TECHNICAL

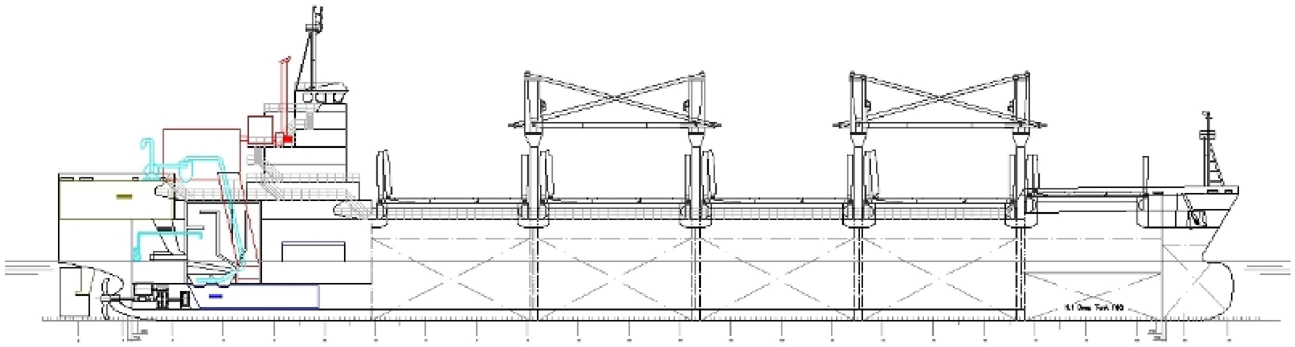
DESCRIPTION

34,000 DWT DOUBLE HULL

HANDYSIZE BULK CARRIER

GREENSHIP BI-FUEL 34K

Patented technology



Prepared By: WEST Logistics S.r.l.

October 2008

GREEN SHIP BI-FUEL 34K

O-1 General Description of the Vessel

O-10 General Arrangement (GA)

The vessel shall be designed as an ocean going, single screw, steam driven bulk carrier.

Accommodations, including navigation bridge and engine rooms, shall be located as shown on the General Arrangement Drawing.

The vessel shall be divided by bulkheads, decks and platforms into the following spaces and compartments.

Aft Body
The aft body with Transom stern shall be used for the steering gear compartment, fresh water tanks, aft peak and storage.

Engine Room Area
The engine rooms shall be divided by a bulkhead, into an aft engine room and forward engine room.

The aft engine room shall be arranged to accommodate the electric motor for propulsion, the boiler, platforms for auxiliaries, workshop, storage, etc. Service, settling and storage tanks for fuel and lubricating oils and other miscellaneous tanks shall be provided in the most suitable locations.

The forward engine room shall be arranged to accommodate, on tween deck, the steam turbine generator, two auxiliary diesel generators, the main switch-board and the control room. All auxiliaries shall be located under the tween deck.

Cargo Area
The cargo area shall have four (4) transversal bulkheads with double bottom and double hull, consisting of five (5) Holds plus five (5) pairs of ballast water tanks.

Fore Body
The fore-body with the fore deck and bulbous bow shall be used for the fore peak tank, chain lockers, paint and lamp storage, bosun storage and emergency fire pumps.

Intended Cargos

O-11 Dimensions

Length overall	ab	186 meters
Length between perpendiculars	ab	178 meters
Breadth, moulded	ab	30 meters
Depth, moulded	ab	16 meters
Design Draft	ab	9.24 meters
Scantling Draft	ab	10.24 meters
Light weight	ab	10,000 Tons

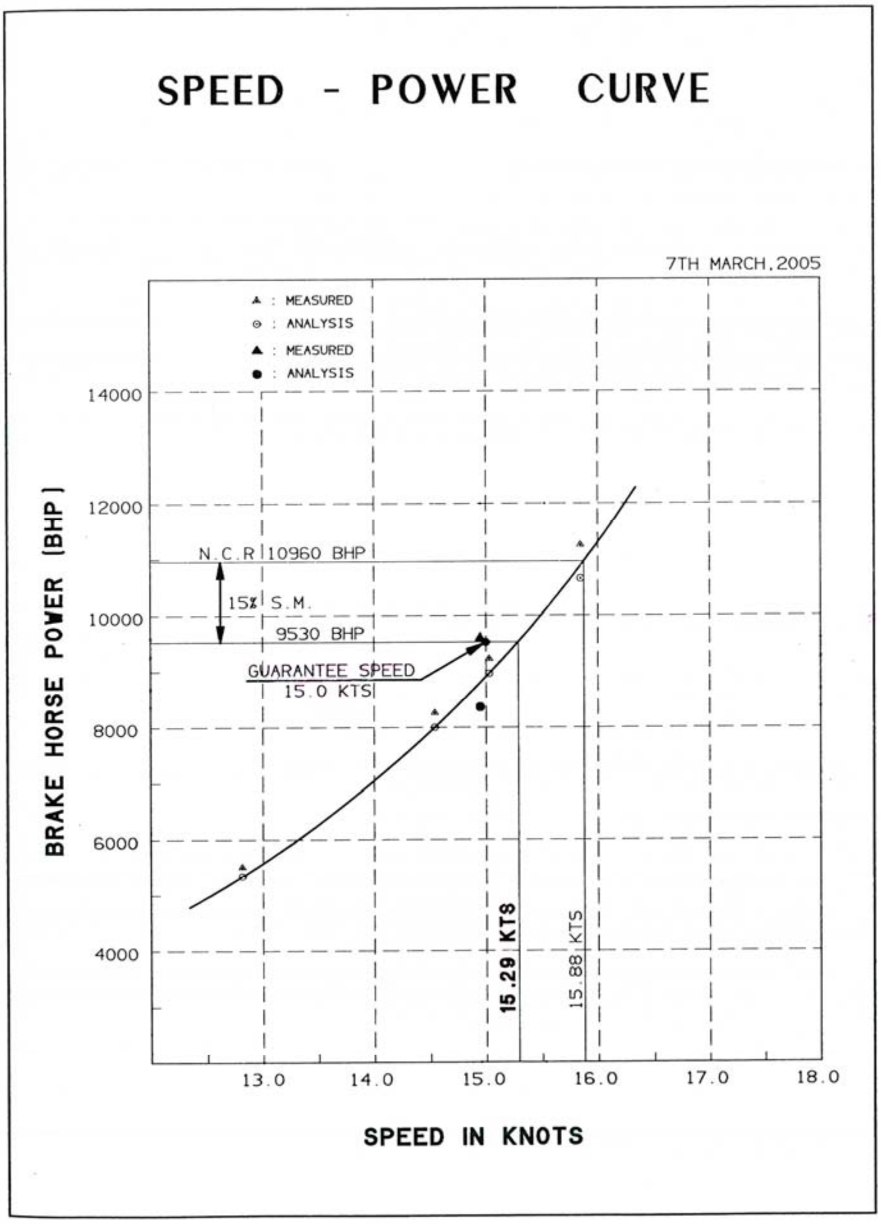
O-12 Dead Weight

At Design Draft	ab	31,500 tons
At Scantling Draft	ab	35,000 tons

O-13 Cargo Volume and Cargo Hold Dimensions

Cargo Hold	No. 1	No. 2	No. 3	No. 4	No. 5
Breadth (mm)	22,500	25,000	25,000	25,000	25,000
Length (m)	22,2	25,6	25,6	25,6	25,6
Volume (m^3)	7,800	9,400	9,400	9,400	9,400

Total volume about 45,500 m^3



CRUISING SPEED – AUTONOMY – POWER

1.0 Considering the width of the breadth (30 m), as a preliminary conservative evaluation we can use the Power Vs Velocity curve of a ship with the following characteristics.

L.O.A.	=	183 m.
LPP	=	173,9 m.
Breadth	=	32,2 m.
Design draft	=	11 m.
Dead weight	=	39,600 m. at 11,00 m.

From the curve the following data is determined

For a velocity of 12 knots, an engine of 4200 hp (3,1 MW) is required
For a velocity of 13 knots, an engine of 5750 hp (4,22 MW) is required
For a velocity of 14 knots, an engine of 7000 hp (5,15 MW) is required

1.1 Using a velocity of 14 knots and considering an additional requirement for onboard services of 0.35 MW and 0,5 Mw for auxiliaries of the steam propulsion system, it is reasonable to assume a 6 MW steam cycle is required to reach the 14 knots design speed.

The steam propulsion system would have a consumption of approximately 1.0 Tons per MW per hour, which converts into:

- Hourly consumption 6 MW x 1t/Mw/hr= 6 Tons/hour
- The daily consumption therefore would be 6T/hr x 24hr = 144T/day
- This translates into a daily navigation of 14 knots/hr x 24 hr = 336 miles

In order to achieve navigational autonomy of 5000 miles it would therefore be necessary to have RDF storage of:

5000 miles/336 miles/day ~ 14,9 days

14,9 days x 144T/day ~ 2146 Tons of RDF

Utilizing a filling coefficient of 0.75 and a density of 1T/ m^3, the volume of the RDF storage required would be:

2146 Tons/0,75tons/ m^3 ~2860 m^3.

The ship was therefore designed with a RDF hold of 3000 m3, more than enough to ensure a navigational autonomy of 5000 miles at 14 knots

1.2 Using a velocity of 12 knots a propulsion system of 4200 hp = 3,1 MW is required.
Two diesel generators of 1,8 MW each were contemplated to ensure the 12 knot design velocity.

A typical engine with of that size would be 7L 27/38 MAN-B&W – 60Hz –RPM 720
Bore 270 m. – stroke 380 mm.

This has a shaft power of kW 2310 and produces 2195 kW at the generator.

The total power available would be 4390 kW or 5970 hp, allowing for 350kW of auto consumption, there would be about 4000kW or 5440 hp available at the propeller, more than enough to ensure the design velocity utilizing the secondary fuel.

The secondary fuel consumption would therefore be:

3100 kW + 350 kW = 3460 kW or 4692 hp
4692 x 148 gr/hp x 24 = 16,6 T/day

Therefore, using a consumption of 16,6 Tons/day to achieve the 12 knot velocity the ship would travel 12 x 24 = 228 miles/day.

To have a additional navigational autonomy of 10000 miles (for a total of 15000 miles), the ship would require sufficient secondary fuel to travel; 10000/288 = 34,72 days.

This calculates to 34,72/day x 16,6T/day ~ 556 Tons of fuel consumption.

The secondary fuel storage capacity would therefore have to take into account the actual fuel to be consumed (with a margin of 4%) plus a reserve of an additional 3 navigation days for a total secondary fuel storage capacity of; 3 x 16 + 1,04/556 = 48 + 578 ~ 630 (fuel) + 70 (diesel) = 700 (fuel total).

1.3 Summary

Navigational Autonomy at 14 knots is approximately 5000 miles utilizing 2146 T of RDF; maximum power output 6 MW;

Navigational Autonomy at 12 knots is approximately 10000 miles consuming 556 Tons of secondary fuel, exploiting a maximum power of 5114 Hp= 2760 kW.

2.0 CAPITAL COST

A) A complete ship of traditional design costs between 5-6000 USD/Ton, with an average cost of 5500 USD/Ton.

With a Dead Weight of 34000 Tons and a Light Weight of 8000 Tons; the estimated capital costs would be between 40-48 million USD.

B) A BI-Fueled Ship, with a RDF propulsion system and a Light Weight of approximately 10.000 Tons with the same technical characteristics as the traditional ship above.

Cost of a traditional ship ~ 50-60 million USD
Cost of the main engine in a traditional ship ~ 4.5 million USD
Cost of a RDF propulsion system ~ 2500 €/kW
Cost of a 6 MW RDF propulsion system ~ 6000 kW x 2500 €/kW = 15.1 million €

With an exchange rate of €/$ = 1,41 you arrive at the following costs.

Cost of the ship traditional ship ~ 55 million USD = 39 million €
Cost of the main engine to be deducted ~ 4.5 million USD = 3,19 million €.
Cost of RDF propulsion system ~ 15.1 million €
Total cost of Bi-Fuel ship with a 6 MW RDF propulsion system ~ (39-3,19+15.1) = 50,8 million € or 71,63 million USD.

Therefore the delta capital cost between a tradition ship and the Bi-Fuel is ~ 25 million USD

3.0 SUMMARY OF THE PROPULSION SYSTEM

The propulsion system is comprised of a RDF fuelled boiler that produces superheated steam at 60 bar.

The steam is fed into a steam turbine which operates at 6000 RPM. This in turn is connected to a reducing gear with a ration of 1/3,33 which powers a generator at 1800 RPM (60hz, 4 poles, 6600 V) which feeds the main switchboard (MSB).

Connected to main switchboard are the following:

- 2 auxiliary diesels generators rated at 1800 kW each
- the electric motor (or motors) connected to the main propeller

The main electric drive motor (16 poles 450 RPM, 5150 kW) is connected to the propeller shaft through a reducing gear with a ratio of 1:4. The propeller is actioned by a split shaft, such that it can be removed for maintenance and is connected to the hull by way of the thrust bearing.

At maximum power, the propeller will turn at 112 RPM

In order to guarantee a high efficiency, a 4-bladed, 6 meter propeller is proposed.

2.1 The Boiler

The structure of the boiler for supporting the refractory elements as well as the tube bundles shall be incorporated into the ship hull design; ensuring a lighter more compact package.

To ensure a 6 MW_e output from the steam turbine, a 31 MW_t input is required to the boiler which in turn will produce 27 MW_t net to the steam turbine.

A boiler of this type would occupy approximately 1800 m^3, (a cube of 12 m).

The boiler design most reliable for this type of installation would be a grate type boiler with the hydraulic ram fuel feed system supplied directly by a fuel hopper. The hydraulic ram would also act as the security valve ensuring no flashback.

The grate shall have an adjustable speed control and be air cooled by the primary air entering from beneath the grate.

The combination of the grate speed control and the hydraulic ram feeder regulate the power produced by the boiler in function of the heating value of the fuel supplied.

Above the grate is an adiabatic zone where the secondary air is injected and where the auxiliary fuel injectors are located. In this adiabatic zone, the combustion is controlled to ensure proper NO_x levels.

Downstream of the adiabatic zone is the area for steam production. It is comprised of tube bundles, the steam drum, the super heaters and the economizers.

Beyond the grate is a system for the dousing of the bottom ash and collection of the fly ash.

2.2 Fuel Consumption

Utilizing a corrosion resistant material such as INCONEL for the super heaters, it is possible to implement a steam cycle with an overall efficiency of approximately 29%, generating 29 t/h of steam at 500 °C, 60 bar_a.

With such a steam cycle, the gross electrical efficiency would be approximately 27%, which means 6 t/h of RDF with a lower heating value of 18'400 kJ/kg would be required.

The power of the boiler could be regulated in the follow way:

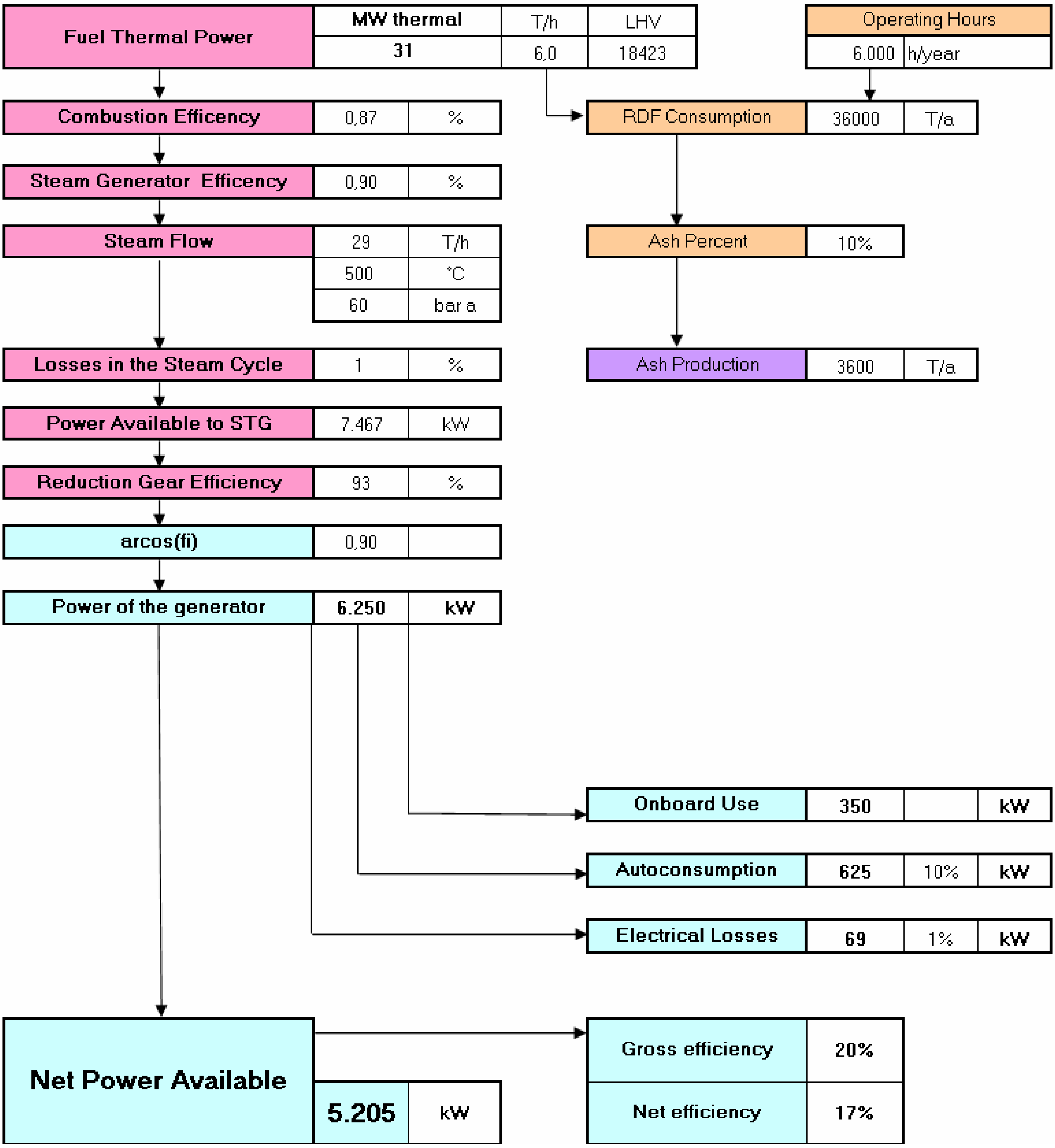
0-30%	auxiliary burners
30-40%	auxiliary burners plus RDF
40-110%	RDF

Assuming a nominal LHV of 18'400 kJ/kg, the grate boiler could accept fuel with the following deviations from nominal:

$LHV_{min} = PCI_{nominal} - 30\%$
$LHV_{max} = PCI_{nominal} + 15\%$

2.3 Summary of the steam cycle and electrical production

Power at the Propeller	5.2 MW	
Avg. LHV of the RDF	18,423	kJ/kg
Annual Operating Hours	6,000	h/anno
Annual Fuel Requirement	36,000	T/a
Gross Overall Efficiency	20	%
Net Overall Efficiency	17	%
Power at the Generator Terminals	6,968	kVA
Steam Cycle		
RDF Consumption	6.0	T/h
Combustion Efficiency	0.87	%
Thermal Power Input	31	MW
Thermal Power Steam Output	27	MW
Steam Production	29	T/h
Condenser Load	19	MW
Steam Pressure	60	bar a
Steam Temperature	500	°C
Steam Enthalpy	846	kcal/kg
Feedwater Enthalpy	140	kcal/kg
Power Available at the STG	7,743	kW
Ash Production	3,600	T/a
Generator		
Generator Power	6,272	kW
Electrical Losses	70	kW
Auto Consumption	627	kW
On-Board Services	350	kW
Net propulsion Power Available	5,225	kW


Fuel Thermal Power
MW thermal
31
T/h
6,0
LHV
18423
Operating Hours
6.000
h/year
Combustion Efficency
0,87
%
RDF Consumption
36000
T/a
Steam Generator Efficency
0,90
%
Steam Flow
29
T/h
500
°C
60
bar a
Ash Percent
10%
Losses in the Steam Cycle
1
%
Ash Production
3600
T/a
Power Available to STG
7.467
kW
Reduction Gear Efficiency
93
%
arcos(fi)
0,90
Power of the generator
6.250
kW
Onboard Use
350
kW
Autoconsumption
625
10%
kW
Electrical Losses
69
1%
kW
Net Power Available
5.205
kW
Gross efficiency
20%
Net efficiency
17%

2.4 Condenser

The condenser shall be sized to dissipate 19 MWt at a temperature of 40°C which corresponds to an absolute pressure of 0.1 bar.

The condenser will operate utilizing closed loop cooling water system in turn cooled by sea water through appropriate heat exchanger. The sea water will be considered to be on average 30 °C.

2.5 Steam Turbine Generator - STG

The steam turbine utilizes superheated steam produced by the boiler and has a fixed bleed at 130 °C to supply the needed steam to the Dearator.

The condensing steam turbine exhausts at an absolute pressure of 0.01 bar maintained by a system of steam air ejectors and hogging ejectors.

The liquid phase shall be pumped with a system of two stage pumps that will reach a pressure equal to that of the feedwater.

The boiler feed water pumps shall be redundant both in terms of number as well as powering (electrical supply from the on-board services as well as a dedicated diesel generator)

The steam turbine operates at 6000 rpm and powers the asynchronous generator (60 Hz 6.600 V) via a reducing gear with a ratio of 1:3.33, and is connected to the main switchboard. Also attached to the MSB are the auxiliary diesel generators used for secondary propulsion.

2.6 Electrical Distribution

The transformers for the on-board services, control panels and power circuit breakers are connected to the master power center.

2.7 Flue Gas Treatment.

The flue gas cleaning system shall be design to meet the emission limits dictated by the maritime regulations. As of today, there are no such limits for RDF as it was never contemplated as a maritime fuel. However, if we use the existing limits imposed for bunker fuel the flue gas treatment system would be composed of an electrostatic preceptor to reduce the particulates and heavy metals, whereas the nitrous oxides shall be controlled during combustion.

2.8 Distributed Control System

The Distributed Control System (DCS) oversees functioning and controls of the following principal parameters:

1. Boiler
2. Air Emissions
3. Steam Turbine Generator
4. Main Propulsion Motor
5. Auxiliary Diesel Generators
6. RDF Storage and Handling
7. Auxiliary Fuel Storage and Handling

2.9 Auxiliary Systems

1. Steam by-pass
2. Demi Water
3. Turbine Cooling
4. Generator Cooling
5. Cooling of Main Propulsion Motor

2.9 RDF Storage Areas

RDF storage shall have a capacity of 2900 m^3, which corresponds to the amount of RDF necessari to provide a navigational autonomy of 5000 miles at 14 knots.

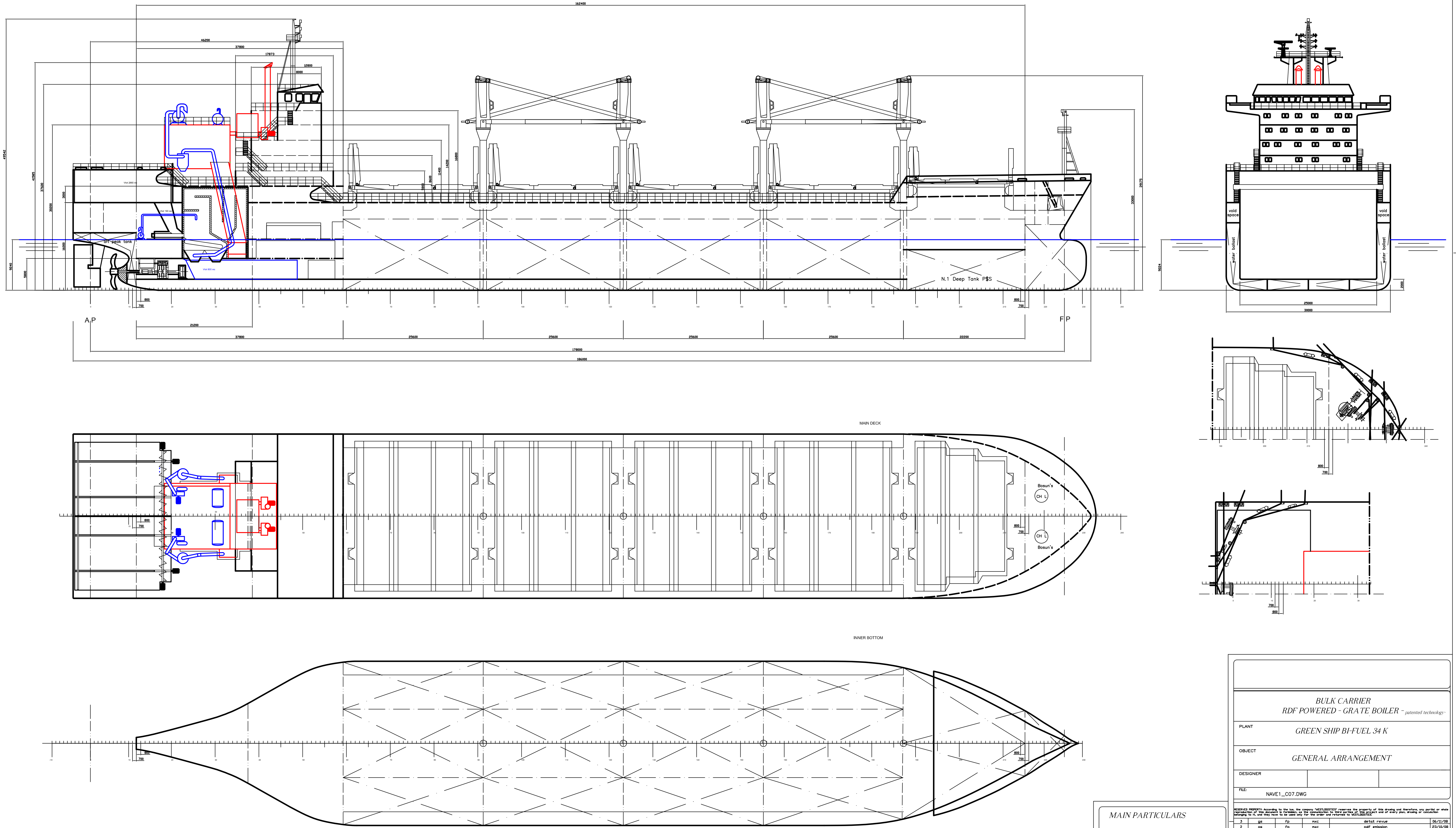
The RDF storage shall be composed of two identical compartments, each connected directly to the fuel feed hopper.

The RDF storage areas shall be equipped with automated fuel supply systems controlled by the distributed control system actuating the fuel feed as required.

Air Emissions Comparison

The environmental benefit is clearly presented below. The most noxious pollutants produced in the maritime sector are reduced by more than 90%. In addition, as the ratio of hydrogen to carbon in the RDF fuel is much more favorable then that in fossil fuels, the CO2 production is lower, in line with the KYOTO Protocol.

	TONS PER YEAR				
Fuel Type	Annual Consumption	CO	NO_x	SO_2	Particulates
IFO 380	6216	9,00	117,30	852,00	60,30
RDF	36000	0,90	39,90	10,50	0,60
Reduced Emissions Utilizing RDF		8,10	77,40	841,50	59,70
Percentage Reduction		90%	66%	99%	99%



MAIN PARTICULARS

LENGHT OVERALL	AB	186,00	m
LENGHT BP	AB	178,80	m
BREDTH MOULDED	AB	30,00	m
DEPTH MOULDED	AB	16,00	m
DESIGN DRAFT	AB	9,24	m
SCANTLING DRAFT	AB	10,24	m
LIGHT WEIGHT	AB	10'000	T

BULK CARRIER
RDF POWERED - GRATE BOILER - patented technology

PLANT: GREEN SHIP BI-FUEL 34 K

OBJECT: GENERAL ARRANGEMENT

DESIGNER

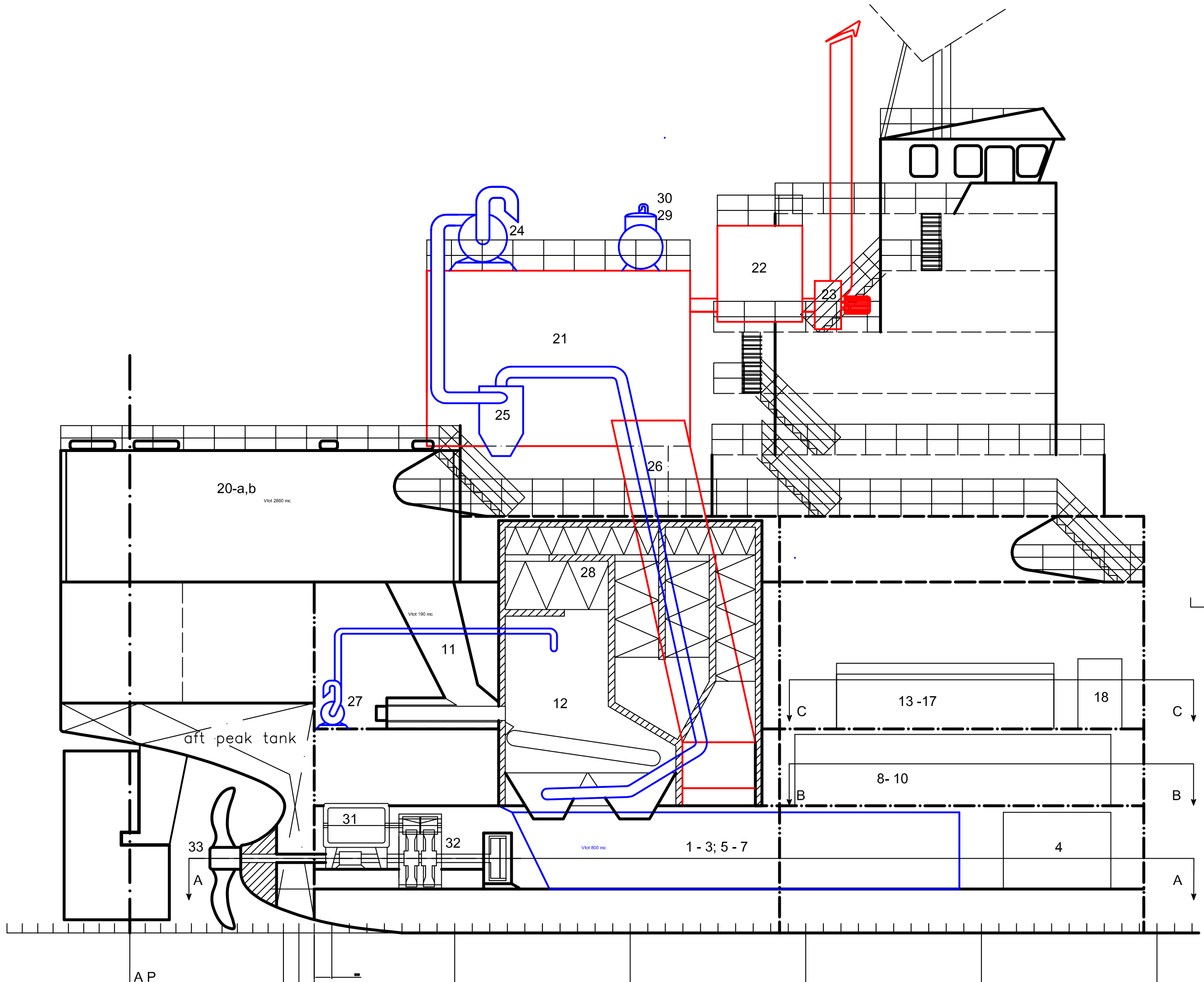
FILE: NAVE1_C07.DWG

REV.	DESIGNED	CHECK	APPROVED	NOTE	DATE
3	gs	fp	mxc	detail revue	06/11/08
2	gs	fp	mxc	pdf emission	23/10/08
1	gs	fp	mxc	general revue	17/10/08
4	gs	fp	mxc	detail revue	07/11/08

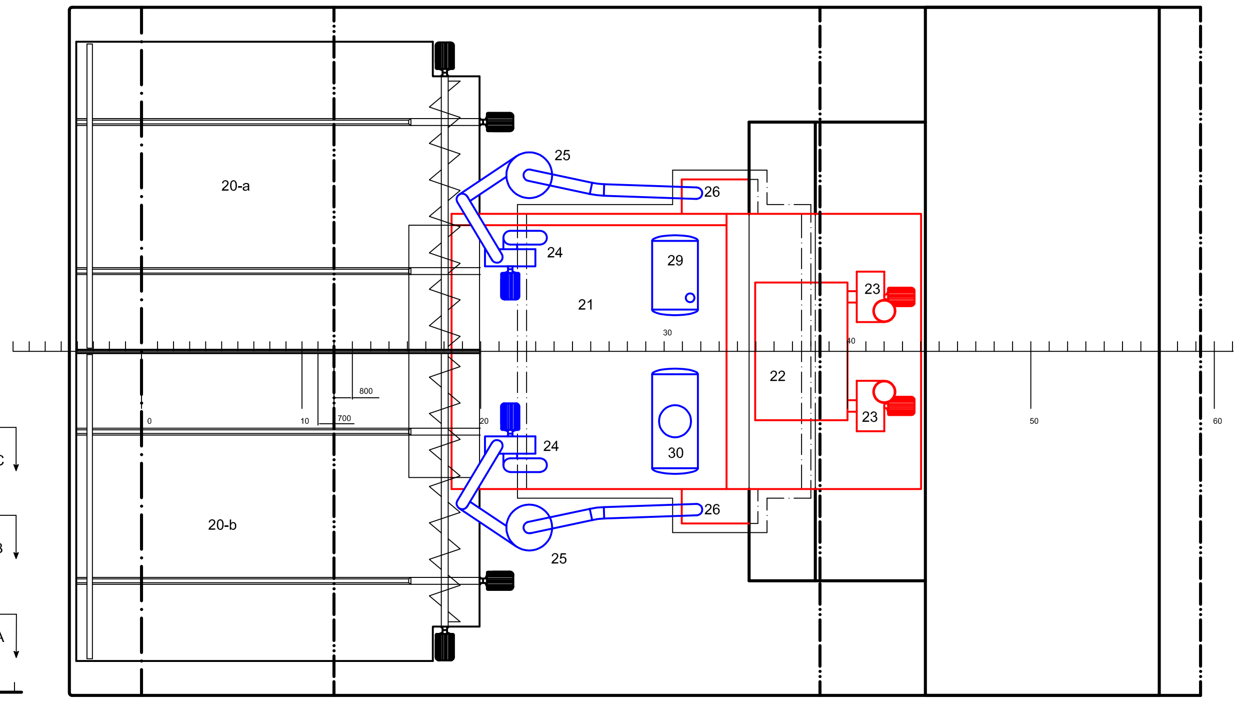
WEST LOGISTICS S.r.l.
Via Latina, 20 - 00179 Roma
C.F./P.iva Reg. Imp. RM 08173671002
info@westlogistics.com
www.westlogistics.com

DATE	as revue
PROJ-CODE	-
DESIGNER	GS
SCALE	1:200

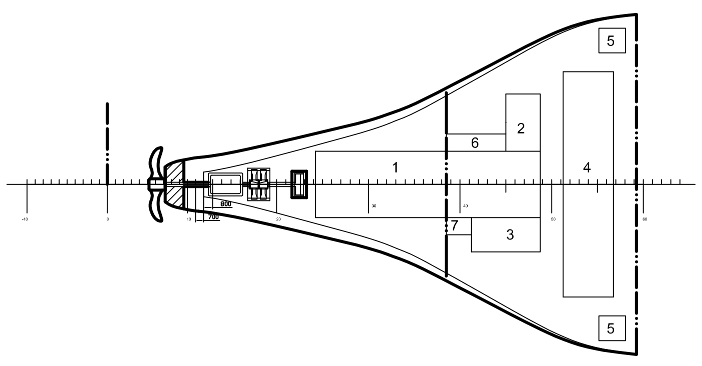
DESIGN-CODE: GSBF34K 1/2



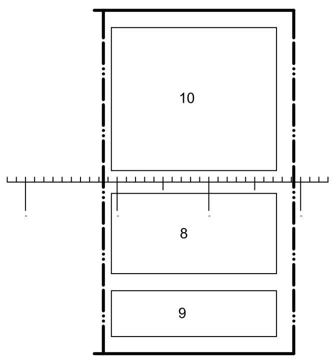
MAIN
SECTION
scale 1:100



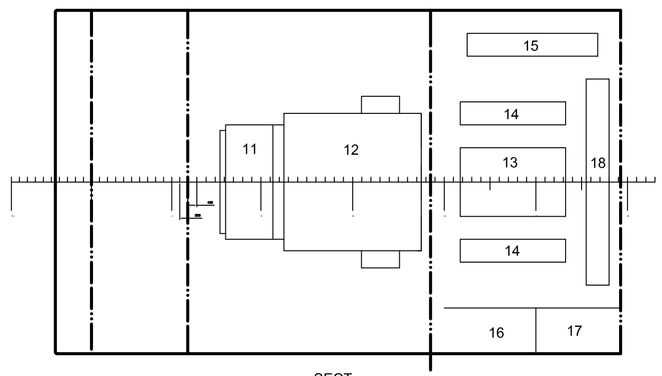
TOP
VIEW
scale 1:100



SECT.
A-A



SECT.
B-B



SECT.
C-C

MAIN PART LIST

1) Bottom Ash Quench Tank
2) Ash Conveyor
3) Ash Pumps And Accessories
4) Heat Exchanger Sea Water – Cooling System
5) Cooling Water Pumps And Accessories
6) Command And Control Center For The Motor
7) Cooling Water System For The Motor And Reduction Gear

8) Turbine Low Pressare Section
9) Pumps, Ejectors And Demi Water Sytem
10) Condenser

11) Rdf Hopper & Feeder
12) Grate Type Boiler
13) Steam Turbine Generator
14) Diesel Generator
15) Main Switch Board
16) Control Room
17) Steam Turbine By-Pass
18) Accessories For The Diesel Generators
19) Accessories For The For The Engine Room

20 a,b) Rdf Storage And Feed System
21) First Stage Flue Gas Treatment
22) Second Stage Flue Gas Treatment
23) Exhaust Fan and Stack

24) Primary Combustion Fan
25) Combustion Air Filter
26) Combustion Air Preheater
27) Secondary Air Fan

28) Boiler
29) Steam Drum
30) Deaerator

31) Main electric motor
32) Ruduction Gear
33) Propeller

BULK CARRIER
RDF POWERED - GRATE BOILER - *patented technology*

PLANT
GREEN SHIP BI-FUEL 34 K

OBJECT
GENERAL ARRANGEMENT

DESIGNER

FILE: NAVE1_C07.DWG

REV.	DESIGNED	CHECK	APPROVED	NOTE	DATE
3	gs	fp	mxc	detail revue	07/11/08
2	gs	fp	mxc	detail revue	06/11/08
1	gs	fp	mxc	pdf emission	23/10/08
0	gs	fp	mxc	emission	17/10/08

WEST Logistics S.r.l.
WEST LOGISTICS S.r.l.
Via Latina, 20 - 00179 Roma
C.F./P.iva Reg. Imp. RM 08173671002
info@westlogistics.com
www.westlogistics.com

DATE	as revue
PROJ–CODE	–
DESIGNER	GS
SCALE	1:200

DESIGN–CODE
GSBF34 2/2