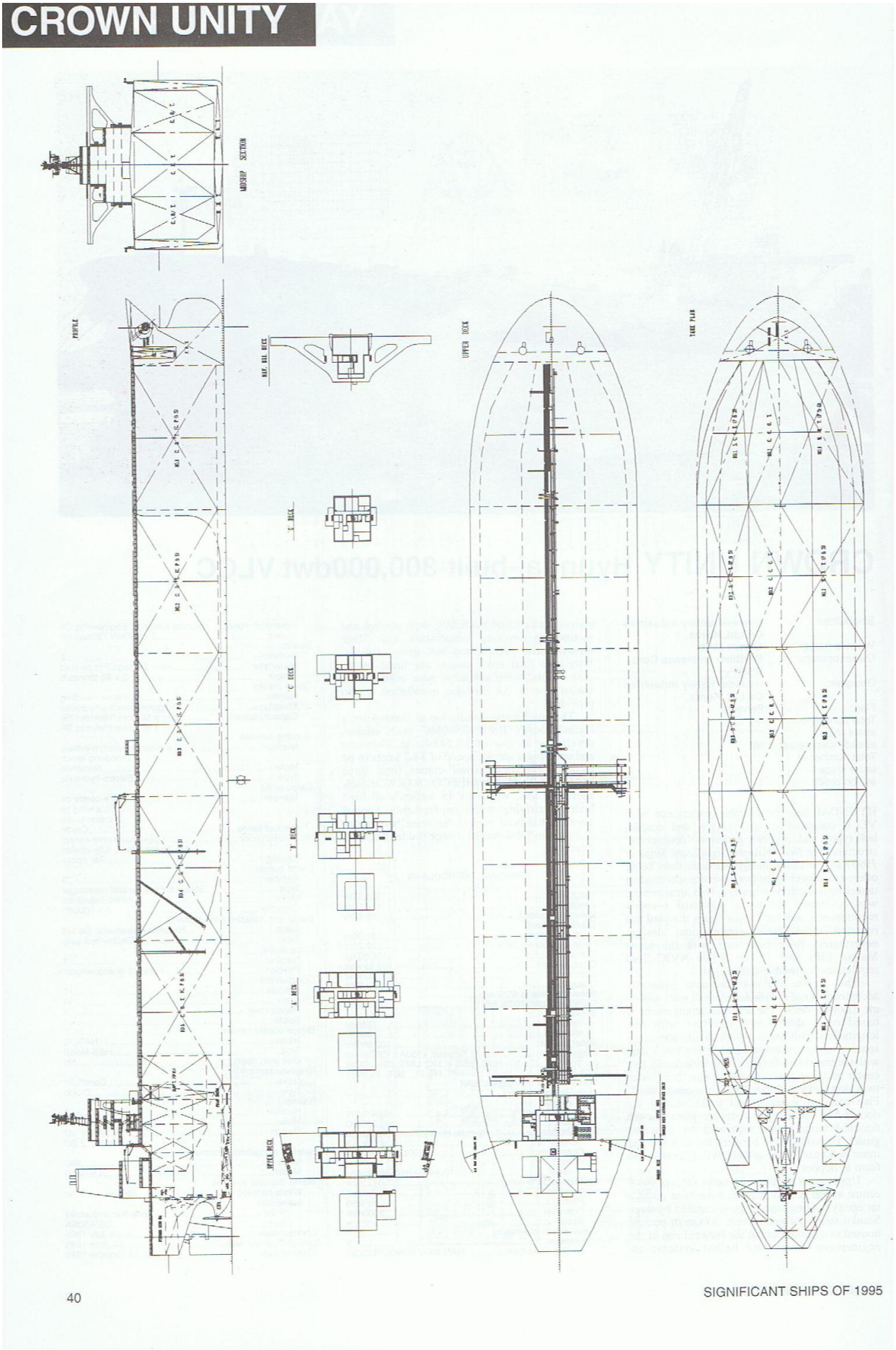
The profile follows the now generally accepted form of a flush decked hull with sunken aft mooring deck. The internal arrangement is based on a double-hull structure with two longitudinal bulkheads which divide the cargo space into port, starboard and centre tanks and, with the transverse bulkheads provide, in all, five centre and five pairs of wing cargo tanks, with twin slop tanks positioned aft of the centre tanks. Five pairs of water ballast tanks occupy the double-hull space, and these are joined to the double-bottom tanks, separated by a centre girder. The connection between the tank top and inner bulkhead of the double skin is cranked to form a 'hopper side'.

Upper parts of all cargo tanks (except No 3 centre which is fully coated) have been given a tar epoxy coating, and cargo is handled by three Shinko steam turbine driven, 5000m³/h pumps, housed in a pumproom at the forward end of the engineroom. Cargo and ballast systems are operated electro-hydraulically, with control and monitoring covering temperature and ullage measurement, pumps, and hull stress analysis. Wire-type float level gauges are fitted to the cargo tanks, with air-purge type used in the ballast system. An inert-gas installation is also provided.

The machinery installation is centred on a Hyundai-MAN B&W 7S80MC main engine, developing an mcr of 33,290bhp at 78rev/min and enabling a service speed of 14.7 knots to be attained. Electrical power comes from three MAN B&W Holeby/HEECO 800kW diesel-alternator sets, with two 45 tonnes/h oil-fired boilers satisfying steam requirements. Special attention has been paid to the vessel's manoeuvrability and as a result, a large rudder has been fitted.

PRINCIPAL PARTICULARS

- Length, oa 330.27m
- Length, bp 314.00m
- Breadth, moulded 58.00m
- Depth, moulded
  - to main deck 31.00m
  - to aft mooring deck 27.70m
- Gross 156,807gt
- Displacement ..... 342,998 tonnes
- Deadweight 300,000dwt
- Draught 22.20m
- Speed, service at 85% mcr ..... 14.7 knots
- Cargo capacity (100% full) 345,096m³
- Bunkers
  - heavy oil 7860m³
  - diesel oil 464m³
- Water ballast 102,999m³
- Classification ..... Lloyd's Register +100A1, Oil Tanker (Double Hull), ESP, +LMC, UMS, IGS, COW PT, HT, PL, SBT, PCWBT
- Percentage of high-tensile steel used in construction ..... –
- Main engine
  - Design ..... MAN B&W
  - Model 7S80MC
  - Manufacturer ..... Hyundai Heavy Industries Co Ltd
  - Number 1
  - Output (mcr) 33,290bhp/78rev/min
- Propeller
  - Material ..... Nickel-aluminium-bronze
  - Manufacturer ..... –
  - Number 1
  - Pitch ..... Fixed
  - Diameter 9500mm
  - Speed ..... –
- Diesel-driven alternators
  - Number 3
  - Engine make/type ..... MAN B&W Holeby/7L23/30
  - Alternator make ..... Hyundai Electrical Engineering Co
  - Output ..... 3 x 800kW/720rev/min
- Boilers
  - Number 2
  - Make/type ..... ABB Sunrod/CPH oil-fired
  - Output ..... 2 x 45 tonnes/h
- Cargo cranes
  - Number ..... 2 x hose handling
  - Make/type ..... Hägglund/electro-hydraulic
  - Capacity/speed ..... 1 x 5tonnes/15m/min (S)
1 x 8tonnes/15m/min (P)
- Mooring winches
  - Number ..... 2 x mooring winch/windlass
8 x mooring winch
  - Make ..... Norwinch
  - Type ..... Electro-hydraulic
- Cargo tanks
  - Number ..... 5 x centre oil
10 x wing oil
2 x slop tanks
  - Product range ..... Crude
  - Coated tanks ..... Upper parts only except No 3 centre tank, fully coated
  - Coating ..... Tar epoxy
- Cargo pumps
  - Number 3
  - Type ..... Steam turbine vertical centrifugal
  - Make ..... Shinko Industries
  - Capacity ..... 3 x 5000m³
- Cargo and ballast control systems
  - Make ..... Nakakita Seisakusho Co Ltd
  - Type ..... Electro-hydraulic
- Pumprooms
  - Number 1
  - Position ..... Forward of engineroom
- Complement
  - Officers 17
  - Crew 11
  - Repair crew 6
  - Spare 3
- Bridge control system
  - Name ..... NABCO
  - Type HBS-M88B
  - One man operation ..... No
- Fire detection system
  - Make ..... Consilium
  - Type C-300
- Radars
  - Number 2
  - Make ..... Raytheon
  - Models ..... 1 x 3425/9 XU
1 x 3410/12 SU
- Satellite navigation systems
  - Make ..... JRC
  - Model JLE-3850
- Waste disposal systems
  - Waste handled ..... Sludge, oil, solid
  - Incinerator
    - Make ..... Kong-Rim Industries
    - Type OSV-50SA
- Contract date ..... 23 July 1993
- Launch/float out date ..... 24 June 1995
- Delivery date ..... 16 October 1995


CROWN UNITY
MIDSHIP SECTION
PROFILE
MAIN HULL DECK
UPPER DECK
TANK PLAN
40
SIGNIFICANT SHIPS OF 1995

FRONT CENTURY: energy-saving VLCC design

Shipbuilder: .....**Hyundai Heavy Industries Co Ltd, Korea**
Vessel's name:.....***Front Century***
Hull number:.....**1106**
Owner/operator:....**Frontline Ltd, Bermuda**
Designer: .....**Hyundai Heavy Industries Co Ltd, Korea**
Flag:.....**Panama**
Total number of sister ships already completed: .....**Nil**
Total number of sister ships still on order:.....**4**

FRONT CENTURY is the first of five C-class VLCCs ordered by Frontline from Hyundai, and constructed to a design which incorporates energy-saving and marine environmental protection features within a new hullform, which has a bluff forebody and wide (58m) beam. Much emphasis has been placed on the structural design in order to reduce hull deflections - which place high stress on secondary members, and a range of detailed structural analyses has been performed. These include fore end tank structure and secondary members' fine mesh analyses; examination of vibration throughout the entire ship range; also bow impact and fatigue strength.

Three of the vessels are being built to Det Norske Veritas rules, where they satisfy the requirements of the CSA-1 structural strength and fatique strength notation, and two to Lloyd's Register, with the inclusion of the ShipRight PC-based advanced procedures for design, construction and life-time ship care.

The single-decked hull has no forecastle, and within a double skin it is divided into 15 cargo tanks, plus two for slops which are coated with coal tar epoxy. The side spaces are combined with centrally divided double-bottom tanks to form water ballast compartments which, with the pumproom, are continuously monitored for hydrocarbon gases. The cargo pumping system uses three Shinko steam turbine pumps which together provide a maximum unloading rate of 15,000m³/h, whilst a loading rate of 20,500m³/h is possible through the cargo manifolds.

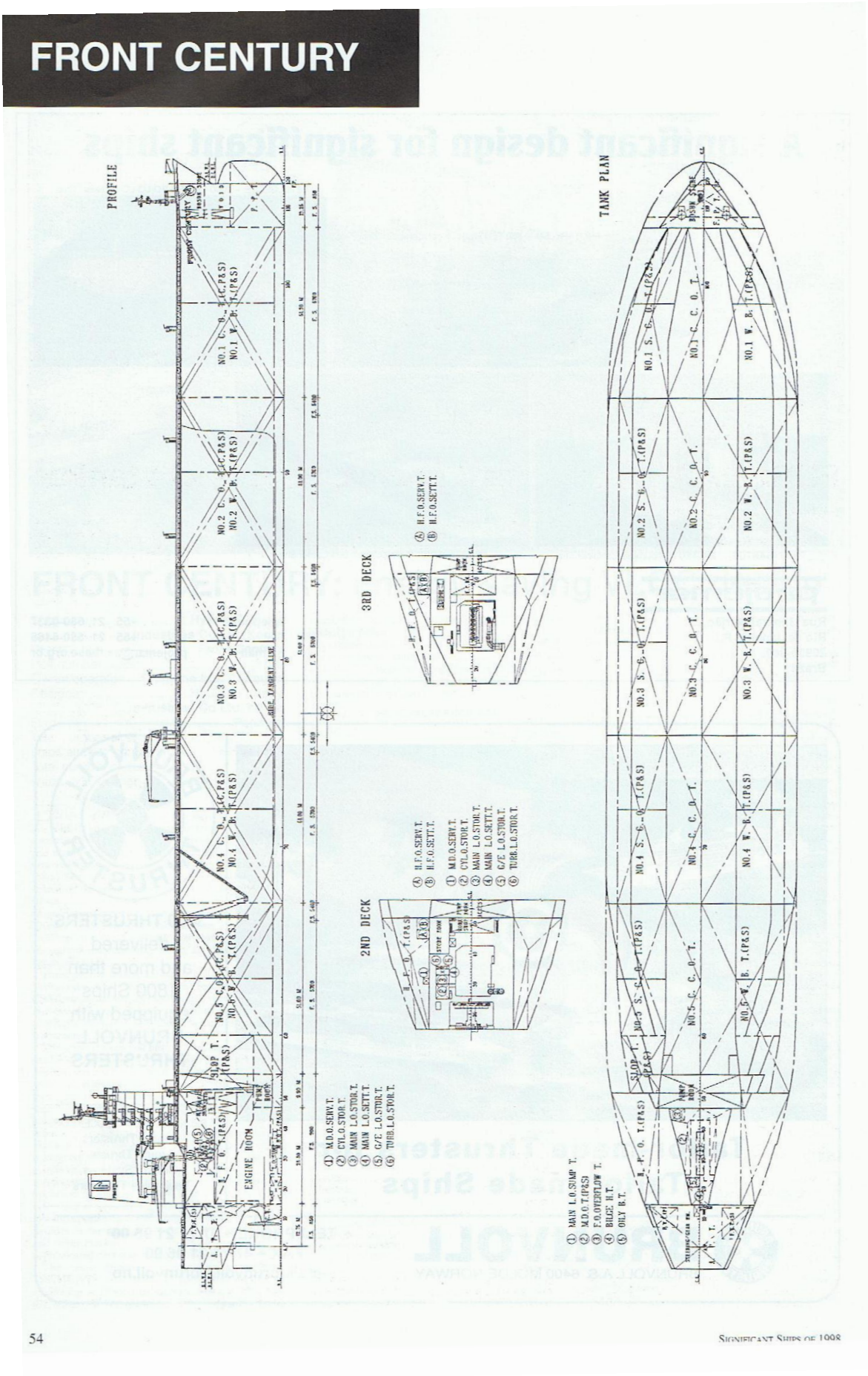
A Super Cargo cargo control system allows one-man operation of loading and discharging duties, including safety and monitoring functions. Another support system incorporated is Super Plant, designed to detect difficulties in the main engine, alternator prime movers and other machinery, using artificial intelligence and sophisticated data acquisition techniques.

The main engine is a Hyundai-MAN B&W 7S80MC(VI) unit with a maximum output of 34,650bhp at 79rev/min. Service rating is 92% MCR (31,920bhp at 76.9rev/min), which enables a service speed of 15.7knots to be attained using a 9700mm four-bladed propeller.

A complement of 33 is housed in the six-tier deckhouse aft, above which is a wheelhouse equipped with an advanced integrated navigation system carrying out route planning, collision manoeuvring, grounding avoidance and navigation monitoring.

PRINCIPAL PARTICULARS

Length, oa ..... approx 335.00m
Length, bp 320.00m
Breadth, moulded 58.00m
Depth, moulded
  to main deck 31.00m
  to sunken deck aft 28.40m
Width of double skin
  side 3.52m
  bottom 3.00m
Gross 157,976gt
Deadweight
  design 281,600dwt
  scantling 311,100dwt
Draught
  design 20.95m
  scantling 22.70m
Speed, service 92% MCR 15.74knots
Cargo capacity
  liquid volume 350,060m³
Bunkers
  heavy oil 7990m³
  diesel oil 390m³
Water ballast ..... -
Fuel consumption
  main engine only 52.71tonnes/day
Classification ..... Lloyd's Register of Shipping +100A1, Double Hull Oil Tanker, ESP, ShipRight (SDA, FDA, CM, PC, WBT), +LMC, UMS, IGS, IWS, SPM, NAV 1, SCM, L1
Percentage of high-tensile steel used in construction ..... approx 35%
Main engine
  Design ..... MAN B&W 7S80MC(VI)
  Manufacturer ..... Hyundai Heavy Industries
  Number 1
  Output, MCR 34,650bhp/79rev/min
Propeller
  Material ..... Nickel-aluminium-bronze
  Manufacturer ..... Hyundai Heavy Industries
  Number 1
  Pitch ..... Fixed
  Diameter 9700mm
  Speed 79rev/min
Diesel-driven alternators
  Number 3
  Engine make/type ..... Wärtsilä/-
  Alternator make/type Hyundai/HFC5-632-14E
  Output ..... 3 x 980kW/720rev/min
Boilers
  Number 2
  Type ..... Automatic oil burning
  Make ..... Mitsubishi MAC-508
  Output ..... 2 x 50,000kg/h
Cranes
  Number ..... 2 x hose handling
  Make ..... Dong-Nam Enterprises
  Capacity/speed ..... 2 x 20tonnes/10m/min
Mooring equipment
  Number ..... 2 x mooring winch/windlass
  ..... 8 x mooring winch
  Make ..... Hyundai-Pusnes
  Type ..... Hydraulic
Cargo tanks
  Number ..... 15 + 2 slop tanks
  Grades 3
Cargo pumps
  Number 3
  Type ..... Steam turbine vertical centrifugal
  Make ..... Shinko
  Capacity ..... 3 x 5000m³/h
Cargo/ballast control system
  Make ..... Samgong-Danfoss
  Type ..... Hydraulic
Pumproom
  Number 1
  Position ..... Aft of cargo tanks
Complement
  Officers 11
  Crew 21
  Single/double rooms 29/3
Bridge control system
  Make ..... Norcontrol
  Type AC-4
  One man operation ..... No
Fire detection system
  Make ..... Consilium
  Type C-300
Fire extinguishing systems
  Cargo tank deck ..... Low-expansion foam
  Make ..... NK Fire Protection
  Engineroom and pumproom ..... High-pressure CO_2
  Make ..... NK Fire Protection
Radars
  Number 2
  Make ..... Consilium
  Models MM950
Satellite navigation systems
  Make ..... Furuno
  Model ..... GP-80 GPS
Computers on ship
  Number 1
  Make ..... Kockumation
  Task ..... Loading calculation
Waste disposal plant
  Incinerator
  Make ..... Kang-Rim Industries
  Model OSV-50SA
Contract date ..... 26 February 1997
Launch/floatout date ..... 22 May 1998
Delivery date ..... 23 July 1998


FRONT CENTURY
PROFILE
TANK PLAN
3RD DECK
2ND DECK
ENGINE ROOM
54
SIGNIFICANT SHIPS OF 1998

HARAD: Samsung-built VLCC for Saudi owner

Shipbuilder: Samsung Heavy Industries Co Ltd, Korea
Vessel's name: *Harad*
Hull number: 1321
Owner/operator: National Shipping Co of Saudi Arabia (NSCSA), Saudi Arabia
Designer: Samsung Heavy Industries Co Ltd, Korea
Model test establishment used: Samsung Ship Model Basin, Korea
Flag: Bahamas
Total number of sister ships already completed: Nil
Total number of sister ships still on order: 3

HARAD is the first of four VLCCs ordered originally by Greek owner Hellespont, but sold on to NSCSA during construction, and, as such, the design retains much that was specified in the initial contract. These features are particularly concerned with the strength and future structural life of the vessel, and include adopting a beam of 58m in order to reduce hull deflection, and strengthening the primary members by adding double structures and buttresses in order to reduce hull deformation by 10%.

The requirements of ABS Safehull and LR ShipRight have been incorporated, and an FEA of the hull structures in different loading conditions has been carried out, in line with the vessel's designed fatigue life, in excess of 40 years. The hull weight includes 45% high-tensile steel, with 'Z' quality used for the outermost strakes of the double bottom, and 'E' grade in the lowest hopper strake. Structural design has reduced the number of individual components used in construction, thereby benefiting future maintenance.

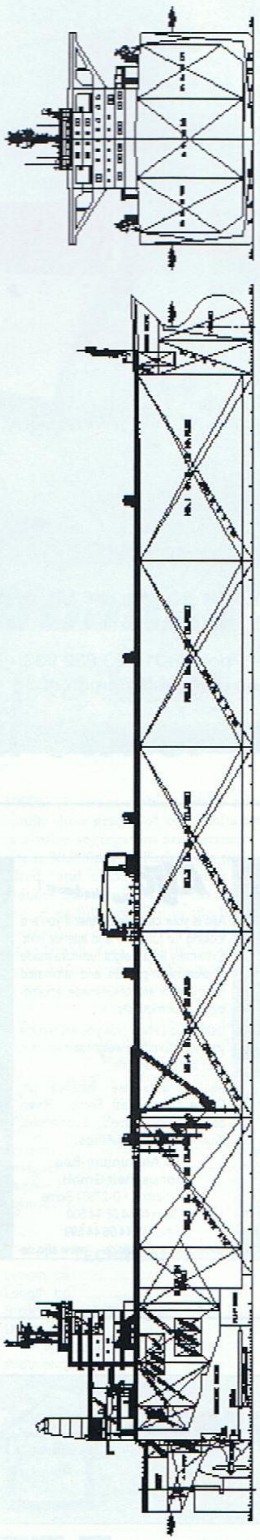
Fifteen cargo tanks are arranged within a double hull designated for segregated water ballast, and there are also two slop tanks. The pumping system allows a maximum discharge rate of 15,000m³/h using three 5000m³/h steam turbine-driven pumps, which can handle three grades of oil simultaneously through a two-valve segregation arrangement. Cargo loading rate is 20,000m³/h. Radar-type tank level gauges are fitted, and a double-scrubber inert gas system reduces SO_2 levels to less than 2ppm. This system also gives full coverage to the ballast tanks, cutting corrosion levels of steelwork and piping considerably. Gas level monitoring is applied to all tanks, ballast spaces and pumprooms, and displayed in the cargo control room.

The main engine has been constructed by Samsung (HSD) to a Sulzer 8RTA84T-D design, developing an MCR of 32,825kW at 76rev/min. The service speed is 16.10knots at an output of 26,780kW, including a 15% sea margin. Electrical requirements are catered for by three Wärtsilä/Hyundai diesel-alternator sets, each producing 1200kW at 720rev/min, and two boilers each supply 45tonnes/h steam to the cargo systems. The vessel is also fitted with an integrated navigation system, which supports the operation of various bridge activities, including route planning and manoeuvring.

TECHNICAL PARTICULARS

Length, oa: 333.30m
Length, bp: 318.00m
Breadth, moulded: 58.00m
Depth, moulded
  to main deck: 31.25m
Width of double skin
  side: 3.38m
  bottom: 3.00m
Draught
  design: 21.40m
  scantling: 22.50m
Displacement: 350,900tonnes
Lightweight: 47,800tonnes
Deadweight
  design: 284,000dwt
  scantling: 303,100dwt
Speed, service, 75% MCR: 16.40knots
Cargo capacity, 100% full
  liquid volume: 350,100m³
Bunkers, 100% full
  heavy oil: 10,970m³
  diesel oil: 570m³
Water ballast: 98,200m³
Percentage segregated ballast: 100%
Fuel consumption (main engine): 124.70tonnes/day
Classification: American Bureau of Shipping + A1(E), 'Oil Carrier', + AMS, + ACCU, SH, UWILD, VEC, ESP
also Lloyd's Register of Shipping, ShipRight (SDA, FDA, CM)
Percentage of high-tensile steel used in construction: 45%
Main engine
  Design: Sulzer
  Model: 8RTA84T-D
  Manufacturer: HSD Engine Co Ltd
  Number: 1
  Output/speed: 32,825kW/76rev/min
Propeller
  Material: Nickel-aluminium-bronze
  Maker: Mecklenburger Metallguss
  Number: 1
  Pitch: Fixed
  Diameter: 10,200mm
  Speed: 76rev/min
Diesel-driven alternators
  Number: 3
  Engine make/type: Wärtsilä
  Alternator make/type: Hyundai
  Output/speed: 3 x 1200kW/720rev/min
Boilers
  Number: 2
  Type: MAC-45B (D-type)
  Make: Mitsubishi
  Output: 2 x 5tonnes/h
Hose-handling cranes
  Number: 2
  Make: Samsung/TTS-Norlift
  Type: Hydraulic, single jib
  Duties: 20tonne/10m/min
Mooring equipment
  Number: 2 x mooring winch/windlass
  8 x mooring winch
  Make: Samsung/Rolls-Royce
  Type: Hydraulic
Cargo tanks
  Number: 15 plus 2 slop tanks
  Grades of cargo carried: 3
  Product range: Crude oil
  Coated tanks: -
Cargo pumps
  Number: 3
  Type: Steam turbine driven, vertical centrifugal
  Make: Shinko
  Material: Bronze casing
  Capacity: 3 x 5000m³/h
Cargo/ballast control systems
  Make: Nakakita
  Type: Hydraulic with mimic board
Complement
  Officers: 17
  Crew: 25
Bridge control system
  Make: JRC
  One man operation: Yes
Fire detection system
  Make: Consilium
Fire extinguishing system
  Cargo deck: Low-expansion foam
  Make: NK Fire Protection
  Engineroom: High-expansion foam
  Make: NK Fire Protection
Radars
  Number: 2
  Make: JRC
Satellite navigation systems
  Number: 2
  Make: JRC
  Models: 1 x Inmarsat-B; 1 x Inmarsat-C
Waste disposal plant
  Incinerator
    Make: Hyundai Maxi 150SL-1 W/S
  Sewage plant
    Make: Hamworthy ST-6A (46 persons)
Contract date: 21 October 1999
Launch/float-out date: 17 July 2001
Delivery date: 8 October 2001

HARAD



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SIGNIFICANT SHIPS OF 2002

LIMBURG: representing a new Daewoo VLCC class

Shipbuilder: ..Daewoo Heavy Industries Ltd, ...Korea
Vessel's name:.....*Limburg*
Hull number:.....5125
Owner/operator: .Beaumer SA, Luxembourg
Designer:.....Daewoo Heavy Industries Ltd, ...Korea
Flag:.....Luxembourg
Total number of sister ships already completed:.....3
Total number of sister ships still on order:.....Nil

IT is some time since a VLCC featured in *Significant Ship* reports, and *Limburg*, the last in a class of four such vessels built in 1999/2000 for companies in the Euronav Luxembourg group, illustrates the current design features of tankers of this size. As this review year 2000 began, more than 500 VLCC and ULCCs remained in service or were on order, mainly in Japan and Korea. Whilst age alone is directing sizeable numbers of this fleet to the scrapyard, orders are still being placed for replacements, with Daewoo itself contracted to build more vessels to the basic design, which includes *Limburg* and her sisters.

Although double-hull (as opposed to single-hull) tankers still represent less than a quarter of the available world tonnage of this size, it is this type of construction (which, of course, is mandatory today) that the shipyard has adopted as a standard, having an eye for possible future regulations. Within a double hull 3.52m wide at the sides and 3.00m deep at the bottom, two longitudinal, plus an arrangement of transversal bulkheads, divide the cargo space into five centre tanks, five pairs of side tanks, and two slop tanks. The side and bottom spaces in the double-hull are joined, with a centreline division forming five pairs of water ballast tanks.

Cargo is handled by three Shinko steam-turbine-driven centrifugal pumps, fitted in a pumproom located between the engineroom and cargo space, with each having a capacity of 5000m³/h. Three manifolds on deck, served by two sets of MacGregor 20tonne hose-handling cranes, allow for three cargo segregations to be carried. Cargo tanks are coated on the bottom, and for 1m above the tank top, with two layers of high-build epoxy paint. Water ballast is carried in a total of 14 tanks, handled by two electrically driven 3000m³/h pumps and controlled, like the cargo systems, by Amri-Seil electro-hydraulic equipment.

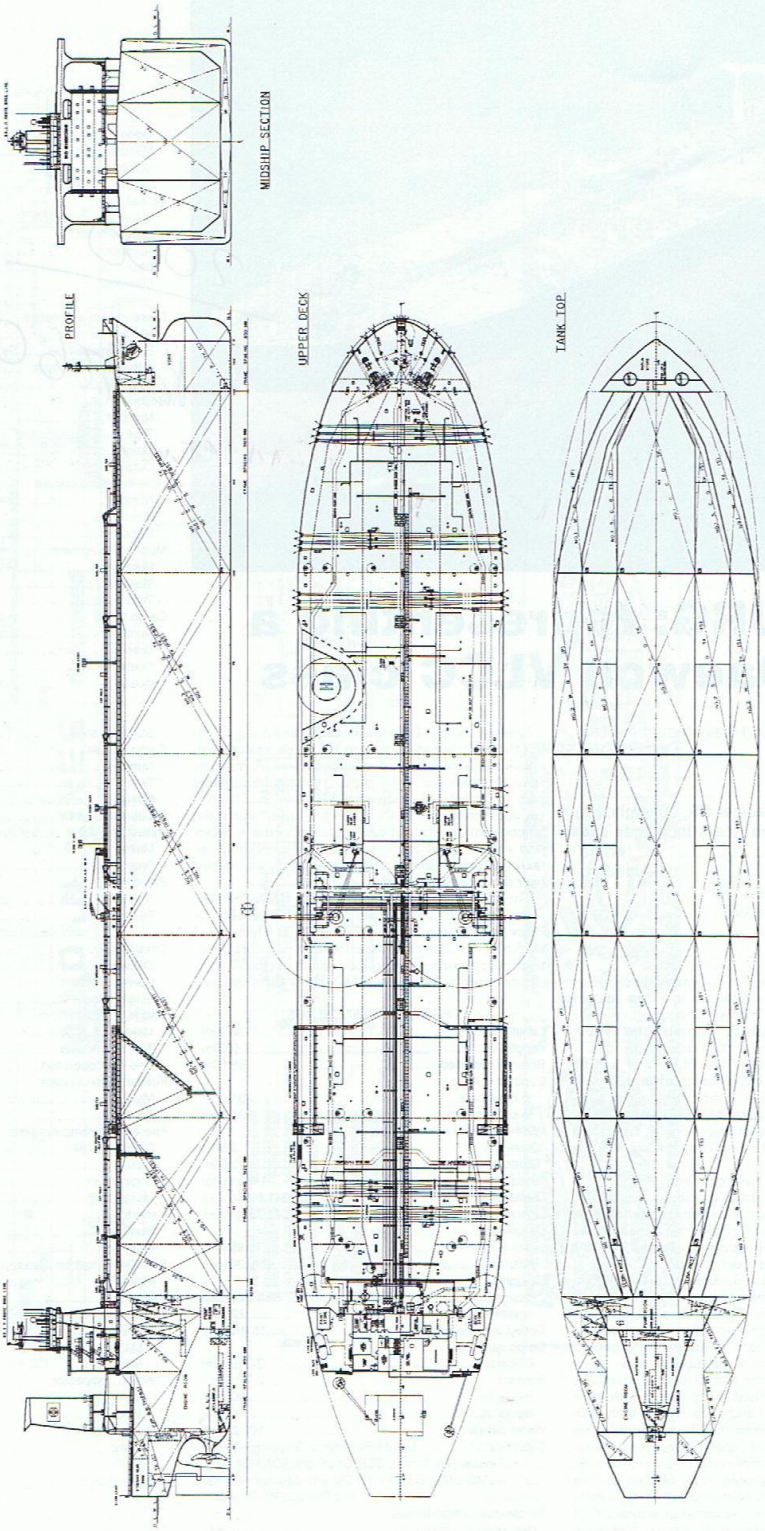
Limburg has been built to a single-decked design without forecastle but with a sunken after deck, a raked stem above the waterline, and a bulbous bow. A transom stern surmounts an open- water-type sternframe fitted with a semi-balanced rudder and FP propeller. The five-tier accommodation block for 28 persons is built at the aft end, with the wide bridge wings supported by pillars port and starboard. Safety access from the deckhouse to the bow is provided by a fore-and-aft gangway carried over the cargo lines on deck.

The main engine is a Hanjung-MAN B&W 7S80MC (Mk6) unit with a maximum output of 34,650bhp at 79rev/min. Service rating is 85%MCR, at which speed is 15.80knots, derived from a 9800mm propeller. Electrical supply comes from three Hyundai 1150kW alternators driven by Ssangyong-MAN B&W diesel engines.

PRINCIPAL PARTICULARS

Length, oa.....332.00m
Length, bp.....320.00m
Breadth, moulded.....58.00m
Depth, moulded
to main deck.....31.00m
to sunken deck.....26.84m
Width of double skin
side.....3.52m
bottom.....3.00m
Gross.....157,833gt
Displacement.....341,097tonnes
Lightweight.....41,732tonnes
Deadweight
design.....278,951dwt
scantling.....299,364dwt
Draught
design.....20.80m
scantling.....22.00m
Speed, service, 85%MCR output.....15.80knots
Cargo capacity
oil cargo.....347,593m³
Bunkers
heavy oil.....9080m³
diesel oil.....493m³
Water ballast.....100,211m³
Classification.....Lloyd's Register of Shipping +100A1 .....Double-Hull Tanker, ESP, ShipRight(SDA,FDA,CM), ...+LMC UMS,IGS,NAV 1,SCM with descriptive notes .....of ShipRight(SERS,PCW,BT)
Percentage of high-tensile steel used in construction.....36%
Main engine
Design.....MAN B&W
Model.....7S80MC (Mk6)
Manufacturer.....Hanjung
Number.....1
Output.....34,560bhp/79rev/min
Propeller
Material.....Nickel-aluminium-bronze
Manufacturer.....Lips BV
Number.....1
Pitch.....Fixed
Diameter.....9800mm
Speed.....79rev/min
Diesel-driven alternators
Number.....3
Engine make/type.....Ssangyong-MAN B&W/6L28/32H
Alternator make/type.....Hyundai/MGS5-634-14K
Output.....3 x 1150kW/720rev/min
Boilers
Number.....2
Type.....Vertical oil-fired
Make.....Mitsubishi
Output.....40tonnes/h
Hose-handling cranes
Number.....2
Make/type.....MacGregor/HH630-2020
Capacity.....2 x 20tonnes/12m/min
Mooring equipment
Number.....10 x MW300H winches
Make.....Rolls-Royce
Type.....Electro-hydraulic
Cargo tanks
Number.....15 plus 2 slop
Grades.....Crude oil
Coated tanks.....Yes
Coating.....2 x high-build coal-.....tar epoxy, bottom and .....1m up sides
Stainless steel.....No
Cargo pumps
Number.....3
Type.....Steam turbine centrifugal
Make.....Shinko
Capacity.....3 x 5000m³/h
Ballast and cargo control systems
Make.....Amri-Seil
Type.....Electro-hydraulic
Pumproom
Number.....1
Position.....Between engineroom .....and cargo tanks
Complement
Officers.....15
Crew.....13
Single rooms.....28
Bridge control system
Make.....Norcontrol
Type.....AutoChief IV
One man operation.....Yes
Fire detection system
Make.....Consilium
Type.....CS-3004
Fire extinguishing systems
Cargo spaces.....Low-expansion foam
Make.....NK (Korea)
Engineroom.....High-expansion foam
Make.....Kashiwa (Japan)
Radars
Number.....1 x X-band; 1 x S-band
Make.....Raytheon Anschütz GmbH
Satellite navigation system
Make.....Raytheon Anschütz
Model.....Mk10 GPS Navigator
Waste disposal plant
Incinerator
Make.....Hyundai
Model.....Maxi 100SL-1 W/S
Waste compactor
Make.....Uson
Model.....Uson UBP-30S
Waste shredder/crusher
Make.....Uson
Model.....Disperator 310
Sewage plant
Make.....Junghap
Model.....Bio-Aerob Type-18
Contract date.....November 1997
Launch/float-out date.....August 1999
Delivery date.....January 2000

LIMBURG



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SIGNIFICANT SHIPS OF 2000

SAMCO AMAZON: Energy saving VLCC

Shipbuilder: ..... **Hyundai Samho Heavy Industries Co.Ltd**
Vessels name: ..... ***Samco Amazon***
Hull No: **S501**
Owner/operator: ..... **Samco Eta Ltd/ Samco Shipholding Pte Ltd**
Country: ..... **Singapore**
Designer: ..... **Hyundai Samho Heavy Industries Co., Ltd**
Country: ..... **Korea**
Model test establishment used: ..... **Hyundai Maritime Research Institute**
Flag: ..... **Marshall Islands**
IMO number: **9528794**
Total number of sister ships already completed (excluding ship presented): ..... **nil**
Total number of sister ships still on order: **3**

Samco Amazon is the first in a series of four very large crude carriers (VLCCs) that are to be constructed at Korean shipyard Hyundai Samho Heavy Industries for the Singapore based shipping company, Samco Shipholding Pte Ltd., and was delivered on 25 August.

A hull stress monitoring system, which enables real-time monitoring, is fitted in the vessel that gives it a high degree of operational flexibility by minimising damage due to hull fatigue stress and also optimises a voyage, through the ship management. A Mewis Duct has also been fitted to the vessel, which consists of a duct and a propeller with an integrated fin system, which contributes largely to the fuel saving potential of 5-7% and the reduction of polluting emissions as well as the improvement in speed of the vessel.

Samco Amazon has been fitted with the latest in energy saving devices such as a Waste Heat Recovery System(WHRS) and a Hyundai-Wärtsilä 7RT-Flex82T main engine and Delta Tuning. The environmentally-friendly technology encapsulated in the WHRS allows the vessel to increase the fuel efficiency through the reuse of high temperature exhaust gas generated from a variety of equipment during the vessels operation.

The Delta Tuning is an option of the RT-flex engine supplied by Wärtsilä, which enables a main engine to reduce SFOC (Specific Fuel Oil Consumption) through variations of fuel injection timing and exhaust valve timing under the condition of NCR load and thus provides significant fuel savings as compared to a conventional engine.

The vessel has, amongst its many green credentials, a ballast water treatment system installed onboard by Samgong Co. Ltd that has a capacity of 6350m³. The vessel is also compliant with the Performance Standard for Protective Coatings (PSPC) and the IACS common structural rules (CSR), enhancing the structural integrity of the vessel as a whole.

TECHNICAL PARTICULARS

Length oa: 333.08m
Length bp: 319.00m
Breadth moulded: 60.00m
Depth moulded
- To main deck: 30.40m
- To upper deck: 30.40m
- To other decks: ..... 28.60m (mooring deck)

Width of double skin
- Side: 3.4m
- Bottom: 3.0m

Draught
- Scantling: 22.60m
- Design: 21.00m

Gross: 160,928gt
Displacement: ..... abt 364,000tonnes
Deadweight
- Design: ..... abt. 289,000dwt
- Assigned: ..... abt. 314,250dwt

Block co-efficient: 0.8201
Speed, service: ..... 16.6knots @90% MCR
Cargo capacity: 352,500m³
Bunkers
- Heavy oil: 7300m³
- Diesel oil: 1500m³

Water ballast: 98,300m³
Tankers- percentage segregated ballast: 96.11%
Daily fuel consumption at assigned dwt
- Main engines only: 107.0tonnes/day

Classification society and notations: ..... ABS, +A1, Oil Carrier, (E), (+)AMS, (+)ACCU, NIBS, VEC-L, TCM, AB-CM, BWE, CSR, ENVIRO, GP, POT, PMA, RRDA,ESP, UWILD, CPS, CRC, HM2+R Hull Girder Stress, RW, SPMA

Main engines .....
- Design: ..... Wärtsilä
- Model: ..... 7RT Flex82t R1+
- Manufacturer: ..... Hyundai
- Number: 1
- Type of fuel: ..... HFO, MDO or MGO
- Output of each engine: ..... 31,640kW x 80.0rpm

Propellers
- Material: ..... Ni-Al-Bronze
- Design/manufacturer: ..... Hyundai
- Number: 4
- Fixed/controllable pitch: ..... Fixed
- Diameter: 10.1m
- Speed: 80rpm

Diesel-driven alternators
- Number: ..... 2 +1
- Engine make/type: ..... Hyundai-Himsen (6H21/32) (5H17/28)
- Type of fuel: ..... HFO, MDO or MGO
- Output/speed of each set: 1200kW/900rpm 575kW/900rpm
- Alternator make/type: Hyundai/HFC7-566-84K Hyundai/HFC7-456-84K
- Output/speed of each set: 1130kW/900rpm 530kW/900rpm

Turbo-generator (for WHRS)
- Number: 1
- Design/manufacturer: ..... Shinko
- Alternator make/type: ..... Hyundai/ HFJ7-566-44E
- Output/speed: 1500/180rpm

Boilers
- Number: 2
- Type: ..... Automatic, forced draft, HFO burning
- Make: ..... Aalborg
- Output, each boiler: 45,000kg/h

Cargo cranes/cargo gear
- Number: 2
- Make: ..... Oriental Precision & Engineering Co., Ltd
- Type: ..... Electro hydro driven
- Performance: 20tonnes

Other cranes
- Number: 2
- Make: ..... Oriental Precision & Engineering Co., Ltd
- Type: ..... Electro Hydro driven
- Tasks: ..... Provisions
- Performance: 10tonnes, 3tonnes

Mooring equipment
- Number: 10
- Make: ..... Aker Pusnes
- Type: ..... Electro-Hydraulic

Special lifesaving equipment
- Number of each and capacity: ..... 2 sets x 40 persons
- Make: ..... Hyundai lifeboats
- Type: ..... Hinged gravity type

Cargo tanks
- Number: 17
- Grades of cargo carried: ..... crude oil
- Coated tanks – make and type of coating: ..... Modified epoxy on ceiling, T/Top

Cargo pumps
- Number: 3
- Type: ..... Vertical, centrifugal single stage
- Make: ..... Shinko Ind., Ltd
- Capacity: ..... 5000m³/hr x 150tonnes/h

Cargo control system
- Make: ..... Nakakita
- Type: ..... Cargo control console of piano type

Ballast control
- Make: ..... Nakakita
- Type: ..... Cargo control console of piano type

Water ballast treatment system
- Make: ..... Samgong Co.Ltd
- Capacity: 6350m³/h

Complement
- Officers: 10
- Crew: 19
- Suez/repair crew: 6

Stern appendages/special rudders: ..... Mewis Duct
Bridge control system
- Make: ..... Hyundai-EES
- Type: ..... Self standing
- One-man operation: ..... Yes

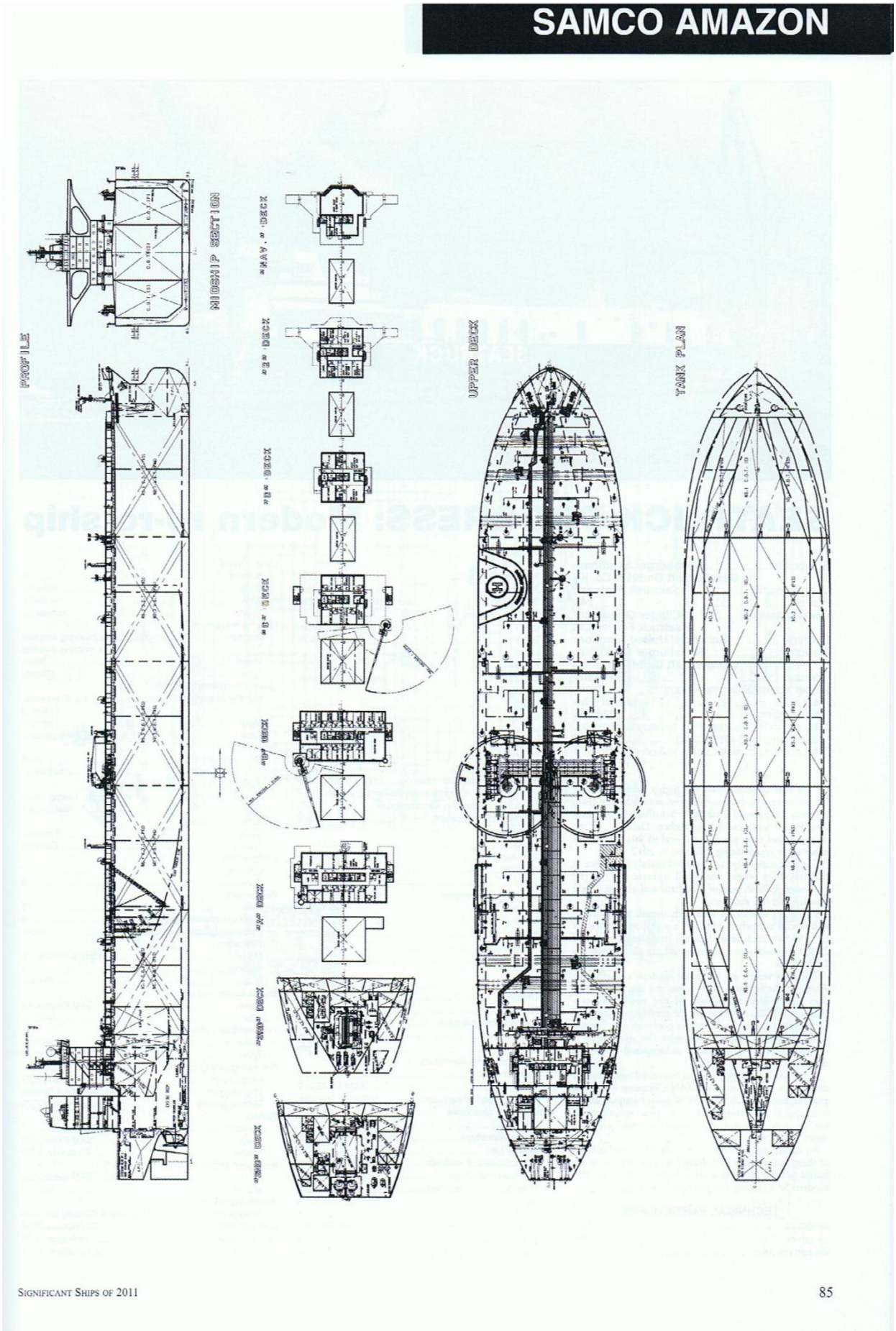
Fire detection system
- Make: ..... Consilium
- Type: ..... Salwico Cargo

Fire extinguishing systems
- Engine room: ..... CO_2 NK/High pressure CO_2
- Public spaces: .. Dry powder NK/ portable extinguisher

Radars
- Number: ..... Two
- Make: ..... JRC
- Model: ..... S-Band: JMA-9132-SA X-Band: JMA-9122-6XA

Waste disposal plant
- Incinerator: ..... Kangrim KFB-110S
- Sewage plant: ..... Hamworthy ST3A-C

Contract date: ..... 14 July 2008
Launch/float-out date: ..... 23 April 2011
Delivery date: ..... 25 August 2011


SAMCO AMAZON
PROFILE
MIDSHIP SECTION
UPPER DECK
TANK PLAN
SIGNIFICANT SHIPS OF 2011
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MUREX: 'Stronger safer' VLCC from Daewoo

Shipbuilder:	**Daewoo Heavy Industries Ltd, Korea**
Vessel's name	***Murex***
Owner/operator:	**Shell International Marine Ltd, UK**
Designer:	**Daewoo Heavy Industries Ltd, Korea**
Flag:	**Liberia**
Total number of sister ships already completed:	**Nil**
Total number of sister ships still on order:	**4**

DAEWOO has developed this series of VLCCs in conjunction with Shell, using a new structural design philosophy aimed at producing 'stronger safer ships', complying with all the latest international safety and environmental regulations. Cargo tanks are located within a double-hull configuration in which side-tank width is 3.52m, and double-bottom depth 3m, compared with minimum Marpol 13F values of 2m. Structurally, cross-ties have been fitted in the centre tanks, and features have been included to improve the fatigue characteristics of VLCCs to the extent that the hull's fatigue life is guaranteed for 25 years.

Mild steel content has been increased to 73.3% (high-tensile steel 26%), and the proportion of T-bar longitudinals from 60% to 92%. Bulb flats are used in place of inverted angle stiffeners to minimise free edges and eliminate blind-spots, thereby improving the quality of protective coatings, to which special attention has been given. Notably, a light coloured tar epoxy paint (of 300 microns instead of a normal 250 microns) has been applied in ballast tanks to allow easier detection of leaks and corrosion, with an 850-micron (standard 600 microns) high-damage-resistant coating on the main deck. Inspection platforms and catwalks with good access arrangements have been fitted to longitudinal bulkheads in cargo and water ballast tanks, and frp ballast piping introduced to prevent corrosion in ballast pipes.

Murex is a flush-decked vessel with lowered mooring deck aft, and has a cargo space divided into five tanks by transverse bulkheads, with two longitudinal bulkheads forming port, starboard and centre separations. The side tanks are combined with double bottoms to provide five water ballast tanks, and there are a pair of slop tanks aft of the cargo tanks.

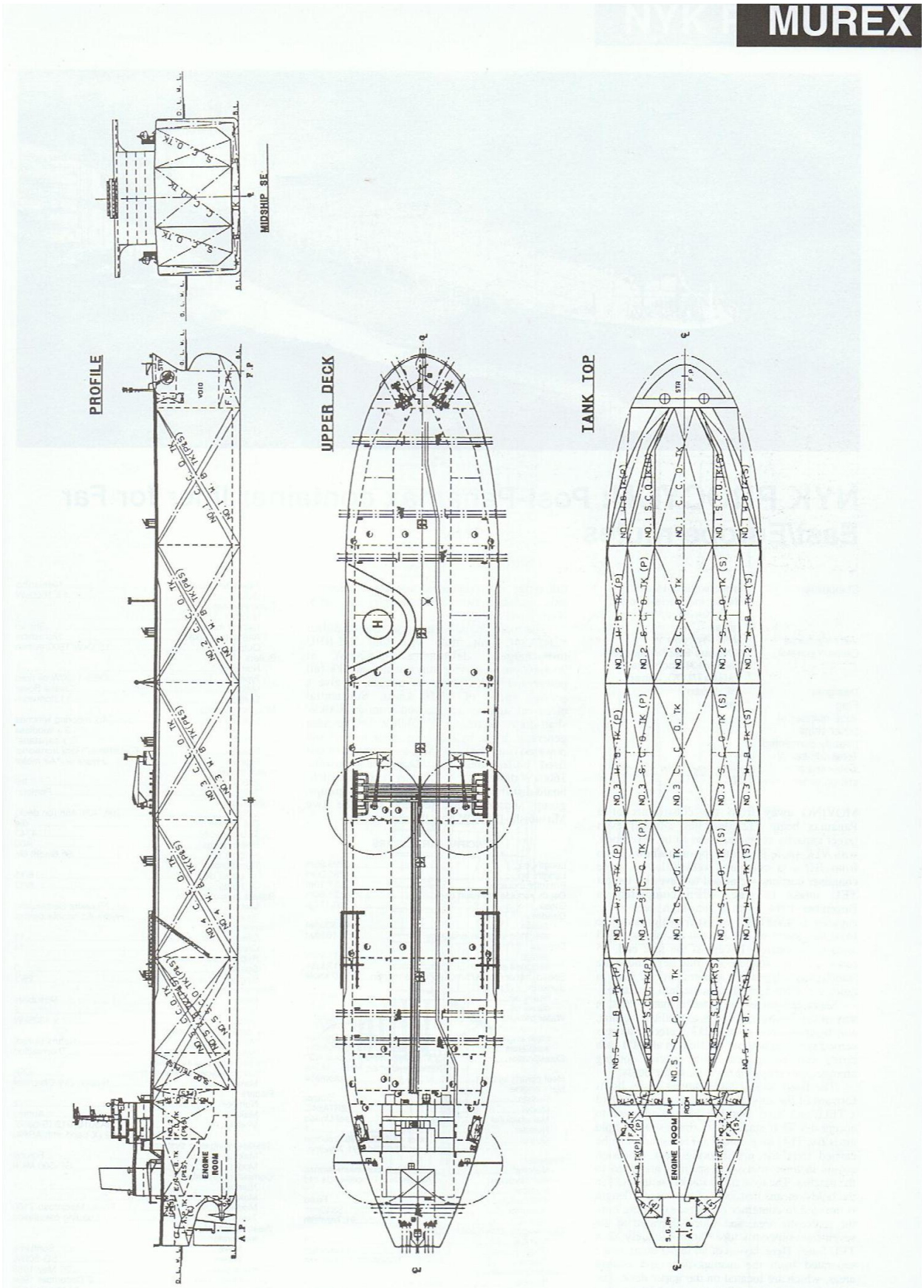
Three cargo segregations can be handled using three Shinko turbine-driven 5000m³/h pumps, with cargo and ballast operations controlled by ABB computerised systems. Bridge control, with a facility for one-man operation, features a Norcontrol Autochief 4 installation, and a Racal-Decca MIRANS (modular integrated radar and navigation system) is fitted, together with an ABB INTEC command, alarm and monitoring system.

Korea Heavy Industries built the Sulzer 7RTA84T main engine, developing 36,000bhp at 73.4rev/min, with a Renk Tacke gearbox providing a power take-off for a 940kW alternator. Three similar-sized diesel-driven sets are also fitted and steam is supplied from two vertical watertube, 45tonnes/h boilers.

PRINCIPAL PARTICULARS

Length, oa	332.00m
Length, bp	320.00m
Breadth, moulded	58.00m
Depth, moulded to main deck	31.00m
Gross	156,800gt
Displacement, at 22.00m draught	341,100 tonnes
Lightweight	42,800 tonnes
Deadweight	
design	277,800dwt
scantling	298,300dwt
Draught	
design	20.80m
scantling	22.00m
Speed, service at 85% mcr output (30,600bhp)	15.5 knots
Cargo capacity	
liquid volume	345,000m³
Bunkers	
heavy oil	7600m³
diesel oil	535m³
Water ballast	99,800m³
Fuel consumption	
main engine only	89.2 tonnes/day
Classification	Lloyd's Register +100A1 Oil tanker (Double Hull), +LMC, UMS,IGS, LNC(AA)
Other regulations complied with	IMO A320;A708;A719, MARPOL 13F, OPA-90
Percentage of high-tensile steel used in construction	26%
Main engine	
Design	Sulzer
Model	7RTA84T
Manufacturer	Korea Heavy Industries Co Ltd
Number	1
Output	36,000bhp/73.4rev/min mcr
Gearbox	
Make	Renk Tacke
Model	power take-off for shaft alternator
Number	1
Propeller	
Material	nickel-aluminium-bronze
Manufacturer	Lips BV
Number	1
Pitch	Fixed
Diameter	10.2m
Speed (csr)	69.5rev/min
Main-engine driven alternator	
Number	1
Make	–
Output	940kW/1800rev/min
Diesel-driven alternators	
Number	3
Engine make/type	Ssangyong-MAN B&W 8L23/30
Alternator make	Hyundai
Output	3 x 940kW/720rev/min
Boilers	
Number	2
Type	Vertical watertube
Make	Mitsubishi Heavy Industries Ltd
Output	2 x 45tonnes/h
Cranes	
Number	2 x hose handling
Make/type	Hägglund electro-hydraulic
Capacity/speed	20tonnes/10m/min
Mooring winches	
Number	2 x mooring winch/windlass 7 x mooring winch
Make	Ulstein Norwinch
Type	Electro-hydraulic
Cargo tanks	
Number	15
Grades	3 segregations
Product range	Crude oil
Coated tanks	No
Cargo pumps	
Number	3
Type	Centrifugal steam turbine
Make	Shinko
Capacity	3 x 5000m³/h
Cargo and ballast control systems	
Make	ABB
Type	Integrated computerised
Pumprooms	
Number	1
Position	Forward of engineroom
Complement	
Officers	18
Crew	12
Repair crew	6
Rooms	26 single/3 double
Bridge control system	
Make	Norcontrol
Type	Autochief 4
One man operation	yes
Fire detection system	
Make	Thorn
Type	Addressable
Fire extinguishing systems	
Cargo spaces	Low-expansion foam
Make	Unitor
Engineroom	High-expansion foam
Make	Unitor
Cabins/public spaces	Portable extinguishers
Make	Unitor
Radars	
Number	2
Make	Racal-Decca
Satellite navigation systems	
Make	Furuno
Type	GP-500 Mk2 GPS
Integrated navigation system	
Make	Racal-Decca
Model	MIRANS
Computers on ship	
Number	4 x PC
Tasks	Loading; planned maintenance; spares
Waste disposal plant	
Waste handled	Sludge; waste oil; solid waste and plastic
Incinerator	
Make	Kvaerner
Model	OG-400
Waste compactor	
Make	Tony Team (Electrolux)
Model	TT180 (4.5 tonnes)
Waste disposal	
Make	Electrolux
Model	310BS
Contract date	8 September 1993
Launch/float out date	26 November 1994
Delivery date	2 June 1995

MUREX



SIGNIFICANT SHIPS OF 1995

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RAPHAEL: a Hyundai standard VLCC

Shipbuilder: .....Hyundai Heavy Industries .....Co Ltd, Korea
Vessel's name: .....*Raphael*
Hull number: 1225
Owner/operator: .....Overseas Shipholding .....Group Inc, USA
Designer: .....Hyundai Heavy Industries .....Co Ltd, Korea
Flag: .....Panama
Total number of sister ships already completed: .....-
Total number of sister ships still on order: .....-

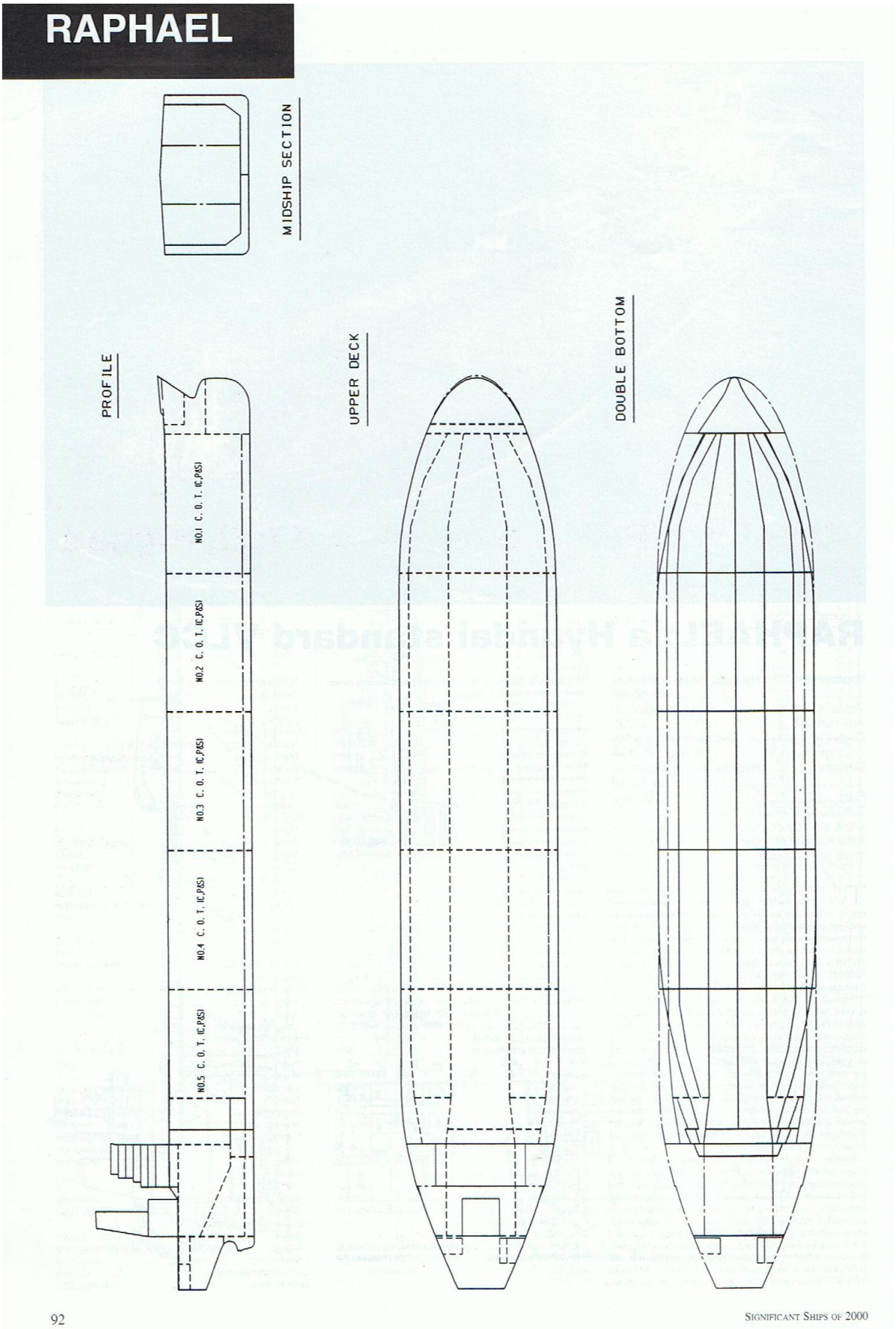
THE well-established Hyundai series of double-hull VLCC is already in service with a number of owners. It includes in its design a number of energy-saving and environmentally friendly features, notably a hull-form with a wide beam and a bluff forebody, both of which contribute to a service speed at 92%MCR of 15.70knots, derived from a Hyundai-MAN B&W 7S80MC main engine rated at 34,650bhp MCR when running at 79rev/min.

Typical of this class of tanker, *Raphael* is single-decked, without forecastle, and arranged with a sunken after deck. There are two longitudinal bulkheads in the cargo section which, with transverse bulkheads, divide the ship into 15 tanks. The double bottom is centrally divided, with the port and starboard tanks joined with the side spaces formed by the double hull, to provide water ballast tanks. The structural design has been carefully developed, with particular emphasis paid to reducing hull deflections, vibration throughout the ship, bow impact and fatigue strength, using the Lloyd's Register ShipRight PC-based advanced procedures for design, construction, and life-time ship care.

Raphael is designed to handle three grades of oil cargo simultaneously, using three Shinko steam turbine cargo pumps, each delivering 5000m³/h. The cargo and ballast control systems are of the medium-pressure hydraulic type, installed by Nakakita and operated from a common piano-type console with remote valve operation included. Radar beam-type level gauges are used for sounding the cargo tanks, with an electro-pneumatic system fitted to the ballast tanks. Supplying the vessel's electrical requirements are three Hyundai 980kW/720rev/min alternators driven by Hyundai-MAN B&W 5L28/32 diesel engines, with steam raised from two 45tonne/h boilers.

PRINCIPAL PARTICULARS

Length, oa	335.00m
Length, bp	320.00m
Breadth, moulded	58.00m
Depth, moulded to main deck	31.00m
Width of double skin	
side	3.52m
bottom	3.00m
Gross	157,883gt
Deadweight	
design	309,600dwt
scantling	309,600dwt
Draught	
design	22.70m
scantling	22.70m
Speed, service at 92%MCR	15.20knots
Cargo capacity	
liquid volume	349,600m³
Bunkers	
heavy oil	7900m³
diesel oil	400m³
Fuel consumption	
main engine only	92.47tonnes/day
Classification	Lloyd's Register of Shipping, +100A1, Double Hull Oil Tanker, ESP, ShipRight (SDA, FDA, CM), +LMC, UMS, LI, IGS, IWS, COW
Percentage of high-tensile steel used in construction	36%
Main engine	
Design	MAN B&W
Model	7S80MC
Manufacturer	Hyundai Heavy Industries
Number	1
Output	34,650bhp/79rev/min
Propeller	
Material	Nickel-aluminium-bronze
Manufacturer	Hyundai Heavy Industies
Number	1
Pitch	Fixed
Diameter	9700mm
Speed	79rev/min
Diesel-driven alternators	
Number	3
Engine make/type	Hyundai-MAN B&W/5L28/32
Alternator make/type	Hyundai/HFC-6-566-14K-EB
Output	3 x 980kW/720rev/min
Boilers	
Number	2
Type	HMT-45
Make	Hyundai
Output	2 x 45tonnes/h
Mooring equipment	
Number	2 x windlass; 8 x mooring winch
Make	Hyundai-Pusnes
Type	Electro-hydraulic
Cargo tanks	
Number	15 + 2 slop
Grades	3
Cargo pumps	
Number	3
Type	Vertical centrifugal
Make	Shinko
Capacity	3 x 5000m³/h
Cargo and ballast control systems	
Make	Nakakita
Type	Combined console with valve remote control
Complement	
Officers	12
Crew	18
Rooms	30 single rooms
Special rudder	Large-sized rudder
Bridge control system	
Make	Nor-Control
Type	AutoChief IV
One man operation	No
Fire detection system	
Make	Consillium Marine
Type	C300
Fire extinguishing systems	
Cargo tank deck	Low expansion foam
Make	NK Co Ltd
Engineroom	High-expansion foam
Make	Unitor
Cabins and public rooms	Portable extinguishers and sea water jets
Make	NK Co Ltd
Radars	
Number	2
Make	Raytheon
Models	C3425/7XU; C3430/12SU
Satellite communication	
Make	Furuno
Model	GP-80(DGPS beacon receiver integrated)
Contract date	-
Launch/float-out date	-
Delivery date	15 March 2000


RAPHAEL
MIDSHIP SECTION
PROFILE
UPPER DECK
DOUBLE BOTTOM
NO.1 C. O. T. (C.P&S)
NO.2 C. O. T. (C.P&S)
NO.3 C. O. T. (C.P&S)
NO.4 C. O. T. (C.P&S)
NO.5 C. O. T. (C.P&S)
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SIGNIFICANT SHIPS OF 2000

STENA VICTORY: designed for safety

Shipbuilder: Hyundai Heavy Industries Co Ltd, Korea
Vessel's name: *Stena Victory*
Hull number: 1251
Owner/operator: Concordia Maritime AB, Sweden
Designer: Hyundai Heavy Industries Co Ltd, Korea
Flag: Liberia
Total number of sister ships already completed: 1
Total number of sister ships still on order: Nil

Note: Illustration shows sister vessel *Stena Vision*.

STENA Group company Concordia Maritime has introduced this advanced 'V-Max' VLCC design with safety and pollution avoidance a prime consideration; this is evidenced by the bold decision to fit twin engines, propellers, steering gears, and rudders. The design has also been awarded the Det Norske Veritas RPS (Redundant Propulsion and Separate) notation, based upon an ability to maintain more than 6knots in a Beaufort force 8 head wind and waves, with only 50% power available.

The 'separate' part of the notation derives from the disposition of the main machinery in completely independent, port and starboard enginerooms aft, which partly occupy the gondola-type pods carrying the twin propellers and rudders. Of interest is the way opportunity has been taken to site the main fuel tanks at the stern, between the propeller shafts, for added protection.

The propelling machinery comprises two Hyundai-MAN B&W 7S60MC-C diesel engines each developing 21,490bhp at 105rev/min. A Vulkan clutch in each propulsion line connects with a Schelde gearbox, reducing revolutions to 66rev/min at the FP propellers for better efficiency. These are fitted forward of the plain rudders, whose course-keeping attributes are enhanced by a skeg built behind them on the sternframe. *Stena Vision*, the lead ship, is equipped with MAN B&W's 'intelligent' software and hardware (an E-suffix on the designation) to allow for future electronic exhaust valve operation without a mechanical camshaft. It is believed that this system is also fitted on *Stena Victory*.

Electrical requirements are served from four diesel-alternator sets fitted in a third, centre engineroom, and steam is produced in a thermal-oil system to drive three 5500m³/h cargo pumps, which together give a maximum unloading rate of 16,500m³/h and allow three cargo grades to be handled simultaneously. Loading is carried out through the manifolds at 23,900m³/h.

Stena Victory and her sister have been placed on long-term charter to Sun Oil, delivering oil to Philadelphia, USA, from West Africa. By adopting a beam of 70m (some 10m greater than usually applied to VLCCs) it has been possible to select a design draught of 16.76m, allowing navigation of the Delaware River with minimal lightening at the river entrance.

The double-skin hull is divided by a series of transverse, and two longitudinal bulkheads, into 15 cargo and 2 slop tanks, protected on the underside of the deck and 2m down, and at the bottom plus 1m up, by an epoxy coating. Two coats of a light coloured composition are used in the ballast tanks. Radar-type tank sounding equipment is fitted, and tank washing is effected using Scanjet machines.

The aft-end of the vessel is characterised by the large, flat expanse of a transom stern, twin, widely spaced funnels, and a superstructure which houses a crew of 34, plus six Suez crew and four repair men. A wheelhouse of, no doubt, adequate proportions, surmounts this accommodation block, but is dwarfed by the huge structure of the bridge wings necessitated by the immense beam.

PRINCIPAL PARTICULARS

Length, oa: 333.49m
Length, bp: 320.00m
Breadth, moulded: 70.00m
Depth, moulded to upper deck: 25.60m
Camber on upper deck: 1.80m
Width of double skin
- side: 3.50m
- bottom: 3.00m

Gross 163,761gt
Deadweight
- design: 266,200dwt
- scantling: 312,600dwt

Draught
- design: 16.76m
- scantling: 19.00m

Speed, service 90% MCR; 12% sea margin
- 16.76m draught: 16.90knots
- 19.00m draught: 16.30knots
- 8.60m (ballast) draught: 17.70knots

Cargo capacity: 358,500m³
Bunkers
- heavy oil: 7900m³
- diesel oil: 540m³

Water ballast: 107,700m³
Segregated ballast: 100%
Fuel consumption
- main engine only: 114.65tonnes/day

Classification: Det Norske Veritas, +1A1, Tanker for Oil, ESP, EO, RPS, CSA-1(25)
Percentage of high-tensile steel used in construction: approx 58%; Types 32 and 36
Main engines
- Design: MAN B&W
- Models: 7S60MC-C
- Manufacturer: Hyundai Heavy Industries
- Number: 2
- Output (MCR): 2 x 21,490bhp/105rev/min

Gearboxes
- Make: Schelde
- Model: Vertical offset reduction
- Number: 2
- Output speed: 66rev/min

Propellers
- Material: Nickel-aluminium-bronze
- Manufacturer: Hyundai Heavy Industries
- Number: 2
- Pitch: Fixed
- Diameter: 9000mm
- Speed: 66rev/min

Diesel-driven alternators
- Number: 4
- Engine make/type: 2 x Hyundai-MAN B&W Holeby/6L28/32H
  2 x Hyundai-MAN B&W Holeby/5L28/32H
- Alternator make/type: 2 x Hyundai/HFJ6 634-14K
  2 x Hyundai/HFJ5 564-14K
- Output: 2 x 1180kW; 2 x 800kW

Boilers (thermal-fluid heaters)
- Number: 2
- Type: CPH40
- Make: Aalborg
- Output: 40tonnes/h

Hose-handling cranes
- Number: 2
- Make: Hochang-NorMarine
- Duty: 20tonnes/10m/min
- Type: Electro-hydraulic

Mooring equipment
- Number: 2 x mooring winch/windlass
  8 x mooring winch
- Make: Hyundai-Ulstein
- Type: Low-pressure electro-hydraulic

Cargo tanks
- Number: 15 + 2 slop
- Grades: 3
- Coated tanks: Deck and bottom
- Make: International epoxy
- Stainless steel: No

Cargo pumps
- Number: 3
- Type: Vertical centrifugal
- Make: Shinko
- Capacity: 3 x 5500m³/h

Cargo/ballast control systems
- Make: Valmarine

Pump room
- Number: 1
- Position: Forward of enginerooms

Complement
- Senior officers: 4
- Officers: 14
- Crew: 16
- Repair crew: 6
- Suez crew: 4

Stern appendage: Rudder skegs
Bridge control systems
- Make: Valmarine
- Type: Damatic XD RC

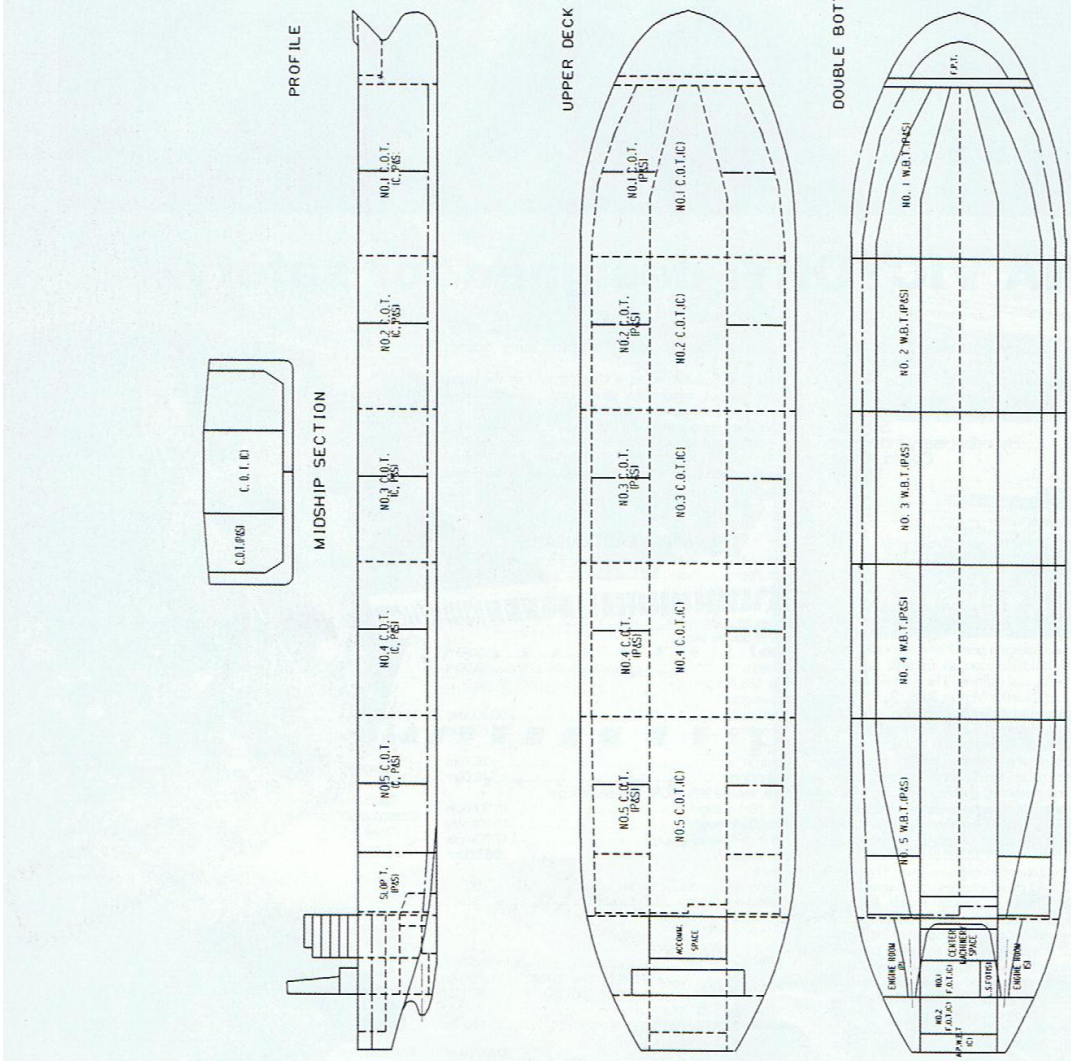
Fire detection systems
- Make: Consillium
- Type: Addressable CS-3004

Fire extinguishing systems
- Tank area: Low-expansion foam
- Make: NK Fire Protection
- Engineroom: High-expansion foam
- Make: Kashiwa
- Accommodation: Sea water, portable
- Make: NK Fire Protection

Waste disposal plant
- Incinerator
  - Make: Kangrim
  - Model: KIN-70 SDA
- Sewage plant
  - Make: Jonghap
  - Model: Bio-Aero 818

Contract date: 17 December 1998
Launch/floatout date: 20 January 20 2001
Delivery date: 24 April 2001

STENA VICTORY



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SIGNIFICANT SHIPS OF 2001

UBUD: IHI's double-hull VLCC series

Shipbuilder:.....Ishikawajima-Harima Heavy ... Industries Co Ltd (Kure Shipyard), Japan
Vessel's name:.....*Ubud*
Hull number:.....3109
Owner/operator:.....Graton Co SA, ...Panama/World Wide Shipping Agency, ...Singapore
Designer:.....Ishikawajima-Harima Heavy .....Industries Co Ltd, Japan
Flag: .....Panama
Total number of sister ships already completed:.....5
Total number of sister ships still on order:.....8

UBUD has been completed as the sixth ship in a series of VLCCs developed by IHI, which claim an advantage over similar vessels by virtue of a lower gross tonnage, obtained from an optimised arrangement of cargo and ballast tanks, engine-room and pumproom. The design is flush-decked, without forecastle and has a cargo space enclosed within a double hull 3.48m wide at the sides, and 2.98m deep at the double bottom. Transverse bulk-heads, and two longitudinal divisions, form 15 wing and centre tanks, plus two slop tanks, for the car-riage of crude oil.

Cargo handling is by means of three Shinko steam turbine-driven, vertical centrifugal pumps with a capacity of 5000m³/h each, arranged so that three cargo segregations can be worked simultane-ously. Additionally, a similar 2400m³/h pump and two 1100m³/h eductors are provided for easy tank cleaning and stripping operations. The tank bot-toms only are coated with tar epoxy.

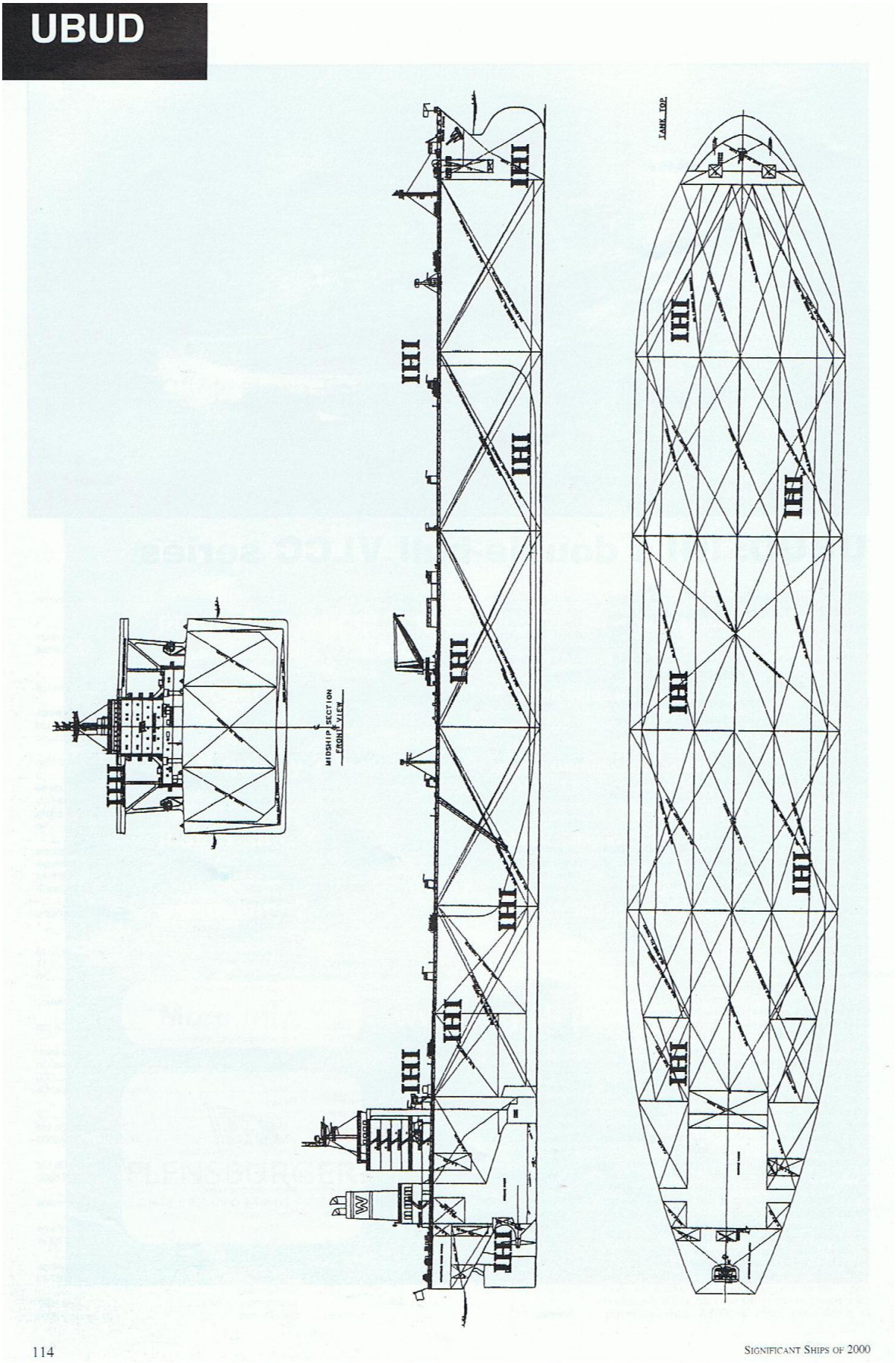
Structure in the wing ballast tanks includes four tiers of continuous stringers arranged so that inspection and maintenance of the spaces can be readily carried out. In addition, the tanks are coated with light-coloured modified epoxy paint for easier visibility. Ventilation and inerting of the ballast tanks is arranged and a fixed flammable gas detec-tion system provided for the double-hull ballast tanks. The 10 wing cargo tanks have a hopper side at the outboard corner, and the side and bottom water ballast tanks are combined to form a central-ly divided common space.

A Diesel United-Sulzer 7RTA84T main engine is fitted having an output of 36,960bhp at 74rev/min, giving a service speed at 80%MCR of 16.10knots by means of a FP propeller. A main engine-driven alternator produces 600kW of elec-trical power to satisfy the sea load, and is controlled in combination with a 900kW turbo-alternator which takes steam from the main engine exhaust-gas economiser, by a thyristor inverter. Two Daihatsu 920kW diesel-driven alternators are also fitted. In each case, the electrical components are supplied by Nishishiba. A crew of 30 man the vessel, with accommodation also available for 10 repair crew.

PRINCIPAL PARTICULARS

Length, oa.....330.00m
Length, bp.....316.60m
Breadth, moulded.....60.00m
Depth, moulded to main deck.....28.90m
Width of double skin
  side.....3.48m
  bottom.....2.98m
Gross.....149,383gt
Deadweight, scantling.....279,999dwt
Draught
  design.....19.10m
  scantling.....20.41m
Speed, service 80%MCR.....16.10knots
Cargo capacity
  liquid volume.....328,458m³
Bunkers
  heavy oil.....7550m³
  diesel oil.....475m³
Water ballast.....101,566m³
Fuel consumption
  main engine only.....89.70tonnes/day
Classification.....Nippon Kaiji Kyokai NS*, Tanker .....Oils Flash point below 60°C, (ESP) .....MNS*, MO.B
Main engine
  Design.....Sulzer
  Model.....7RTA84T
  Manufacturer.....Diesel United
  Number.....1
  Output.....36,960bhp/74rev/min
Propeller
  Material.....Nickel-aluminium-bronze
  Manufacturer.....Mitsubishi Heavy Industries
  Number.....1
  Pitch.....Fixed
  Diameter.....9520mm
  Speed.....74rev/min
Main engine-driven alternator
  Number.....1
  Make/type.....Nishishiba/thyristor control
  Output.....600kW
Diesel-driven alternators
  Number.....2
  Engine make.....Daihatsu
  Alternator make.....Nishishiba
  Output.....2 x 920kW/900rev/min
Turbo-alternator
  Number.....1
  Alternator.....Nishishiba
  Output.....900kW/1800rev/min
Boiler
  Number.....1
  Type.....Two-drum
  Make.....Mitsubishi Heavy Industries
Hose-handling cranes
  Number.....1
  Make/type.....Fukushima Ltd
Mooring equipment
  Number/type.....2 x windlass; 8 x mooring winch
  Make.....Fukushima Ltd
  Type.....Electro-hydraulic
Cargo tanks
  Number.....15 plus 2 slop
  Grades.....3
  Product range.....Crude oil
  Coated tanks.....Bottoms only
  Type of coating.....Tar epoxy
  Stainless steel.....No
Cargo pumps
  Number.....3 plus 1 tank cleaning/stripping
  Type.....Steam turbine vertical centrifugal
  Make.....Shinko
  Capacity.....3 x 5000m³/h; 1 x 2400m³/h
Cargo/ballast control system
  Make.....Nakakita Seisakusho
  Pumproom.....1
Complement
  Officers.....13
  Crew.....17
  Repair crew.....10
Bridge control systems
  Make.....Nabco
Fire detection system
  Make.....Nuomi Bousai Co Ltd
Fire extinguishing systems
  Cargo spaces.....Fixed foam
  Make.....Nippon Dry Chemical Co
  Engineroom.....CO_2
  Make.....Nippon Dry Chemical Co
Radars
  Number.....2
  Make.....Japan Radio Co Ltd
  Models.....1 x JMA9253; 1 x JMA9303
Satellite navigation system
  Make.....Japan Radio Co Ltd
  Model.....JLR-6800
Waste disposal plant
  Waste handled.....Waste oil and solids
  Incinerator
    Make.....Sunflame
    Model.....OSV-70GA
  Sewage plant
    Make.....Taiko Kikai Industries
    Model.....SBT-40
Contract date.....-
Launch/float-out date.....June 1997
Delivery date.....31 January 2000

UBUD



114 SIGNIFICANT SHIPS OF 2000

UNIVERSAL QUEEN: Hyundai 309,000dwt VLCC variant

Shipbuilder: ...Hyundai Heavy Industries Co Ltd, Korea
Vessel's name: ...*Universal Queen*
Hull number: ...1637
Owner/operator: ..Hyundai Merchant Marine Co, Korea
Designer: ...Hyundai Heavy Industries Co Ltd, Korea
Model test establishment used: ...Hyundai Maritime Research Institute, Korea
Flag: ...Panama
Total number of sister ships already completed: ...-
Total number of sister ships still on order: ...1

CONTINUING a long line of VLCC/ULCC tonnage built by Hyundai over the years, *Universal Queen*, delivered into the fleet of associated company Hyundai Merchant Marine, is a variant of a design featured in *Significant Ships of 2003* by the 317,000dwt *Capricorn Star*. Subtle changes in dimensions are, perhaps, the most noticeable differences between the two designs, with *Universal Queen* displaying almost a metre less depth than the earlier vessel, and a reduction of 1.50m in scantling and design draughts. Whilst an overall length of 333m has been retained, the LBP measurement of the newer vessel has been increased by 5m to present an almost vertical stem above the load water line and, as a consequence, reduce the configuration of the bulbous bow.

Universal Queen has one continuous freeboard deck without forecastle but featuring a sunken mooring deck aft. The hull is double-skin with the cargo space divided by two longitudinal bulkheads to form port, starboard and centre cargo tanks, further divided by transverse bulkheads into five pairs of wing tanks, five centre tanks, and one pair of slop tanks. The double hull space is utilised for water ballast tanks joined to centrally divided double bottom compartments. In line with recently introduced practice, the double skin is extended aft to protect bunker tanks built-in P&S at the forward end of the engineroom. Longitudinally framed construction has been adopted for most of the structure.

Three grades of cargo can be carried simultaneously, handled by three Hyundai-MHI steam turbine-driven, 5000m³/h pumps housed in a room forward of the machinery space, and discharged overboard at midships. Ballast and cargo valves are operated by medium-pressure hydraulic power, and control of cargo systems and monitoring includes ullage measurement, operation of pumps, and inert gas plant. Radar-type level gauges are employed in the cargo tanks, with electro-pneumatic models serving the ballast spaces. Crude oil washing is also provided.

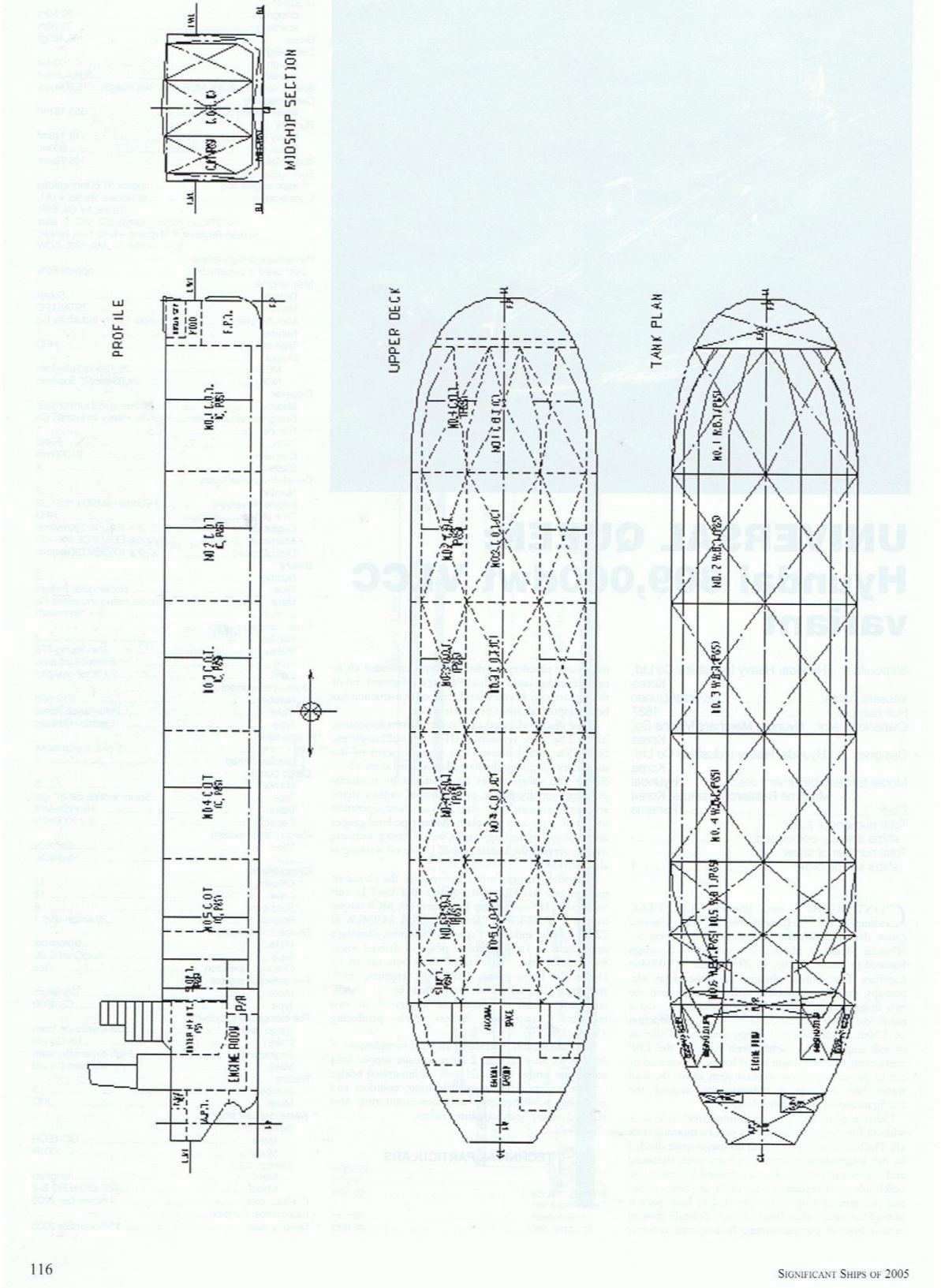
In another change from *Capricorn Star*, the choice of main engine has fallen on a Sulzer 7RTA84T-D unit supplied by Hyundai Heavy Industries. The MCR output of this is 28,720kW at 76rev/min, NCR 24,934kW at 72.50rev/min, and service speed is 15.6knots, allowing a sea margin of 15%. Electrical power is derived solely from diesel-driven alternators: three sets driven by Hyundai's home-grown HiMSEN engines, each supplying 1050kW, and supported by a 300kW emergency machine. Steam is generated in two rectangular two-drum boilers each producing 45tonnes/h.

Accommodation is arranged aft for a complement of 30 plus six Suez crew, in a superstructure topped by a navigation bridge equipped with an integrated bridge system incorporating route planning, collision and grounding avoidance, and navigation monitoring. Also installed on the bridge are three radars.

TECHNICAL PARTICULARS

Length, oa ...333.00m
Length, bp ...324.00m
Breadth, moulded ...60.00m
Depth, moulded
to main deck ...26.56m
to upper deck ...29.60m
Width of double skin
side ...3.38m
bottom ...3.00m
Draught
design ...20.50m
scantling ...21.00m
Gross ...163,465gt
Deadweight
design ...300,100dwt
scantling ...309,400dwt
Speed, service, 86.8% MCR, 15% sea margin ...15.60knots
Cargo capacity
liquid volume ...353,181m³
Bunkers
heavy oil ...10,149m³
diesel oil ...600m³
Water ballast ...105,782m³
Fuel consumption
main engine only ...approx 97.80tonnes/day
Classification ...Det Norske Veritas +1A1, Tanker for Oil, ESP, NAUTICUS (Newbuilding), EQ, VCS-2, also Korean Register of Shipping +KRS 1-Oil Tanker, ESP, +KRM, 1-UMA, IGS, COW
Percentage of high-tensile steel used in construction ...approx 60%
Main engine
Design ...Sulzer
Model ...7RTA84T-D
Manufacturer ...Hyundai Heavy Industries Co
Number ...1
Type of fuel ...HFO
Output
MCR ...28,720kW/76rev/min
NCR ...24,934kW/72.5rev/min
Propeller
Material ...Nickel-aluminium-bronze
Designer/manufacturer ...Hyundai Heavy Industries Co
Number ...1
Pitch ...Fixed
Diameter ...10,000mm
Blades ...4
Diesel-driven alternators
Number ...3
Engine make/type ...Hyundai-HiMSEN/7H21/32
Type of fuel ...HFO
Output/speed ...3 x 1066kW/720rev/min
Alternator make/type ...Hyundai-EES/HFC6 566-10P
Output/speed ...3 x 1050kW/720rev/min
Boilers
Number ...2
Type ...Rectangular 2-drum
Make ...Hyundai Heavy Industries Co
Output ...2 x 45tonnes/h
Hose-handling crane
Number ...2
Make ...Shin Young-TTS
Type ...Electric-hydraulic
Duty ...2 x 20tonnes/20m
Mooring equipment
Number ...10 sets
Make ...Rolls-Royce Korea
Type ...Electric-hydraulic
Cargo tanks
Number ...15 plus 2 slop tanks
Grades carried ...3
Cargo pumps
Number ...3
Type ...Steam turbine centrifugal
Make ...Hyundai-MHI
Capacity ...3 x 5000m³/h
Cargo control system
Make ...Damcos
Type ...Hydraulic
Complement
Officers ...12
Crew ...18
Suez crew ...6
Rooms ...30 single plus 1
Bridge control system
Make ...Norcontrol
Type ...AutoChief C-20
One man operation ...Yes
Fire detection system
Make ...Consilium
Type ...CS 4000
Fire extinguishing systems
Cargo deck ...Low-expansion foam
Make ...NK Co Ltd
Engineroom ...High-expansion foam
Make ...Kashiwa Co Ltd
Radars
Number ...3
Make ...JRC
Waste disposal plant
Incinerator
Make ...GC-TECH
Model ...C-1001R
Sewage plant
Make ...Jonghap
Model ...JMC-BIOAERO B-2
Contract date ...4 November 2003
Launch/float-out date ...-
Delivery date ...11 November 2005

UNIVERSAL QUEEN



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SIGNIFICANT SHIPS OF 2005

YUKONG NAVIGATOR: single hull for Samsung VLCC

Shipbuilder:	**Samsung Heavy Industries Co Ltd, Korea,**
Vessel's name:	***Yukong Navigator***
Owner/operator:	**Yukong Line, Korea,**
Designer:	**Samsung Heavy Industries Co Ltd, Korea,**
Flag:	**Panama**
Total number of sister ships already completed:	**Nil**
Total number of sister ships still on order:	**1 (plus 1 option for double-hull sister)**

THIS first vessel to be built in Samsung's new building dock at its Koje Island yard was – perhaps surprisingly – completed to a single-hull configuration, the owner's choice no doubt influenced by a planned regular trading pattern between Korea and the Arabian Gulf. However, an option for a double-hull sister ship is held by Yukong. Special consideration has been given in the design, which extends the yard's range beyond its previous Suezmax limit, to the development of an economic hull form with reduced wave profile, and improvements in course-keeping, turning and yaw control, coupled with an energy saving propulsion system.

The flush-decked arrangement utilises a much-reduced quantity of high-tensile steel, and features two longitudinal bulkeads, forming a combination of three long and three short wing and centre tanks. The six centre tanks and three pairs of long wing tanks carry cargo oil, with the short wing tanks devoted to water ballast. Two slop tanks in the wings aft complete the layout of tanks.

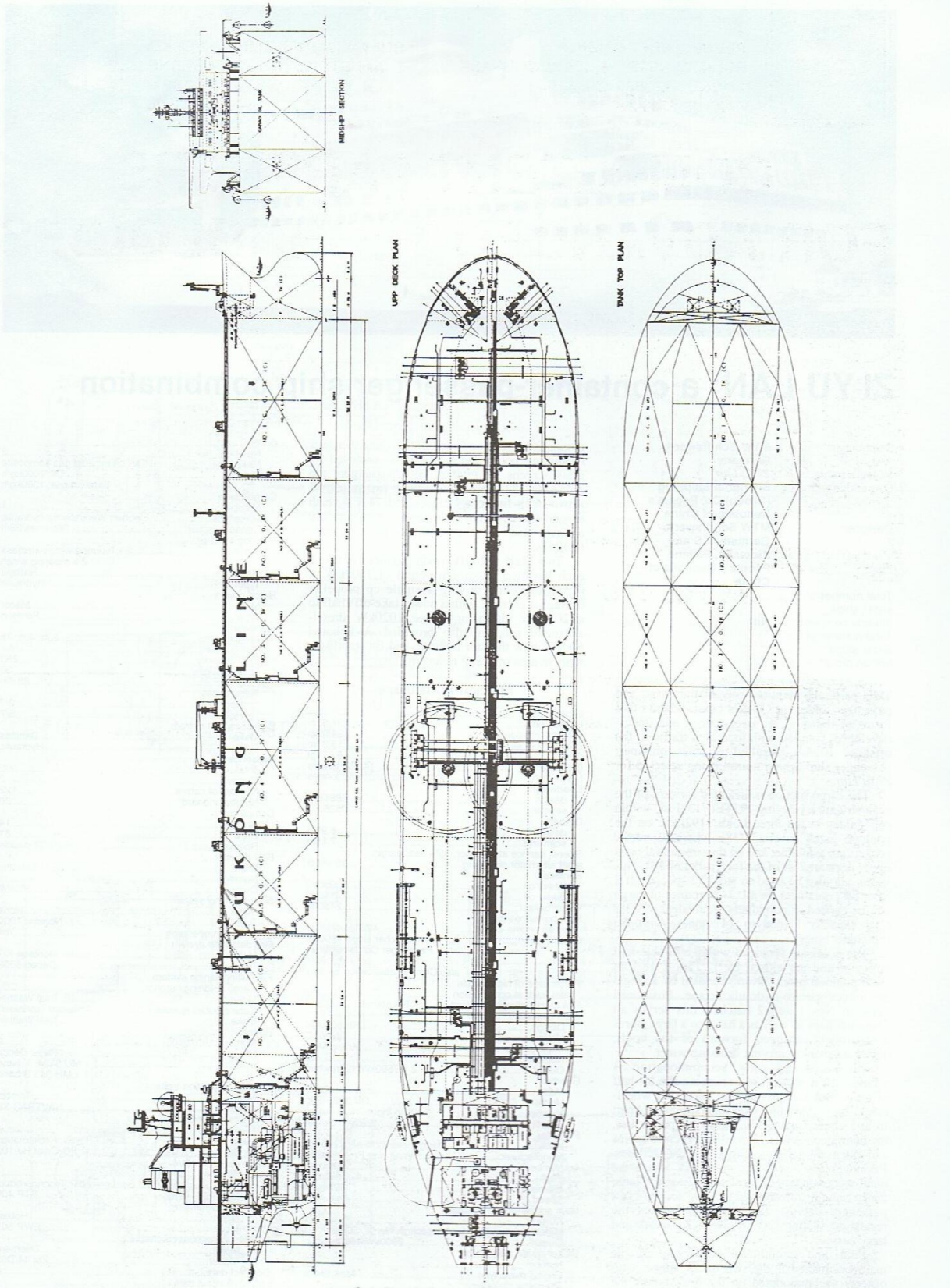
Three grades of oil can be handled by a system centred upon three Naniwa-Eureka 5000m³/h steam-driven centrifugal pumps positioned in a pump room at the forward end of the machinery space, with Nakakita hydraulic remote control operation of the cargo and ballast valves. The main engine is a MAN B&W 7S80MC model, built by Korea Heavy Industries, which delivers 31,670bhp at 72.2rev/min to give a service speed of 15 knots.

Electric power is supplied by three Hyundai 900kW alternators, driven by Ssangyong-MAN B&W 8L23/30 diesel engines, with two 45 tonnes/h boilers satisfying steam requirements. Bridge control of the main engine is by way of a Norcontrol Autochief-4 system which allows the vessel to sail with an unmanned engineroom; however one-man operation of the bridge is not included.

PRINCIPAL PARTICULARS

Length, oa	329.00m
Length, bp	315.00m
Breadth, moulded	51.20m
Depth, moulded	30.40m
Gross	154,651gt
Deadweight	277,798dwt
Draught	20.45m
Speed, service at 90% mcr, 10% sea margin	15 knots
Capacity	330,647m³
Bunkers	
heavy oil	7237m³
diesel oil	426m³
Water ballast	106,817m³
Fuel consumption	
main engine only	98.9tonnes/day
auxiliaries	4.6tonnes/day
Classification	American Bureau of Shipping +A1(E) Oil Carrier, +AMS, +ACCU *also* Korean Register of Shipping +KRS1, +KRM1, UMA-2
Percentage of high-tensile steel used in construction	–
Main engine	
Design	MAN B&W
Model	7S80MC
Manufacturer	Korea Heavy Industries
Number	1
Output	31,670bhp/72.2rev/min
Propeller	
Material	Nickel-aluminium-copper
Manufacturer	Hyundai Heavy Industries
Number	1
Pitch	Fixed
Diameter	9800mm
Speed	72.2rev/min
Diesel-driven alternators	
Number	3
Engine make/type	Ssangyong-MAN B&W 8L23/30
Alternator make/type	Hyundai/HFC6-566-14K
Output	3 x 900kW/720rev/min
Boilers	
Number	2
Type	MAC45B (drum type)
Make	Mitsubishi Heavy Industries
Output	2 x 45tonnes/h
Cranes	
Number	2 x hose handling
Make/type	Samsung-BLM/electro-hydraulic
Capacity	20tonnes
Mooring winches	
Number	2 x mooring winch/windlass 8 x mooring winches
Make	Samsung-Norwinch
Type	Electro-hydraulic
Cargo tanks	
Number	18 plus 2 slop tanks
Grades	3
Product range	Crude oil
Coated tanks	No
Cargo pumps	
Number	3
Type	Steam turbine, vertical centrifugal
Make	Naniwa-Eureka
Capacity	3 x 5000m³/h
Cargo and ballast control systems	
Make	Nakakita
Type	Hydraulic low pressure
Pump room	
Number	1
Position	Fore end of engineroom
Complement	
Officers	13
Crew	17
Owner	1
Suez crew	6
Single/double rooms	31/- (plus 1 x 6)
Bridge control system	
Make	Norcontrol
Type	Autochief-4
One man operation	No
Fire detection system	
Make	Salwico
Type	C-300
Fire extinguishing systems	
Cargo tank deck	Foam and sea water
Make	Unitor Korea
Engineroom	CO_2 and sea water
Make	Unitor Korea
Cabins/public spaces	Sea water and portable extinguishers
Radars	
Number	2
Make	Kelvin Hughes
Models	Nucleus 6000
Satellite navigation systems	
Make	Japan Radio Co
Model	GP-500 Mk2 GPS
Other navigation systems	
Make	Furuno
Model	LC-90 Mk2
Computers on ship	
Number	2
Make	Norcontrol
Models	Datachief-2000
Tasks	Engineroom alarm and monitoring
Waste disposal plant	
Incinerator	
Make	Hyundai Industry Machinery
Contract date	21 June 1993
Launch/float out date	1 July 1995
Delivery date	18 September 1995

YUKONG NAVIGATOR



SIGNIFICANT SHIPS OF 1995 119

UTIK: new VLCC tonnage for World-Wide

Shipbuilder: .....Daewoo Shipbuilding & Marine Engineering Co Ltd, Korea
Vessel's name:.....*Utik*
Hull number: 5187
Owner/operator: ..Kolex Ltd, Hong Kong/World-Wide Shipping Ltd, Singapore
Designer: .....Daewoo Shipbuilding & Marine Engineering Co Ltd, Korea
Flag: .....Hong Kong
Total number of sister ships already completed:.....1
Total number of sister ships still on order:.....Nil

WORLD-WIDE'S long involvement with the operation of VLCC tonnage continues with the acceptance into its fleet of further vessels of this type. *Utik* is an example of a standard design from Daewoo, a yard which has made the construction of this size of tanker something of a speciality in recent years.

The new completion is configured with a double hull 3.52m wide at the sides and 3.00m deep at the bottom. The internal bulkhead of the side space is sloped inwards at the bottom, with side and bottom tanks combined into five pairs of water ballast tanks divided by the centre girder.

Cargo handling is accomplished by three Shinko steam turbine-driven, centrifugal cargo pumps each with a capacity of 5000m³/h, fitted in a pumproom at the forward end of the machinery space. Three cargo manifolds on deck allow for three cargo segregations and are positioned so that their centre above the waterline meets a maximum air-draught of 22.50m in a normal harbour ballast departure condition.

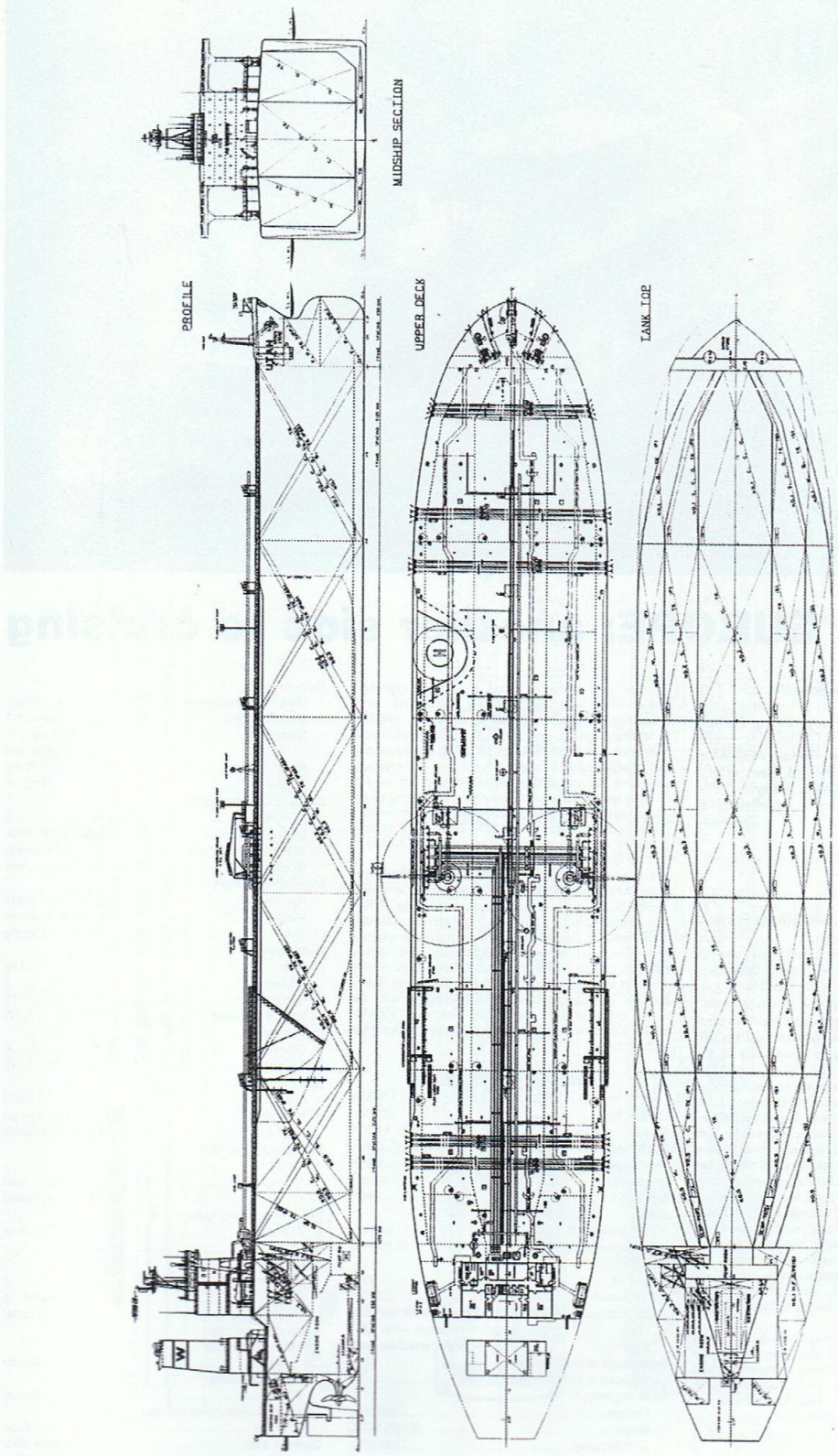
The piping system can also be arranged to load two parcel cargoes in approximately 30/70; 40/60; or 50/50 proportions. Ballast handling is by means of two 3000m³/h electric pumps.

Utik is a single-decked vessel without forecastle but with a sunken aft deck, on which the funnel casing is built. Forward of that on the upper deck, a five-tier deckhouse, surmounted by the navigating bridge and wheelhouse, accommodates a crew of 32 and a six-person repair crew.

The machinery installation is centred upon a Hanjun-built MAN B&W 7S80MC (Mk6) main engine developing 34,650bhp at 79rev/min MCR. When operating at an NCR of 31,190bhp/776.3rev/min, a service speed of 15.3knots is achieved, allowing a 15% sea margin.

PRINCIPAL PARTICULARS

Length, oa.....332.00m
Length, bp.....320.00m
Breadth, moulded.....58.00m
Depth, moulded
to main deck.....31.00m
to sunken deck aft.....26.84m
Width of double skin
side.....3.52m
bottom.....3.00m
Gross.....157,814gt
Deadweight
design.....279,084dwt
scantling.....299,497dwt
Draught
design.....20.80m
scantling.....22.00m
Speed, service at NCR, 15% sea margin.....15.30knots
Cargo capacity
liquid volume.....347,593m³
Bunkers
heavy oil.....9131m³
diesel oil.....400m³
Water ballast.....101,672m³
Fuel consumption
main engine only.....90.2tonnes/day
Classification.....Lloyd's Register of Shipping, +100A1, Double Hull Oil Tanker, ESP, LI, ShipRight (SDA, FDA, CM), +LMC, UMS, IGS, with descriptive notes PtHt, PL(LR), SBT(LR), COW(LR), ShipRight(PCWBT), SCM
Percentage of high-tensile steel used in construction.....35%
Main engine
Design.....MAN B&W
Model.....7S80MC (Mk6)
Manufacturer.....Hanjun
Number.....1
Output.....34,650bhp/79rev/min MCR
Propeller
Material.....Nickel-aluminium-bronze
Manufacturer.....Lips BV
Number.....1
Pitch.....Fixed
Diameter.....9800mm
Speed.....79rev/min
Diesel-driven alternators
Number.....3
Engine make/type.....Ssangyong-MAN B&W/-
Alternator/type.....Hyundai/HFC5 634-14K
Output.....3 x 850kW/720rev/min
Boilers
Number.....3
Type.....2 x vertical oil fired
1 x exhaust gas
Make.....Mitsubishi
Output.....2 x 40tonnes/h; 1 x 2.6tonnes/h
Hose-handling cranes
Number.....2
Make/type.....MacGregor/hydraulic
Capacity.....20tonnes/10m/min
Mooring equipment
Number.....2 x mooring winch/windlass
8 x mooring winch
Make.....Rolls-Royce
Type.....Electric-hydraulic
Cargo tanks
Number.....15 plus 2 slop
Grades.....3
Product range.....Crude oil
Coated tanks.....No
Cargo pumps
Number.....3
Type.....Steam turbine centrifugal
Make.....Shinko
Capacity.....3 x 5000m³/h
Cargo/ballast valve control
Make.....Nakakita
Type.....Electro-hydraulic
Complement
Officers.....15
Crew.....17
Repair crew.....6
Cabins.....32 x single; 1 x 6-berth
Fire detection system
Make.....Nittan
Type.....Addressable
Fire extinguishing systems
Cargo area.....Foam
Make.....NK
Engineroom.....CO_2
Make.....Iijin
Waste disposal plant
Incinerator
Make.....Kangrim
Model.....KEI-70SDA
Contract date.....15 March 2000
Launch/floatout date.....17 March 2001
Delivery date.....5 October 2001



SIGNIFICANT SHIPS OF 2001 123

C. GALAXY: A 317,000dwt VLCC from Hyundai

Shipbuilder: **Hyundai Heavy Industries Co., Ltd**
Vessel's name: ***C. Galaxy***
Hull No: **1964**
Owner/Operator: **SK Shipping**
Country: **Korea**
Designer: ... **Hyundai Heavy Industries Co., Ltd**
Country: **Korea**
Model test establishment used:
Flag: **Panama**
IMO number: **IMO 9404924**
Total number of sister ships already completed (excluding ship presented): **Nil**
Total number of sister ships still on order: **Nil**

The 317,000dwt VLCC *C. Galaxy*, built by Hyundai Heavy Industries Co., Ltd, was delivered to SK Shipping, Korea, on 13 February 2009.

C. Galaxy is designed to carry three grades of cargo simultaneously. This is handled by three steam turbine cargo pumps, each delivering 5000m³/h, installed in a pump room at the forward of engine room. *C. Galaxy* has five centre cargo oil tanks, five pairs of side cargo oil tanks and one pair of slop tanks aft. Water ballast tanks form the vessel's double skin.

The cargo and ballast control systems of the ship are electro-hydraulically operated. Radar beam type level gauges are fitted to cargo tanks with electro pneumatic type level gauges being used in the ballast tanks.

The vessel is equipped with the highly advanced navigation system which supports integrated bridge operations of the ship such as route planning, manoeuvring for collision and grounding avoidance and navigation monitoring. A large rudder is fitted to ensure good manoeuvrability.

C. Galaxy has an overall length of 336m, width of 60m and depth of 29.6m with a design draft of 20.5m. She is powered by a Hyundai-B&W 6S90MC-C main engine with an MCR output of 29,340kW at 76rev/min, enabling her to sail at a service speed of 16knots. Electric power is supplied by three main diesel generators with an output of 1277kW and one 300kW emergency generator.

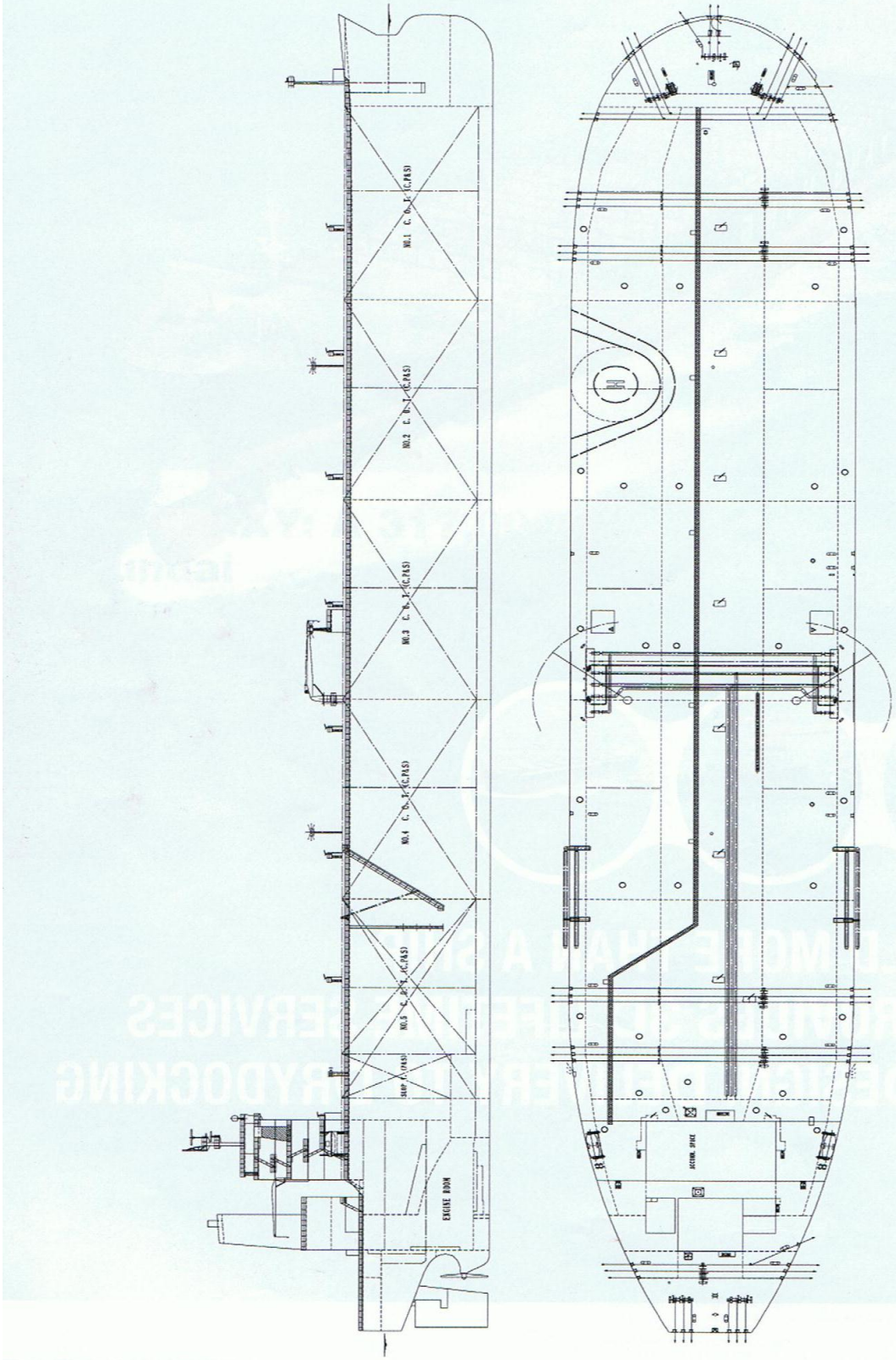
The ship is classed by American Bureau of Shipping 1A(E), Oil Carrier, ESP, CSR, SAFESHIP-CM, +AMS, +ACCU, VEC, RW, SPM, UWILD and Korea Register of Shipping + KRS1, Oil Tanker(Double Hull), ESP, (CSR), Sea Trust(HCM), +KRM1, UMA, IGS, COW, LI, IWS.

SK Shipping, the Owner of *C. Galaxy* operates more than 10 vessels in the VLCC and Aframax classes and is part of Korea's SK Group of companies. *C. Galaxy* is on long term charter to SK Energy, a member company of the same group.

TECHNICAL PARTICULARS

Length oa: 336m
Length bp: 324m
Breadth moulded: 60m
Depth moulded to main deck: 29.6m
Width of double skin:
  side: 3.55m
  bottom: 3.0m
Draught:
  scantling: 22m
  design: 20.5m
Gross: 160,600gt
Displacement: 364,500tonnes
Deadweight:
  Design: 289,100dwt
  scantling: 316,400dwt
Speed, service : 16knots at 90% MCR with 15% sea margin
Cargo capacity:
  Liquid volume: 347,000m³
Bunkers:
  Heavy oil: 8000m³
  Diesel oil: 380m³
Water ballast: 101,000m³
Daily fuel consumption:
  Main engine only: 104.5tonnes/day
Classification society and notations: American Bureau of Shipping, +A1(E), Oil Carrier, ESP, CSR, SAFESHIP-CM, +AMS, +ACCU, VEC, RW, SPM, UWILD, Korean Register of Shipping +KRS1, Oil Tanker(Double Hull), ESP, (CSR), Sea Trust(HCM), +KRM1, UMA, IGS, COW, LI, IWS
Main engine:
  Design: MAN – B&W
  Model: 6S90MC-C
  Manufacturer: Hyundai- B&W
  Number: 1
  Type of fuel: HFO
  Output: 29,340kW@76rev/min(MCR), 26,406kW@73.4rev/min(NCR)
Propeller(s)
  Material: Ni-Al Bronze
  Designer/Manufacturer: HHI-EMD
  Number: 1
  Fixed/Controllable pitch: Fixed
  Diameter: 9.6m x 4 blades
  Speed: 76rev/min at MCR, 73.4rev/min at NCR
Diesel-driven alternators
  Number: 3
  Engine make/type: Hyundai-Himsen / 7H21/32
  Type of fuel: HFO
  Output/speed of each set: 1277kW / 900rev/min
  Alternator make/type: HHI-EES / HFJ 568-8P
  Output/speed of each set: 1200kW / 900rev/min,
Boilers
  Number: 2
  Type: Auto. Forced draft, HFO burning, marine boiler
  Make: Mitsubish Heavy Industries
  Output, each boiler: 45,000kg/h @ 16/6 bar(g)
Cargo cranes/cargo gear
  Number: 2
  Make: Oriental Precision
  Type: Electro-hydraulic, cylinder luffing
  Performance: 20tonnes, 10m/min
Other cranes:
  Number: 2
  Make: Oriental Precision
  Type: Electro-hydraulic, cylinder luffing
  Tasks: Handling provision and spare parts
  Performance: 10/3tonnes, 10/25m/min
Mooring equipment:
  Number: 2 windlass/mooring winch combinations, 8 mooring winches
  Make: Rolls-Royce
  Type : Electro-hydraulic, low pressure
Special lifesaving equipment:
  Number of each and capacity: 2, 30 persons each.
  Make: Hyundai Lifeboat
  Type: Totally enclosed, FRP
Cargo tanks:
  Number: 5 at centre, 10 at sides
  Grades of cargo carried: Crude oil (Three grades simultaneously)
Cargo pumps:
  Number: 3
  Type: Vertical centrifugal
  Make: Hyundai Heavy Industries Co., Ltd.
  Capacity (each): 5000m³/h
Cargo control system:
  Make: Emerson Marine
  Type: Electro-Hydraulic
Complement:
  Officers: 12
  Crew: 18
  Suez/Repair Crew: 6
  Single/double/other rooms: 30 single, 1 multiple
Bridge control system:
  Make: Kongsberg
  Type: Autochief-C20
  Is bridge fitted for one-man operation? Yes
Fire detection system:
  Make: Saracom-Thorn
  Type: T2000, Addressable type
Fire extinguishing systems:
  Engine room: Kashiwa high expansion foam
Radars:
  Number: 2
  Models: Furuno FAR-2827, FAR-2837S
Integrated bridge:
  Make: Furuno
Waste disposal plant:
  Incinerator G-C Tech Co. Ltd. Model GC-100IR
Contract date: -
Launch/float-out date: -
Delivery date: 13 February 2009

C GALAXY



DAR SALWA: Supertanker from DSME

Shipbuilder: ..... **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Vessels name: ..... ***Dar Salwa***
Hull No: **5344**
Owner/operator: ..... **Kuwait Oil Tanker Company (S.A.K)**
Country: ..... **Kuwait**
Designer: ..... **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Country: ..... **Korea**
Model test establishment used: ..... **SSPA**
Flag: ..... **Kuwait**
IMO number: **9534779**
Total number of sister ships already completed (excluding ship presented): **0**
Total number of sister ships still on order: **3**

DAR Salwa is the first in a series of four new supertankers for Kuwait Oil Tanker Company from Korean shipbuilder Daewoo Shipbuilding & Marine Engineering Co., Ltd, with the delivery of the vessel taking place in October.

Kuwait Oil Tanker Company is planning to enlarge its fleet to 32 vessels, between 2013-14. *Dar Salwa* is a significant first step for the Kuwait tanker operator in its move to expand and renew the fleet.

The vessel has a fully welded upper deck with aft sunken deck, a raked stem with a bulbous bow, a transom stern with open water type stern frame, a semi balanced rudder and a fixed pitch propeller directly driven by a slow speed diesel engine with pre-swirl stator.

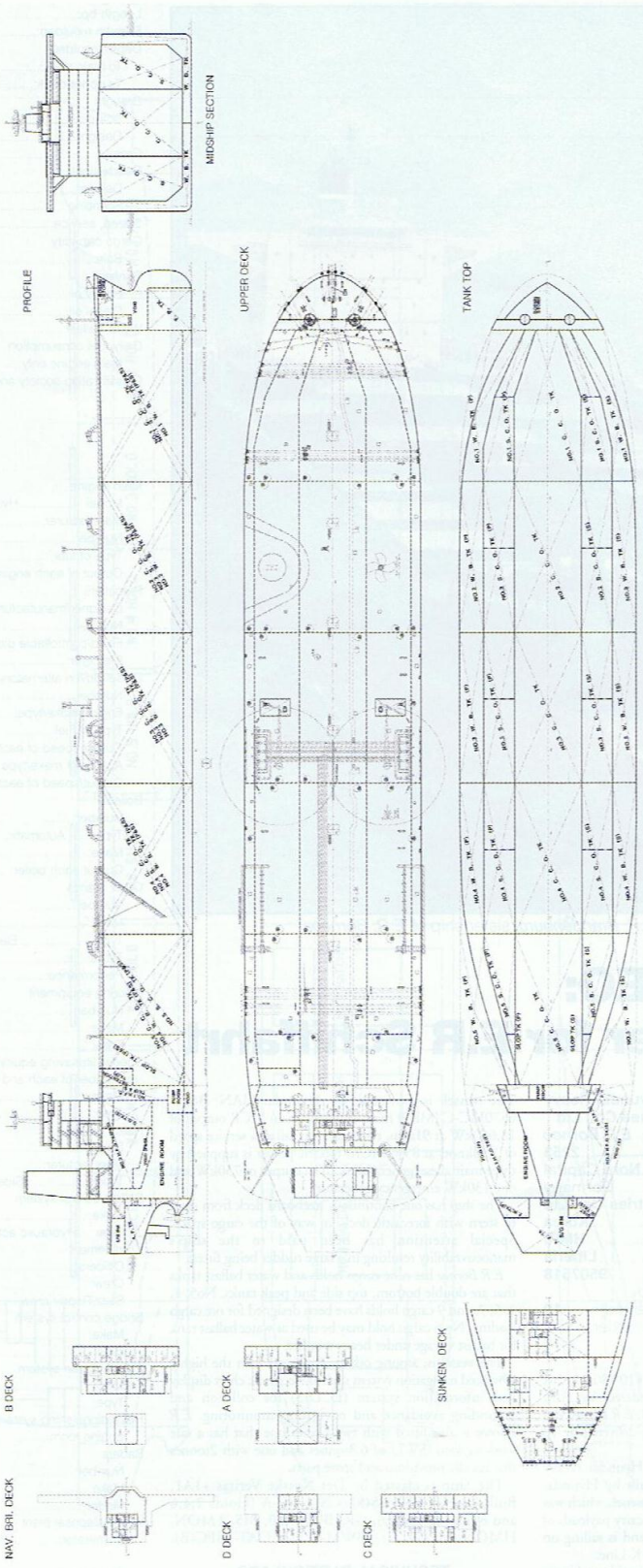
The vessel is also equipped with various optimum, high quality, efficient and environmentally friendly systems such as an electronically controlled main engine, provisions for crew comfort, safety and anti-piracy, and high performance fuel saving systems which can operate under ambient temperature 50°C.

Dar Salwa is 333m in length overall with a width of 60m and a deadweight of 319,000dwt. The vessel is powered by a MAN B&W 7S 80 ME-8 with a total power out put of 29,260kW x 78rpm, giving the vessel a speed of 16.2knots at design draft at 85% MCR with a 15% sea margin.

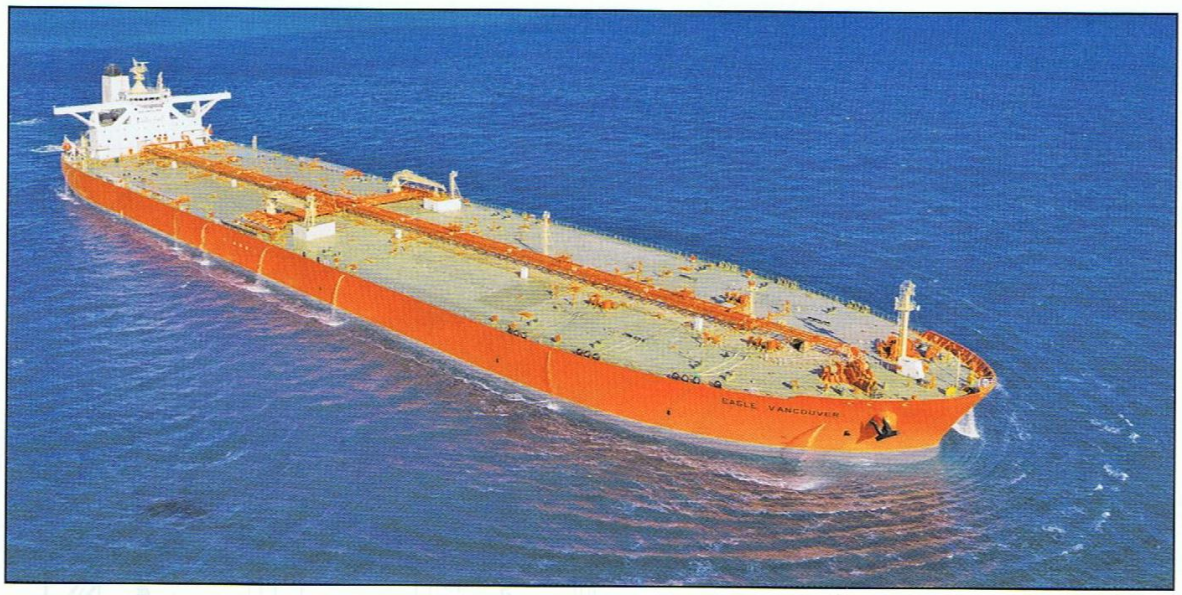
TECHNICAL PARTICULARS

Length oa: 333m
Length bp: 320m
Breadth moulded: 60m
Depth moulded
To upper deck: 30.5m
Draught
Scantling: 22.5m
Design: 21m
Gross: 162,625gt
Displacement: 363,843tonnes
Lightweight: 44,083tonnes
Deadweight
Design: 293,046dwt
Scantling: 319,760dwt
Block co-efficient: ..... approx 0.82
Speed, service: 16.2knots
Cargo capacity
Liquid volume: 358,484m³
Bunkers
Heavy oil: 7872m³
Diesel oil: 1139m³
Water ballast: 97,779m³
Daily fuel consumption
Main engine only: ..... approx. 124.9
Classification society and notations: ..... Det Norske Veritas +1A1, "Tanker for oil ESP", EO, CSR, PLUS, HMON(G4, A1), UMS, CLEAN, VCS-2, TMON, SPM, BIS, NAUT-OC, NAUTICUS(Operation), COMF-V(3)
% high-tensile steel used in construction: ..... Approx 55% as a design target
Heel control equipment: ..... Anti heeling pump
Main engine
Design: ..... MAN B&W
Model: ..... MAN B&W 7S 80 ME-8
Manufacturer: ..... Doosan Engine Co., Ltd
Number: 1
Type of fuel: ..... HFO & MDO
Output of each engine: ..... MCR 29,260kW x 78rpm NCR 24,870kW x 73rpm
Propellers
Material: ..... Ni-Al-Bronze
Designer/Manufacturer: ..... Hyundai Heavy Industries Co., Ltd
Number: 1
Fixed/controllable pitch: ..... Fixed pitch propeller
Diameter: 9.90m
Speed: 78rpm
Diesel-driven alternators
Number: 3
Engine make/type: ..... Doosan/4-stroke, trunk piston
Type of fuel: ..... HFO & MDO
Output/speed of each set: ..... 1980kW x 900rpm
Alternator make/type: Hyundai/HFJ7 638-8P
Output/speed of each set: ..... 1700kW x 900rpm
Boilers
Number: 2
Type: ..... Large oil fired
Make: ..... Aalborg Industries
Output, each boiler: 55tonnes/h, 55kG/h, 20.0/7.0bar
Other cranes
Number: ..... 2 x provision cranes 2 x hose handling cranes
Make: ..... Oriental
Type: ..... Electro-hydraulic driven crane
Tasks: ..... Provision handling and hose handling
Performance: ..... Hoisting, slewing, luffing
Mooring equipment
Number: ..... 2 x windlass 8 x winches
Make: ..... Rolls-Royce
Type: ..... Electro-hydraulic driven low pressure type Remote valve control system
Make: ..... Nakakita
Type: ..... Remote control system
Complement
Officers: 23
Crew: 13
Suez/Repair crew: 6
Bridge control system
Make: ..... Nabtesco
Type. M-800-III
One-man operation: ..... Yes
Fire detection system
Make: ..... Consilium
Type: ..... Salwico CS4000, addressable detector
Fire extinguishing systems
Cargo holds: ..... NK Co., Ltd
Engine room: ..... Kashiwa Co., Ltd Low pressure water system
Radars
Number: ..... 2 x X-Band 1 x S-Band
Make: ..... Japan Radio Co., Ltd
Model: JMA-923B-7XA
Integrated bridge system
Make: ..... Japan Radio Co., Ltd
Waste disposal plant
Sewage plant: ..... IL Sueng Co., Ltd ISS-60N
Contract date: ..... 21 August 2008
Launch/float-out date: ..... 21 August 2010
Delivery date: ..... 28 October 2010

DAR SALWA



SIGNIFICANT SHIPS OF 2010 31



EAGLE VANCOUVER: VLCC with BWTS

Shipbuilder: **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Vessel's name: ***Eagle Vancouver***
Hull No: **5380**
Owner/operator: **American Eagle Tankers (AET)**
Country: **Singapore**
Designer: **Daewoo Shipbuilding & Marine Engineering Co., Ltd**
Country: **Korea**
Model test establishment used: **SSPA**
Flag: **Singapore**
IMO number: **9597240**
Total number of sister ships already completed (excluding vessel presented): **2**
Total number of sister ships still on order: **nil**

EAGLE Vancouver was built for American Eagle Tankers Inc. Ltd by Daewoo Shipbuilding & Marine Engineering (DSME), delivered in July, amid the debate of the ballast water convention (BWMC) still waiting to be ratified, at the time, along with concerns for ballast water treatment capacity of these larger vessels. *Eagle Vancouver* is one of the first VLCCs to be built with a ballast water system fitted onboard.

Eagle Vancouver has double skinned cargo holds and is arranged with 17 cargo oil tanks and 12 water ballast tanks. The total capacity of cargo oil tanks is approximately 357,000m^3 with heavy fuel oil tanks of capacity of approximately 8,100m^3.

The vessel has a fully welded upper deck with aft sunken deck, a raked stem with a bulbous bow, a transom stern with open water type stern frame, a semi-balanced rudder and a fixed-pitch propeller directly driven by a MAN B&W 7S80MC-C8.2 slow-speed diesel engine with maximum rating of 26,900kW at 75.8rpm.

The vessel has been designed to meet with environmental regulations with features such as enlarged grey water holding tank, full double hull protection of oil tanks, ballast water treatment system, and Green Passport notations.

The hull form has also been optimised for a wide range of the vessel's operations. Also, a variety of energy saving devices have been fitted, such as a Pre-Swirl Stator (PSS), weather routing and trim optimisation system, rudder bulb, and Propeller Boss Cap Fins (PBCF).

Adding to the vessel's green credentials is the derated main engine that offers low fuel consumption, however, all the auxiliary machinery including the propeller and shaft have been designed at the full nominal rating of the main engine. The speed of the vessel is 15.8knots at the designed draught of 21.0m on even keel at 85% MCR.

TECHNICAL PARTICULARS

Length oa: 333.00m
Length bp: 320.00m
Breadth moulded: 60.00m
Depth moulded
- To main deck: 30.50m
- To sunken deck: 27.37m

Width of double skin
- Side: 3.40m
- Bottom: 3.00m

Draught
- Scantling: 22.50m
- Design: 21.00m

Gross: 161,974gt
Deadweight
- Design: 292,880dwt
- Scantling: 319,580dwt

Speed, service: 15.8knots
Cargo capacity
- Oil cargo: 357,000m^3

Bunkers
- Heavy oil: 8,100m^3
- Diesel oil: 500m^3

Water ballast: 97,000m^3
- Tankers segregated ballast: 93.7%

Daily fuel consumption
- Main engine only: 91.5tonnes/day

Classification society and notations: GL +100A5E, Container Ship, +MC E, AUT, IW, DG, NAV-O, RSD, STAR, EP, CM (shaft monitoring)
% high-tensile steel used in construction: 48%
Main engines
- Design: MAN B&W
- Model: 7S80MC-C8.2
- Manufacturer: Doosan Engine
- Number: 1
- Type of fuel: HFO/MDO & LSMGO
- Output of each engine: 26,900kW x 75.8rpm

Propeller
- Material: Ni-Al-Bronze
- Designer/manufacturer: DSME/MMG
- Number: 1
- Fixed/controllable pitch: Fixed
- Diameter: 9.9m
- Speed: 71.8rpm

Diesel-driven alternator
- Number: 3
- Engine make/type: Hyundai HiMSEN 6H21/32
- Type of fuel: HFO, MDO & LSMGO
- Output/speed of each set: 1,320kW x 900rpm
- Alternator make/type: HHI
- Output/ speed of each set: 1,250kW x 900rpm

Boilers
- Number: 2
- Type: Vertical, water tube
- Make: Alfa Laval – Aalborg
- Output, each boiler: 40,000kg/h at 20bar

Other cranes
- Number: 2
- Make: Oriental
- Type: Electro-hydraulic, luffing jib type
- Performance: 20tonnes

Mooring equipment
- Number: 2 x windlass 8 x mooring winches
- Make: TTS-Kocks
- Type: Electro-hydraulic high pressure

Special lifesaving equipment
- Number of each and capacity: 2 x 40 persons
- Make: Hyundai Lifeboat
- Type: Conventional

Cargo tanks
- Number: 15 + 2 slop tanks
- Grades of cargo carried: 3

Cargo pumps
- Number: 3
- Type: Centrifugal, vertical, single stage, direct coupled steam turbine
- Make: Shinko
- Capacity: 5,500m^3/h

Cargo control system
- Make: Kongsberg Maritime
- Type: Radar beam type cargo monitoring

Ballast control system
- Make: Scan-jet Macron
- Type: Electro-pneumatic type level gauging

Water ballast treatment system
- Make: Techcross
- Capacity: 6,000m^3/h

Complement
- Crew: 17

Bridge control system
- Make: Kongsberg Maritime
- Type: AC C20
- One-man operation: Yes

Fire detection system
- Make: Consilium
- Type: Addressable type

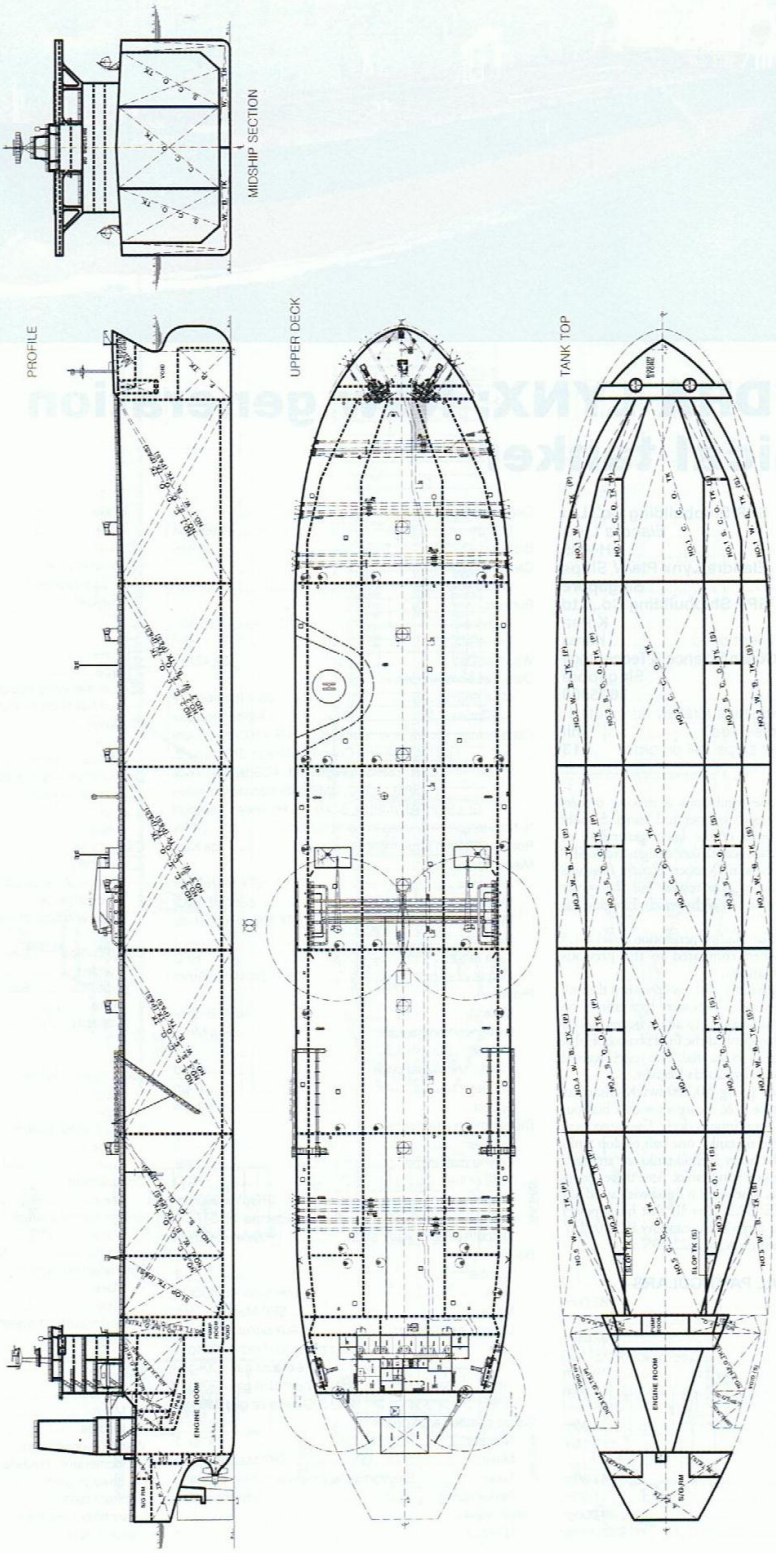
Fire extinguishing systems
- Cargo holds: NK/ Foam
- Engine room: NK/ Foam

Radars
- Number: 3
- Make: JRC
- Model: JMA-9100s

Integrated bridge system
- Make: JRC
- Model: JAN-901s

Contract date: 20 July 2010
Launch/float-out date: 7 October 2012
Delivery date: 16 July 2013

EAGLE VANCOUVER



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SIFA: First VLCC with BWTS installed

Shipbuilder: **Hyundai Heavy Industries Co., Ltd**
Vessel's name: ***Sifa***
Hull no: **2247**
Owner/operator: **Oman Shipping/NITC**
Country: **Oman**
Designer: **Hyundai Heavy Industries Co., Ltd**
Country: **Korea**
Model test establishment used: **Hyundai Maritime Research Institute**
Flag: **Malta**
IMO number: **9441245**
Total number of sister ships already completed (excluding ship presented): **1**
Total number of sister ships still on order: **1**

The 317,000dwt very large crude carrier (VLCC) *Sifa* was built at Hyundai Heavy Industries Co., Ltd. (HHI) and was delivered to Oman Shipping, on 10 January. *Sifa* is the first of a series of three VLCCs to be constructed for the Oman based ship owner, and is the first VLCC to be fitted with a ballast water treatment system (BWTS).

The Techcross BWTS has been installed to prevent the transfer of harmful aquatic organisms and pathogens in ballast water onboard the vessel and meets with regulatory requirements.

The valve control of the cargo and ballast system is hydraulically operated. Cargo control and monitoring covers ullage measurement, pump operation and inert gas systems. Radar beam type level gauges are fitted to cargo tanks while electro-pneumatic type level gauges are used in the ballast tanks.

Sifa is designed to carry three grades of cargo simultaneously, handled by three steam turbine cargo pumps, each delivering 5500m^3/h and housed in a pump room forward of the engine room. The ship has five centre cargo oil tanks, five pairs of side cargo oil tanks, one pair of slop tanks and water ballast tanks surrounding cargo oil tanks.

The ship has one continuous freeboard deck from stem to stern, transverse bulkheads, four longitudinal bulkheads, and double bottom and double side construction in way of the cargo space.

Sifa is, among others, equipped with a highly advanced navigation system, which supports integrated bridge operations of the ship, such as route planning, manoeuvring for collision and grounding avoidance and navigation monitoring. These green features include a vessel performance system supplied by Kongsberg, designed to reduce fuel consumption and emissions by up to 5%. This system allows continuous online monitoring and control of NOx, SOx and CO$_2$ emissions from both main and auxiliary engines' exhaust gas. At the same time the information can be transferred to head office by advanced communications systems like VSAT.

TECHNICAL PARTICULARS

Length oa: 333m
Length bp: 319m
Breadth moulded: 60m
Depth moulded
- To main deck: 30.4m
- To upper deck: 30.4m

Width of double skin
- Side: 3.4m
- Bottom: 3m

Draught
- Scantling: 22.6m
- Design: 21m

Gross: 163,000gt
Deadweight
- Design: 287,900dwt
- Scantling: 316,400dwt

Speed, service: 15.5knots @ 90% MCR with 20% sea margin
Cargo capacity
- Liquid volume: 351,200m^3
- Diesel oil: 1100m^3

Water ballast
- Tankers – percentage segregated ballast: 98,500m^3

Daily fuel consumption
- Main engine only: 104.4tonnes/day

Classification society and notations: Lloyd's Register +100A1 Double Hull Oil Tanker ESP, CSR, ShipRight(CM), +LMC, UMS, IGS, COW, LI, SPM, EP, *IWS, NAV1 with descriptive notes of BWMP(S), PCWBT, SCM, SEA(HSS-4, L), Pt Ht.
% high-tensile steel used in construction: 35%
Main engine
- Design: Hyundai-Wärtsilä
- Model: 7RT-Flex 82T
- Manufacturer: Hyundai Heavy Industries Co., Ltd
- Number: 1
- Type of fuel: HFO, MDO
- Output of each engine: 31,640kW

Propellers
- Material: Ni-Al-Bronze
- Designer/manufacturer: Hyundai Heavy Industries Co., Ltd
- Number: 1
- Fixed/controllable pitch: Fixed
- Diameter: 10m

Diesel-driven alternators
- Number: 3
- Engine make/type: HHI-EMD/ Himsen 8H21/32
- Type of fuel: HFO, MDO
- Output/speed of each set: 1490kW
- Alternator make/type: HHI-EES/ HFJ7/ 634-84E
- Output/speed of each set: 1400kW x 900rpm

Boilers
- Number: 2
- Type: Automatic, Marine boiler (MAC-55B)
- Make: Mitsubishi Heavy Industries Co., Ltd
- Output, each boiler: 55,000kg/h

Cargo cranes/cargo gear
- Number: 2
- Make: Oriental Precision & Engineering Co., Ltd
- Type: Provisions crane
- Performance: 5, 10tonnes

Mooring equipment
- Number: 2 x combined winches 8 x windlasses
- Make: Rolls-Royce Marine AS
- Type: Hydraulic

Special lifesaving equipment
- Number of each and capacity: 2 x 50 persons
- Make: Hyundai Life Boat Co., Ltd
- Type: ..Freefall launching totally enclosed engine driven

Cargo pumps
- Number: 3
- Type: Vertical centrifugal signle stage
- Make: Shinko
- Stainless steel: Bronze
- Capacity: 5500m^3/h x 150mTH

Cargo control system
- Make: Nakakita
- Type: Hydraulic/ conventional piano type

Ballast control system
- Make: Nakakita
- Type: Hydraulic/ conventional piano type

Water ballast treatment system
- Make: Techcross
- Capacity: 5000m^3/h

Complement
- Officers: 17
- Crew: 10

Bridge control system
- Make: Kongsberg
- Type: K-chief
- One-man operation: Yes

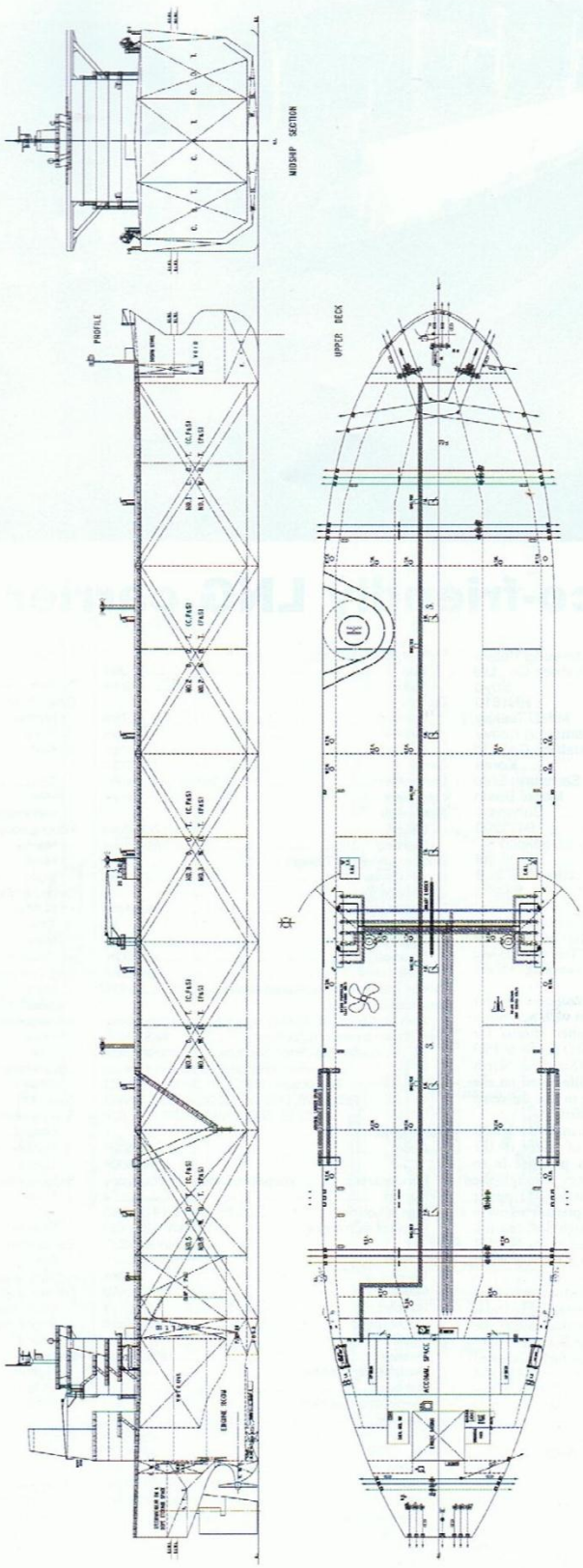
Fire detection system
- Make: Consilium
- Type: Smoke/thermal/flame detector

Fire extinguishing systems
- Pump room: Kashiwa/ Hi-expansion foam
- Engine room: Kashiwa/ Hi-expansion foam

Radars
- Number: 3
- Make: Kongsberg
- Model: K-Bridge Radar

Contract date: 11 February 2008
Launch/float-out date: 27 August 2010
Delivery date: 10 January 2011

SIFA



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