EV2 – NEW RESCUE BOAT POWERED BY LNG: POTENTIAL USE OF LNG AS AN ALTERNATIVE FUEL FOR THE MARITIME RESCUE FLEET

Deliverable D3.3 – Final report on the potential use of LNG in maritime rescue fleets

SASEMAR / ARMON

SOCIEDAD DE SALVAMENTO Y SEGURIDAD MARÍTIMA

ASTILLEROS ARMÓN S.A.

CORE LNGas hive

Core Network Corridors and Liquefied Natural Gas

2014-EU-TM-0732-S

D3.3 – Final report on the potential use of LNG in maritime rescue fleets

Start of project: 01 January 2014 Duration: 60 Months

Lead Contractor for this deliverable: SASEMAR

Revision: 00

Co-financed by the European Union
Connecting Europe Facility

Dissemination level		
PU	Public	
CO	Confidential, only for members of the consortium (including the Commission Services)	X

Revision History

Deliverable Administration and summary		
Project Acronym: CORE LNGas Hive		INEA/CEF/TRAN/M2014/1026196
Document Identifier: D3.3 - FINAL REPORT ON THE POTENTIAL USE OF LNG IN MARITIME RESCUE FLEETS		
Leading partner: SASEMAR		
Report version: 00		
Report preparation date: 28/11/2019		
Classification:		
Status		Plan
		Draft
		Working
		Final
	X	Submitted
		Approved

The Core LNGas Hive consortium has addressed all comments received, making changes as necessary. Changes to the document are detailed in the change log table below.

Date	**Edited by**	**Status**	**Changes made**

Copyright

This report is © CORE LNGas Hive Consortium 2015. Its duplication is allowed only in the integral form for personal use or for the purposes of research and education.

Citation

SASEMAR 2018. Deliverable D3.3 – Final report on the potential use of LNG in maritime rescue fleets CORE LNGas Hive consortium, **www.corelngashive.eu**

Acknowledgements

The work presented in this document has been conducted in the context of the action INEA/CEF/TRAN/M2014/1026196 CORE LNGas Hive. CORE LNGas HIVE is a 60 months project started on January 1st, 2014.

The Project consortium is composed by: Enagás Transporte, S.A.U. (Enagás), Sociedad de Salvamento y Seguridad Marítima (SASEMAR), Universidad Politécnica de Madrid (UPM), Universidade de Santiago de Compostela (USC), ENTE VASCO DE LA ENERGÍA (EVE), Autoridad Portuaria de Barcelona - Port de Barcelona (APB), Port Authority of Cartagena (PAC), AUTORIDAD PORTUARIA DE FERROL-SAN CIBRAO (APF), Autoridad Portuaria de la Bahía de Algeciras (APBA), Port Authority of Huelva (PAH), COMPAÑÍA ESPAÑOLA DE PETRÓLEOS S.A.U. (CEPSA), Regasificadora del Noroeste, S.A. (RdN), HAM CRIOGENICA, S.L. (HAM), BUREAU VERITAS IBERIA SLU (BVI), GUASCOR POWER SA (GP), IDIADA AUTOMOTIVE TECHNOLOGY S.A (IAT), FLOTA SUARDIAZ, S.L. (Suardiaz), ITSAS GAS BUNKER SUPPLY SL (ITSAS), COMPAÑIA DE REMOLCADORES IBAIZABAL, S.A. (IBAI), TERMINAL DE CONTENIDORS DE BARCELONA, S.L. (TCB), Terminal Catalunya, S.A. (TC), UTE REMOLCADORES DE BARCELONA-SAR, UNION TEMPORAL DEEMPRESAS, LEY 18/1982 (URB), ASTILLEROS ARMON, S.A. (AA), GAS NATURAL SDG, S.A. (GN), INSTITUTO ENERXÉTICO DE GALICIA (IEG), Fundación de la Comunidad Valenciana para la Investigación, Promoción y Estudios Comerciales de Valenciaport (Fundación Valenciaport) (FV), Planta de Regasificación de Sagunto, S.A. (PRS), MOLGAS ENERGÍA, SAU (ME), Autoridad Portuaria de Valencia (APV), SEAPLACE SL (Seaplace), BOLUDA CORPORACION MARITIMA S.L. (BCM), Autoridad Portuaria de Bilbao (APBi), RENFE MERANCÍAS S.A. (Renfe), Puertos del Estado (PdE), Dirección General de la Marina Mercante (DGMM), PORT AUTHORITY OF GIJON (PAG), Port Authority of Melilla (PAM), Santander Port Authority (SPA), Port Authority of Tarragona (PAT), Port Authority of Vigo (PAV), Port Authority of Santa Cruz de Tenerife (PASCT) and REN Gasoductos, S.A. (RENG).

More Information

Public CORE LNGas HIVE reports and additional information related with the project execution and results are available through CORE LNGas Hive public website at **www.corelngashive.eu**

Table of contents

0. EXECUTIVE SUMMARY 7
1. INTRODUCTION 8
2. PREVIOUS WORKS 9
2.1. FEASIBILITY STUDY: GAS AS FUEL IN SASEMAR FLEET 9
2.1.1 Conclusions 11
2.2. RETROFITTING OF A MULTIPURPOSE SALVAGE TUG 13
2.2.1 CONCLUSIONS 19
2.3. MANOEUBRAVILITY STUDY COMPARING DIESEL TUGBOAT TYPE "LUZ DE MAR" AND DUAL FUEL DIESEL-LNG TUGBOAT 21
2.3.1 RESULTS OF THE MANOEUVRES 24
2.3.2 CONCLUSIONS 27
2.4. NEW BUILDING DEFINITION 28
2.4.1 CONCLUSIONS 35
3. PHASE 2 36
3.1. SWOT and internal dissemination 36
3.1.1 SWOT ANALYSIS 36
3.1.2 SWOT FOR THE USE OF GAS AS FUEL IN SASEMAR FLEET 38
3.2. NEW BUILDING PROJECT 40
3.3. THIRD VERIFICATION PARTY 42

List of tables

Table 1. Summary of the preliminary feasibility analysis on the use of LNG on SASEMAR fleet units. 11

Table 2 - Luz de Mar Main particulars 16

Table 3. Comparison of advantages and disadvantages. 20

Table 4. Towed vessels.....22

Table 5 – Summary table of manoeuvres.....26

List of figures

Figure 1. General layout side view. 17

Figure 2. Main deck general layout. 17

Figure 3. Double bottom general layout.....17

Figure 4 – Luz de Mar model 22

Figure 5 - Manoeuvres 23

Figure 6 – Vertical tank arrangement - Profile 29

Figure 7 – Vertical tank arrangement – Tank top / Tween deck 30

Figure 8 – LNG tank transversal aft - Profile.....31

Figure 9 - LNG tank transversal aft – Tank top / Tween deck 32

Figure 10 – LNG tank longitudinal center - Profile 33

Figure 11 - LNG tank longitudinal center - Tank top / Tween deck 34

Figure 12 – SWOT TOOL.....37

Figure 13 – SWOT diagram 37

0. EXECUTIVE SUMMARY

The Spanish Society of Salvage and Maritime Safety (SASEMAR) is compromised with the reduction of emissions of their fleet. SASEMAR participate partnering with ARMON Shipyards in the CORE LNGas hive project aiming the evaluation of the feasibility of using gas as fuel as an alternative of conventional fuels (MGO / MDO) as the first step to achieve a more sustainable operation. At present, the technology to use gas as fuel on board is sufficient mature to be considered as a viable alternative without major drawbacks. More than a hundred ships, not gas carriers, are in operation using gas as fuel and even more units (more than 150) are on construction or planned/announced to be built in the following years.

SASEMAR after a first phase where the fleet was assessed, has developed a second phase aiming to further develop a new building concept design including a third party analysis done by Lloyds Register, develop a SWOT analysis providing good knowledge of where we are and the strategies to be followed.

The main output of the second phase is that the New Building is technical feasible but due to the external and internal issues that impacts (or could impact) in the project, a survival strategy seems to be the more appropriate, where the uncertainties can be maintained under control and the weaknesses are still strong enough not to be underestimated.

1. INTRODUCTION

The Society of Salvage and Maritime Safety (hereinafter SASEMAR) and Shipyards ARMÓN, S.A. (hereinafter ARMON), are partners in the consortium formed for the development of the CORE LNGas hive Project. Both entities were designed for the development of the EV2 sub-activity "Rescue boat powered by LNG".

The main objectives to be achieve with this activity are focused, within the policy of reducing emissions from maritime transport, in developing an study about the use of Liquefied Natural Gas (LNG) as alternative fuel in anti-pollution and salvage vessels, since it is a viable alternative to the use of conventional fuels (MGO/MDO) more harmful to the environment from the point of view of emissions.

Based on it, the application of LNG as fuel in salvage vessels requires a technical analysis because of the particularities and the wide range of typologies that these ships actually give service in the coasts of the world. Within the present study an analysis of the state of the art in relation to the use of LNG will be carried out, as well as a study on the feasibility of using in both existing and new building SASEMAR fleet vessels. The global study to be developed along the project CORE LNGas HIVE will also include a monitoring on the latest technological developments in the use of LNG in ships in order to keep it up to the end of the EV2 sub-activity.

2. PREVIOUS WORKS

The project developed by SASEMAR and ARMON, contains the following tasks, deliverables and milestones:

EV2 - Rescue boat powered by LNG
T1 - Analysis of the current fleet, operating profiles and trends
T2 - Design requirements imposed by the use of LNG technologies, regulation and infrastructure...
T3 - Retrofitting study including maneuvering tests
T4 - Design of a new bulding of a LNG power multipurpose vessel. Including maneuvering test
T5 - Monitoring the infrastructure, regulations and technology progress for the use of LNG as fuel
T6 - SWOT analysis
T7 - Internal dissemination and engaging activities
D3.2 - Feasibility and technological development study of an LNG-powered rescue boat
D3.3 - Finalreport on the potential use of LNG in maritime rescue fleets
M7 - Approved intermediate report on the progress and first results of feasibility studies EV2, 3...
M9 - Final results of feasibility studies EV2, EV3 and EV7 are approved

Figure - 1 Project tasks, milestones and deliverables

During the first phase of the project, several works where carried out in order to define the potential use of gas as fuel in Sasemar fleet. The studies comprised from an initial survey of Sasemar fleet and the LNG potential to the preliminary definition of the main aspects of a New Building. Such studies where included in the Deliverable 3.2 F*easibility and Technological development study of an LNG-powered rescue boat*. In the following subsections it is shown the main topics of the Deliverable 3.2 and the conclusions.

2.1. FEASIBILITY STUDY: GAS AS FUEL IN SASEMAR FLEET

The feasibility study carried out considers the overall SASEMAR fleet and categorize the suitability of each type of unit to be upgraded to use Gas as fuel. The analysis where carried out considering operational and technical requirements such as power, range, LNG logistics and LNG technology on board.

SASEMAR fleet was divided into the following categories:

- SALVAMARES: Fifty-five units with a range of total lengths between 15 and meters and beams between 3.80 and 5.60 meters. These are quick response rescue and salvage units with a certain towing capacity.
- GUARDAMARES: Four units (Calíope, Concepción Arenal, Polimnia and Talía) built in the 2008-2009 period, which are quick response vessels with towing capacity, with a size of 31 meters in length and 7 meters of breadth.
- SALVAMARES: Fifty-five units with a range of total lengths between 15 and meters and beams between 3.80 and 5.60 meters. These are quick response rescue and salvage units with a certain towing capacity.
- GUARDAMARES: Four units (Calíope, Concepción Arenal, Polimnia and Talía) built in the 2008-2009 period, which are quick response vessels with towing capacity, with a size of 31 meters in length and 7 meters of breadth.
- HIGH SEA TUGS: Seven units (María de Maeztu, María Pita, María Zambrano, Marta Mata, SAR Gavia, SAR Mastelero and SAR Mesana)

delivered in the period of 2007-2010. They have a size of 39.7 meters in length and 12.50 meters of breadth.

- MULTIPURPOSE VESSELS CATEGORY 1: Two units (Luz de Mar y Miguel de Cervantes) built in 2004 with a length overall of 56 meters and a breadth of 15 meters. They can perform, among other functions, towing and anti-pollution Works, as well as rescue and salvage operations.
- MULTIPURPOSE VESSELS CATEGORY 2: These are two units (Clara Campoamor y Don Inda) built in the year 2002. They have a size of 80 meters in length and 18 meters of breadth, and are capable of develop a wide range of operational functions.

As per the operational and technical requirements, the feasibility analysis of the fleet where categorized by a colour code indicating the fulfilment of the criteria:

- **Green**: It is considered feasible to comply with the requirements imposed on a particular ship category.
- **Orange**: It is considered feasible to comply with the requirements imposed on a particular ship category, although with caveats and several risks of not meeting the requirements
- **Red**: It is not considered feasible to comply with the requirements imposed on a particular ship category.

2.1.1 Conclusions

Based on the analysis carried out, a series of conclusions and data are summarized below, for each of the blocks in which the study has been divided:

POWER REQUIREMENTS / AVAILABLE LNG ENGINES	RANGE REQUIREMENTS / CALCULATED VOLUME
Dual main engine alternatives have been found for all the ship categories in the current power ranges. Regarding the auxiliary groups only dual alternatives have been found for the multipurpose vessels. The analysis of this point has yielded the following preliminary feasibility results: SALVAMARES ✓ GUARDAMARES ✓ HIGH SEAS TUG ✓ MULTIPURPOSE CATEGORY 1 ✓ MULTIPURPOSE CATEGORY 2 ✓	It is calculated the required volume of LNG to reach the 10%, 25% and 50% of the range. In a first analysis, it is not possible to evaluate the volumes corresponding to the 50% because they are considered excessive. The rest of the calculations are evaluated once the tanks are dimensioned in the section of technology integration. SALVAMARES ✓ GUARDAMARES ✓ HIGH SEAS TUG ✓ MULTIPURPOSE CATEGORY 1 ✓ MULTIPURPOSE CATEGORY 2 ✓
SUPPLY CHAIN / RESPONSE TIME	**LNG TECHNOLOGY INTEGRATION ON BOARD / AVAILABLE SPACE**
It is evaluated the state of the LNG supply infrastructures in Spain, although the results of the horizontal activities of the CORE LNGas HIVE project regarding the current and planned infrastructure os LNG supply points are awaited. The following conclusions based on the current requirements of the SASEMAR fleet are obtained: SALVAMARES × GUARDAMARES × HIGH SEAS TUG ✓ MULTIPURPOSE CATEGORY 1 ✓ MULTIPURPOSE CATEGORY 2 ✓	The preliminary dimensioning of the different equipment and a first analysis on the integration of these equipment into the current provisions of the ships are carried out at this point. Also a series of requirements imposed by the IMO in relation to the location of tanks and the classification of spaces are analysed. The following results are obtained: SALVAMARES × GUARDAMARES × HIGH SEAS TUG × MULTIPURPOSE CATEGORY 1 ✓ MULTIPURPOSE CATEGORY 2 ✓

Table 1. Summary of the preliminary feasibility analysis on the use of LNG on SASEMAR fleet units.

The implementation of power plants based on dual engines is technically complex since it involves the installation of additional systems and equipment, having in addition to comply with demanding requirements regarding their arrangement on board, which are imposed by regulation. The versatility of the vessels under study

greatly complicates this work since the normal operation of the new equipment cannot interfere in any way with the missions/operations that they develop. This will require a detailed analysis of the location of each element as well as the study of hazardous areas and escape routes, in accordance with the applicable regulations.

The on board volume requirements needed by the gas equipment are very high, since in addition to occupying more space than the equivalent technology of oil-based liquid fuels, require significant regulatory distances, which further complicates the feasibility of installation on board.

The preliminary feasibility study addressed has resulted in the integration of LNG technology could become possible in the MULTIPURPOSE VESSELS, since they have a larger space and therefore offer greater possibilities in terms of generating alternatives for the integration of the necessary equipment for the consumption of LNG on board.

Even more, between the MULTIPURPOSE VESSELS, it seems more reasonable to carry out the implementation of gas as fuel in the MULTIPURPOSE VESSELS CATEGORY 1 due to the following:

- Amount of LNG
- Complexity and economics
- Operational profile

2.2. RETROFITTING OF A MULTIPURPOSE SALVAGE TUG

As per the conclusions of the feasibility study: gas as fuel in SASEMAR fleet a retrofitting analysis was carried out in the MULTIPURPOSE VESSELS CATEGORY 1, based on the twin ships Luz de Mar and Miguel de Cervantes.

These vessels are designed to operate in four main scenarios:

- Salvage and Rescue
- Anti-pollution
- Fire fighting
- Support

Each of these situations requires different specialized equipment in order to complete the missions with the maximum efficiency possible, what makes this kind of ships highly technological instruments.

In the following tables and figures it can be seen the main particulars of these vessels:

Main Particulars	Name	Miguel de Cervantes / Luz de Mar	
	Vessel Type	Multipurpose Salvage and Rescue Tug, Oil Spill Response Vessel	
	Length Overall		56.00 m
	Length Between Perpendiculars		48.00 m
	Beam		15.00 m
	Depth	To Main Deck	7.00 m
	Draft	Design	5.50 m
	Net Tonnage		534
	Gross Tonnage		1,780
	Displacement (at summer draft)		2,940 t
	Deadweight		483/1,190 t
	Hull	Material	Steel
	Speed	Maximum	16.40 knots
		Cruise	13 knots
		Back	15.80 knots
	Range (80% MCR)		6,000 nm
	Bollard Pull	100% MCR	128.5 t

		80% MCR	107.0 t
	Crew	Standard	14
		Maximum	18
		Technicians And Auxiliary Services	8
Registration and P&I	Flag	Spain (CSR)	
	Port of Registry	Santa Cruz de Tenerife	
	Current P&I Club	Britannia Steam Ship Inc Assoc	

Classification	Classification Society	Bureau Veritas	
	Class	I HULL MACH, Fire Fighting Ship, Tug, Water Spraying-1, Unrestricted Navigation, AUT-UMS, Dynypos-R, IG	
Propellers	Bow Propellers	Manufacturer	SCHOTTEL Gmbh
		Model	SRP 3040 CP
		Diameter	4,300 mm
		Number of Blades	4
		Speed SRP	600 RPM
		SRP Gear Reduction	3.246:1
		Turn Rate	15 s / 180°
	Stern Thruster	Manufacturer	SCHOTTEL
		Model	STT 330 LK CP
		Power	400 kW
		Rotatory Speed	1.470 RPM
		Reduction Rate	3,54:1
		Propeller Diameter	1.490 mm
		Number of Blades	4
		Blades Type	Variable Pitch
		Nominal Push	68 kN

Engines	Main Engines	Manufacturer	MAK
		Model	8M32C
		Number of Engines	2
		Power	5,222.40 CV / 3,870.00 kW
		Rotatory Speed	600 RPM
		Gearbox	Kumera 4FGCCC500/525
		Fuel Consumption	214 g/kW at 2,400 RPM
		Number of Shafts	2
Generators	Auxiliary	Manufacturer	CATERPILLAR
		Model	3508B
		Rotatory Speed	1500 RPM
		Power	1.480 kW / 2.013 HP at 1.500 RPM
		Fuel Consumption	206 g/kW
		Fuel	Gas-Oil
		Generator	CATERPILLAR
		Power	1.000 kVA / 800 kW
		Voltage	400 V
		Frequency	50 Hz

	Harbour Generator (Emergency Generator)	Manufacturer	CATERPILLAR
		Model	CATERPILLAR 3406
		Power	307 kW / 494 HP
		Consumption	204 g/kWh
		Power	440 kVA / 352 kW
		Voltage	400 V
		Units	1
	Tail Shaft Generator	Generator	Satmfor
		Power	1.000 kVA / 800 kW
		Voltage	400 V
		Frequency	50 Hz

Table 2 - Luz de Mar Main particulars

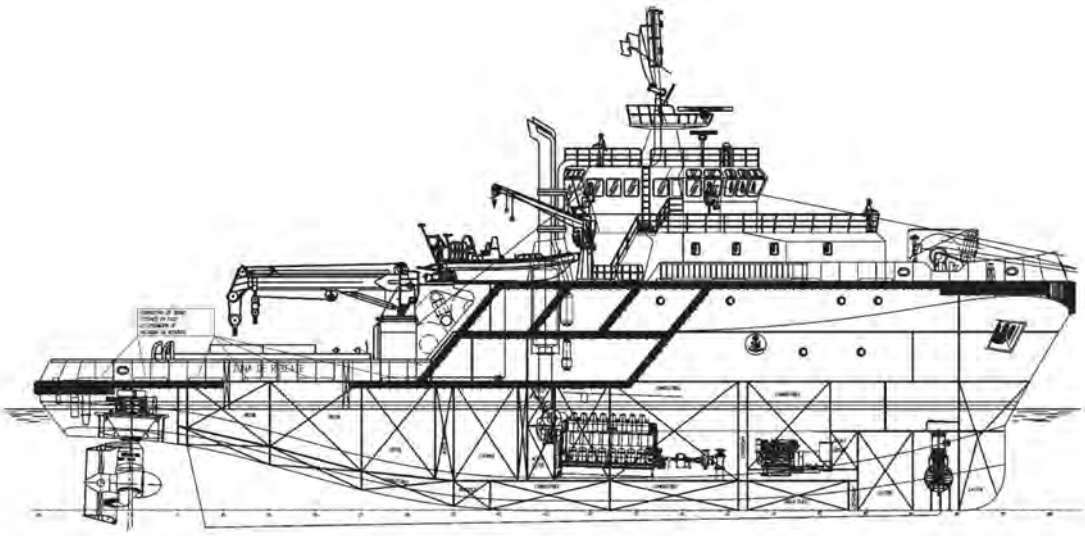


Figure 1. General layout side view.

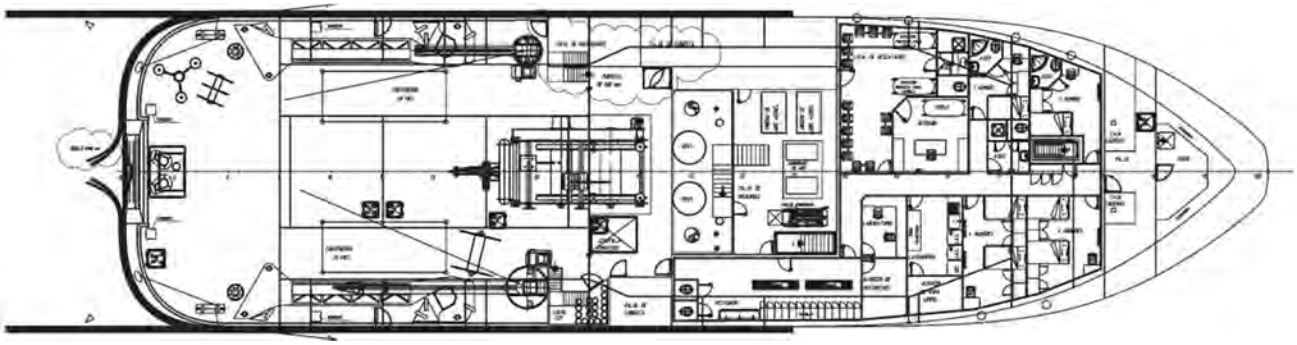


Figure 2. Main deck general layout.

).

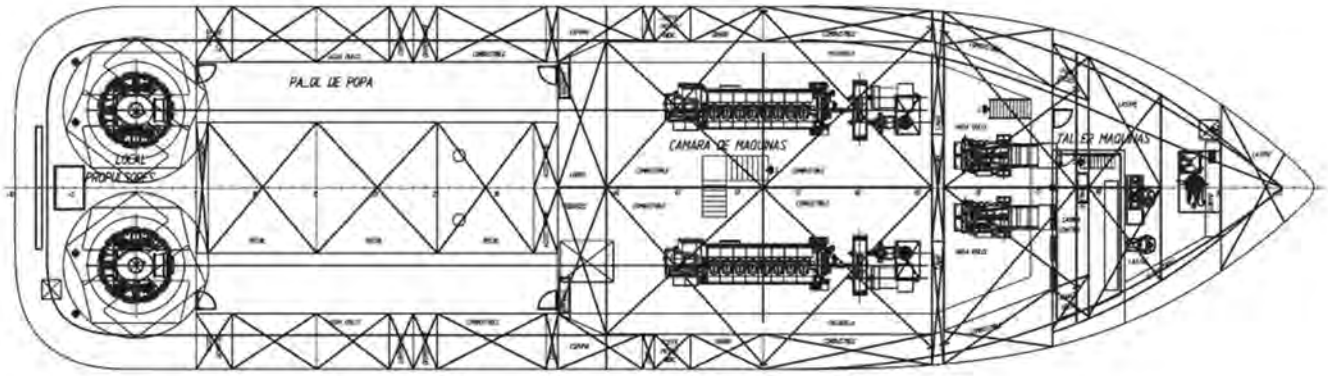


Figure 3. Double bottom general layout.

The retrofitting analysis was carried out based on the following requirements in order to maintain the operational capabilities:

- Range should be maintained operating with diesel at 85% of the MCR.
- Arrangement of fuel tanks should not be modified.
- The range will be approximately two days operating with LNG as fuel in a MCR range of 70% -85% (10-12 knots).
- Range in port will be ten days only using LNG as fuel.
- Bureau Veritas class notations will be maintained: I + HULL + MACH TUG, FIRE FIGHTING SHIP 1 WATER SPRAY, SPECIAL SERVICE, OIL RECOVERY SHIP, UNRESTRICTED NAVIGATION, + AUT-UMS, + DYNAPOS-AM-R Adding necessary requirements to the introduction of LNG as on-board as a fuel.
- It will be necessary to calculate the towing capacity reduction (From bow and stern) after retrofitting, in both cases using diesel and LNG as fuels. Do not miss more than 10% capacity in both cases.
- It will be necessary to calculate the ship speed reduction after retrofitting at different engine speeds and propeller pitches, do not miss more than more than 10% of the ship speed at any operational situation.
- It will be necessary to calculate the response time increments related to power demand and propulsion response at any operational situation.
- It will be necessary to calculate downtime due to LNG bunkering operations.
- If necessary, it would admit a loss of oil recovery capacity up to two thirds for LNG tanks installation.
- Rescue area, towing deck and towing operation area must be kept without obstacles.

2.2.1 CONCLUSIONS

It is clear that the Natural gas engines have a lot of advantages relating with environmental aspects, reducing emissions of CO_2 and even almost making disappear others like SO_X and particulates. This aspect could be very beneficial for the environment, and was the main reason to think about making this change in the ship of SASEMAR, because it could be a flag project to be an example to others, in accordance with the international trends of looking for solutions to reduce emissions, (not only in maritime environment).

Other very important aspects to go for LNG system is that there are some very developed rules at different stages like IMO and different Class Societies. Indeed, along the document have been explained that these systems are widely known, and the main maritime engineering supplier brands also have different solutions to provide for any type of ship which had been exposed along this document (specially from MAN and Wärtsilä). These solutions have been utilized by many shipyards along the world, and have a proven efficiency and performance, making them suitable for the project exposed.

Also, it is necessary to add that there are different forms of bunkering that are safe, and Spain has a correct infrastructure to provide gas to these ships, and, in this aspect it could be plausible to use dual motors, even more when the LNG gas is becoming an option to a lot of ships to comply with the rules about emissions.

Also, it was decided to develop the analysis taking into account the type C tanks to storage LNG gas, because is widely use in the maritime field, and is an advanced technology that has proven a good efficiency in maritime systems.

For the reasons outlined above, the LNG was a good alternative focusing in environmental aspects but the main problems found along the retrofitting analysis are mainly technical aspects.

The biggest disadvantage of LNG in the current project is that it needs a huge space to provide enough autonomy. This made impossible to install the tank inside the recoil tanks at the stern of the ships and it was not possible to change the length and beam of these tanks. In the alternative analysis, there were explored the tanks of suppiers MAN and Wärtsilä, trying to check if it would be possible to install tanks reducing the operative requirements given at the beginning. Even with lower requirements, the problem persisted; the tanks were too large to be introduced inside the recoil tanks.

To install the LNG tanks in the main deck was not a feasible option, because it would conflict the normal operation of the ship, fact that would become the vessel useless.

In these terms, it should be emphasized the logistic problem of the size of the LNG tanks, and it must be taken into account in every retrofitting project of the same characteristics, although other parameters could be quite positive in different ranges.

Estimations provided by the shipyard indicate that there would be a speed loss between 0,5-0,75 knots and between 10-12 tons of bollard pull.

In the following table the different advantages and disadvantages are gathered:

RETROFITTING COMPARISON	
ADVANTAGES	**DISADVANTAGES**
less emissions during short period of time	Increase fuel consumption due to the higher MDO specific consumption of the new engines
	More contamination in MDO operational mode
	High retroffiting cost compared to the residual value of the vessel
	Loss of recoil capacity
	Oversized boiler
	Loss of ship speed due to new dual main engines characteristics.
	Loss of ship bollard pull due to new dual main engines characteristics.

Table 3. Comparison of advantages and disadvantages.

2.3. MANOEUBRAVILITY STUDY COMPARING DIESEL TUGBOAT TYPE "LUZ DE MAR" AND DUAL FUEL DIESEL-LNG TUGBOAT

Based on the importance of the towing for SASEMAR fleet, it has been developed a study to understand the impact of the use of gas as fuel propulsion in the towing operation in comparison with the current diesel propulsion These ship manoeuvres have been carried out using the most advanced tools in this field.

To do this we have used the set of Polaris simulators: Simulator ship manoeuvring Jovellanos Integral Maritime Center for being the tools that offer more realism and reliability available today.

Given the diversity of the types of accidents that can occur to a ship in emergency situations, the severity of the consequences that the management of them can cause on the lives of people on board and on the environment, the variability of the coast and changing both its ocean-weather and its terrain, it has proceeded to study a simulated ship damaged and requires rescue is intact, drifting without propulsion or government and it is towed with a ¨Luz de Mar¨ type unit. In case the vessel had limited propulsion or reduced government the conditions of handling of it would be less demanding and would improve the manoeuvrability of the vessel-tug boat.

The multipurpose ships modelled have been the Luz de Mar and the Luz de Mar LNG propulsion. They have been handled with the maximum level of realism that the simulator allows and has had the experience of one of the Captains of the SASEMAR Fleet that was are responsible of the unit Miguel de Cervantes twin of Luz de Mar. The developed models correspond to specific numerical models with six freedoms degrees that integrate not only the movements of the tugboat but also the behaviour of the towing cable and the propulsive system of the afore mentioned units.

The basic difference between both tugs has been exemplified taking into account the variation of the response time of the main engines in the face of a demand for variable power, as can be deduced from the manufacturer's project guides.

To compare both tugs, the shunting have been repeated twice in each weather condition and assisted vessel, the first towing with the current engine and the second towing with the model of dual fuel engines operating with LNG onwards.

Figure 4 – Luz de Mar model

The development of these models has been possible thanks to the development of the company ENRED that was responsible of do it, with the collaboration of Armón Shipyards, constructor of the twin multi-purpose ships Miguel de Cervantes and Luz de Mar and that are operated by Maritime Rescue, and the manufacturer of the engines of the MAK units, which have provided all the technical information necessary to model the possible dual fuel engine for manoeuvring behaviour.

The towed vessels have consisted of very large vessels with the following main particulars:

NAME	IMAGE	TYPE	LENGTH	BEAM	DRAUGHT	PROPULSION
VLCC07F FULL LOAD		TANKER	342	53	11,4	FIXED PITCH PROPELLER
GAS 05 L		GAS CARRIER QMAX	333	54	12	2 FIXED PITCH PROPELLER
CNTNR28L		CONTAINER SHIP	332	43	14,5	FIXED PITCH PROPELLER
EUROPA		CRUISER	225,3	26,7	6,5	AZIPOD

Table 4. Towed vessels

The general program of manoeuvres proposed consists basically in the performance of various type manoeuvres executed in different meteorological conditions. Specifically the manoeuvres are those described below:

MANOEUVRE	TUG	TOWED VESSEL	WIND Speed(knots)	WAVE H(m)	DESCRIPTION
1	LUZ DE MAR	TANKER	25	3	Approach to towed vessel, hitch, start of towing and towing
2			37	4	
3			48	6	
4		GAS CARRIER	25	3	
5			37	4	
6			48	6	
7		CRUISER	25	3	
8			37	4	
9			48	6	
10		CONTAINER SHIPS	25	3	
11			37	4	
12			48	6	
13	LUZ DE MAR GAS	TANKER	25	3	
14			37	4	
15			48	6	
16		GAS CARRIER	25	3	
17			37	4	
18			48	6	
19		CRUISER	25	3	
20			37	4	
21			48	6	
22		CONTAINER SHIPS	25	3	
23			37	4	
24			48	6	

Figure 5 - Manoeuvres

2.3.1 RESULTS OF THE MANOEUVRES

The results of the manoeuvres are those that are reflected below in the following table in terms of viability:

1. **HITCH**: in the first phase of the manoeuvre the approach and hooking of the tug to the towed is made.
2. **HOLD**: the second phase of the manoeuvre consists of reducing the drift speed of the towed vessel.
3. **REVOLVING AND TOWING**: the third phase of the manoeuvre consists in checking the possibility of turning the vessel and towing it to take it to the shelter zone.
4. **RESULT**: In the last column we can observe the joint result of the manoeuvre, that is to say it will be viable in those cases in which it has been in all the phases previously described.

MANOEUVRE	TUG	TOWED VESSEL	WIND Speed(knots)	WAVE H(m)	DESCRIPTION	CAPTAIN´S COMMENTS	HOOK	MAINTAINING	TURN AND TOWING	OVERALL RESULTS
1	LUZ DE MAR	TANKER	25	3	Approach to towed vessel, hitch, start of towing and towing	Not necessary for being viable in a higher condition	*feasible*	*feasible*	*feasible*	*feasible*
2			37	4		Viable manoeuvre, in hook, maintaining the boat and change course	*feasible*	*feasible*	*feasible*	*feasible*
3			48	6		For the hold it would be necessary to throwing, with projectile. The sea sweeps the bow of the tanker, making it difficult to manoeuvre in the bita´s tug. With this condition of sea the tanker derives between 1 and 3 of a knots towards earth. The approach is risky. The movements of both units are abrupt. By the existing swell the approximation and separation must be quick and precise, to avoid the collision of the tugboat with the tanker. After getting the hook if this is feasible, and against the wind the tug is able to stop the starting from 1 to half a knot, with tensions of up to 106 ton and full machine. The turn of the tanker is not viable, it a lot the tension with all the picht and the tanker does not follow the tug but it drags it, so you can´t running the manoeuvre safely and is terminated.	*feasible*	*feasible*	*Unfeasible*	*Unfeasible*
4		GAS CARRIER	25	3		feasible the hook and mainting gas carrier. Not possible to turn it.	*feasible*	*feasible*	*feasible*	*feasible*
5			37	4		feasible	*feasible*	*Unfeasible*	*Unfeasible*	*Unfeasible*
6			48	6		The reaction to the wind of the LNG is more noticeable than with the tanker the approximation is very complex. The tug is not able to drag the gas carrier or carry out the turn.	*Unfeasible*	*Unfeasible*	*Unfeasible*	*Unfeasible*
7		CRUISER	25	3		Not necessary for being viable in a higher condition	*feasible*	*feasible*	*feasible*	*feasible*
8			37	4		feasible	*feasible*	*feasible*	*feasible*	*feasible*
9			48	6		feasible the hook and mainting gas carrier. If possible to turn it.	*feasible*	*feasible*	*Unfeasible*	*Unfeasible*
10		CONTAINER SHIPS	25	3		Not necessary for being viable in a higher condition	*feasible*	*feasible*	*feasible*	*feasible*
11			37	4		feasible	*feasible*	*feasible*	*feasible*	*feasible*
12			48	6		feasible the hook and mainting gas carrier. If possible to turn it.	*feasible*	*feasible*	*Unfeasible*	*Unfeasible*

MANOEUVRE	TUG	TOWED VESSEL	WIND Speed(knots)	WAVE H(m)	DESCRIPTION	CAPTAIN´S COMMENTS	HOOK	MAINTAINING	TURN AND TOWING	OVERALL RESULTS
13	LUZ DE MAR GAS	TANKER	25	3	Approach to towed vessel, hook, start of towing and towing	Not necessary for being viable in a higher condition	*feasible*	*feasible*	*feasible*	*feasible*
14			37	4		Viable manoeuvre, in hook, maintaining the boat and change course	*feasible*	*feasible*	*feasible*	*feasible*
15			48	6		For the hook it would be necessary to throwing, with projectile. The sea sweeps the bow of the tanker, making it difficult to manoeuvre in the bita´s tug. With this condition of sea the tanker derives between 1 and 3 of a knots towards earth. The approach is risky.The response of this gas-engine unit is slower. However this can be saved by climbing the PICTH to 100% and manoeuvring with the rotation of the thrusters. In this case it decreases the safety margin of the manoeuvre by having less angle availability. It should be noted that in case of failure of the gas plant, during the change to diesel both boats would be adrift. The movements of both units are abrupt. By the existing swell the approximation and separation must be quick and precise, to avoid the collision of the tugboat with the tanker. After getting the hitch if this is feasible, and against the wind the tug is able to stop the starting from 1 to half a knot, with tensions of up to 106 ton and full engine. The turn of the tanker is unfeasible, it raises a lot the tension with all the picht and the tanker does not follow the tugboat but it drags it., so you can´t running the manoeuvre safely and is terminated	*Unfeasible*	*feasible*	*Unfeasible*	*Unfeasible*
16		GAS CARRIER	25	3		feasible the hook and mainting gas carrier. If possible to turn it.	*feasible*	*feasible*	*feasible*	*feasible*
17			37	4		feasible	*feasible*	*Unfeasible*	*Unfeasible*	*Unfeasible*
18			48	6		This manoeuvre isn´t feasible for sure. The approximation for the hold requires greater agility of response. It continues manoeuvre simulating hold and turn is unfeasible neither	*Unfeasible*	*Unfeasible*	*Unfeasible*	*Unfeasible*
19		CRUISER	25	3		Not necessary for being viable in a higher condition	*feasible*	*feasible*	*feasible*	*feasible*
20			37	4		feasible	*feasible*	*Unfeasible*	*Unfeasible*	*Unfeasible*
21			48	6		Viable but with many reserves, first to proceed to hook. You miss speed from the machine. Once hooked you can maintening the position of the towed ship and even change the bow and carry it towed. The problem arises when making the turn because the effect of wind and sea which would lead to undesirable situations for the tug.	*Unfeasible*	*feasible*	*Unfeasible*	*feasible*
22		CONTAINER SHIPS	25	3		Not necessary for being viable in a higher condition	*feasible*	*feasible*	*feasible*	*feasible*
23			37	4		feasible	*feasible*	*feasible*	*feasible*	*feasible*
24			48	6		feasible the hook and mainting gas carrier. Not possible to turn it.	*feasible*	*feasible*	*Unfeasible*	*Unfeasible*

Table 5 – Summary table of manoeuvres

2.3.2 CONCLUSIONS

The present study reflects very realistic conditions from the point of view of the manoeuvrability of ships, since each of the boats involved responds to a mathematical model of six specific freedom degrees and has been manoeuvred, in real time, by a Captain with great experience in the real tugboat.

The potential response to the effective tugboat´s pull once the trailer is delivered does not differ between the operation with engines powered by diesel, or natural gas.

The conditions of simulation have been very harsh although they contemplate the casuistry of tow in emergency from the aspect of the limitation of the viability of the rescue for this type of unit.

The change of fuel type has not affected the manoeuvres of drag and revolt although it has affected at the time of coupling. Although the way to manoeuvre the propulsion has varied in this cases between having diesel fuel or Natural Gas. In the first case, the pitch of the propellers was modified, and in the second case, the propellers were rotated at an angle of rotation.

With winds of 25 knots coupled to 3 meter waves, the result of all the manoeuvres is positive regardless of the type of propulsion.

With winds of 37 knots coupled to waves of 4 meters, there are differences that affect the operation of the tugboats analysed during the rescue operation.

With winds of 48 knots coupled to 6-meter waves, there are also differences that affect the operation of the tugboats analysed during the rescue operation.

For tougher storms the manoeuvres are not considered operationally viable, so they have not been analysed.

2.4. NEW BUILDING DEFINITION

The purpose of the new building definition is to develop the technical requirements of a new building vessel using gas as fuel. The storage and handling of a cryogenic fluid presents several challenges to be taken into account during the design phase.

The scope of the definition of the New Building contains several technical and operational requirements that will define the feasibility of the unit.

- Selection of the reference unit to be defined. Base case scenario
- Requirements and operational profile
- Preliminary dimensioning of the vessel
- Technology review for the present unit
- Rules and regulations
- New Building feasibility

The preliminary development is based on the present operation of the vessels Clara Campoamor and Don Inda plus additional capabilities in order to provide SASEMAR with the latest technology available improving the present operability.

The new building definition has been developed defining the main configuration of the ship:

- Propulsion plant:
    - Power requirements of the propulsion plant are as follows:
    - 2 main engines 5.500 kW each
    - 2 PTO 2.000 kW each
    - 2 PTI 3.000 kW each
    - 2 Auxiliary engines of 3.000 kW each
    - Port generator of 600 kW
- Bollard pull
    - 235 t
- FIFI-II
- LNG tank
    - 200m3
- Moonpool
- Helideck
    - AW139

The following configurations, shown in the following pages, are considered:

- Vertical located forward
- Horizontal – transverse aft
- Horizontal - longitudinal centre

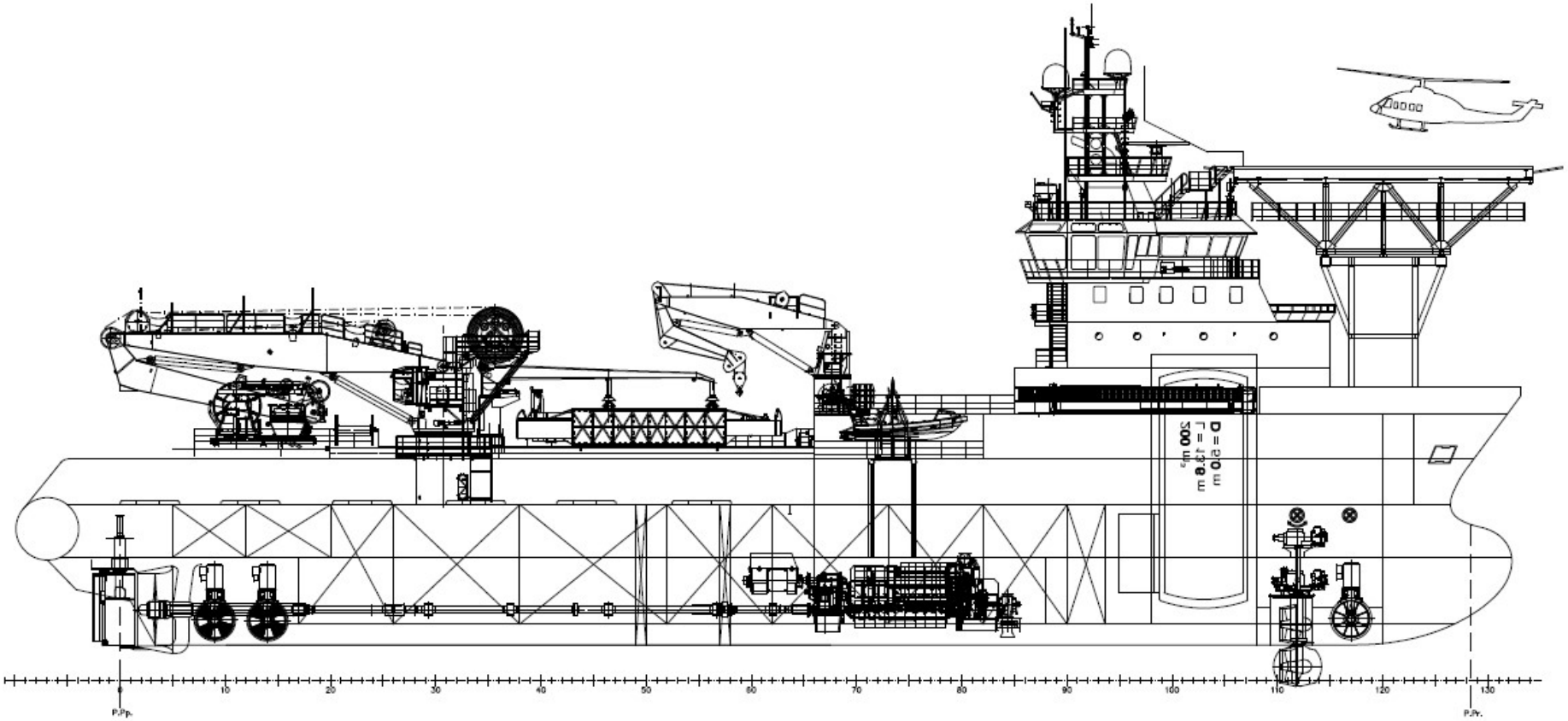


Figure 6 – Vertical tank arrangement - Profile

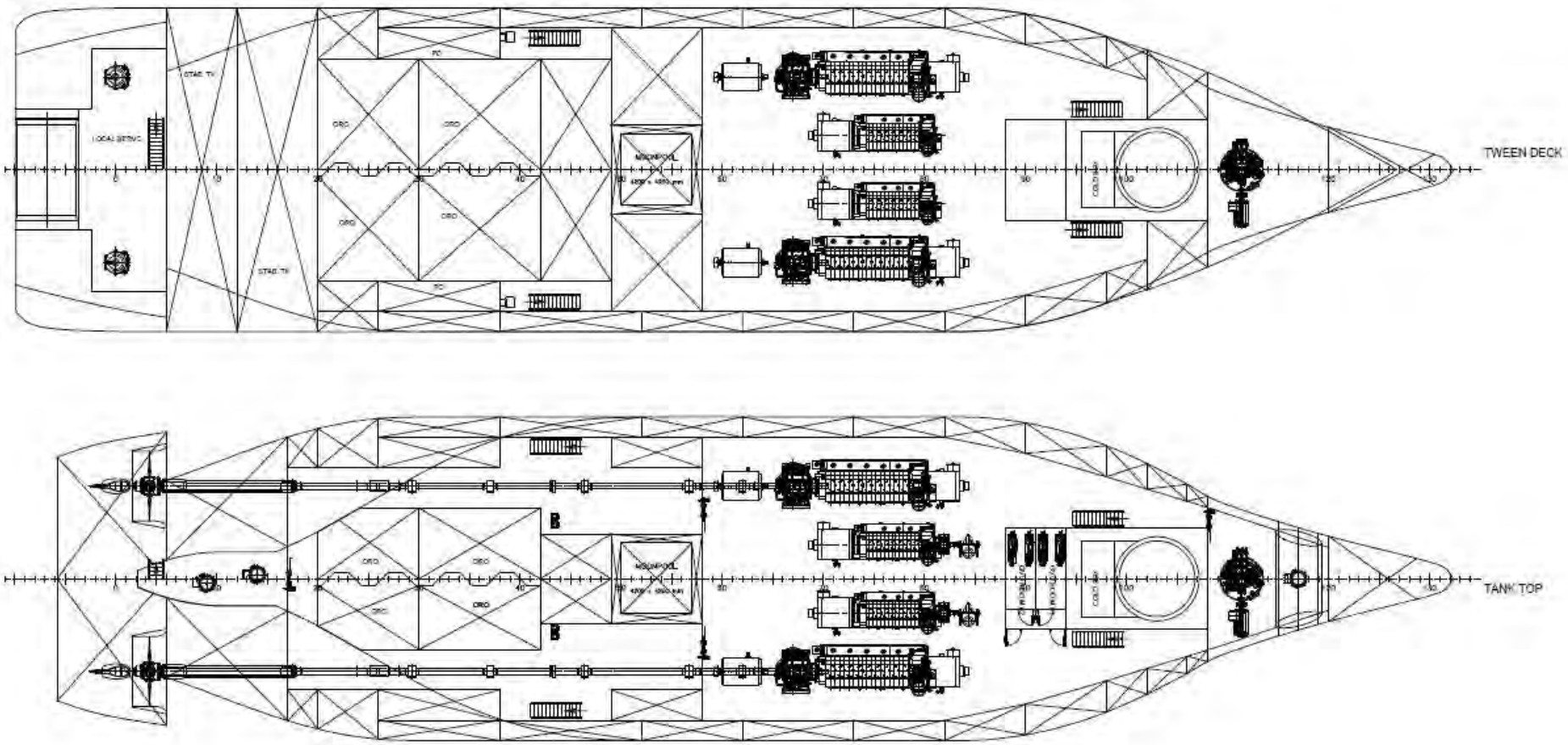


Figure 7 – Vertical tank arrangement – Tank top / Tween deck

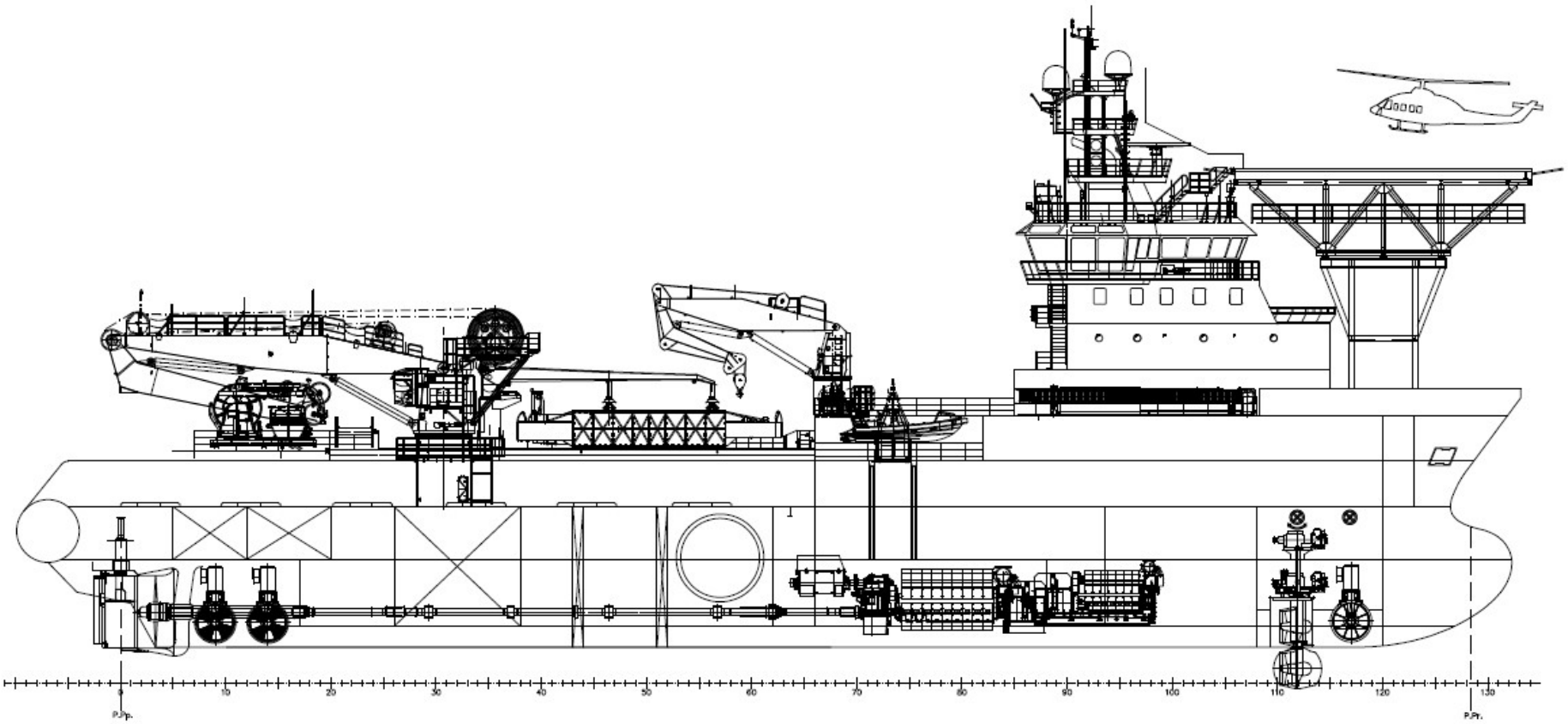


Figure 8 – LNG tank transversal aft - Profile

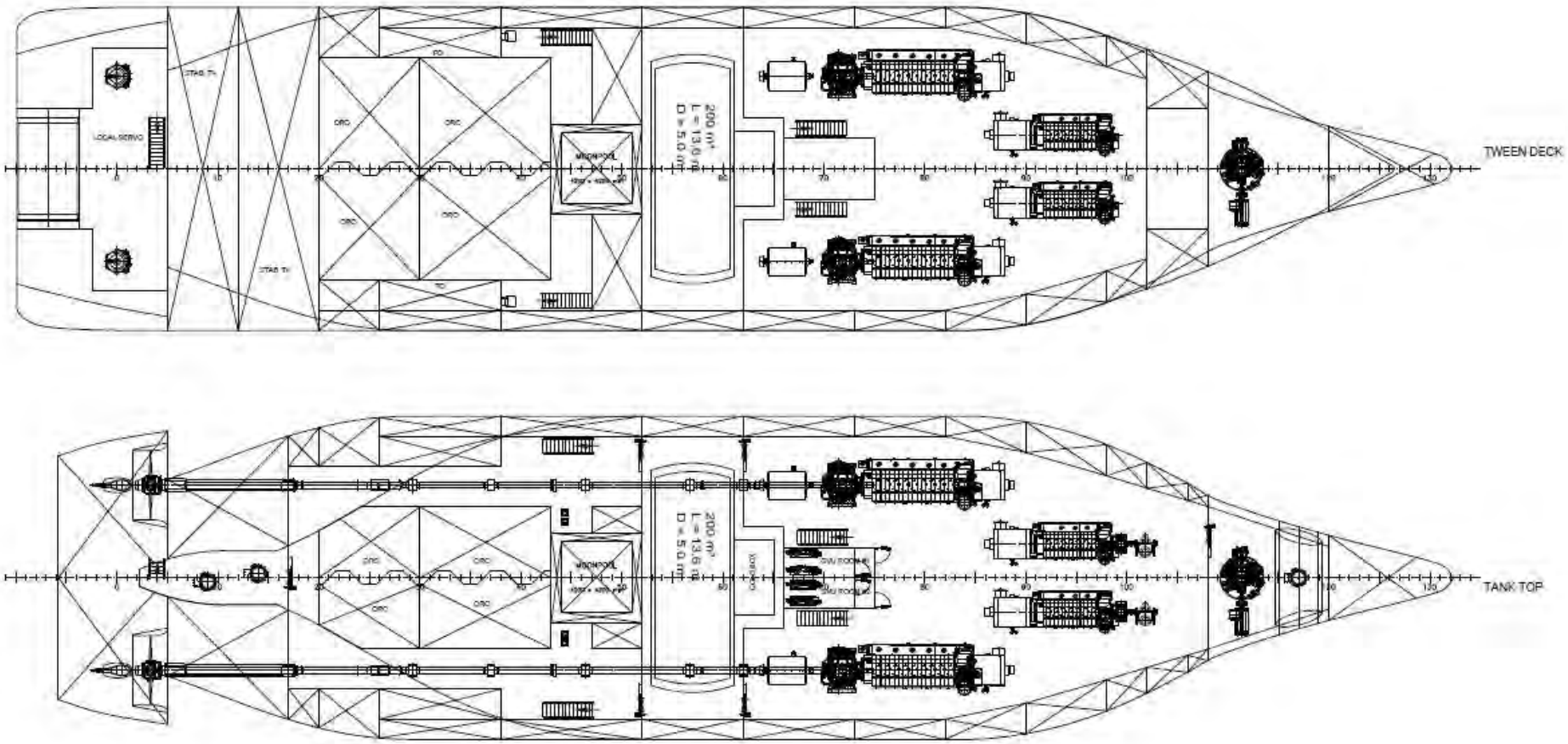


Figure 9 - LNG tank transversal aft – Tank top / Tween deck

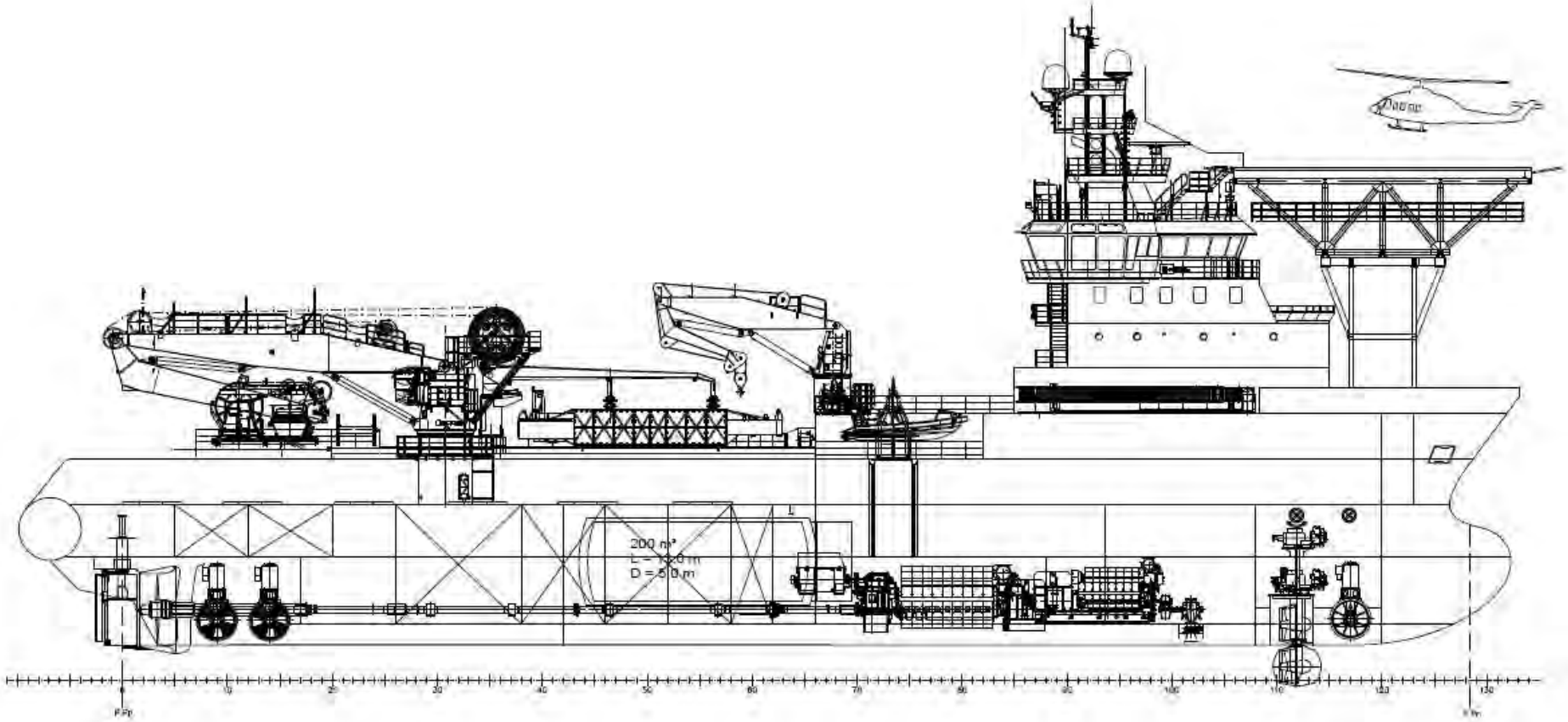


Figure 10 – LNG tank longitudinal center - Profile

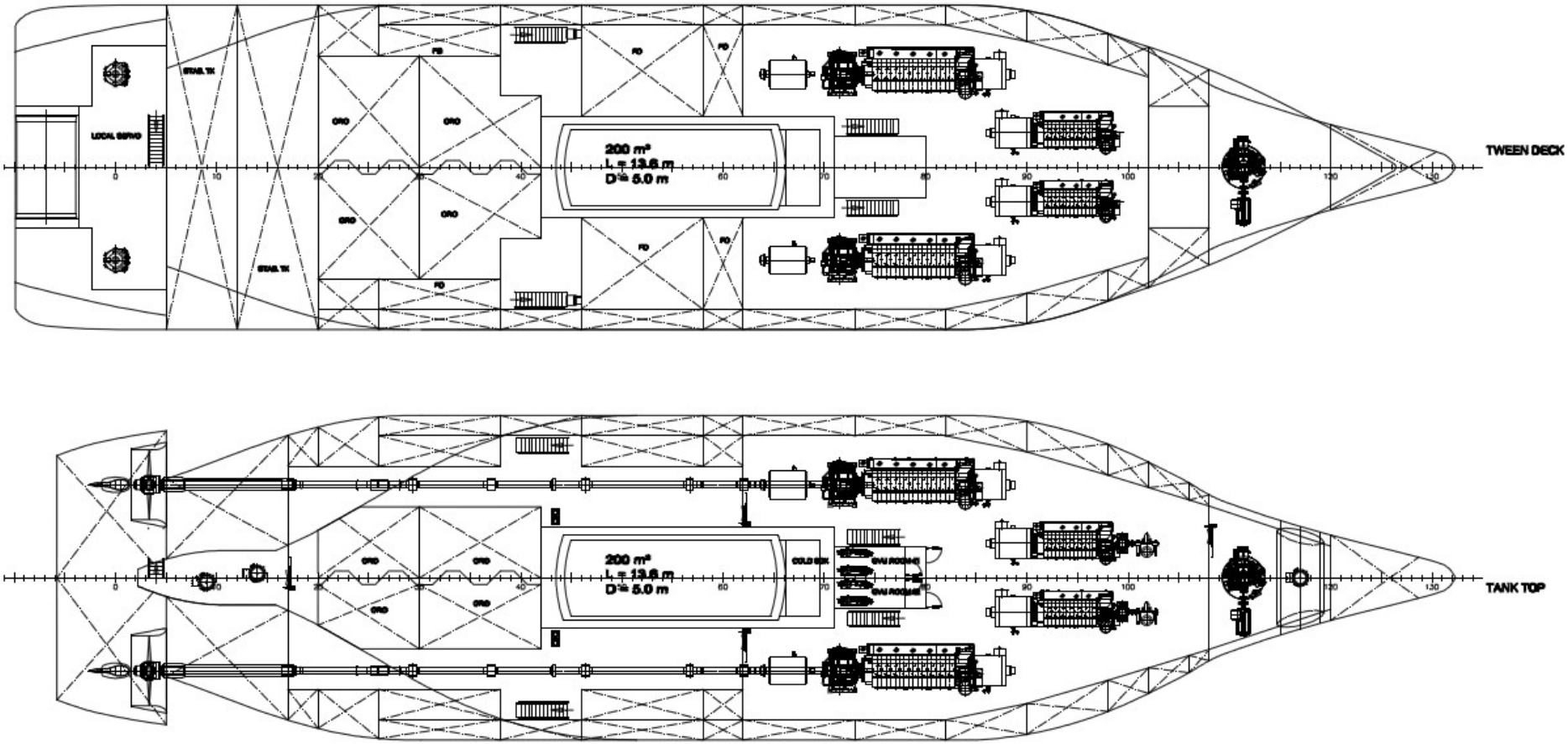


Figure 11 - LNG tank longitudinal center - Tank top / Tween deck

2.4.1 CONCLUSIONS

The New Building allows to design on purpose the unit with the specifications and requirements overcoming limitations.

At present there is only one existing vessel (k/v Turva) with similar capabilities and operating in gas fuel mode. On the other hand sixteen platform support vessels (and growing number) with similar size are in operation in gas fuel mode.

The market review regarding technology development of main engines (dual fuel) and LNG tanks show that at present, the technology is mature enough to go ahead with the construction of a new unit using gas as fuel and provides sufficient flexibility to operate in different modes (Transit, Port, Diving, Oil recovery).

The preliminary design of the as fuel new building propose three different alternatives in the configuration of the vessel based on the operational requirements. All of them are feasible but with some limitations. The implementation of the LNG tank means the reduction on the oil recovery storage capacity. Such limitation is not of paramount importance as the installation of separation equipment on deck reduces the need for available volume. The main drawback is the potential incompatibility of the LNG tank arrangement with the installation of a moonpool required for diving and ROV operations.

3. PHASE 2

During the second phase of the project, the following activities has been carried out:

- SWOT and internal dissemination
- New Building project definition
- Third verification party of the New Building

In the following subsections, the three activities will be reviewed.

3.1. SWOT and internal dissemination

In general terms, the decision to use gas as fuel for a private shipowner is mainly dependant of the economics of the company, the technical solution adopted plus company mission / vision regarding the environmental compromise with the use of low carbon fuels.

In the case of SASEMAR, the use of gas as fuel is not driven by economics and such use must not impact the main mission of SASEMAR: protect life at sea. This means that the evaluation of upgrading fleet to use gas as fuel cannot jeopardize the services of the fleet:

- Saving human life at sea
- Preventing and combating pollution of the marine environment
- Provision of monitoring and assistance services for maritime traffic, maritime safety and navigation
- Tug operation and auxiliary vessels

In the first phase of the project, it was evaluated from a technical point of view, the main factors defining the use of gas as fuel.

SASEMAR identified that, additionally to the technical point of view, it was required to explore certain issues, internal and external to the organization, that could positively or negatively influence decision making about the use of gas as fuel.

In order to fulfil the requirement, a SWOT analysis were carried out in 2018.

3.1.1 SWOT ANALYSIS

A SWOT analysis is a tool created to help to develop the business strategy based on the assessment of an specific situation.

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats.

Strengths and Weaknesses are internal to your company—things that you have some control over and can change. Examples include who is on your team, your patents and intellectual property, and your location.

Opportunities and Threats are external—things that are going on outside your company, in the larger market. You can take advantage of opportunities and protect against threats, but you can’t change them. Examples include competitors, prices of raw materials, and customer shopping trends.

Figure 12 – SWOT TOOL

A SWOT analysis organizes your top strengths, weaknesses, opportunities, and threats into an organized list and is usually presented in a simple two-by-two grid:

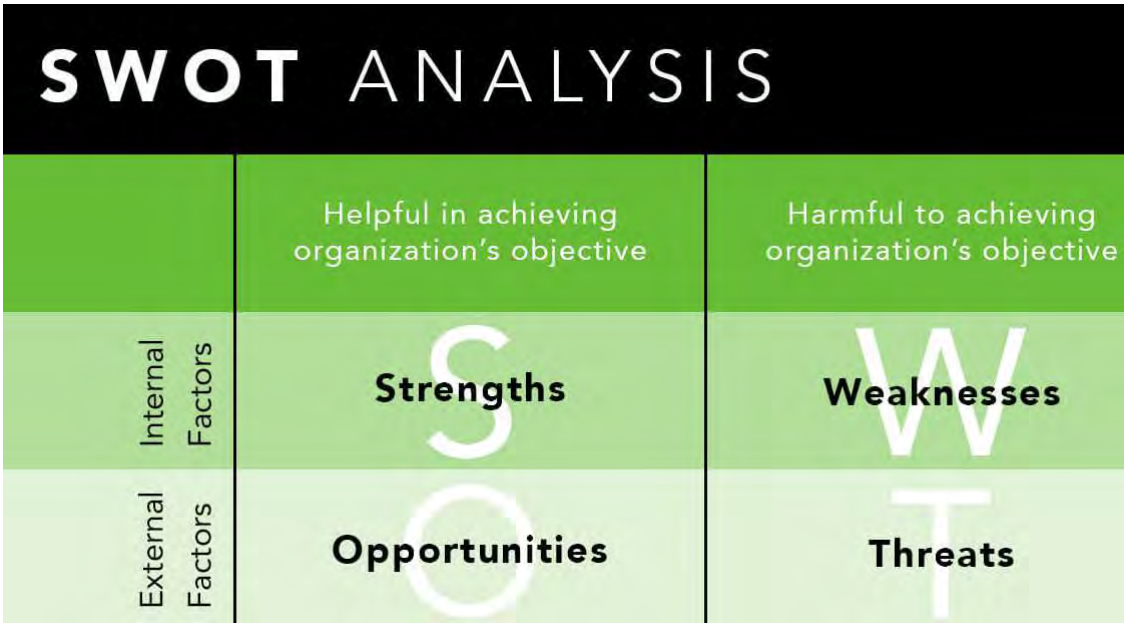


Figure 13 – SWOT diagram

3.1.2 SWOT FOR THE USE OF GAS AS FUEL IN SASEMAR FLEET

The SWOT carried out in Centro Jovellanos[1] on 21st November 2018, gathered experts from SASEMAR including personnel from:

- Environment and Quality Area of the Technical Secretariat
- Department of Maritime Inspection
- Trainers from the course on fire management due to spills of liquefied natural gas
- Captains and Chief Engineer of ships in operation at Maritime Rescue

Among the items identified during the workshop, in the following bullets it is included the main ones:

1. **Strengths**

Nº	Description
2	Existence of human potential to develop the project inside SASEMAR
3	There is no need to generate economic profit as in a private company
7	Feasibility studies have already been carried out on the fleet
8	Have your own training centre: Jovellanos
10	Possibility of gaining political support (influence capacity)

2. **Weaknesses**

Nº	Description
5	Possible lack of economic resources
7	Risk maneuvers (the usual Maritime Rescue operation is in emergency situations)
9	Rigidity and slowness in decision making due to being a public entity.

3. **Threats**

Nº	Description
1	Political and economic instability
3	Uncertainty in the evolution of the use of clean fuels / New technologies

[1] The mission of Centro Jovellanos is to implement, develop and design comprehensive rescue and maritime safety training systems that are high quality, highly specialised, certified, innovative, and sustainable to ensure the most remarkable levels of professional training

9	In case of unit transformation, possible loss of operating capacities.

4. Opportunities

Nº	Description
2	Gradual fleet renewal
4	Knowledge of LNG and the possibility of application in emergency situations
5	Possibility of EU funding

The four of them, were combined in order to define potential strategies to follow for the development of gas as fuel in the fleet. Four different strategies arise:

- Offensive (Strengths – Opportunities)
- Adaptative (Opportunities – Weakness)
- Defensive (Strengths – Threats)
- Survival (Weakness – Threats)

Among the strategies, the one that seems to suit better is the Survival one:

The survival strategy would involve not acquiring any LNG-fuelled vessel or transforming any of the existing ones into the Maritime Rescue fleet. This would not require additional financial resources, would not lose operability and decision making would be minimised. Additionally, the political and economic instability would cease to be relevant and the uncertainty caused by the evolution of the use of clean fuels and the emergence of new technologies would take secondary role, to the expectations of the sector itself to move towards fuels and technologies of the future.

The full SWOT report can be found in Annex I

3.2. NEW BUILDING PROJECT

Astilleros Armón, as partner of SASEMAR in the development of the EV2 – NEW RESCUE BOAT POWERED BY LNG: POTENTIAL USE OF LNG AS AN ALTERNATIVE FUEL FOR THE MARITIME RESCUE FLEET has developed a gas fuelled Emergency response and rescue vessel (ERRV) design considering a New Building with the following main particulars required by SASEMAR:

Main dimensions:

- LOA 79,20 m
- Beam 19,20 m
- Depth to main deck 8,50 m
- Design draft 7,00 m
- Deck surface > 400 m2
-

Tanks capacity:

- MDO 812 m3
- Oil recovery 1.295 m3
- LNG (100%) 260 m3
- Ballast 1.050 m3
- Fresh water 50 m3

Operation:

- Bollard pull (100%) 230 tons (including bow azimuth)
- Max. speed 17 knots
- Crew 33
- Range 9.000 nm (economical speed)

Main Propulsion:

- 2x Dual fuel Gensets of 4.000 kW, Wärtsila 8L34DF or similar
- 2x Dual fuel Gensets of 4.500 kW, Wärtsila 9L34DF or similar
- 2x azimuth propellers 6.000 kW Schottel SRP 800 plus 2x electric motors of 6.000 kW
- 2x bow electric bow thursters:
    - 1x azimuth retractile of 2.000 kW Rolls Royce TCNS/C 100
    - 1 tunnel of 900 kW

Auxiliary gensets:

- 1x port generator of 500 kW Siemens SGE-36SL (Gas fuelled)
- 1x emergency generator of 100 kW (MDO)

LNG:

- 2x LNG tanks of 130 m3 each

FIFI:

- 2x 3.600 m3/h pumps
- 2x monitors of 3.600 m3/h

CRANES:

- 2x 10 tons @ 10 m with AHC and Oil recovery arm
- 1x foldable crane of 2.300 kg @ 13.6 m

OTHER relevant EQUIPMENT:

- Helideck
- Moonpool
- DP2
- 1x Fast Rescue Craft
- 1x Daughter Craft
- 1x Dacon Scoop
- Oil recovery system

Astilleros Armón has developed the following technical drawings:

- PR 119-18_Ship technical file
- GA-PR-119-18_General Arrangement
- D-PR-119-18_Body Plan
- D-PR-119-18_Capacity Plan
- D-PR-119-18_Midship Section
- D-PR-119-18_Fuel System (MDO)
- D-PR-119-18_Gas fuel system (LNG)
- D-PR-119-18_Ballast system
- D-PR-119-18_Bilge system
- F-Pr 119-18-D-00-One line diagram
- D-PR-119-18_Safety

Design documents can be found in Annex II

3.3. THIRD VERIFICATION PARTY

SASEMAR has hired Lloyds Register to determine feasibility and key design aspects for an Emergency Response and Rescue Vessel (ERRV) with respects to the principal safety requirements of the IGF Code.

An important aspect of using 'LNG as fuel' is to understand design requirements for safe operation. This is because LNG presents additional hazards and risks compared with traditional ship fuels, such as marine diesel oil; for example: cryogenic temperature; potential asphyxiation; excess pressure; rapid phase transition; jet fire; flash fire; and explosion.

Lloyd's Register conducted the desk-top screening exercise against the IGF Code to carry out a 'brainstorming' exercise in order to identify scenarios, limitations and design issues.

The assessment has been conducted starting from general requirements for such ERRV ships, and specifically attending to the drawings and preliminary technical specification submitted by ASTILLEROS ARMON.

The approach taken by Lloyds Register is:

1. Agreeing the key IMO safety requirements for review that are fundamental to layout and operation. The IMO requirements refer to both passenger ships and cargo ships, and ERRVs were considered as cargo ships in the review
2. Grouping requirements into related topics and summarising each requirement
3. Comparing the requirements in respect of an ERRV

In addition, only requirements for LNG fuel tanks located below deck were reviewed. This is because LNG fuel tanks on ERRVs are likely to be located below deck to: (i) protect fuel tanks during rescue and recovery activities (e.g. protection from impact and fire); (ii) maximise available deck space for working and recovered items; and, (iii) avoid limiting the type of rescue and recovery activities that can be undertaken.

As deliverable, Lloyds Register has issued a report summarising the key design aspects with respects to the principal safety requirements of the IGF Code.

The deliverable addresses the following topics:

4. Fuel tank Location
5. Fuel Storage hold space (FSHS)
6. Tank connection space (TCS)
7. Master gas fuel valve (MGFV)
8. Gas valve unit (GVU)
9. Pressure relief valves (PRVs)
10. Bunker Station

As main output of the review is that it is feasible to use Natural Gas as fuel for an Emergency Response and Rescue Vessel (ERRV). However, several design challenges has been identified to satisfy the requirements of the IGF Code. To be highlighted:

11. The provision of appropriate access to the Fuel Storage Hold Space (FSHS) and Tank Connection Space (TCS). This may prove difficult due to limitations on available space below deck;
12. Ensuring certain equipment items, such as lights, antennas and communication equipment are not a potential ignition source. This may prove difficult due to the required location of such equipment for navigation and ERRV operations, or the requirements for manufacturing, installation and maintenance of such equipment.
13. Helicopter operations in relatively close proximity to the vent mast outlet. This will require additional consideration and modelling to determine safe helicopter approach/departure and helideck location.

The full report can be found in Annex II

ANNEX I

SWOT REPORT

Salvamento Marítimo

INFORME SOBRE EL USO DEL COMBUSTIBLE GNL EN BUQUES DE SALVAMENTO MARÍTIMO

Reunión de expertos
Asturias (21/11/18)

CORE LNGas hive

Co-financed by the European Union
Connecting Europe Facility

ÍNDICE

1. INTRODUCCIÓN 3

2. OBJETIVO DE LA REUNIÓN 3

3. ANTECEDENTES 3

4. METODOLOGÍA UTILIZADA EN LA REUNIÓN 5

5. DESARROLLO DE LA REUNIÓN 6

5.1 CUESTIONES INTERNAS 6

5.1.1 DEBILIDADES 6

5.1.2 FORTALEZAS 7

5.2 CUESTIONES EXTERNAS 8

5.2.1 AMENAZAS 8

5.2.2 OPORTUNIDADES 10

5.3 PRIORIZACIÓN DE LAS CUESTIONES INTERNAS Y EXTERNAS IDENTIFICADAS 11

6. CIERRE DE LA REUNIÓN 15

7. ESTRATEGIAS POSIBLES 16

7.1 ESTRATEGIA OFENSIVA 17

7.2 ESTRATEGIA ADAPTATIVA 17

7.3 ESTRATEGIA DEFENSIVA 18

7.4 ESTRATEGIA DE SUPERVIVENCIA 19

1. INTRODUCCIÓN

Este informe recoge las conclusiones sobre el uso del combustible gas natural licuado (GNL) en buques de Salvamento Marítimo que fueron obtenidas en la reunión de expertos celebrada en el Centro de Formación Jovellanos (Asturias) el 21/11/18.

Para moderar esta reunión se contrataron los servicios del consultor José Manuel Pardo Álvarez, que contó con el apoyo técnico del consultor Pedro López Vizcayno. Ambos son los autores del presente informe.

Antes de esta reunión de expertos se celebraron dos sesiones previas para prepararla, en las que participaron los consultores antes citados y personal de Salvamento Marítimo: Laura de la Torre Gutiérrez (Jefe de Área de Medio Ambiente y Calidad de la Secretaría Técnica), Daniel Hernanz Gómez (Jefe de Inspección Marítima) y Gracia Alburquerque López-Tofiño (Jefe de Área de Contaminación Química del Servicio de Operaciones Especiales).

El grupo de expertos reunido en el Centro de Formación Jovellanos contó con personal del Área del Área de Medio Ambiente y Calidad de la Secretaría Técnica, del Departamento de Inspección Marítima, formadores del curso de gestión de incendios por derrames de gas natural licuado, capitanes y jefes de máquinas de buques en operación de Salvamento Marítimo.

2. OBJETIVO DE LA REUNIÓN

El objetivo pretendido de la reunión era identificar posibles factores que pudieran condicionar la decisión sobre el uso del combustible GNL en buques de Salvamento Marítimo, más allá de las consideraciones puramente técnicas. Se trataba de explorar cuestiones internas y externas a la organización que pudieran influir positiva o negativamente en la toma de decisiones.

Este informe formará parte de la documentación generada en el proyecto europeo CORE LNG HIVE en el que Salvamento Marítimo participa dentro de la subactividad EV2.

3. ANTECEDENTES

Durante 2017 se realizó un estudio sobre la viabilidad técnica del uso del GNL en la flota de buques de Salvamento Marítimo. Este trabajo se dividió en cuatro partes fundamentales:

1. Estudio de viabilidad del uso de gas como combustible en la flota de Salvamento Marítimo.

2. Estudio de una transformación de uno de los barcos específicos.

3. Estudio de la comparativa de maniobrabilidad entre dos buques, uno de ellos con motor convencional y el otro usando gas como combustible.

4. Estudio de una nueva construcción.

Los estudios se realizaron en base a la nueva normativa de combustibles en el sector naval que obligará a consumir combustibles de bajo contenido en azufre en 2020 así como el compromiso de Salvamento Marítimo en realizar una operación medioambientalmente sostenible.

El primer estudio, centrado en el uso de GNL como combustible en la flota de Salvamento Marítimo, tuvo como conclusiones más relevantes las siguientes:

- Existe tecnología suficientemente madura y normativa consolidada como para ser implementada en la flota.

- Las limitaciones del espacio a bordo de las embarcaciones así como el espacio mínimo requerido para el almacenamiento de gas a bordo hacen que no sea posible operar en grandes rangos con gas.

- Solo los buques de mayor porte de toda la flota son candidatos a utilizar gas como combustible.

Una vez seleccionada las unidades potenciales en el estudio anterior, el estudio de la transformación de la unidad tuvo la siguiente conclusión general:

- Aunque el uso de GNL como combustible sea una alternativa técnicamente viable, habría unas limitaciones operativas y un sobrecoste (además del tiempo de inactividad del buque – coste de oportunidad) que no justifican la transformación de las unidades, siendo la única ventaja la reducción de emisiones durante un periodo parcial del tiempo de operación.

El estudio comparativo de maniobra del buque entre un combustible convencional y uno de gas tuvo como conclusión principal que:

- La operativa del buque no se ve afectada por el combustible utilizado excepto en unas condiciones muy reducidas.

El estudio de una nueva construcción concluyó lo siguiente:

- Una nueva construcción, no sujeta a las restricciones de una transformación, es viable y aunque no existen unidades iguales en el mercado, sí que existen unidades similares con operativa similar que permiten verificar la idoneidad de la selección del gas como combustible. La nueva construcción no sólo implementaría el uso de gas como combustible sino que permitiría dotar a la unidad de una nueva operativa y capacidades identificadas como deseables en la flota actual.

4. METODOLOGÍA UTILIZADA EN LA REUNIÓN

En el mundo de los negocios es posible que la certeza ronde en torno a lo que queremos, sin embargo, resulta difícil entender lo que nos pueda estar impidiendo conseguirlo. Antes de tomar una decisión estratégica es necesario realizar un diagnóstico de situación y para ello se puede utilizar la matriz DAFO (FODA), método sencillo y eficaz que nos ayudará a decidir sobre el futuro.

La matriz DAFO permite realizar un análisis interno y externo sobre una determinada situación. Cuando entendemos las condiciones que nos pueden afectar, podemos ejercer una influencia más efectiva sobre lo que vendrá a continuación.

DAFO responde a las siglas: Debilidades, Amenazas, Fortalezas y Oportunidades. Las debilidades y fortalezas son elementos de índole interno a la organización, mientras que las amenazas y oportunidades son elementos que surgen del ámbito externo. En la siguiente tabla se representa un DAFO genérico, donde se explica cada una de sus partes:

	INTERNO	EXTERNO	
INTERNO	**DEBILIDADES** Son los puntos débiles (falta de conocimientos, comunicación deficiente, mal ambiente, mala reputación, localización física inadecuada…) Limitan o reducen la capacidad de desarrollo	**AMENAZAS** Toda fuerza del entorno que pueda llegar a constituir una dificultad (nueva legislación, corrientes de opinión desfavorables, restricciones ambientales…) Pueden impedir la implantación de una estrategia o reducir su efectividad, incrementar los riesgos o los recursos necesarios, reducir los ingresos esperados, etc.	EXTERNO
INTERNO	**FORTALEZAS** Son los puntos fuertes (capacidades, recursos, imagen, posición alcanzada…) Representan las ventajas competitivas	**OPORTUNIDADES** Fuerzas del entorno que pueden ser aprovechadas (nuevos nichos de mercado, nuevas necesidades, nuevas tecnologías, acceso a un recurso antes no disponible…) Afectan positivamente a los objetivos pretendidos	EXTERNO
	INTERNO	EXTERNO	

Durante la reunión se realizó una breve presentación de la herramienta y se pasó a identificar debilidades, fortalezas, amenazas y oportunidades centradas en el objetivo definido: **USO DEL COMBUSTIBLE GNL EN BUQUES DE SALVAMENTO MARÍTIMO**.

5. DESARROLLO DE LA REUNIÓN

5.1 CUESTIONES INTERNAS

5.1.1 DEBILIDADES

Las debilidades para el **USO DEL COMBUSTIBLE GNL EN BUQUES DE SALVAMENTO MARÍTIMO** identificadas por el grupo de especialistas reunido fueron las siguientes:

1. Actitud de oposición del personal ante el cambio a GNL. Se pueden dar situaciones de resistencia por parte de algunos trabajadores ante el cambio que supone tener que operar buques propulsados con GNL.

2. Dispersión de la flota. Salvamento Marítimo tiene repartida su flota por distintos puertos de la costa española, lo que puede dificultar la utilización de GNL como combustible debido a la posible falta de infraestructura, suministro, etc.

3. Edad de la flota. Puede constituir una debilidad para la realización del retrofitting (conversión de los buques actuales a la utilización del GNL).

4. Falta de conocimiento en el manejo del GNL. Salvamento Marítimo no dispone en la actualidad de ningún buque que utilice este tipo de combustible, lo cual puede constituir una barrera en la implantación.

5. Posible falta de recursos económicos. Puede darse la situación de que no se encuentren recursos económicos suficientes para efectuar el tránsito a GNL.

6. Formación escasa de las tripulaciones y equipo técnico en GNL. Existe actualmente inexperiencia de la mayoría del personal para manejar este tipo de combustible.

7. Maniobras de riesgo (la operativa de Salvamento Marítimo habitual es en situaciones de emergencia). En general, Salvamento Marítimo realiza maniobras de emergencia, que pueden verse comprometidas cuando se usa como combustible GNL, pues en ciertas circunstancias, los motores con este combustible disminuyen su potencia.

8. Primera tripulación certificación IGF. Los tripulantes que operen un buque con combustible GNL deberán disponer del certificado IGF (acredita cumplir los requisitos especiales de formación y cualificación para el personal que presta servicios en buques regidos por el Código Internacional de seguridad para las embarcaciones que utilicen gases u otros combustibles de bajo punto de inflamación). Esta titulación requiere periodos de prácticas en buques que utilicen gases como combustible, con los que Salvamento Marítimo no cuenta actualmente, lo que requerirá que la primera tripulación se tenga que formar en buques de otras flotas.

9. Rigidez y lentitud en la toma de decisiones por ser ente público. Por lo general, los mecanismos para la toma de decisiones en las Administraciones Públicas suelen ser más formalistas que los de la empresa privada, lo que les confiere ciertas rigideces y los hace menos dinámicos.

5.1.2 FORTALEZAS

Las fortalezas identificadas para el **USO DEL COMBUSTIBLE GNL EN BUQUES DE SALVAMENTO MARÍTIMO** fueron las siguientes:

1. Existe personal en Salvamento Marítimo con iniciativa para atender al proyecto. Esta organización cuenta con empleados con empuje y entusiasmo suficiente como para desarrollar el proyecto de uso de combustible GNL en los buques de su flota.

2. Existencia de potencial humano para desarrollar el proyecto. Existen empleados con la competencia suficiente para abordar el proyecto de uso de combustible GNL.

3. No hay necesidad de generar beneficio económico como en una empresa privada. La misión de Salvamento Marítimo no pasa por generar rentabilidad económica, lo cual puede condicionar inversiones donde lo económico pueda estar subordinado a otro tipo de criterios, como el social, medio ambiental, etc.

4. Referentes en medio ambiente. Salvamento Marítimo es una entidad referente en el sector naval por su comportamiento ambiental limpio.

5. La diversidad de flota aporta flexibilidad al tipo de proyecto a poner en marcha. Salvamento Marítimo dispone de una flota de buques muy diversa, lo que puede facilitar la adaptación de ciertas unidades al uso de GNL o la adquisición de nuevos buques propulsados por este combustible.

6. Posibilidad de acceso a información de otras flotas extranjeras. Al ser Salvamento Marítimo un ente público, existen posibilidades amplias de intercambiar información sobre el uso de GNL como combustible marino con otros entes públicos extranjeros con experiencia.

7. Existen estudios de viabilidad ya realizados en la flota. No se parte de cero, ya que se cuentan con estudios de viabilidad que pueden ayudar en la toma de decisiones.

8. Contar con Centro de Formación propio de Jovellanos (Asturias). El Centro de Formación Jovellanos está dotado de medios para atender muchas de las necesidades formativas que pudieran surgir al implantar el GNL como combustible en la flota de Salvamento Marítimo.

9. Capacidad de integración e innovación. En Salvamento Marítimo existe vocación para integrar novedades tecnológicas que mejoran su operación y también la puesta en marcha de proyectos de innovación.

10. Posibilidad de conseguir apoyo político (capacidad de influencia). Personal de Salvamento Marítimo pueden llegar a influir en la toma de decisiones políticas que apoyen el uso de combustible GNL en su flota.

11. Buena imagen en el sector y la opinión pública. Salvamento Marítimo por su comportamiento y sus acciones tiene una excelente imagen en el sector naval y entre la opinión pública.

5.2 CUESTIONES EXTERNAS

5.2.1 AMENAZAS

Para el **USO DEL COMBUSTIBLE GNL EN BUQUES DE SALVAMENTO MARÍTIMO** se señalaron las siguientes amenazas:

1. Inestabilidad política y económica. El clima político y la situación económica pueden condicionar la decisión de usar o no GNL como combustible en la flota de Salvamento Marítimo.

2. El cambio a GNL puede generar nuevas necesidades de recursos humanos. La operación con GNL obliga a una vigilancia 24 horas de los tanques de combustible, lo que en algunos casos puede llegar a incrementar la necesidad de personal para poder acometer esta tarea.

3. Incertidumbre en la evolución del uso de combustibles limpios / nuevas tecnologías. El desarrollo tecnológico acelerado y la transición hacia el uso de combustibles más limpios generan una incertidumbre elevada en el sector naval para la toma de decisiones acertadas sobre cuál será la tecnología y el combustible más idóneo.

4. Limitación en el suministro y la calidad de GNL. La escasez de infraestructura para el suministro de GNL e incluso la calidad del propio combustible pueden ser un condicionante para la movilidad de la flota y para ciertas operaciones.

5. El incremento del tiempo para realizar el bunkering reduce el tiempo de disponibilidad. El tiempo para repostar GNL se incrementa respecto a otros combustibles, lo que puede disminuir el tiempo disponible para la operación.

6. Incertidumbre de la legislación en cuanto a bunkering. La legislación para el uso de gases como combustible está en plena evolución, lo que puede generar nuevas necesidades de recursos, restricciones en el uso para el suministro, etc.

7. Aceptación social del GNL (posible afectación de la imagen). En general, la opinión pública tiene la idea generalizada de que el uso de gas como combustible entraña graves riesgos (fugas, explosiones, intoxicaciones, etc.). Debido a esta cuestión, el uso de GNL en la flota de Salvamento Marítimo puede llegar a afectar a su imagen.

8. Incertidumbre en el precio del bunkering de GNL. La nueva normativa de combustibles en el sector naval que obligará a consumir combustibles de bajo contenido en azufre en 2020, puede presionar los precios de aquellos combustibles que cumplan con los nuevos requisitos legales.

9. En caso de transformación de unidades posible pérdida de capacidades operativas. Las limitaciones del espacio a bordo de las embarcaciones de la flota actual de Salvamento Marítimo, así como el espacio mínimo requerido para el almacenamiento de gas a bordo hacen que no sea posible operar en grandes rangos con gas. Por otro lado, el volumen necesario para el almacenamiento de gas a bordo limita el espacio para otros usos como los tanques anticontaminación y los tanques antibalance.

10. Falta de conocimientos en GNL de los agentes implicados en el sector naval. En general, existe bastante desconocimiento sobre este combustible entre los distintos agentes implicados en este sector (autoridades portuarias, capitanía marítima…).

11. Posibilidad de salto a otras empresas del personal formado en GNL (fuga de talentos). Si la utilización de GNL se implanta en la flota de Salvamento Marítimo y se generaliza su uso entre las navieras, pueden surgir en el mercado laboral altas necesidades de personal cualificado en el uso de GNL, que pueden provocar la salida de trabajadores de Salvamento Marítimo hacia otras empresas.

12. Riesgo de pérdida de eficacia o generación de situaciones de emergencia debido a la necesidad de un periodo de adaptación ante unos procedimientos más restrictivos. El uso de GNL como combustible conllevará la puesta en marcha de procedimientos de operación más restrictivos, lo cual puede limitar la eficacia del servicio prestado e incluso pueden surgir situaciones de emergencia, sobre todo en la fase inicial.

13. Falta de compresión por parte de la sociedad al incrementar la inversión. El uso de GNL como combustible puede requerir mayores inversiones que si se utilizan otras alternativas, lo cual puede ser percibido de manera negativa por la sociedad, afectando a la imagen de Salvamento Marítimo.

14. Posible falta de combustible convencional a futuro si no se tiene la posibilidad de emplear GNL. La normativa ambiental está condicionando la existencia de ciertos combustibles convencionales, lo que puede hacer que en un futuro haya escasez de los mismos.

15. Falta de experiencia en esta tecnología. No hay experiencias a nivel nacional y muy escasas a nivel internacional sobre el uso de GNL como combustible en buques de salvamento.

5.2.2 OPORTUNIDADES

Para el **USO DEL COMBUSTIBLE GNL EN BUQUES DE SALVAMENTO MARÍTIMO** se determinaron las siguientes oportunidades:

1. Ser referentes/pioneros en el empleo de GNL en buques de salvamento. El uso del GNL como combustible en la flota de Salvamento Marítimo puede convertirla en referente, dada la baja implantación de este tipo de combustible en buques de salvamento a nivel internacional en la actualidad.

2. Renovación de la flota de forma gradual. Aprovechando que la flota ha de renovarse de forma progresiva se podrían adquirir unidades que utilicen combustible GNL.

3. Posibilidad de salto profesional del personal. El uso de combustible GNL obligaría a la formación del personal y a asumir nuevas responsabilidades, que en algunos casos podrían ir acompañadas de saltos profesionales.

4. Conocimiento del GNL y la posibilidad de aplicación en situación de emergencia. Operar buques con GNL puede suponer que la asistencia en situaciones de emergencia a buques propulsados con este combustible se realicen con más eficacia.

5. Posibilidad de financiación de la UE. Existe la posibilidad de que surjan fondos europeos para adaptar unidades al uso de GNL e incluso para la adquisición de nuevos buques propulsados por este gas.

6. Mejora de la imagen. El uso de GNL reforzaría aún más la imagen ambiental de la entidad.

7. Oportunidad comercial para el centro de formación de autofinanciación. Si se decide utilizar GNL como combustible en los buques de Salvamento Marítimo obligará a formar al personal propio. Este tipo de formación se puede ofrecer al sector naval, lo que constituiría una nueva línea de negocio para el Centro de Formación Jovellanos.

8. Aprovechar el conocimiento de GNL de la industria en España. La industria española tiene un alto conocimiento en el uso de GNL, que puede verse favorecida por el impulso de entidades públicas como Salvamento Marítimo que apuesten por el uso de este combustible.

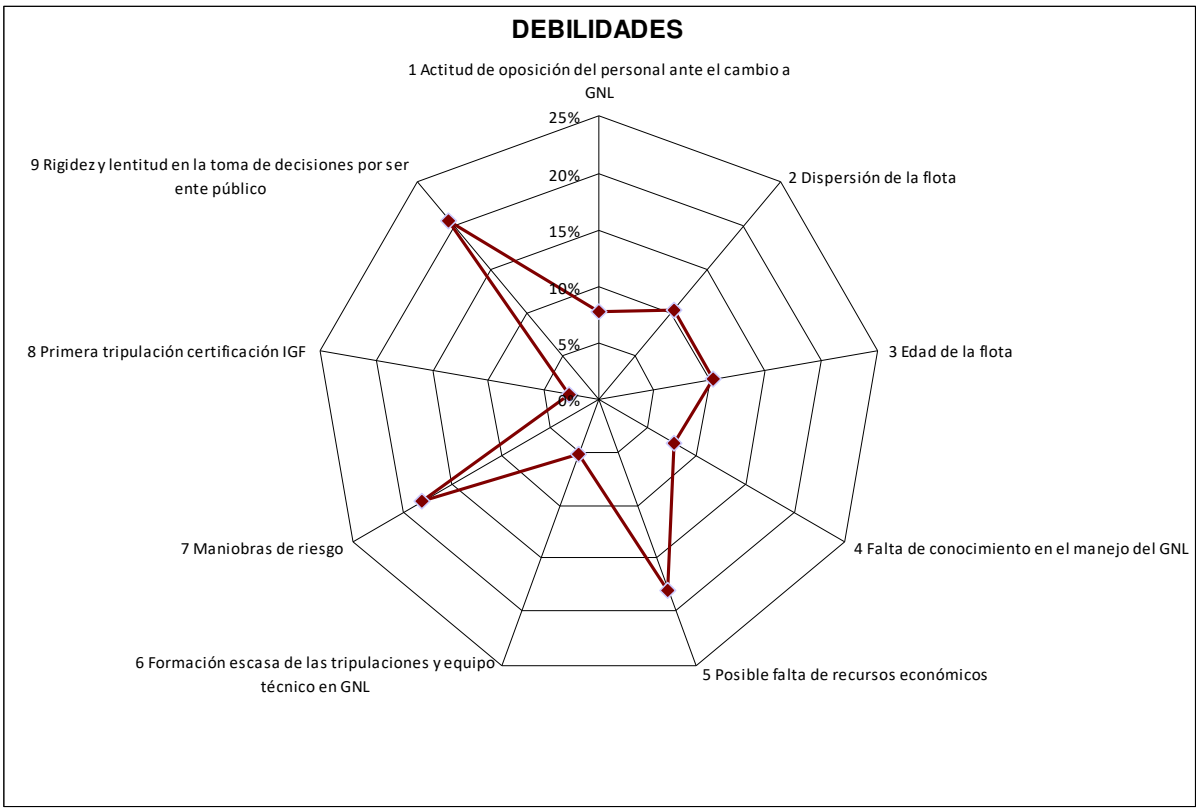
9. Flota más activa. El almacenamiento de GNL no se puede prolongar mucho en el tiempo por razones de sobrepresión. Para evitar este problema, la flota que utilizase GNL podría incrementar sus salidas respecto a la situación actual.

5.3 PRIORIZACIÓN DE LAS CUESTIONES INTERNAS Y EXTERNAS IDENTIFICADAS

Una vez identificadas y revisadas todas las cuestiones internas (debilidades y fortalezas) y externas (amenazas y oportunidades) se procedió a señalar aquellas que los asistentes percibiesen como más relevantes para el **USO DEL COMBUSTIBLE GNL EN BUQUES DE SALVAMENTO MARÍTIMO**. Cada uno de los asistentes votó a las tres cuestiones que les parecieron más importantes. Los resultados alcanzados fueron los siguientes:

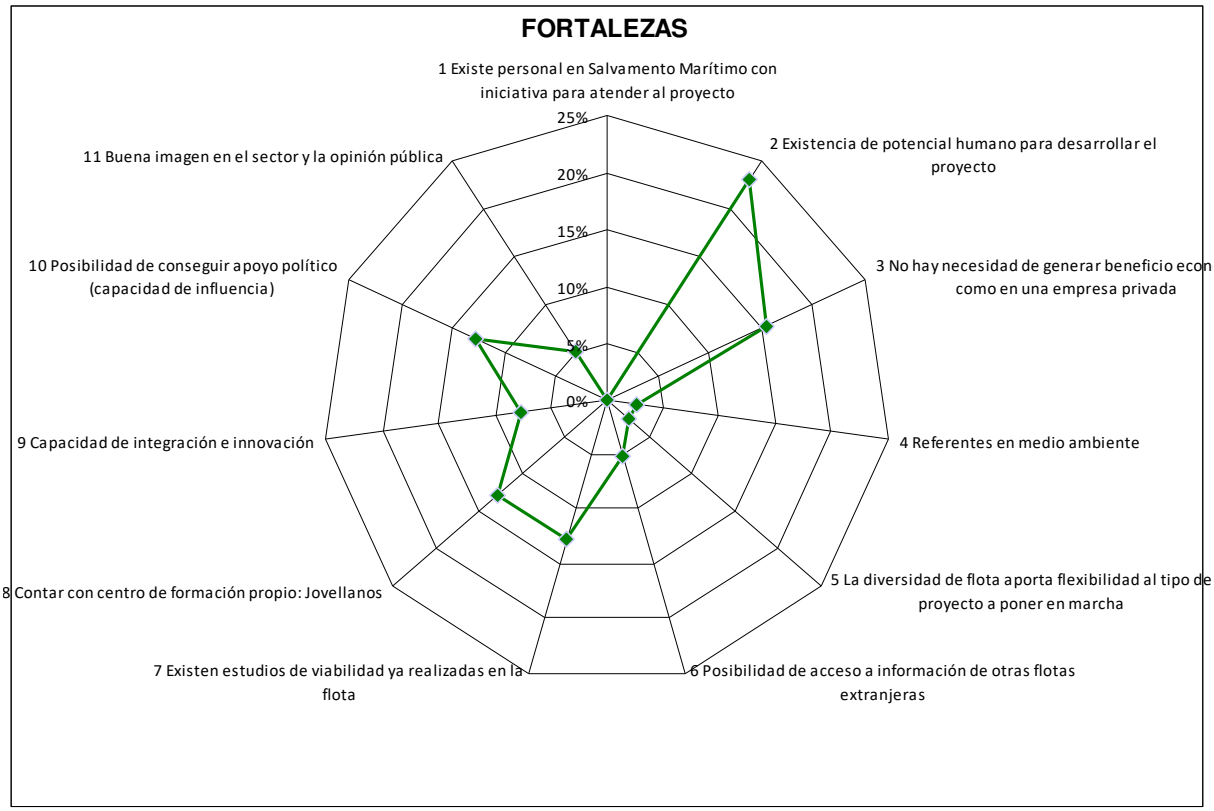
DEBILIDADES

Nº	DEBILIDADES IDENTIFICADAS	VOTOS	%
1	Actitud de oposición del personal ante el cambio a GNL	3	8%
2	Dispersión de la flota	4	10%
3	Edad de la flota	4	10%
4	Falta de conocimiento en el manejo del GNL	3	8%
5	Posible falta de recursos económicos	7	18%
6	Formación escasa de las tripulaciones y equipo técnico en GNL	2	5%
7	Maniobras de riesgo (la operativa de Salvamento Marítimo habitual es en situaciones de emergencia)	7	18%
8	Primera tripulación certificación IGF	1	3%
9	Rigidez y lentitud en la toma de decisiones por ser ente público	8	21%



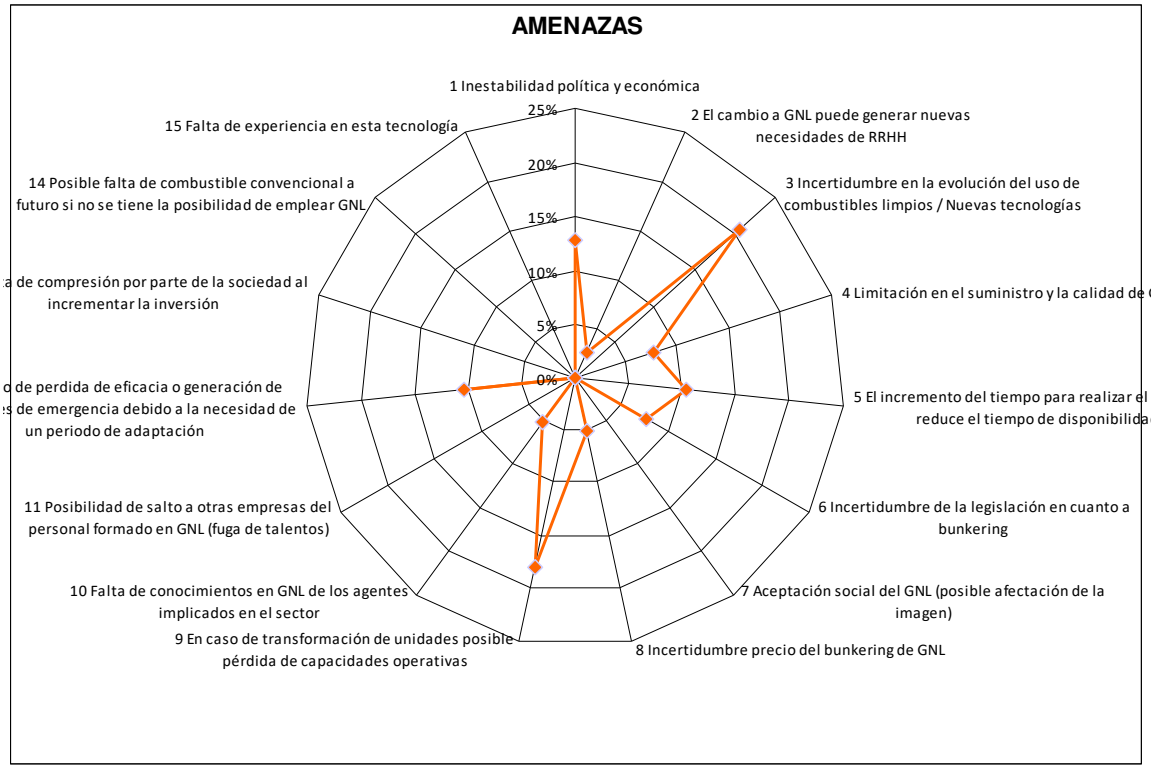
FORTALEZAS

Nº	FORTALEZAS IDENTIFICADAS	VOTOS	%
1	Existe personal en Salvamento Marítimo con iniciativa para atender al proyecto	0	0%
2	Existencia de potencial humano para desarrollar el proyecto	9	23%
3	No hay necesidad de generar beneficio económico como en una empresa privada	6	15%
4	Referentes en medio ambiente	1	3%
5	La diversidad de flota aporta flexibilidad al tipo de proyecto a poner en marcha	1	3%
6	Posibilidad de acceso a información de otras flotas extranjeras	2	5%
7	Existen estudios de viabilidad ya realizadas en la flota	5	13%
8	Contar con centro de formación propio: Jovellanos	5	13%
9	Capacidad de integración e innovación	3	8%
10	Posibilidad de conseguir apoyo político (capacidad de influencia)	5	13%
11	Buena imagen en el sector y la opinión pública	2	5%



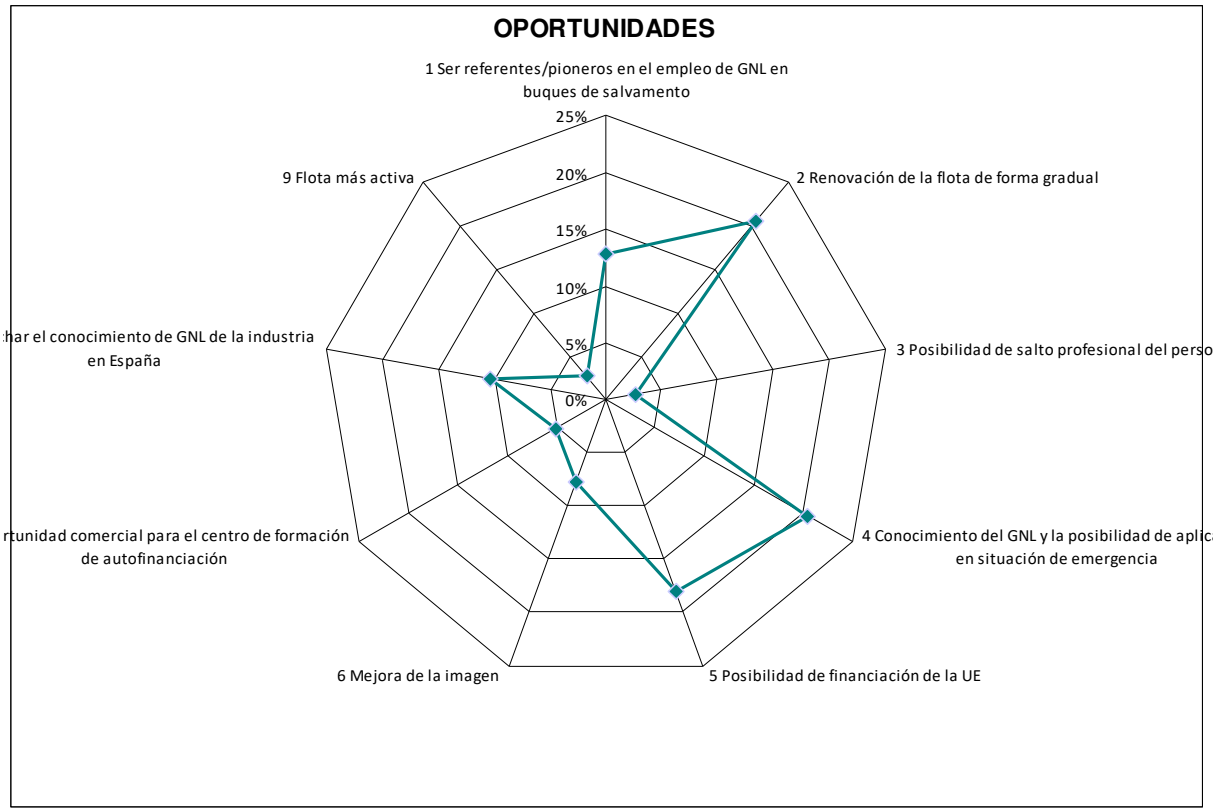
AMENAZAS

Nº	AMENAZAS IDENTIFICADAS	VOTOS	%
1	Inestabilidad política y económica	5	13%
2	El cambio a GNL puede generar nuevas necesidades de RRHH	1	3%
3	Incertidumbre en la evolución del uso de combustibles limpios / Nuevas tecnologías	8	21%
4	Limitación en el suministro y la calidad de GNL	3	8%
5	El incremento del tiempo para realizar el bunkering reduce el tiempo de disponibilidad	4	10%
6	Incertidumbre de la legislación en cuanto a bunkering	3	8%
7	Aceptación social del GNL (posible afectación de la imagen)	0	0%
8	Incertidumbre precio del bunkering de GNL	2	5%
9	En caso de transformación de unidades posible pérdida de capacidades operativas	7	18%
10	Falta de conocimientos en GNL de los agentes implicados en el sector	2	5%
11	Posibilidad de salto a otras empresas del personal formado en GNL (fuga de talentos)	0	0%
12	Riesgo de perdida de eficacia o generación de situaciones de emergencia debido a la necesidad de un periodo de adaptación	4	10%
13	Falta de compresión por parte de la sociedad al incrementar la inversión	0	0%
14	Posible falta de combustible convencional a futuro si no se tiene la posibilidad de emplear GNL	0	0%
15	Falta de experiencia en esta tecnología	0	0%



OPORTUNIDADES

Nº	OPORTUNIDADES IDENTIFICADAS	VOTOS	%
1	Ser referentes/pioneros en el empleo de GNL en buques de salvamento	5	13%
2	Renovación de la flota de forma gradual	8	21%
3	Posibilidad de salto profesional del personal	1	3%
4	Conocimiento del GNL y la posibilidad de aplicación en situación de emergencia	8	21%
5	Posibilidad de financiación de la UE	7	18%
6	Mejora de la imagen	3	8%
7	Oportunidad comercial para el centro de formación de autofinanciación	2	5%
8	Aprovechar el conocimiento de GNL de la industria en España	4	10%
9	Flota más activa	1	3%



6. CIERRE DE LA REUNIÓN

A la vista de las todas cuestiones internas y externas que se identificaron en la reunión relacionadas con el uso del combustible GNL en buques de salvamento marítimo las impresiones finales de los asistentes pasan por cuestiones como:

- La idea prefijada de muchos de los asistentes antes del inicio de la reunión era de oposición al uso del combustible GNL en buques de salvamento marítimo. Tras el análisis DAFO, muchos expresan que esa idea inicial se ha matizado y que utilizar GNL en buques de salvamento tiene ahora para ellos mejor opinión.

- No obstante, algunos expresan que la utilización de GNL en buques de salvamento que operan emergencias no es la mejor opción.

- Una alternativa podría pasar por adaptar o adquirir una unidad propulsada por GNL que sirviese de experiencia piloto, refuerce la imagen ambiental del Salvamento Marítimo y sirva para aprender sobre el manejo de este tipo de combustible, también en situaciones de emergencia.

- Podría ser muy interesante establecer contacto con los responsables de operar una patrullera finlandesa propulsada con GNL, que también actúa en emergencias, para recabar su experiencia y saber cual es el comportamiento del buque en situaciones difíciles, como una mala mar.

- Todo lo nuevo cuesta arrancarlo y este asunto no será una excepción.

- Las alternativas al uso de GNL pasarían por la hibridación de baterías y diesel o baterías y GNL, y más a largo plazo la propulsión con hidrógeno quizá pueda llegar a ser viable.

Como conclusión final de la reunión se expresa lo siguiente:

EMPEZAR A:

- Concienciar a todo el personal de Salvamento Marítimo sobre el uso de GNL.

- Elegir el tipo de unidad de entre las utilizadas en la flota de Salvamento Marítimo sobre el que sería más idóneo desplegar el proyecto de uso de combustible GNL.

- Estudiar oportunidades de financiación sobre un proyecto piloto.

CONTINUAR CON:

- La formación en GNL.

- El seguimiento de la evolución tecnológica y legal sobre el combustible GNL.

7. ESTRATEGIAS POSIBLES

Del cruce de las debilidades, fortalezas, amenazas y oportunidades surgen varios tipos de estrategias, como se puede apreciar en el siguiente cuadro:

Partiendo del análisis DAFO realizado por el grupo de expertos los autores del presente informe han cruzado las debilidades, amenazas, fortalezas y oportunidades elegidas como más relevantes y han planteado algunas estrategias posibles.

7.1 ESTRATEGIA OFENSIVA

Esta estrategia utiliza las fortalezas para aprovechar las oportunidades.

PRINCIPALES FORTALEZAS	PRINCIPALES OPORTUNIDADES
• Existencia de potencial humano para desarrollar el proyecto • No hay necesidad de generar beneficio económico como en una empresa privada • Existen estudios de viabilidad ya realizadas en la flota • Contar con centro de formación propio: Jovellanos • Posibilidad de conseguir apoyo político (capacidad de influencia)	• Renovación de la flota de forma gradual • Conocimiento del GNL y la posibilidad de aplicación en situación de emergencia • Posibilidad de financiación de la UE para alargar la vida de nuestra flota

En este caso las alternativas podrían pasar por:

1. Aprovechar la necesidad de renovación de la flota para adquirir un buque propulsado por GNL, para lo cual debería ponerse en marcha la capacidad de influencia para lograr el apoyo político necesario. Los que ejerciesen esta capacidad de influencia podrían utilizar como argumentarlo para condicionar la decisión los estudios de viabilidad ya realizados, el potencial humano y de conocimiento existente y la no necesidad de dar beneficios. Si la UE pusiese en marcha posibles subvenciones para la adquisición de unidades propulsadas por GNL sería un argumento más para reforzar los planteamientos.

2. Aprovechar posibles subvenciones de la UE para la transformación de una unidad. Si apareciesen las subvenciones se debería poner en marcha la capacidad de influencia utilizando como argumentario las mismas cuestiones antes mencionadas.

La puesta en marcha de cualquiera de las dos alternativas permitiría mejorar el conocimiento sobre GNL y su aplicación en emergencias, hecho que puede verse reforzado por formaciones específicas en el Centro de Formación Jovellanos.

7.2 ESTRATEGIA ADAPTATIVA

La estrategia adaptativa aprovecha las oportunidades para superar debilidades. Esta estrategia se puede combinar con la anterior.

PRINCIPALES OPORTUNIDADES	PRINCIPALES DEBILIDADES
• Renovación de la flota de forma gradual • Conocimiento del GNL y la posibilidad de aplicación en situación de emergencia • Posibilidad de financiación de la UE para alargar la vida de nuestra flota	• Posible falta de recursos económicos • Maniobras de riesgo (nuestra operativa es la emergencia) • Rigidez y lentitud en la toma de decisiones por ser ente público

En la primera alternativa (adquisición de un buque propulsado por GNL), y dentro de lo posible también en la segunda, el diseño del buque debería minimizar la posible falta de operatividad en determinadas situación de riesgo.

Por otro lado, la posible falta de recursos económicos para adquirir o transformar una unidad podría verse complementada por la aparición de subvenciones de la UE que soporten la adquisición/transformación.

La rigidez y lentitud en la toma de decisiones por ser ente público se puede convertir en algo positivo, al permitir ejercer la capacidad de influencia de una manera progresiva, tratando de alcanzar el mayor nivel de consenso en la toma de decisiones.

7.3 ESTRATEGIA DEFENSIVA

La estrategia defensiva maximiza las fortalezas para evitar amenazas.

PRINCIPALES FORTALEZAS	PRINCIPALES AMENAZAS
• Existencia de potencial humano para desarrollar el proyecto • No hay necesidad de generar beneficio económico como en una empresa privada • Existen estudios de viabilidad ya realizadas en la flota • Contar con centro de formación propio: Jovellanos • Posibilidad de conseguir apoyo político (capacidad de influencia)	• Inestabilidad política y económica • Incertidumbre en la evolución del uso de combustibles limpios / nuevas tecnologías • En caso de transformación de unidades posible pérdida de capacidades operativas

Potenciar la formación, aprovechar todo el potencial humano y toda la información de los estudios de viabilidad para minimizar la posible pérdida de capacidades en el caso de transformación de unidades.

Toda la información existente en los estudios de viabilidad puede servir para minimizar la incertidumbre en la evolución del uso de combustibles limpios y aparición de nuevas tecnologías.

La búsqueda de apoyo político puede ajustarse a la incertidumbre existente evitando una situación contraria para los intereses de Salvamento Marítimo esperando al momento más favorable.

7.4 ESTRATEGIA DE SUPERVIVENCIA

La estrategia de supervivencia minimiza las debilidades para evitar amenazas.

PRINCIPALES DEBILIDADES	PRINCIPALES AMENAZAS
• Posible falta de recursos económicos • Maniobras de riesgo (nuestra operativa es la emergencia) • Rigidez y lentitud en la toma de decisiones por ser ente público	• Inestabilidad política y económica • Incertidumbre en la evolución del uso de combustibles limpios / nuevas tecnologías • En caso de transformación de unidades posible pérdida de capacidades operativas

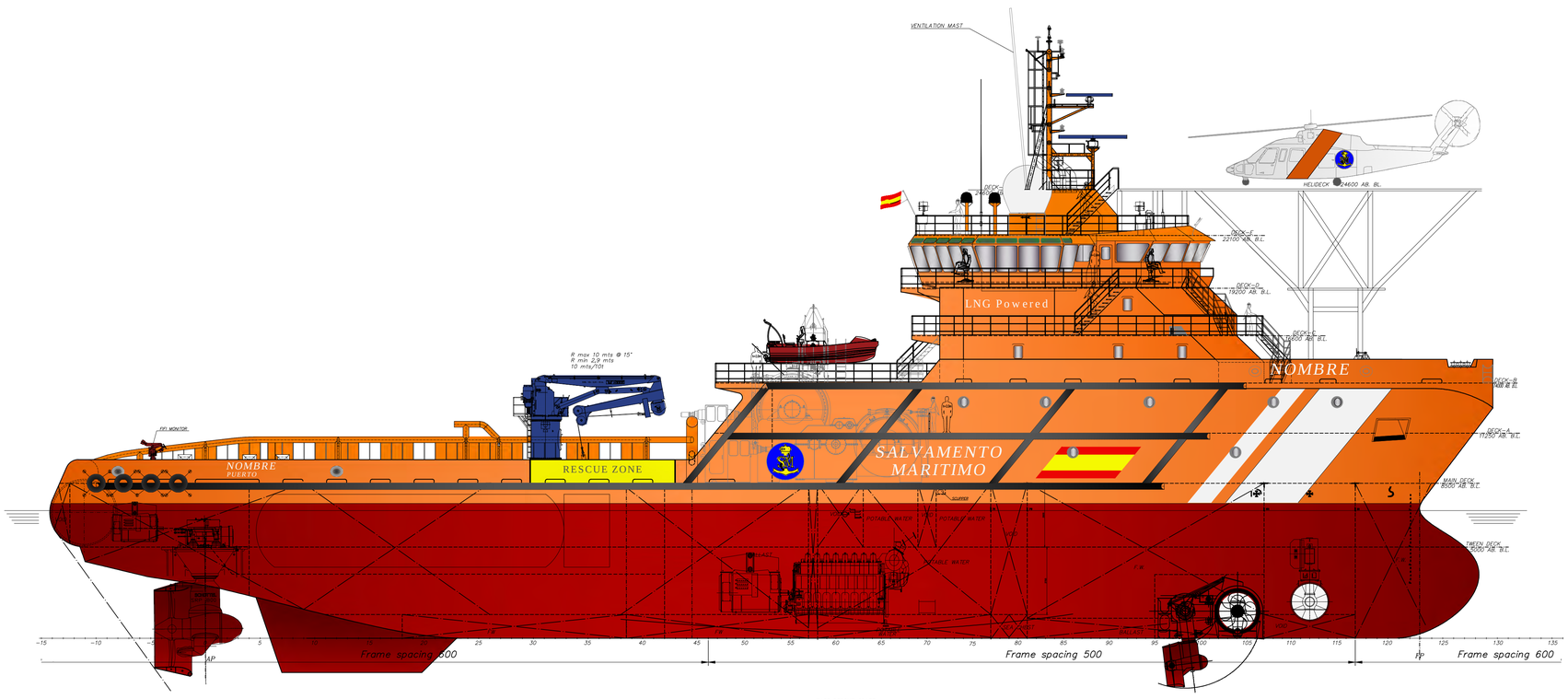
La estrategia de supervivencia pasaría por no adquirir ningún buque que utilizase GNL como combustible, ni tampoco transformar ninguno de los ya existentes en la flota de Salvamento Marítimo. Con ello, no serían necesarios recursos económicos adicionales, no se perdería operatividad y la toma de decisiones se minimizaría. Adicionalmente la inestabilidad política y económica dejaría de ser relevante y la incertidumbre causada por la evolución del uso de combustibles limpios y la aparición de nuevas tecnologías pasaría a un segundo plano, a la espera de que el propio sector vaya direccionándose hacia los combustibles y las tecnologías del futuro.

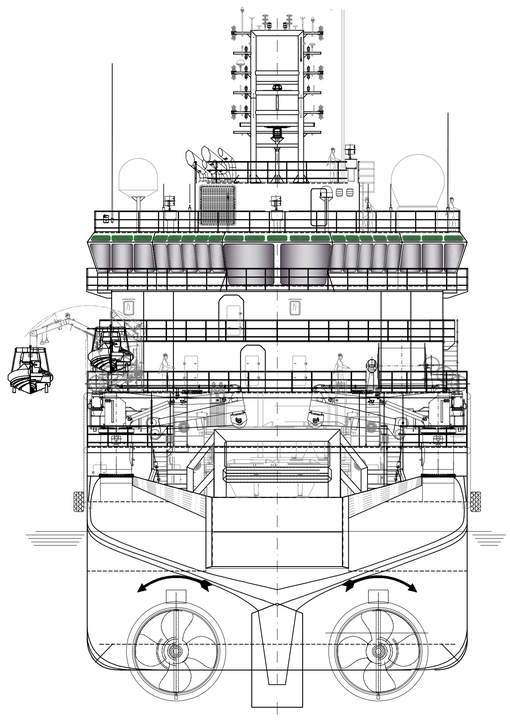
A día de hoy puede ser la más adecuada si se tiene en cuenta que Salvamento Marítimo ya cumple con los niveles de emisiones fijados por la legislación para 2020.

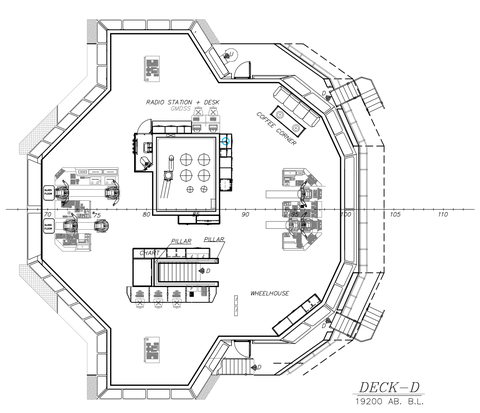
ANNEX II

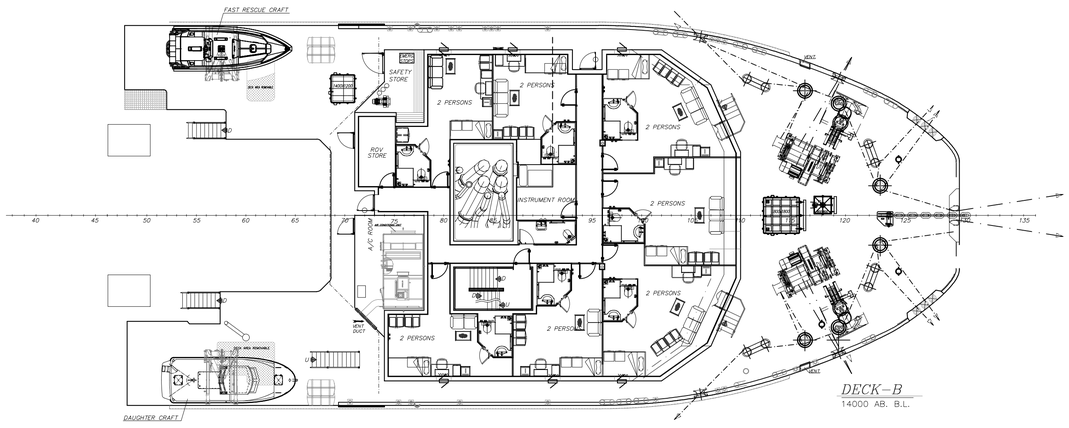
NEW BUILDING DESIGN DOCUMENTS

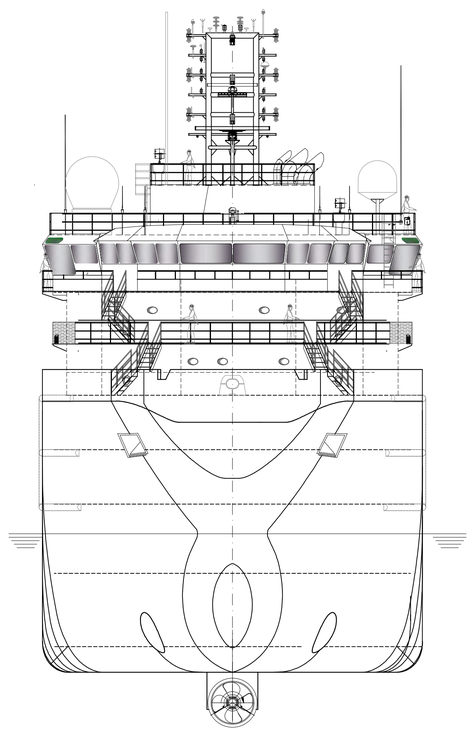
SWOT REPORT

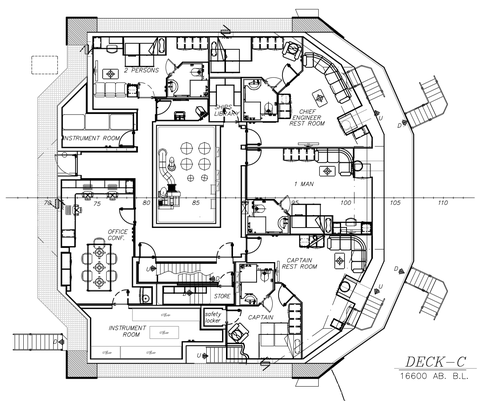


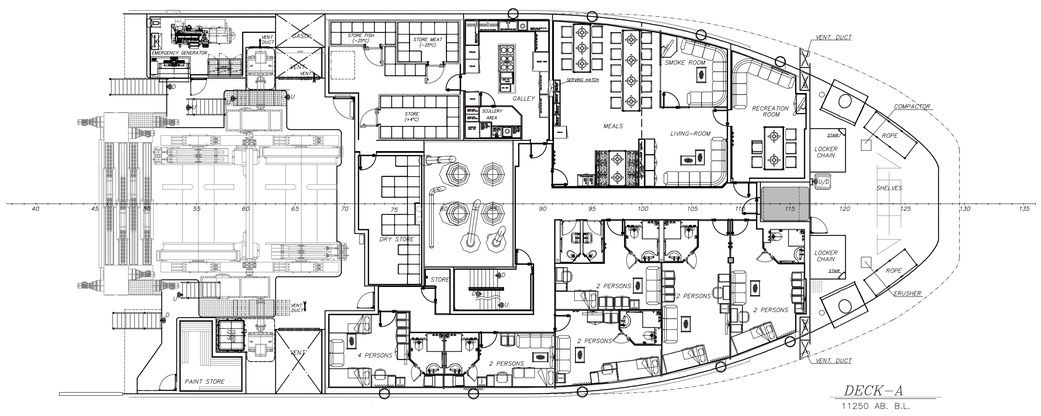


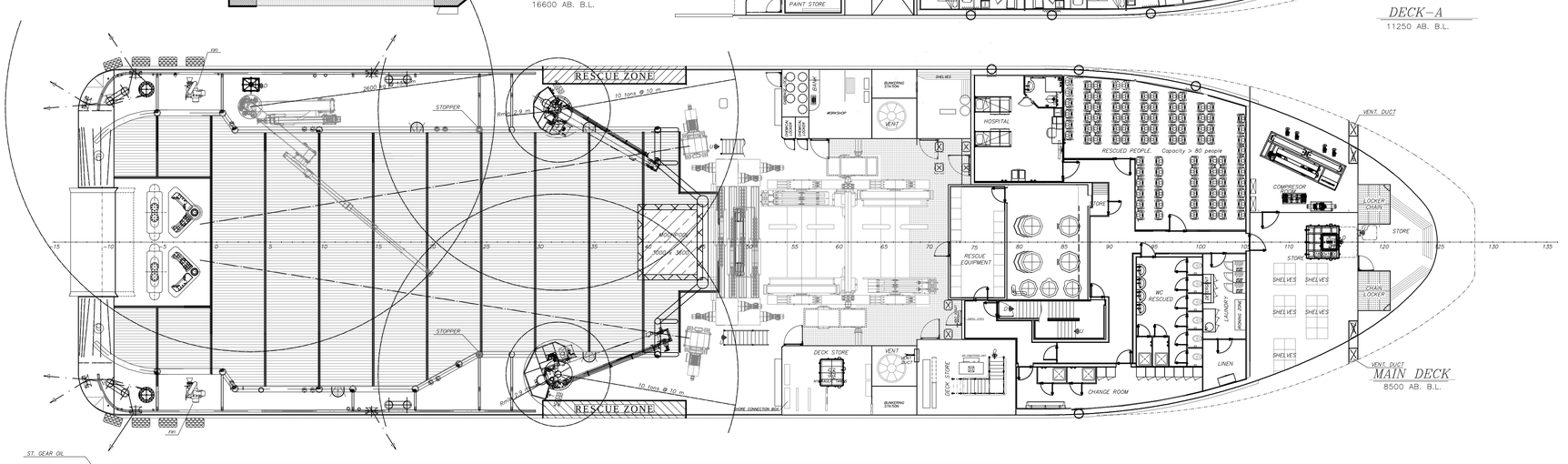


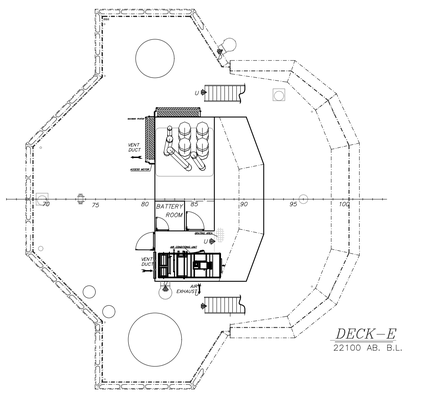


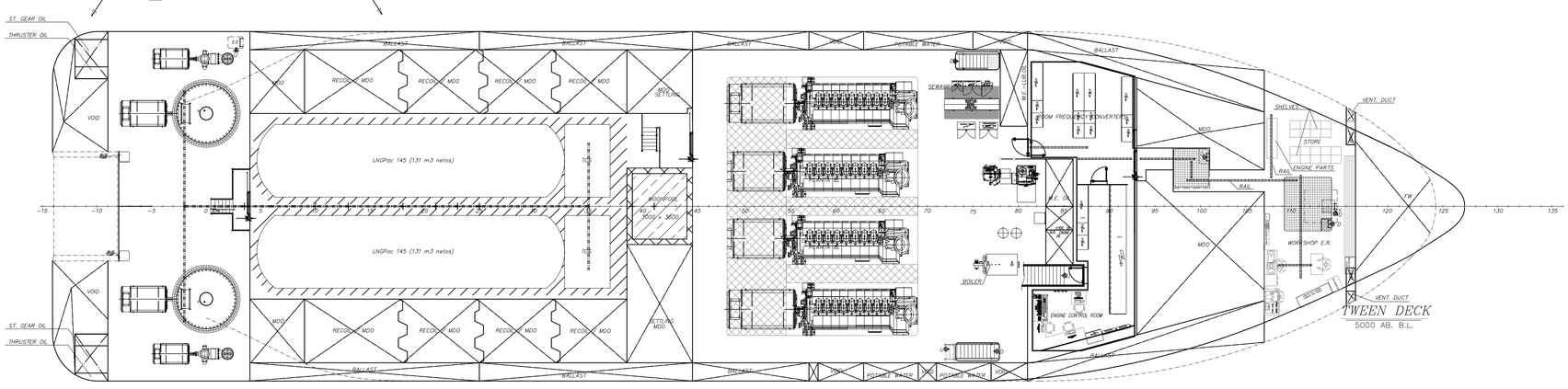


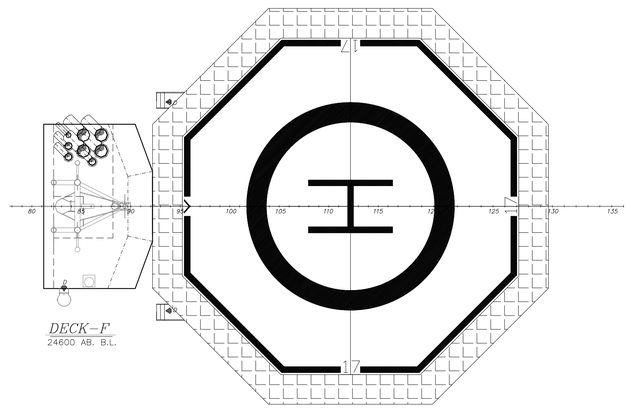


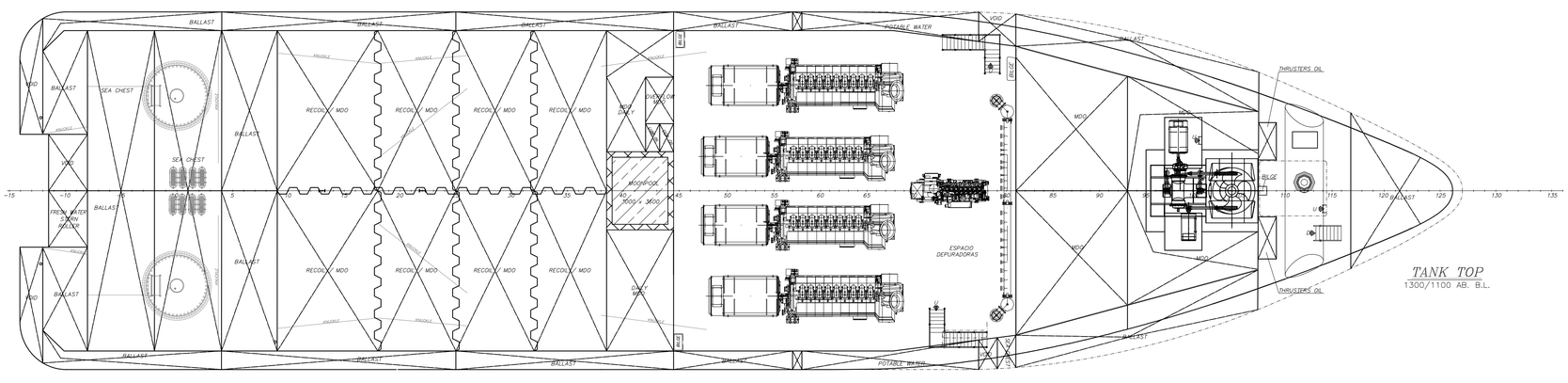


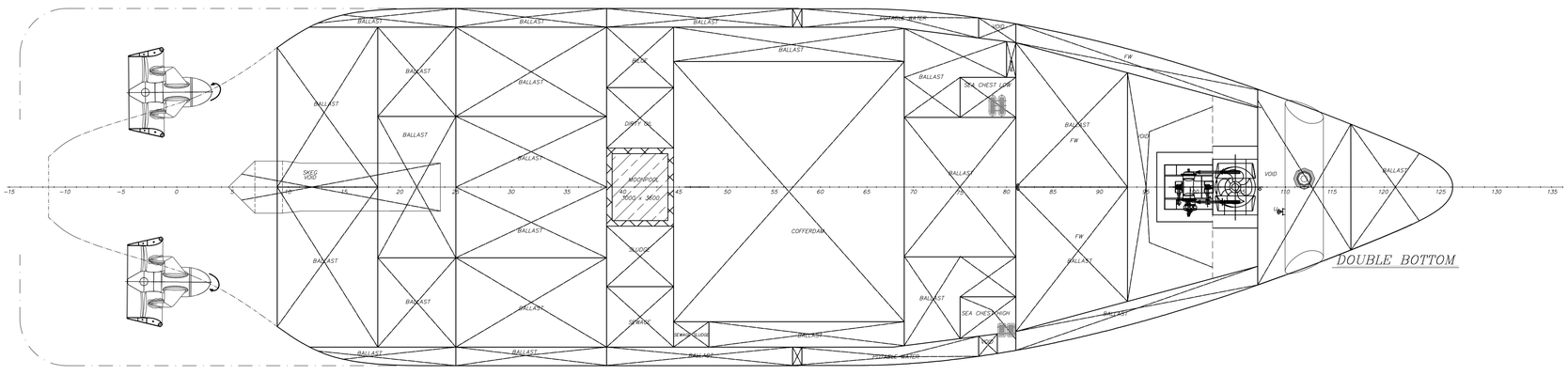












MAIN PARTICULARS

LENGTH OVER ALL.....: 79.20 m
LENGTH BETWEEN PERP. .....: 66.63 m
BREADTH MOULDED.....: 19.20 m
BOLLARD PULL.....: 235 tons
MDO CAPACITY.....: 812 m3
OIL RECOVERY.....: 1295 m3
LNG CAPACITY.....: 260 m3
HELIDECK..... D17

Modif.	Fecha	Nombre	Observaciones:

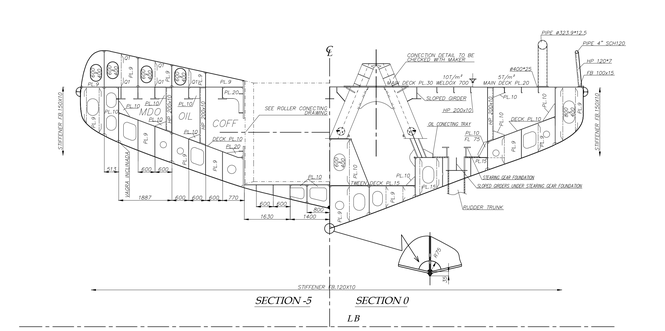
ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

	Fechas	Nombres	Observaciones
Dibujado	17-09-2018	J.López-Fando	
Comprobado	20-09-2018	A.N.	

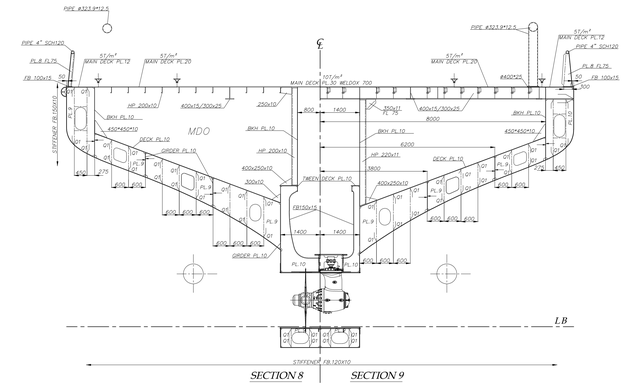
Buque: PR-119-18 - REMOLCADOR SASEMAR
Constr. Nº: PR 119-18
Escala: 1:150 e indicadas
Designacion: DISPOSICIÓN GENERAL
Plano Nº: GA-119-18-100
Sustituye a:
Nº de hojas: 01 Hoja Nº: 01

ARMADOR / CLASIFICACION / AUTORIDADES / APROBADO

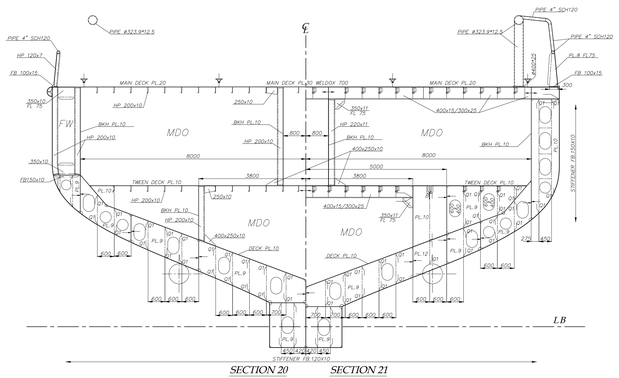
Documentación propiedad de ASTILLEROS ARMON GIJON, S.A.
Su contenido no puede ser copiado, reproducido, entregado a terceras personas, ni usado con fines no autorizados sin permiso escrito del propietario.



SECTION -5 SECTION 0

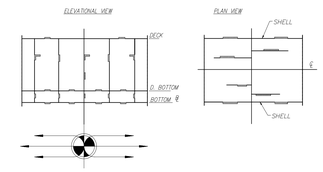


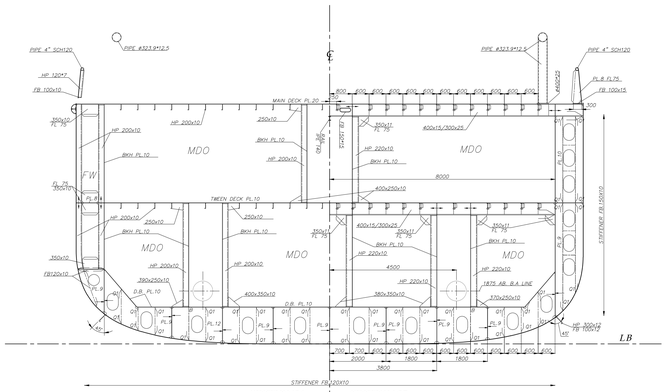
SECTION 8 SECTION 9



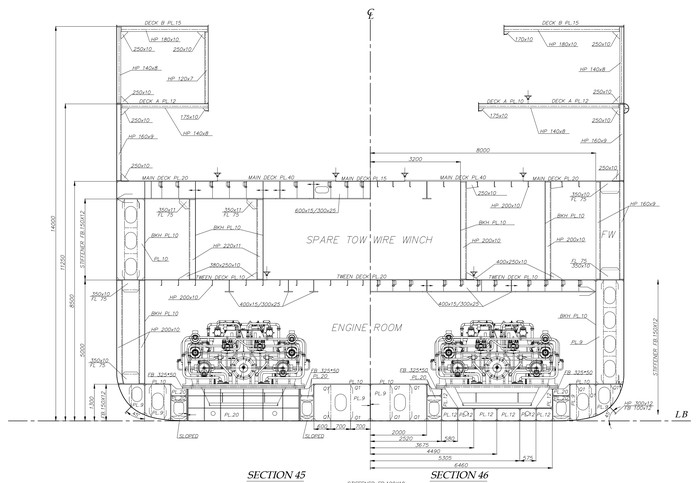
SECTION 20 SECTION 21

THICKNESS ARRANGEMENT

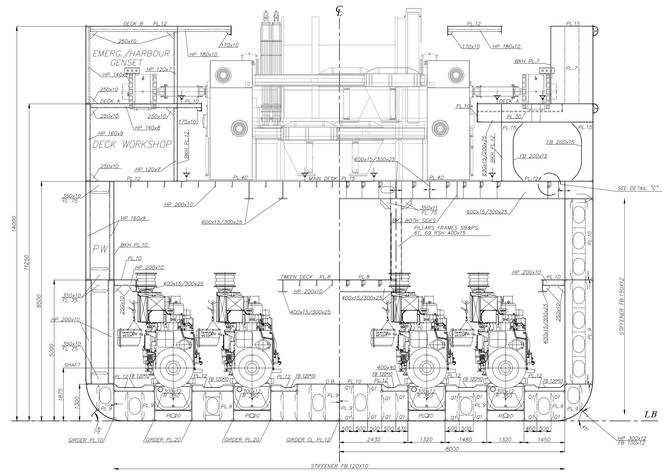




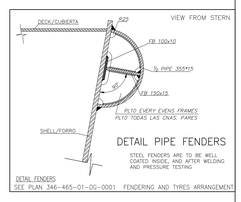
SECTION34 SECTION 35

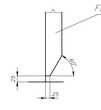


SECTION 45 SECTION 46

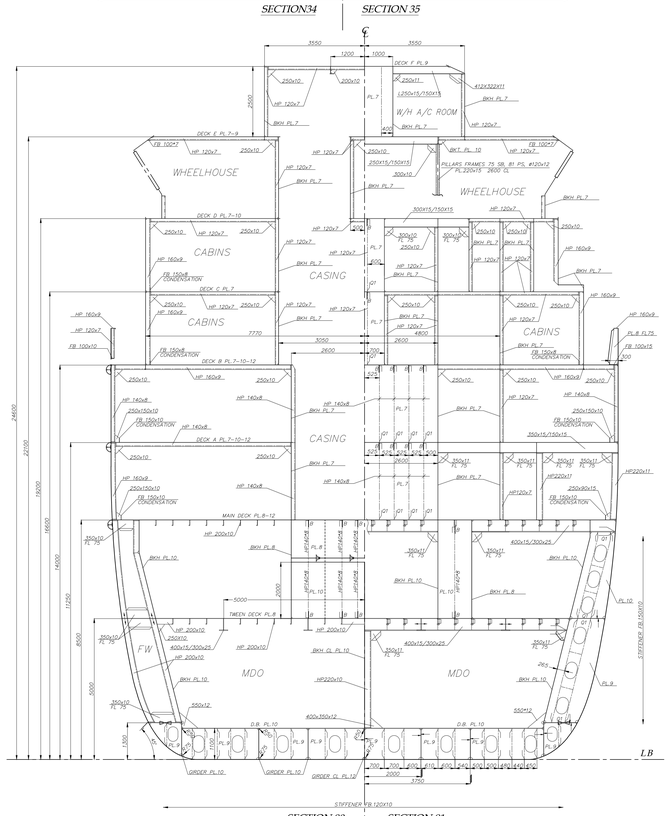


SECTION 53 SECTION 54

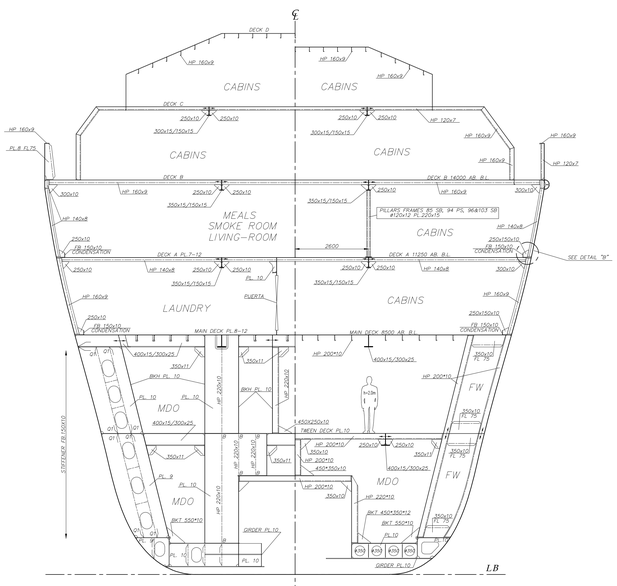




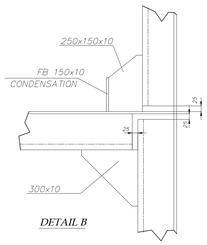
DETAIL Q1



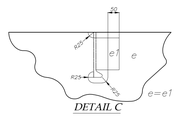
SECTION 80 SECTION 81



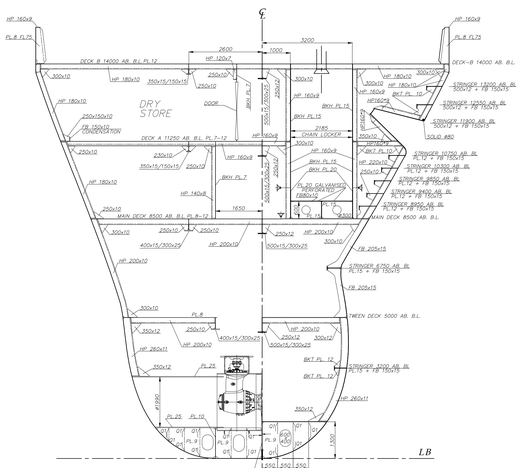
SECTION 95 SECTION 96



DETAIL B



DETAIL C



SECTION 105 SECTION 113

CLASSIFICATION:

LLOYD'S REGISTER: +100A1 TUG Anchor Handler
Deck load of 5 m.t/m²; +LMC, UMS, IWS, CAC(3) DP(AA) EP SCM

EQUIPMENT NUMBER: V

$$Nc = \Delta^{2/3} + 2(aB + \Sigma h_n b_n) + 0.1A$$

$$\boxed{Nc = 974}$$

- 2 ANCHORS OF HIGH HOLDING "SPEK" TYPE OF 2850 KG. PER ANCHOR (THE THIRD ANCHOR IS INTENDED AS A SPARE AND IS NOT REQUIRED FOR THE PURPOSE OF CLASSIFICATION)
- 495 m. (OWNER 742.5 m.) CHAIN OF ø46 QUALITY Q3
- 4 MOORING LINES OF 170 m. EACH ONE WITH 216 KN. BREAKING LOAD

PRINCIPAL DIMENSIONS

LENGTH OVER ALL.....: 79.90 m
BREADTH MOULDED..... : 19.20 m
DEPTH MOULDED..... : 8.50 m
DRAUGHT, scantling..... : 7.50 m

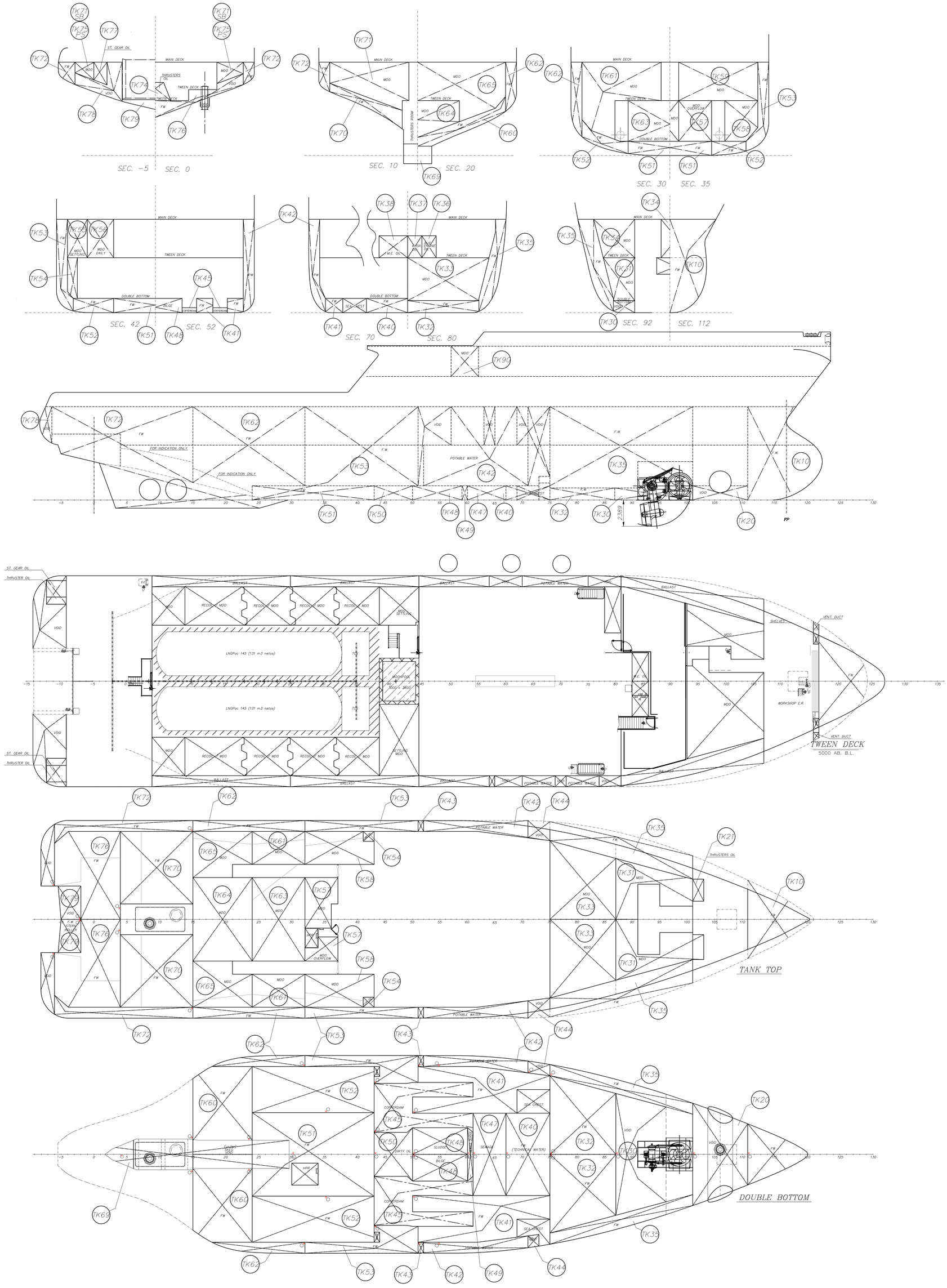
NOTES:
ALL MATERIALS WILL BE STEEL GRADE D EXCEPT INDICATIONS

Rev.	Date year-month-day	Drawn by	Checked by	Approved by	Description
1	07/02/2019	–	AN	–	Primera edición

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

Vessel: BUQUE MULTIPROPOSITO
Hull Nº Pr 118-19
Scale: 1/75
Designation: MIDSHIP SECTION PROPERTIES PLAN MAESTRA Y SECCIONES TIPO
Document Code: 346-201-02-DR-0001
Total sheets: 1 sheet Nº: 1

Documentation SHIPYARD property ARMON GIJON, SA
Its contents may not be copied, reproduced, given to third parties or used for purposes unauthorized without written permission from the owner.



TOTAL VOLUME OF EACH CONTENT	
BALLAST	1000
TOTAL POTABLE WATER	50
TOTAL DIRTY OIL	18.00
TOTAL SLUDGE	14.53
TOTAL BILGE	14.53
TOTAL SEWAGE	26.91
TOTAL SEWAGE SLUDGE	2.65
TOTAL OIL	55.5
TOTAL MDO	812
TOTAL LNG	260
OIL RECOVERY	1295
CONTENT	CAPACITY(m3)

Rev.	Date year-month-day	Drawn by	Checked by	Approved by	Description
0	07/02/2019	–	AN	–	Primera edición

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

Vessel: BUQUE MULTIPROPOSITO

Hull Nº Pr 119-18

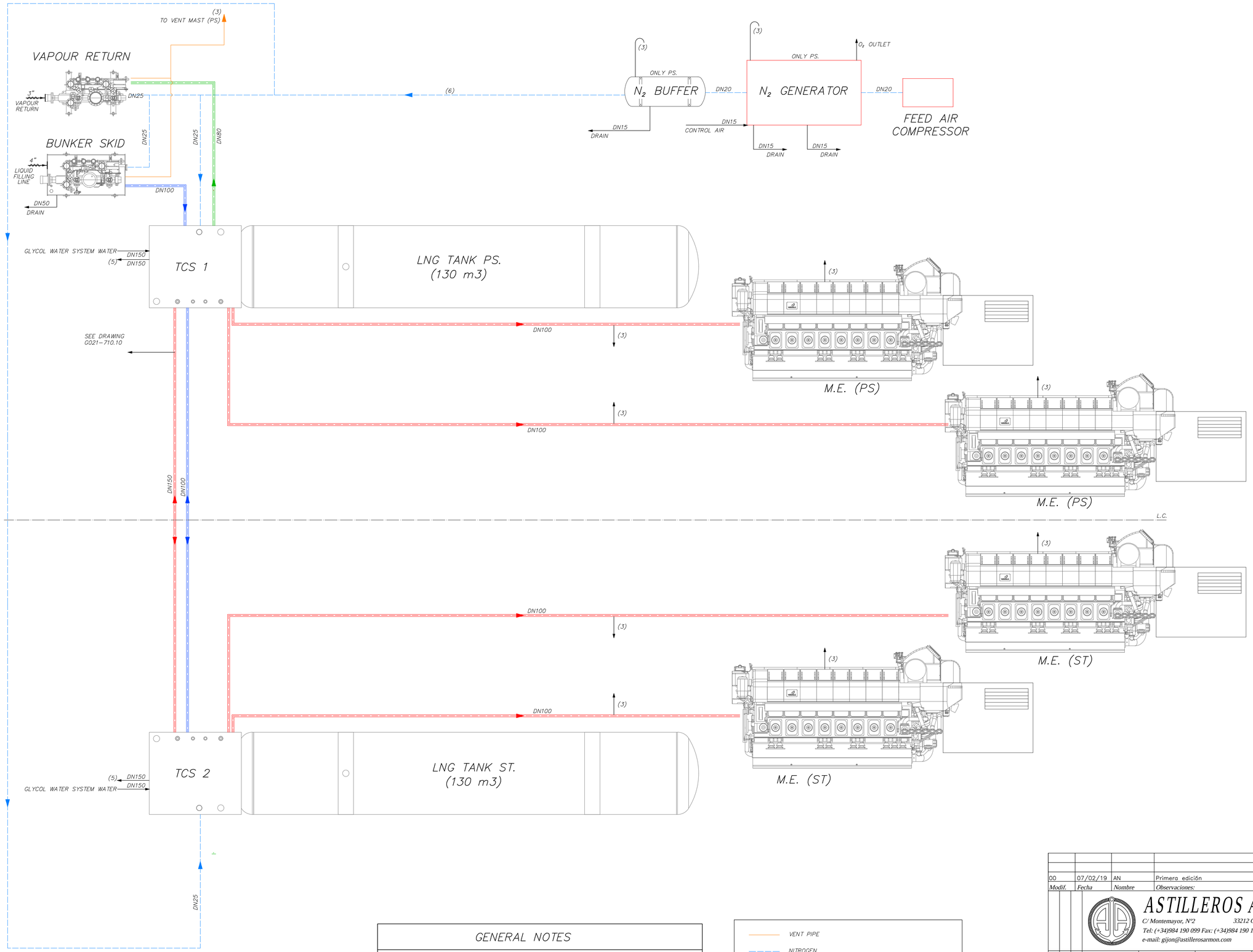
Scale: 1/150

Designation: TANK & CAPACITY PLAN DISPOSICION DE TANQUES

Document Code: 346-133-03-DG-0001

Total sheets: 1 sheet Nº: 1

Documentation SHIPYARD property ARMON GIJON, SA
Its contents may not be copied, reproduced, given to third parties or used for purposes unauthorized without written permission from the owner.



GENERAL NOTES

(1) ALL DIAMETERS SHOWN REFER TO ØINT.

(2) GAS VALVE UNIT (GVU) OF THE MAIN ENGINES ARE INCLUDING IN THE CORRESPONDIG TCS

- VENT PIPE
- NITROGEN
- DOUBLE WALLED PIPE VACUUM INSULATED +MLI (LNG)
- DOUBLE WALLED PIPE AIR VENTILATED (NG)
- DOUBLE WALLED PIPE AIR VENTILATED (NG COLD)

Modif.	Fecha	Nombre	Observaciones:
00	07/02/19	AN	Primera edición

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

	Fechas	Nombres	Observaciones
Dibujado	22-01-2019	L.G.F.	
Comprobado	22-01-2019	P.V.F.	

Buque: BUQUE MULTIPROPOSITO

Constr. Nº: Pr 119-18

Escala: S/E e indicadas

Designacion: LNG & GAS System Diagram

Plano Nº: G021 - 710.00

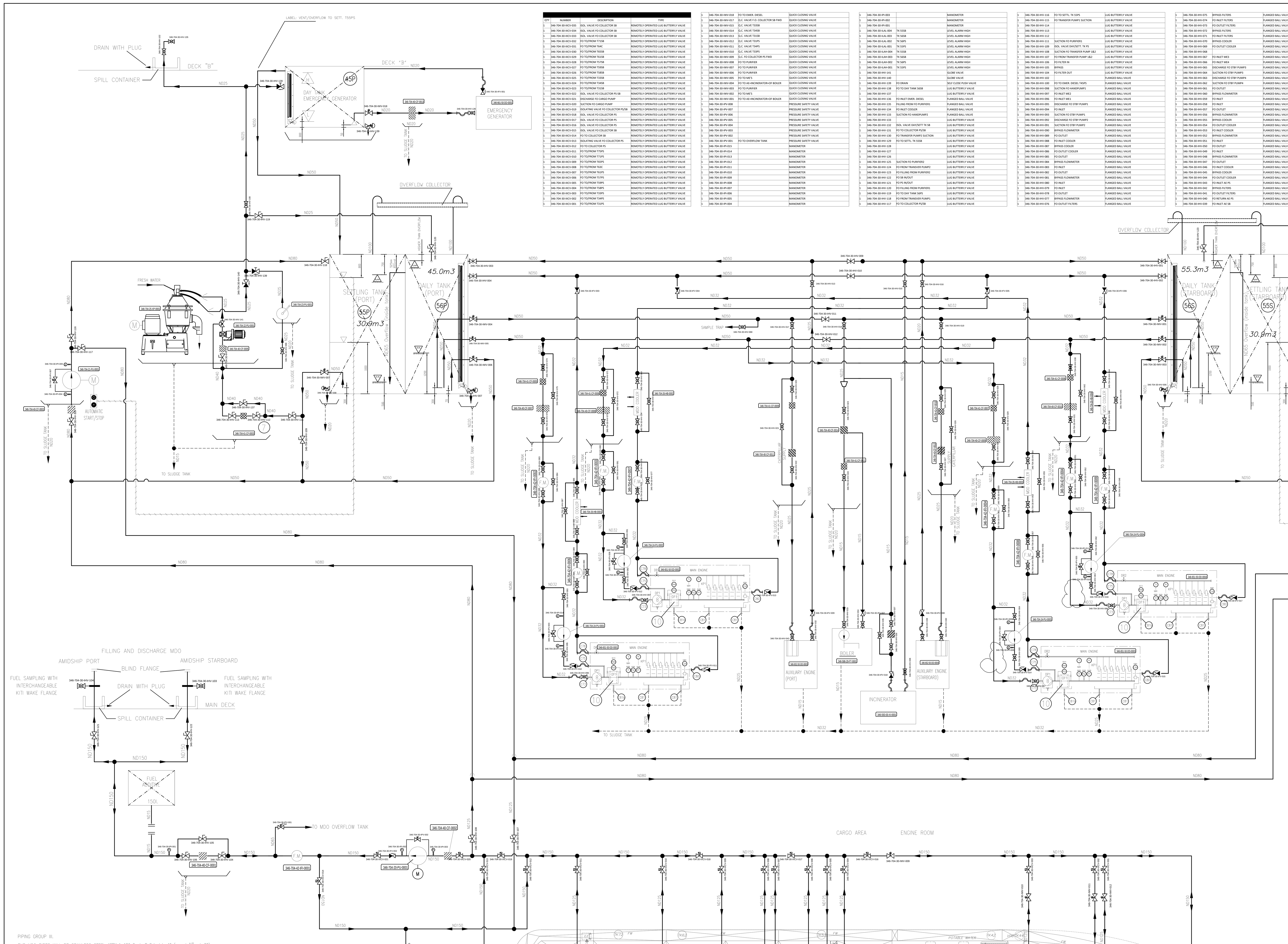
Sustituye a:

Nº de hojas: Hoja Nº:

ARMADOR / CLASIFICACION / AUTORIDADES / APROBADO

Documentación propiedad de ASTILLEROS ARMON GIJON, S.A.
Su contenido no puede ser copiado, reproducido, entregado a terceras personas, ni usado con fines no autorizados sin permiso escrito del propietario.

A1



PIPING GROUP III.

THE MDO PIPES WILL BE SEAMLESS STEEL ASTM A-106 Grado B Schedule 40 (except ½" sch 80).

THE MDO PIPES SHALL BE CLEANED BY PICKLING PRIOR TO INSTALLATION AND SHALL BE FLUSHED AFTER INSTALLATION.

THE MDO TRANSFER PUMP AND PURIFIER WILL DISPOSE OF EMERGENCY STOP FROM THE OUTSIDE OF THE ENGINE ROOM.

EXACT LOCATION AND HEIGHT OF LEVEL ALARMS AND OVERFLOW PIPES FOR BOTH DAYTANKS WILL BE DETERMINED ON THE SPOT DURING CONSTRUCTION.

A PLATE TO BE FITTED ON SUCTION HEAD OF EACH TANK.

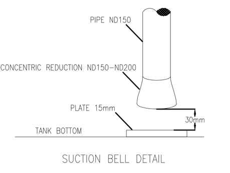
MATERIAL OF QUICK CLOSING VALVES IS NODULAR IRON (DUCTILE IRON) WITH ELONGATION NOT LESS THAN 12% IN 50 MM (GGG40-12).

ALL REMOTE CONTROL VALVES IN CARGO SYSTEM SHALL BE PROVIDED WITH A READILY ACCESIBLE MANUAL MEANS OF OPERATION IN CASE OF LOSS OF POWER TO THE VALVE CONTROL SYSTEM.

A 150 MM SAVE-ALL TO BE FITTED UNDER THE BUNKERING MANIFOLDS.

SPILL CONTAINERS AROUND VENT PIPES, ALL BUNKERING STATIONS, FILLING PIPES, MANIFOLDS, ETC., TO BE PROVIDED.

FUEL CATCHERS FORESEEN TO BE 400 LITRES CAPACITY.



SUCTION BELL DETAIL

TANK	SIDE	POSITION	CONTENT	CAP.(m3)
TK45-PS	PORTSIDE	FR57-FR62	MDO EMERG. GENSET	7.4

TANK	SIDE	POSITION	CONTENT	CAP.(m3)
			TOTAL MDO	2516.8
TK75-PS	PORTSIDE	FR06-FR2	MDO	14.8
TK71-PS	PORTSIDE	FR4-FR15	MDO	148.3
TK71-SB	STARBOARD	FR06-FR15	MDO	153.1
TK65-PS	PORTSIDE	FR15-FR24	MDO	149.2
TK65-SB	STARBOARD	FR15-FR24	MDO	149.2
TK64	CENTRAL	FR15-FR24	MDO	100.8
TK63	CENTRAL	FR24-FR32	MDO	130.9
TK61-PS	PORTSIDE	FR24-FR32	MDO	153.8
TK61-SB	STARBOARD	FR24-FR32	MDO	153.8
TK59-PS	PORTSIDE	FR32-FR41	MDO	119.3
TK59-SB	STARBOARD	FR32-FR41	MDO	107.8
TK58-PS	PORTSIDE	FR32-FR43	MDO	62.4
TK58-SB	STARBOARD	FR32-FR43	MDO	62.4
TK57-PS	PORTSIDE	FR32-FR37	MDO	42.8
TK57-SB	STARBOARD	FR32-FR37	MDO (OVERFLOW)	22.2
TK56-PS	PORTSIDE	FR41-FR51	MDO (DAILY)	45.0
TK56-SB	STARBOARD	FR41-FR51	MDO (DAILY)	55.3
TK55-PS	PORTSIDE	FR41-FR51	MDO (SETTLING)	30.9
TK55-SB	STARBOARD	FR41-FR51	MDO (SETTLING)	30.9
TK34-PS	PORTSIDE	FR87-FR101	MDO	78.7
TK34-SB	STARBOARD	FR87-FR101	MDO	169.9
TK33-PS	PORTSIDE	FR75-FR87	MDO	155.7
TK33-SB	STARBOARD	FR75-FR87	MDO	155.7
TK31-PS	PORTSIDE	FR87-FR101	MDO	97.7
TK31-SB	STARBOARD	FR87-FR103	MDO	155.7

QTY	NUMBER	DESCRIPTION	TYPE
1	346-704-30-IXCV-035	ISOL. VALVE FO COLLECTOR SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-034	ISOL. VALVE FO COLLECTOR SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-033	ISOL. VALVE FO COLLECTOR SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-032	FO TO/FROM T71SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-031	FO TO/FROM T64C	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-030	FO TO/FROM T65SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-029	FO TO/FROM T61SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-028	FO TO/FROM T57SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-027	FO TO/FROM T59SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-026	FO TO/FROM T58SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-025	FO TO/FROM T33SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-024	FO TO/FROM T34SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-023	FO TO/FROM T31SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-022	ISOL. VALVE FO COLLECTOR PS-SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-021	DISCHARGE FO CARGO PUMP	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-020	SUCTION FO CARGO PUMP	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-019	ISOLATING VALVE FO COLLECTOR PS/SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-018	ISOL. VALVE FO COLLECTOR PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-017	ISOL. VALVE FO COLLECTOR PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-016	ISOL. VALVE FO COLLECTOR PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-015	ISOL. VALVE FO COLLECTOR SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-014	FO TO COLLECTOR SB	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-013	ISOLATING VALVE FO COLLECTOR PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-012	FO TO COLLECTOR PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-011	FO TO/FROM T75PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-010	FO TO/FROM T71PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-009	FO TO/FROM T65PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-008	FO TO/FROM T63C	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-007	FO TO/FROM T61PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-006	FO TO/FROM T57PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-005	FO TO/FROM T59PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-004	FO TO/FROM T58PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-003	FO TO/FROM T33PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-002	FO TO/FROM T34PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IXCV-001	FO TO/FROM T31PS	REMOTELY OPERATED LUG BUTTERFLY VALVE
1	346-704-30-IWV-018	FO TO EMER. DIESEL	QUICK CLOSING VALVE
1	346-704-30-IWV-017	Q.C. VALVE F.O. COLLECTOR SB FWD	QUICK CLOSING VALVE
1	346-704-30-IWV-015	Q.C. VALVE T33SB	QUICK CLOSING VALVE
1	346-704-30-IWV-014	Q.C. VALVE T34SB	QUICK CLOSING VALVE
1	346-704-30-IWV-013	Q.C. VALVE T31SB	QUICK CLOSING VALVE
1	346-704-30-IWV-012	Q.C. VALVE T31PS	QUICK CLOSING VALVE
1	346-704-30-IWV-011	Q.C. VALVE T34PS	QUICK CLOSING VALVE
1	346-704-30-IWV-010	Q.C. VALVE T33PS	QUICK CLOSING VALVE
1	346-704-30-IWV-009	Q.C. FO COLLECTOR PS FWD	QUICK CLOSING VALVE
1	346-704-30-IWV-008	FO TO PURIFIER	QUICK CLOSING VALVE
1	346-704-30-IWV-007	FO TO PURIFIER	QUICK CLOSING VALVE
1	346-704-30-IWV-006	FO TO PURIFIER	QUICK CLOSING VALVE
1	346-704-30-IWV-005	FO TO ME'S	QUICK CLOSING VALVE
1	346-704-30-IWV-004	FO TO AE+INCINERATOR+OF BOILER	QUICK CLOSING VALVE
1	346-704-30-IWV-003	FO TO PURIFIER	QUICK CLOSING VALVE
1	346-704-30-IWV-002	FO TO ME'S	QUICK CLOSING VALVE
1	346-704-30-IWV-001	FO TO AE+INCINERATOR+OF BOILER	QUICK CLOSING VALVE
1	346-704-30-IPV-008		PRESSURE SAFETY VALVE
1	346-704-30-IPV-007		PRESSURE SAFETY VALVE
1	346-704-30-IPV-006		PRESSURE SAFETY VALVE
1	346-704-30-IPV-005		PRESSURE SAFETY VALVE
1	346-704-30-IPV-004		PRESSURE SAFETY VALVE
1	346-704-30-IPV-003		PRESSURE SAFETY VALVE
1	346-704-30-IPV-002		PRESSURE SAFETY VALVE
1	346-704-30-IPV-001	FO TO OVERFLOW TANK	PRESSURE SAFETY VALVE
1	346-704-30-IPI-015		MANOMETER
1	346-704-30-IPI-014		MANOMETER
1	346-704-30-IPI-013		MANOMETER
1	346-704-30-IPI-012		MANOMETER
1	346-704-30-IPI-011		MANOMETER
1	346-704-30-IPI-010		MANOMETER
1	346-704-30-IPI-009		MANOMETER
1	346-704-30-IPI-008		MANOMETER
1	346-704-30-IPI-007		MANOMETER
1	346-704-30-IPI-006		MANOMETER
1	346-704-30-IPI-005		MANOMETER
1	346-704-30-IPI-004		MANOMETER
1	346-704-30-IPI-003		MANOMETER
1	346-704-30-IPI-002		MANOMETER
1	346-704-30-IPI-001		MANOMETER
1	346-704-30-ILAL-004	TK 55SB	LEVEL ALARM HIGH
1	346-704-30-ILAL-003	TK 56SB	LEVEL ALARM HIGH
1	346-704-30-ILAL-002	TK 56PS	LEVEL ALARM HIGH
1	346-704-30-ILAL-001	TK 55PS	LEVEL ALARM HIGH
1	346-704-30-ILAH-004	TK 55SB	LEVEL ALARM HIGH
1	346-704-30-ILAH-003	TK 56SB	LEVEL ALARM HIGH
1	346-704-30-ILAH-002	TK 56PS	LEVEL ALARM HIGH
1	346-704-30-ILAH-001	TK 55PS	LEVEL ALARM HIGH
1	346-704-30-IHV-141		GLOBE VALVE
1	346-704-30-IHV-140		GLOBE VALVE
1	346-704-30-IHV-139	FO DRAIN	SELF CLOSE PUSH VALVE
1	346-704-30-IHV-138	FO TO DAY TANK 56SB	LUG BUTTERFLY VALVE
1	346-704-30-IHV-137		LUG BUTTERFLY VALVE
1	346-704-30-IHV-136	FO INLET EMER. DIESEL	FLANGED BALL VALVE
1	346-704-30-IHV-135	FILLING FROM FO PURIFIER1	FLANGED BALL VALVE
1	346-704-30-IHV-134	FO INLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-133	SUCTION FO HANDPUMP2	FLANGED BALL VALVE
1	346-704-30-IHV-133		LUG BUTTERFLY VALVE
1	346-704-30-IHV-132	ISOL. VALVE DAY/SETT TK SB	LUG BUTTERFLY VALVE
1	346-704-30-IHV-131	FO TO COLLECTOR PS/SB	LUG BUTTERFLY VALVE
1	346-704-30-IHV-130	FO TRANSFER PUMP2 SUCTION	LUG BUTTERFLY VALVE
1	346-704-30-IHV-129	FO TO SETTL. TK 55SB	LUG BUTTERFLY VALVE
1	346-704-30-IHV-128		LUG BUTTERFLY VALVE
1	346-704-30-IHV-127		LUG BUTTERFLY VALVE
1	346-704-30-IHV-126		LUG BUTTERFLY VALVE
1	346-704-30-IHV-125	SUCTION FO PURIFIER2	LUG BUTTERFLY VALVE
1	346-704-30-IHV-124	FO FROM TRANSVER PUMP2	LUG BUTTERFLY VALVE
1	346-704-30-IHV-123	FO FILLING FROM PURIFIER2	LUG BUTTERFLY VALVE
1	346-704-30-IHV-122	FO SB IN/OUT	LUG BUTTERFLY VALVE
1	346-704-30-IHV-121	FO PS IN/OUT	LUG BUTTERFLY VALVE
1	346-704-30-IHV-120	FO FILLING FROM PURIFIER1	LUG BUTTERFLY VALVE
1	346-704-30-IHV-119	FO TO DAY TANK 56PS	LUG BUTTERFLY VALVE
1	346-704-30-IHV-118	FO FROM TRANSVER PUMP1	LUG BUTTERFLY VALVE
1	346-704-30-IHV-117	FO TO COLLECTOR PS/SB	LUG BUTTERFLY VALVE
1	346-704-30-IHV-116	FO TO SETTL. TK 55PS	LUG BUTTERFLY VALVE
1	346-704-30-IHV-115	FO TRANSFER PUMP1 SUCTION	LUG BUTTERFLY VALVE
1	346-704-30-IHV-114		LUG BUTTERFLY VALVE
1	346-704-30-IHV-113		LUG BUTTERFLY VALVE
1	346-704-30-IHV-112		LUG BUTTERFLY VALVE
1	346-704-30-IHV-111	SUCTION FO PURIFIER1	LUG BUTTERFLY VALVE
1	346-704-30-IHV-109	ISOL. VALVE DAY/SETT. TK PS	LUG BUTTERFLY VALVE
1	346-704-30-IHV-108	SUCTION FO TRANSFER PUMP 1&2	LUG BUTTERFLY VALVE
1	346-704-30-IHV-107	FO FROM TRANSFER PUMP 1&2	LUG BUTTERFLY VALVE
1	346-704-30-IHV-106	FO FILTER IN	LUG BUTTERFLY VALVE
1	346-704-30-IHV-105	BYPASS	LUG BUTTERFLY VALVE
1	346-704-30-IHV-104	FO FILTER OUT	LUG BUTTERFLY VALVE
1	346-704-30-IHV-102		FLANGED BALL VALVE
1	346-704-30-IHV-100	FO TO EMER. DIESEL T45PS	FLANGED BALL VALVE
1	346-704-30-IHV-098	SUCTION FO HANDPUMP1	FLANGED BALL VALVE
1	346-704-30-IHV-097	FO INLET ME2	FLANGED BALL VALVE
1	346-704-30-IHV-096	FO INLET ME1	FLANGED BALL VALVE
1	346-704-30-IHV-095	DISCHARGE FO STBY PUMP1	FLANGED BALL VALVE
1	346-704-30-IHV-094	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-093	SUCTION FO STBY PUMP1	FLANGED BALL VALVE
1	346-704-30-IHV-092	DISCHARGE FO STBY PUMP2	FLANGED BALL VALVE
1	346-704-30-IHV-091	SUCTION FO STBY PUMP2	FLANGED BALL VALVE
1	346-704-30-IHV-090	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-089	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-088	FO INLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-087	BYPASS COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-086	FO OUTLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-085	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-084	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-083	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-082	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-081	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-080	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-079	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-078	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-077	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-076	FO OUTLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-075	BYPASS FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-074	FO INLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-073	FO OUTLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-072	BYPASS FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-071	FO INLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-070	BYPASS COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-069	FO OUTLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-068		FLANGED BALL VALVE
1	346-704-30-IHV-067	FO INLET ME3	FLANGED BALL VALVE
1	346-704-30-IHV-066	FO INLET ME4	FLANGED BALL VALVE
1	346-704-30-IHV-065	DISCHARGE FO STBY PUMP3	FLANGED BALL VALVE
1	346-704-30-IHV-064	SUCTION FO STBY PUMP3	FLANGED BALL VALVE
1	346-704-30-IHV-063	DISCHARGE FO STBY PUMP4	FLANGED BALL VALVE
1	346-704-30-IHV-062	SUCTION FO STBY PUMP4	FLANGED BALL VALVE
1	346-704-30-IHV-061	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-060	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-059	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-058	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-057	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-056	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-055	BYPASS COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-054	FO OUTLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-053	FO INLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-052	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-051	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-050	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-049	FO INLET	FLANGED BALL VALVE
1	346-704-30-IHV-048	BYPASS FLOWMETER	FLANGED BALL VALVE
1	346-704-30-IHV-047	FO OUTLET	FLANGED BALL VALVE
1	346-704-30-IHV-046	FO INLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-045	BYPASS COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-044	FO OUTLET COOLER	FLANGED BALL VALVE
1	346-704-30-IHV-043	FO INLET AE PS	FLANGED BALL VALVE
1	346-704-30-IHV-042	BYPASS FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-041	FO OUTLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-040	FO RETURN AE PS	FLANGED BALL VALVE
1	346-704-30-IHV-039	FO INLET AE SB	FLANGED BALL VALVE
1	346-704-30-IHV-038		FLANGED BALL VALVE
1	346-704-30-IHV-037		FLANGED BALL VALVE
1	346-704-30-IHV-036		FLANGED BALL VALVE
1	346-704-30-IHV-035		FLANGED BALL VALVE
1	346-704-30-IHV-034	FO RETURN OF BOILER	FLANGED BALL VALVE
1	346-704-30-IHV-033	FO INLET OF BOILER	FLANGED BALL VALVE
1	346-704-30-IHV-032		FLANGED BALL VALVE
1	346-704-30-IHV-031	FO OUTLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-030	FO INLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-029	BYPASS FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-028	FO INLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-027	FO OUTLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-026	BYPASS FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-025	FO INLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-024	FO FILTER OUTLET OF BOILER	FLANGED BALL VALVE
1	346-704-30-IHV-023	FO INLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-022	FO OUTLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-021	BYPASS FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-020	FO INLET FILTERS	FLANGED BALL VALVE
1	346-704-30-IHV-019	FO SUPPLY AE SB	FLANGED BALL VALVE
1	346-704-30-IHV-018	FO SUPPLY OF BOILER	FLANGED BALL VALVE
1	346-704-30-IHV-017	FO SUPPLY AE PS	FLANGED BALL VALVE
1	346-704-30-IHV-016	FO RETURN AE SB	FLANGED BALL VALVE
1	346-704-30-IHV-015	FO RETURN INCINERATOR	FLANGED BALL VALVE
1	346-704-30-IHV-013	FO RETURN AE PS	FLANGED BALL VALVE
1	346-704-30-IHV-012	ISOL. VALVE PS/SB FO TO ME'S	GATE VALVE
1	346-704-30-IHV-011	ISOL. VALVE PS/SB FO TO AE'S+INCINERATOR	GATE VALVE
1	346-704-30-IHV-010	ISOL. VALVE PS/SB FO RETURN ME'S	GATE VALVE
1	346-704-30-IHV-009	ISOL. VALVE PS/SB FO RETURN AE+INCINERATOR	GATE VALVE
1	346-704-30-IHV-008	FO DRAIN	SELF CLOSE PUSH VALVE
1	346-704-30-IHV-007	FO DRAIN	SELF CLOSE PUSH VALVE
1	346-704-30-IHV-006	FO DRAIN	SELF CLOSE PUSH VALVE
1	346-704-30-IHV-005	FO DRAIN	SELF CLOSE PUSH VALVE
1	346-704-30-IHV-004	FO RETUN ME'S	GATE VALVE
1	346-704-30-IHV-003	FO RETURN AE+INCINERATOR	GATE VALVE
1	346-704-30-IHV-002	FO RETUN ME'S	GATE VALVE
1	346-704-30-IHV-001	FO RETURN AE+INCINERATOR	GATE VALVE
1	346-704-30-IFV-018		NON RETURN VALVE
1	346-704-30-IFV-017	FO RETURN ME4	NON RETURN VALVE
1	346-704-30-IFV-016	FO INLET ME4	NON RETURN VALVE
1	346-704-30-IFV-015	FO RETURN ME3	NON RETURN VALVE
1	346-704-30-IFV-014	FO INLET ME3	NON RETURN VALVE
1	346-704-30-IFV-013	FO RETURN ME2	NON RETURN VALVE
1	346-704-30-IFV-012	FO INLET ME2	NON RETURN VALVE
1	346-704-30-IFV-011	FO RETURN ME1	NON RETURN VALVE
1	346-704-30-IFV-010		NON RETURN VALVE
1	346-704-30-IFV-009	FO RETURN AE PS	NON RETURN VALVE
1	346-704-30-IFV-008		NON RETURN VALVE
1	346-704-30-IFV-007		NON RETURN VALVE
1	346-704-30-IFV-006	FO RETURN ME4	NON RETURN VALVE
1	346-704-30-IFV-005	FO RETURN ME2	NON RETURN VALVE
1	346-704-30-IFV-004	FO RETURN ME3	NON RETURN VALVE
1	346-704-30-IFV-003	FO RETURN ME1	NON RETURN VALVE
1	346-704-30-IFV-002		NON RETURN VALVE
1	346-704-30-IFV-001	FO RETURN EMER. DIESEL	NON RETURN VALVE

SFI	DESCRIPTION	MARK/TYPE	CAPACITY	SUPPLIER	PLATE
346-586-29-FT-0001	Boiler		300 kW	HEATMASTER	
346-593-00-XI-0001	Incinerator	MOD: IRLA-018E-G01 R0		DETEGASA	
346-651-50-DD-0001	Main Engine No.1	MAK MOD: 6M32	3000 kW	FINANZAUTO	
346-651-50-DD-0002	Main Engine No.2	MAK MOD: 6M32	3000 kW	FINANZAUTO	
346-651-50-DD-0003	Main Engine No.3	MAK MOD: 6M32	3000 kW	FINANZAUTO	
346-651-50-DD-0004	Main Engine No.4	MAK MOD: 6M32	3000 kW	FINANZAUTO	
346-652-50-DD-0003	Auxiliary Generator Diesel Engine no. 1	C39	975 kW	FINANZAUTO	
346-652-50-DD-0004	Auxiliary Generator Diesel Engine no. 2	C39	975 kW	FINANZAUTO	
346-661-50-DD-0001	Emergency Generator Diesel Engine	C18	500 kW	FINANZAUTO	
346-704-20-PU-0001	FO transfer cargo pump	BT-LV-110T2-F	100m³/h-60 w.c.m.	AZCUE	FO CARGO PUMP
346-704-21-PU-0001	FO transfer pump no.2	BT-IV70D4	25m³/h-30 w.c.m.	AZCUE	FO TRANSFER PUMP1
346-704-21-PU-0002	FO transfer pump no.2	BT-IV70D4	25m³/h-30 w.c.m.	AZCUE	FO TRANSFER PUMP 2
346-704-22-PU-0001	FO separator feed pump no.2				
346-704-22-PU-0002	FO separator feed pump no.2				
346-704-23-PU-0001	FO transfer hand pump no.2				HAND PUMP1 TO DAY TANK PS
346-704-23-PU-0002	FO transfer hand pump no.2				HAND PUMP2 TO DAY TANK SB
346-704-24-PU-0001	FO standby pump main engine no.2	BT-HM38D4-F	2.2m³/h-50 w.c.m.	AZCUE	FO STBY PUMP1
346-704-24-PU-0002	FO standby pump main engine no.2	BT-HM38D4-F	2.2m³/h-50 w.c.m.	AZCUE	FO STBY PUMP2
346-704-24-PU-0003	FO standby pump main engine no.4	BT-HM38D4-F	2.2m³/h-50 w.c.m.	AZCUE	FO STBY PUMP3
346-704-24-PU-0004	FO standby pump main engine no.4	BT-HM38D4-F	2.2m³/h-50 w.c.m.	AZCUE	FO STBY PUMP4
346-704-25-XP-0001	FO separator no.2	MOD:P615+ACP032N	3150 l/h	ALFA LAVAL	FO PURIFIER 1
346-704-25-XP-0002	FO separator no.2	MOD:P615+ACP032N	3150 l/h	ALFA LAVAL	FO PURIFIER 2
346-704-26-HB-0001	FO plate cooler main engine no. 1				FO COOLER1
346-704-26-HB-0002	FO plate cooler main engine no. 2				FO COOLER2
346-704-26-HB-0003	FO plate cooler main engine no. 3				FO COOLER3
346-704-26-HB-0004	FO plate cooler main engine no. 4				FO COOLER4
346-704-40-CF-0001	FO primary filter bunkering supply line				
346-704-40-CF-0002	FO primary filter suction FO transfer cargo pump				FILTER FO CARGO PUMP
346-704-40-CF-0003	FO primary filter suction FO transfer pump no.1				
346-704-40-CF-0004	FO primary filter suction FO transfer pump no.2				
346-704-40-CF-0005	FO primary filter suction FO separator feed pump no.1				
346-704-40-CF-0006	FO primary filter suction FO separator feed pump no.2				
346-704-40-CF-0007	FO primary filter suction main engine no.1	MOD: 2.04.5.90.95	2200L/h 30µm	BOLLFILTER	
346-704-40-CF-0008	FO primary filter suction main engine no.1	MOD: 2.04.5.90.95	2200L/h 30µm	BOLLFILTER	
346-704-40-CF-0009	FO primary filter suction main engine no.3	MOD: 2.04.5.90.95	2200L/h 30µm	BOLLFILTER	
346-704-40-CF-0010	FO primary filter suction main engine no.3	MOD: 2.04.5.90.95	2200L/h 30µm	BOLLFILTER	
346-704-40-CF-0011	FO primary filter suction main engine no.1	SEDIMENT FILTER		MAK	
346-704-40-CF-0012	FO primary filter suction main engine no.2	SEDIMENT FILTER		MAK	
346-704-40-CF-0013	FO primary filter suction emergency generator	MOD: 2.04.5.90.95			
346-704-40-CF-0014	FO primary filter suction boiler				
346-704-41-CF-0003	FO de-bug filter suction FO separator feed pump no.1				
346-704-41-CF-0004	FO de-bug filter suction FO separator feed pump no.2				
346-704-41-CF-0005	FO de-bug filter suction main engine no.1	MOD: BM 750			
346-704-41-CF-0006	FO de-bug filter suction main engine no.2	MOD: BM 750			
346-704-41-CF-0007	FO de-bug filter suction main engine no.3	MOD: BM 750			
346-704-41-CF-0008	FO de-bug filter suction main engine no.4	MOD: BM 750			
346-704-41-CF-0009	FO de-bug filter suction auxiliary generator no.1	MOD: BM 750			
346-704-41-CF-0010	FO de-bug filter suction auxiliary generator no.2	MOD: BM 750			
346-704-41-CF-0011	FO de-bug filter suction boiler	MOD: BM 750			
346-704-42-IFI-0001	FO primary filter bunkering supply line		2250 L/min CONTINUOUS, 2750 L/min INTERMITTENT		FO COUNTER
346-704-42-IFI-0002	FO primary filter bunkering supply line			MAK	FO SUPPLY METER1
346-704-42-IFI-0003	FO flow meter supply main engine no.2			MAK	FO SUPPLY METER2
346-704-42-IFI-0004	FO flow meter supply main engine no.3			MAK	FO SUPPLY METER3
346-704-42-IFI-0004	FO flow meter supply main engine no.3			MAK	FO SUPPLY METER4
346-704-42-IFI-0006	FO flow meter return main engine no.1			MAK	FO RETURN METER1
346-704-42-IFI-0007	FO flow meter return main engine no.2			MAK	FO RETURN METER2
346-704-42-IFI-0008	FO flow meter return main engine no.3			MAK	FO RETURN METER3
346-704-42-IFI-0009	FO flow meter return main engine no.4			MAK	FO RETURN METER4

NUMBER	TYPE
346-704-30-IPI-001	MANOMETER
346-704-30-IPI-002	MANOMETER
346-704-30-IPI-003	MANOMETER
346-704-30-IPI-004	MANOMETER
346-704-30-IPI-005	MANOMETER
346-704-30-IPI-006	MANOMETER
346-704-30-IPI-007	MANOMETER
346-704-30-IPI-008	MANOMETER
346-704-30-IPI-009	MANOMETER
346-704-30-IPI-010	MANOMETER
346-704-30-IPI-011	MANOMETER
346-704-30-IPI-012	MANOMETER
346-704-30-IPI-013	MANOMETER
346-704-30-IPI-014	MANOMETER
346-704-30-IPI-015	MANOMETER

NUMBER	TYPE	DESCRIPTION
346-704-30-ILAH-001	LEVEL ALARM HIGH	TK 55PS
346-704-30-ILAH-002	LEVEL ALARM HIGH	TK 56PS
346-704-30-ILAH-003	LEVEL ALARM HIGH	TK 56SB
346-704-30-ILAH-004	LEVEL ALARM HIGH	TK 55SB
346-704-30-ILAL-001	LEVEL ALARM HIGH	TK 55PS
346-704-30-ILAL-002	LEVEL ALARM HIGH	TK 56PS
346-704-30-ILAL-003	LEVEL ALARM HIGH	TK 56SB
346-704-30-ILAL-004	LEVEL ALARM HIGH	TK 55SB

SEAMLESS STEEL PIPES (ASTM A-106 Grado B Schedule 80)

NOMINAL PIPE SIZE	ØOUTSIDE mm	THICKNESS mm	ØINSIDE mm
ND15	21.34	3.73	13.88

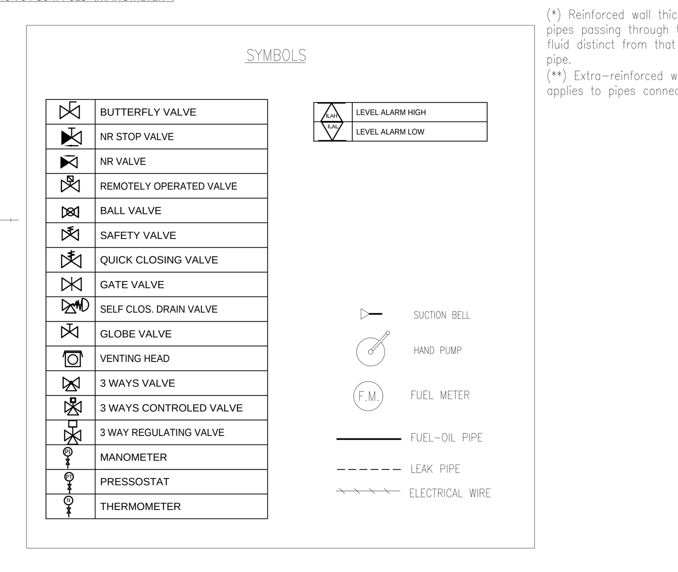
(*) Reinforced wall thickness applies to pipes passing through tanks containing a fluid distinct from that conveyed by the pipe.
(**) Extra-reinforced wall thickness applies to pipes connected to the shell.

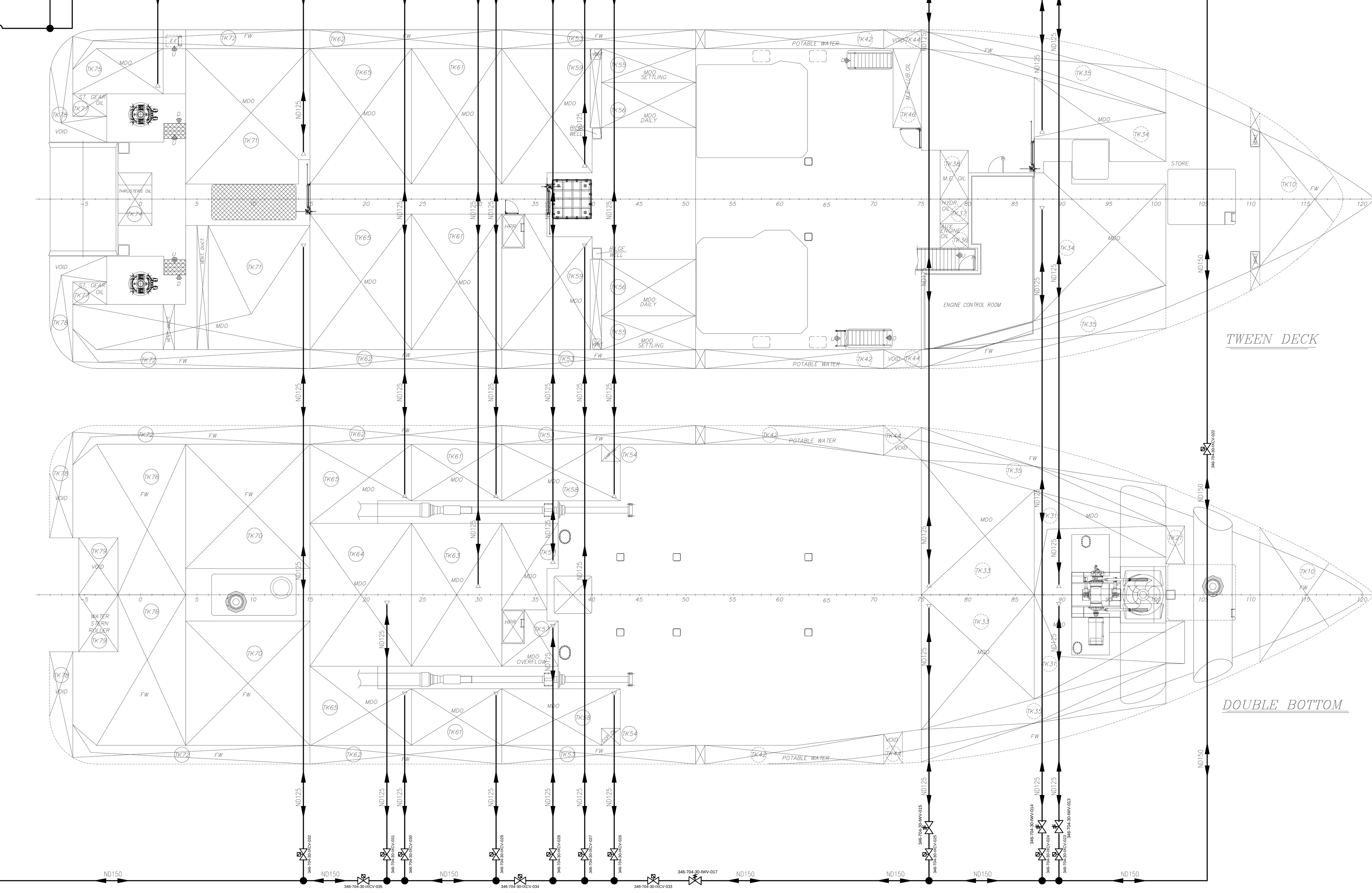
REINFORCED WALL THICKNESS

ØOUTSIDE mm	* MIN.THICKNESS mm	** MIN.THICKNESS mm
38.0-82.5	6.3	7.6
88.9-108	7.1	7.8
114.3-127.0	8.0	8.8
133.0-139.7	8.0	9.5
152.4-168.3	8.8	11.0
177.8-457.2	8.8	12.7

SEAMLESS STEEL PIPES (ASTM A-106 Grado B Schedule 40)

NOMINAL PIPE SIZE	ØOUTSIDE mm	THICKNESS mm	ØINSIDE mm
ND6	10.29	1.73	6.83
ND8	13.72	2.23	9.26
ND10	17.14	2.31	12.52
ND20	26.67	2.87	20.93
ND25	33.40	3.38	26.64
ND32	42.16	3.56	35.04
ND40	48.26	3.68	40.9
ND50	60.32	3.91	52.5
ND65	73.02	5.16	62.7
ND80	88.90	5.49	77.92
ND90	101.60	5.74	90.12
ND100	114.30	6.02	102.26
ND125	141.30	6.55	128.2
ND150	168.27	7.11	154.05
ND200	219.07	8.18	202.71
ND250	273.05	9.27	254.51
ND300	323.85	10.32	303.21
ND350	355.60	11.13	333.34
ND400	406.40	12.70	381
ND450	457.20	14.27	428.66
ND500	508.00	15.06	477.88
ND600	609.60	17.44	574.72





Rev.	Date (year-month-day)	Drawn by	Checked by	Approved by	Description
00	07/02/2019	-	AN	-	Primera edición

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

Vessel: BUQUE MULTIPROPOSITO

Hull Nº PR 119-18

Scale: 1/150

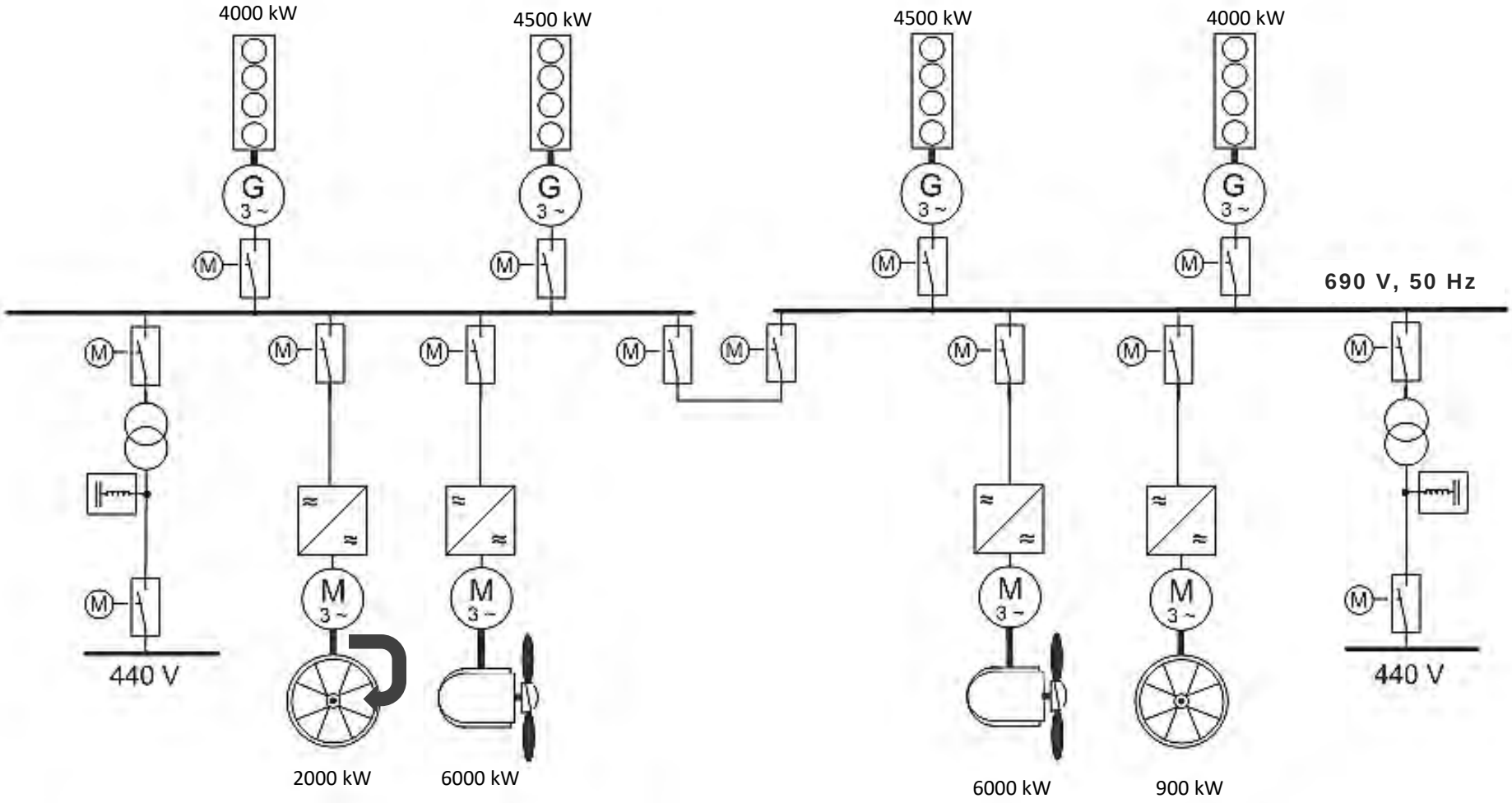
Designation: MDO SERVICE, TRANSFER AND SUPPLY PRINCIPLE DIAGRAM

Document Code: 346-704-01-DD-0001

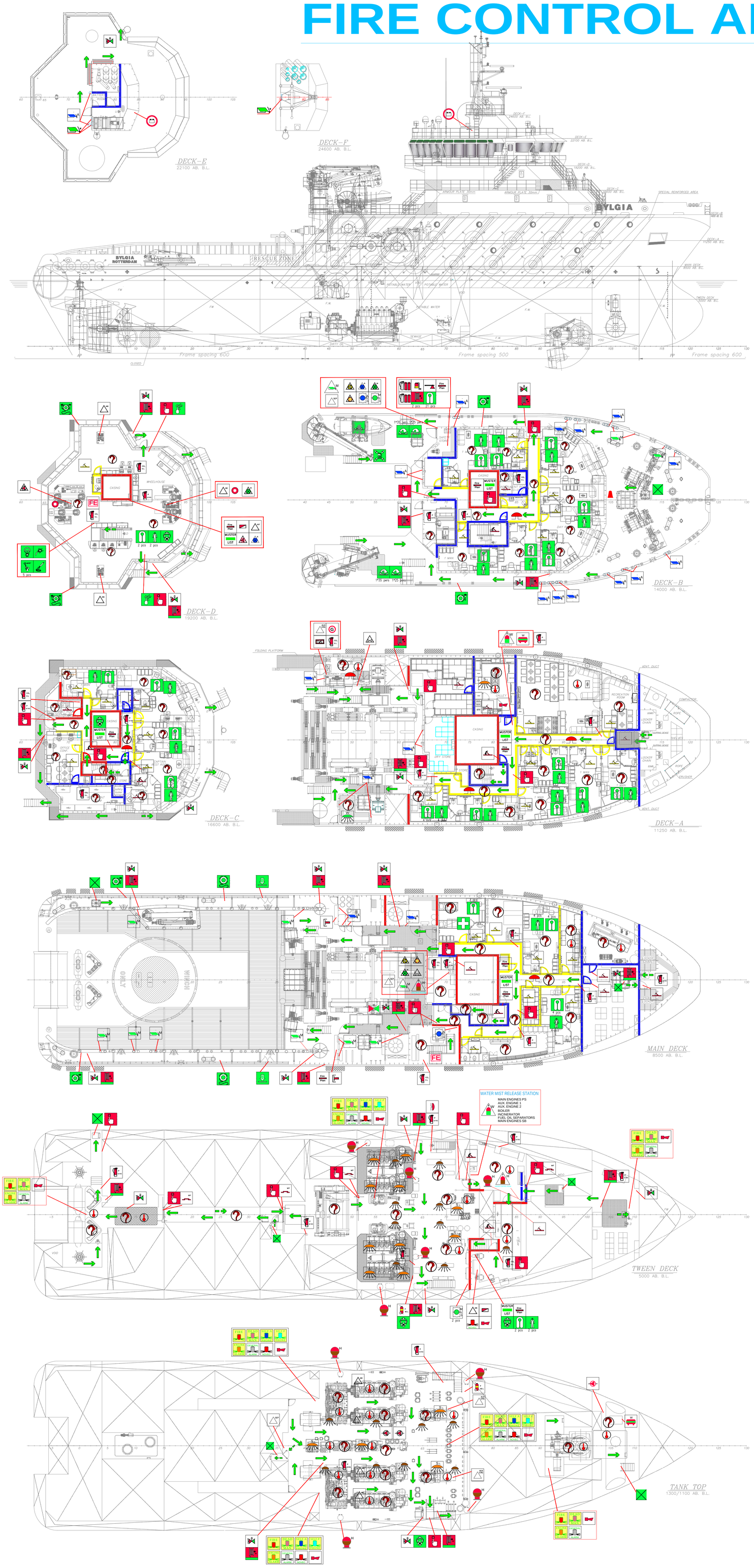
Total sheets: 1 sheet Nº: 1

Documentation SHIPYARD property ARMON GIJON, SA
Its contents may not be copied, reproduced, given to third parties or used for purposes unauthorized without written permission from the owner.

Pr 119-18 SISTEMA UNIFILAR



FIRE CONTROL AND SAFETY PLAN



SYMBOL	DESCRIPTION	DECK - E	DECK - D	DECK - C	DECK - B	DECK - A	MAIN DECK	TWEEN DECK	TANK TOP	TOTAL	
LIFE SAVING APPLIANCES											
	FAST RESCUE BOAT				1					1	
	LIFERAFT, 2 LIFERAFT FOR 25 PERSONS LIFERAFT, 2 LIFERAFT FOR 35 PERSONS				4					4	
	LIFE BUOY W/ LINE						2			2	
	LIFE BUOY W/ LINE AND LIGHT				2		2			4	
	LIFE BUOY W/ SMOKE/LIGHT AND LINE		2							2	
	EMBARKATION LADDER						2			2	
	IMMERSION SUIT		2	4	7	9	8	2		32	
	LIFEJACKET		2	4	28	9	11	2		56	
MUSTER LIST	MUSTER LIST		1	1	1	1	1	1		6	
	MUSTER STATION				1					1	
	PYROTECHNIC DISTRESS SIGNALS 4 ROCKET PARACHUTES 6 HAND FLARES 2 BUOY SMOKE SIGNALS		1							1	
	ROCKET PARACHUTE FLARES 12 RED PARACHUTE		1							1	
	LINE THROWING APPLIANCE UNIT (ROCKET + LINE)		1							1	
	TWO-WAY VHF RADIOTELEPHONE APPARATUS		3							3	
	EMERGENCY POSITION INDICATING RADIO BEACON (EPIRB)		2							2	
	SEARCH AND RESCUE TRANSPONDER (SART)		2							2	
	HOSPITAL						1			1	
	EMERGENCY ESCAPE BREATING DEVICE (EEBD)		1	1				2	2	6	
	BELL				1					1	
	MAIN ZONE (A60 INSULATED BULKHEAD)										ON PLANS
	A0-CLASS (A0 BULKHEAD)										ON PLANS
	B-CLASS (B15 INSULATED BLKH'D) OTHER ACC. BHDS										ON PLANS
	A-CLASS HINGED SELF-CLOSING FIRE DOOR										ON PLANS
	WATERTIGHT SLIDING DOOR							4		4	ON PLANS
	B-CLASS HINGED FIRE DOOR (ALL, U.N.O.)										ON PLANS
MEANS OF ESC											
	PRIMARY MEANS OF ESCAPE										
	SECONDARY MEANS OF ESCAPE										
	EMERGENCY EXIT				1		2		2	4	ON PLANS
FIRE DETECTION SYSTEM FIRE SIGNALS & ALARMS											
	FIRE ALARM PANEL		1					1		2	
	PUSH-BUTTON FOR GENERAL ALARM		1							1	
	MANUAL CALL POINT		2	2	3	3	3	7	1	21	
	SMOKE DETECTOR TO BE CHECKED WITH FIRE DETECTION ENGENIER		3	13	13	15	15	11	12	81	
	HEAT DETECTOR TO BE CHECKED WITH FIRE DETECTION ENGENIER					3	2	6	11	22	
	FIRE ALARM HORN / SIREN					1		4	4	9	
	FIRE ALARM BELL TO BE CHECKED WITH FIRE DETECTION ENGENIER			1	1	3	1			6	
	EMERGENCY GENERATOR					1				1	
	EMERGENCY SWITCHBOARD					1				1	
	EMERGENCY BATTERIES	2								2	
	CLOSING DEVICE FOR VENTILATION, ACCOM. SPACES	1			15	5	4			25	
	CLOSING DEVICE FOR VENTILATION, MACH. SPACES	2			3		9			14	
	VENTILATION REMOTE CONTR. OR SHUT-OFF MACHINERY				1		1			2	
	FIREDAMPER,MACH. SPACES						2			2	
	REMOTE CONTROL FOR CLOSING DEVICES FOR VENTILATION INLET AND OUTLET				3		1			4	
	VENTILATION REMOTE CONTR. OR SHUT-OFF ACCOMODATION		1		1					2	
	FIREDAMPER, ACCOMONDATION SPACES						1			1	
STRUCTURAL FIRE PROTECTION											
	REMOTE CONTR. FOR WATERTIGHT DOORS		1							1	
	EMERGENCY STOP, ENGINES		3				1	4		8	
	EMERGENCY STOP, AUX ENGINES		1			1		1	2	5	
	EMERGENCY STOP, SEPARATORS				1		1		1	3	
	REMOTE CONTROL FOR FIRE PUMPS		1							1	
	REMOTE CONTROL EMERGENCY FIRE PUMP		1							1	
	FUEL PUMPS REMOTE SHUT-OFF				1		1			2	
	LUBE OIL PUMPS REMOTE SHUT-OFF				1		1			2	
	REMOTE RELEASE STATION FO & LO QUICK CLOSING VALVES					1	1			2	
	FIXED FIRE WATER BASED LOCAL APPLICATION SYSTEM					1				1	
	SPACE COVERED BY NOVEC 1230 FLOODING							9	8	17	
	APPLICATION WATER MIST SYSTEM (FW)					1		10	4	15	
FIRE PROTECTION APPLIANCES											
	BILGE AND FIRE PUMP, 55 m³/h - 8 BAR								2	2	
	EMERGENCY FIRE PUMP, 35 m³/h - 6 BAR								1	1	
	MAIN FIRE SECTION VALVE						1			1	
	RELEASE RELEASE STATION FOR WATER MIST					1		1		2	
	STATION FOR WATER MIST					1			1	2	
	NOVEC 1230 BOTTLES							5	4		
	INTERNATIONAL SHORE CONNECTION						2			2	
	FIRE HYDRANT	0	2	2	3	2	7	4	2	23	
	FIRE HOSE, WITH JET AND FOG NOZZLE MAX. 20M IN GENERAL SPACES	0	2	1	5	2	7	4	2	24	
	FIRE EXTINGUISER, POWDER 12 KG	0	1	2	2	3	5	6	2	21	
	FIRE EXTINGUISER, CO2 5 L		2	2	1	1	2	1		9	
	WHEELED FIRE EXTINGUISHER, FOAM, 45 LTR							1	1	2	
	PORTABLE FOAM APPLICATOR UNIT 200 L FOAM CONST.				1					1	
	SPARE: POWDER 12 KG: + N2 CH.UNIT 6L				16					16	
	SPARE: CO2 6L				9					9	
	LOCATION OF FIRE AND SAFETY PLAN		1	1	2	1	3(*)	1		9	(*) 1 IN CYLINDER
	FIREMANS OUTFIT		1				1			2	
	FIREAXE				1					1	
SYMBOL	DESCRIPTION	DECK - E	DECK - D	DECK - C	DECK - B	DECK - A	MAIN DECK	TWEEN DECK	TANK TOP	TOTAL	

WATER MIST BACK-UP PUMP

S: RELEASE STATION FOR TOTAL FLOODING IN ECR

BOWTHRUSTER-ROOM WATERMIST: LOCAL APPLICATION ZONES

Z1: 4 NOZZLES MAIN ENGINE NO.1
Z2: 4 NOZZLES MAIN ENGINE NO.2
Z1: 4 NOZZLES MAIN ENGINE NO.3
Z2: 4 NOZZLES MAIN ENGINE NO.4
Z3: 2 NOZZLES AUX. ENGINE NO.1
Z4: 2 NOZZLES AUX. ENGINE NO.2
Z5: 1 NOZZLE BOILER
Z6: 4 NOZZLES FO SEPARATORS
Z7: 1 NOZZLE INCINERATOR:

SPACE/EQUIPMENT PROTECTED BY FIRE LINE
H1 PAINT STORE

COLUMNE ALARM DEVICE IN MACHINERY SPACES WITH AUDIBLE SOUNDER

PRINCIPAL DIMENSIONS:

L.O.A. .....APPROX.. : 79,20 m
BREADTH MOULDED ..... : 19,20 m
DEPTH TO MAIN DECK..... : 8,5 m
DRAUGHT, SCANTLING... : 7,0 m

Rev.	Date year-month-day	Drawn by	Checked by	Approved by	Description
00	07/02/2019	–	AN	–	Primera edición

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

Vessel: BUQUE MULTIPROPOSITO

Hull Nº PR-119-18

Scale: 1/175

Designation: LIFE SAVING AND SAFETY ARRANGEMENT
PLANO DE SALVAMENTO

Document Code: 346-132-10-DG-0001

Total sheets: 1 | sheet Nº: 1

Documentation SHIPYARD property ARMON GIJON, SA
Its contents may not be copied, reproduced, given to third parties or used for purposes unauthorized without written permission from the owner.

ANNEX III

IDENTIFICATION OF KEY DESIGN ASPECTS REPORT

Lloyd's Register

Working together
for a safer world

Identification of Key Design Safety Aspects - ERRV

EU Project CORE LNG as Hive (EV2 - Rescue boat powered by LNG)

17th October 2019

Report prepared by

Davies, P.A. & Nardo, M.
Lloyd's Register Marine & Offshore

Contact
T: +44 (0)1625 538 928
Email: paul.davies@lr.org

CONTENTS

1. INTRODUCTION 1
2. APPROACH 2
3. FUEL TANK LOCATION 3
   4.1 SEPARATION REQUIREMENTS 3
4. FUEL STORAGE HOLD SPACE (FSHS) 5
   4.1 SEPARATION, COFFERDAM AND CLASS DIVISION REQUIREMENTS 5
   4.2 SECONDARY BARRIER REQUIREMENTS 7
   4.3 HAZARDOUS AREA CLASSIFICATION (ZONING) AND ACCESS REQUIREMENTS 7
   4.4 BILGE REQUIREMENTS 8
5. TANK CONNECTION SPACE (TCS) 9
   5.1 HAZARDOUS AREA CLASSIFICATION (ZONING) AND ACCESS REQUIREMENTS 9
   5.2 VENTILATION REQUIREMENTS 10
   5.3 PROBABLE MAXIMUM LEAKAGE REQUIREMENTS 10
   5.4 LEAKAGE DETECTION REQUIREMENTS 11
   5.5 FIRE-FIGHTING REQUIREMENTS 11
6. MASTER GAS FUEL VALVE (MGFV) 12
   6.1 LOCATION AND INVENTORY REQUIREMENTS 12
7. GAS VALVE UNIT (GVU) 13
   7.1 LOCATION REQUIREMENTS 13
8. PRESSURE RELIEF VALVES (PRVS) 14
   8.1 PRESSURE RELIEF VALVE (PRV) SEPARATION REQUIREMENTS 14
9. BUNKER STATION (BS) 16
   9.1 SEPARATION REQUIREMENTS 16
   9.2 CLASS DIVISION REQUIREMENTS 16
   9.3 HAZARDOUS AREA CLASSIFICATION (ZONING) AND ACCESS REQUIREMENTS 16
   9.4 VENTILATION REQUIREMENTS 17
   9.5 LEAKAGE PROTECTION AND DETECTION REQUIREMENTS 17
10. CONCLUSION 18

ANNEX A REVIEW TEAM
ANNEX B EMERGENCY RESCUE & RECOVERY VESSEL (ERRV) - GENERIC EXEMPLAR

1. INTRODUCTION

As part of the EU Project, 'CORE LNGas Hive', there is a requirement to determine the feasibility of using liquified natural gas (LNG) as fuel for an Emergency Response and Rescue Vessel (ERRV).

An important aspect of using 'LNG as fuel' is to understand design requirements for safe operation. This is because LNG presents additional hazards and risks compared with traditional ship fuels, such as marine diesel oil; for example: cryogenic temperature[1]; potential asphyxiation[2]; excess pressure[2]; rapid phase transition[3]; jet fire[4]; flash fire[4]; and explosion[4].

As a result of these hazards and risks, to help ensure safe operation of vessels using 'LNG as fuel', the International Maritime Organisation (IMO)[5] has developed a set of requirements, referred to as the IGF Code. These requirements have been reviewed in respect of the generic characteristics and operation of an ERRV.

1. In contact with low temperature LNG, materials can lose ductility and become brittle resulting in fracture and failure.
2. Upon release, LNG rapidly 'boils' to gas and this can cause: (a) asphyxiation as the gas displaces and mixes with the surrounding air; and, (b) increased pressure in confined spaces as the gas warms and expands to about 600 times the liquid volume.
3. In contact with a large mass of water, LNG can rapidly transition from liquid to gas. This is known as Rapid Phase Transition (RPT) and is an explosive vaporisation that can result in liquid ejection and damaging overpressure.
4. In addition to a pool fire, a release may: (a) discharge as a pressurised stream or 'jet', resulting in a jet fire if ignited; (b) disperse gas that can be rapidly, violently and audibly consumed within a few seconds if ignited, known as a flash fire; and, (c) disperse gas that can result in a deflagrative explosion if ignited in a semi-confined environment after a few tens of seconds.
5. International Code for Safety of Ships Using Gases or Other Low-flashpoint Fuels (IGF Code).

2. APPROACH

From a ship classification and safety perspective, the review was undertaken by a team with extensive experience of design appraisals for 'LNG as fuel'. The team's relevant qualifications and experience are summarised in Annex A.

The approach taken by the team was as follows:

.1 agreeing the key IMO safety requirements for review that are fundamental to layout and operation. The IMO requirements refer to both passenger ships and cargo ships, and ERRVs were considered as cargo ships in this review;

.2 grouping requirements into related topics and summarising each requirement; and

.3 comparing the requirements in respect of an ERRV.

In addition, only requirements for LNG fuel tanks located below deck were reviewed. This is because LNG fuel tanks on ERRVs are likely to be located below deck to: (i) protect fuel tanks during rescue and recovery activities (e.g. protection from impact and fire); (ii) maximise available deck space for working and recovered items; and, (iii) avoid limiting the type of rescue and recovery activities that can be undertaken.

To assist in the review, and to provide visual and relatable context, a preliminary ERRV design by Astilleros Armon was used as a generic exemplar. The general arrangement (GA), LNG piping diagram, and basic details of this exemplar vessel are given in Annex B

3. FUEL TANK LOCATION

3.1 SEPARATION REQUIREMENTS – IGF CODE 5.3.3

To protect against collisions, impacts and groundings that could penetrate the vessel, and thereby damage or puncture the LNG fuel tank, the tank is required to be located behind the collision bulkhead with a minimum separation between the hull and tank, as follows:

.1 B/5 at the summer load line (SLL)
that is, one fifth (20%) of the greatest moulded breadth (B) of the ship at or below the deepest draught (SLL);

.2 0.8 m other than at the SLL
that is, 0.8 m from the side of the ship and aft terminal (except at the SLL where separation of B/5 is required); and

.3 B/15 from the bottom of the ship
that is, one fifteenth (approximately 6.6%) of the greatest moulded breadth (B) of the ship at or below the deepest draught (SLL).

The minimum separation is measured from the ship's side shell plating to the primary barrier of an independent tank (i.e. the barrier in contact with the LNG) and to the bulkhead surrounding tank insulation for a non-independent tank. An independent tank, such as a pressure vessel[6] used in the ERRV Exemplar, is entirely self-supporting and does not form part of, or rely upon hull structure to maintain its structural integrity. Whereas, a non-independent tank, such as a membrane tank, is supported by, and relies upon hull structure to maintain its structural integrity.

Importantly, the separation requirements also apply to pipework that cannot be isolated from the tank, and the isolating valve along such pipework.

If the breadth (B) is greater than 57.5 m, B/5 can be limited to 11.5 m from the side of the ship. Similarly, if B is greater than 30 m, B/15 can be limited to 2 m from the bottom of the ship. It is unlikely that these limits would apply to an ERRV because the breadth (B) of such vessels is typically less than 20 m to 25 m.

In comparison to the limitations on B/5 and B/15, the side separation of 0.8 m is increased if tank volume (Vc) is greater than 1,000 m^3. This increase is calculated as follows: (i) separation equals 0.7 + Vc x 0.2/4,000 m where Vc is less than 5,000 m^3; and, (ii) separation equals 0.8 + Vc/25,000 m where Vc is between 5,000 m^3 and 30,000 m^3. Where Vc is 30,000 m^3 or more, then separation is taken as 2 m.

If the required minimum separation between the tank and side of the ship cannot be satisfied (i.e. B/5) then the IMO requirements allow the separation to be reduced provided a given

6. The IGF Code refers to a pressure vessel (with or without a secondary barrier) as a 'Type C' tank. An atmospheric tank with a complete secondary barrier is referred to as a 'Type A' tank, and an atmospheric tank with a partial secondary barrier as a 'Type B' tank.

calculation is performed and stated criterion met (IGF Code 5.3.4). This approach is commonly referred to as the 'probabilistic approach'.

It has been argued that this probabilistic approach is not as 'protective'[7] as applying B/5 or providing equivalent physical protection to B/5. This is because:

.1 the approach reduces separation using a calculation based upon a limited number of collisions studied for the analysis of compartmental flooding;

.2 a separation of B/5 was chosen by IMO based upon established practice and sheer pragmatism, since the same incident data show that about 50% of collisions penetrate to a distance of B/5 or more. This means that a separation of B/5 protects against half of the collisions studied; and,

.3 side collision is a known hazard that is managed day-to-day, it is a reasonably foreseeable event and if it involved tank puncture, however unlikely, the consequences could be catastrophic in terms of loss of life and assets.

Equivalent physical protection to B/5 can be provided by improving the resistance of the hull and structure in way of the LNG fuel tank[8].

EXEMPLAR VS IGF CODE REQUIREMENTS

From inspection of the GA in Annex B, the location of the two LNG fuel tanks clearly satisfies the separation requirements noted above.

As required, the tanks are far behind the collision bulkhead.

At a breadth (B) of 19.2 m, the required minimum separation at the SLL (i.e. B/5) approximates 3.8 m between the tank and side of the ship. The separation shown on the GA approximates 5.1 m. This distance more than satisfies the separation requirement of 3.8 m and provides a margin above the minimum of about 1.3 m.

The net volume of each Exemplar LNG fuel tank (i.e. 130 m^3) is far less than 1,000 m^3. Hence, the required minimum separation other than at the SLL is 0.8 m. From inspection, this required separation (0.8 m) is satisfied, and the separation is far greater than 0.8 m.

The required minimum separation between the tanks and the bottom of the ship (i.e. B/15) approximates 1.3 m. The separation shown on the GA approximates 1.9 m aft and 3.9 m forward. This distance satisfies the separation requirement of 1.3 m and provides a margin above the minimum of between 0.6 m aft and 2.6 m forward.

7. Support to UK Maritime & Coastguard Agency at MSC94/MSC95, IMO, London. Lloyd's Register.
8. Lloyd's Register. (2016). Guidance Notes for Collision Assessment for the Location of Low-flashpoint Fuel Tanks.

4. FUEL STORAGE HOLD SPACE (FSHS)

The space below deck, in which the LNG fuel tanks are located, is referred to as the Fuel Storage Hold Space (FSHS)[9].

4.1 SEPARATION, COFFERDAM AND CLASS DIVISION REQUIREMENTS – IGF CODE 11.3.3

A fire, external to the FSHS, could subject the tanks to high levels of thermal radiation, and this could lead to rapid vaporisation of the LNG and unwanted venting of gas. As such, to help minimise the likelihood of venting there is a requirement for:

.1 a minimum separation of 900 mm between the LNG fuel tank and boundaries with spaces of high fire risk; and

.2 the minimum separation to be in the form of a cofferdam if the tanks are located above a high fire risk space or if the LNG fuel tank is of Type A or Type B[10] or is a membrane tank.

The minimum separation is measured from the tank's primary barrier or from the bulkheads surrounding the tank insulation for membrane tanks. This separation also applies to pipework that cannot be isolated from the tank, and the isolating valve along such pipework.

High fire risk spaces include: (i) machinery spaces of SOLAS Category A; (ii) cargo spaces (except cargo tanks for liquids with a flashpoint above 60 °C and cargo spaces complying with SOLAS II-2/10.7.1.4); (iii) service spaces such as galleys; (iv) certain store rooms and accommodation spaces; and, (v) spaces for the storage of flammable liquids.

Importantly, an A-60 class division is required between adjoining spaces of high fire risk. This A-60 division should also protect ventilation ducts (up to the fire damper) to and from the FSHS. For adjoining spaces of low fire risk, the class division should be in accordance with SOLAS regulation II-2/9, where the FSHS is considered as a machinery space of category A.

The A-60 class division is in addition to the minimum separation for the LNG fuel tanks (noted in .1 and .2 above), and in addition to the following requirements:

1. for Type A, Type B and Membrane tanks, a cofferdam between the FSHS and high fire risk spaces; and,
2. for Type C tanks, a cofferdam between high fire risk spaces (e.g. m/c space Cat A) that are located immediately above the FSHS[11].

9. International Code for Safety of Ships Using Gases or Other Low-flashpoint Fuels (IGF Code).
10. Refer to footnote 6.
11. International Association of Classification Societies (IACS) Unified Interpretations (UI) - IACS UI, IMO CCC 4/3/1 & IMO CCC 4/7.

EXEMPLAR VS IGF CODE REQUIREMENTS

With reference to the GA given in Annex B, the FSHS is adjoined by the following spaces/areas:

1. portside, starboard and below
   MDO tank storage. This is not considered a high fire risk space. However, if MDO valves or connections are located within the FSHS then space categorisation, hazardous area classification and fire-fighting provisions would need to be determined;

2. aft
   Pod Room. Although this is a machinery space, provided it does not contain fuel or engines then it is not considered a high fire risk space;

3. forward
   Moonpool and Engine Room. The Moonpool is not a high fire risk space. The Engine Room is categorised as a high fire risk space; and

4. above
   Rescue Zone and open deck. It is assumed that these areas are not categorised as high fire risks when considering space separation, cofferdam and class division requirements.

Based on the above, an A-60 division is required between the FSHS and Engine Room (forward). It can be seen on the GA that the boundary between these two spaces is via a sliding door (assumed water-tight). The suitability of this door in an A-60 class division needs evaluation or alternative access considered.

Prescriptive requirements only require an A-0 division between the FSHS and Moonpool – however, risk assessment (as required by the IGF Code) may recommend an A-60 division. All other FSHS boundaries only require an A-0 division.

From inspection of the GA in Annex B, the minimum separation of 900 mm between the LNG fuel tanks and the Engine Room (i.e. a high fire risk space) far exceeds the required minimum of 900 mm.

The LNG fuel tanks are to be of Type C and therefore, no cofferdam is required between the FSHS and adjoining spaces/areas (assuming the above Rescue Zone and open deck are not high fire risk spaces).

4.2 Secondary Barrier Requirements – IGF Code 2.2.15.1

Other than the LNG fuel tanks, LNG/gas-containing equipment and pipework within the FSHS must be enclosed in a secondary barrier that maintains its integrity if the inner (primary) barrier fails. If this cannot be achieved then the FSHS must meet the requirements for a Tank Connection Space (TCS), as noted in Section 5 of this document.

Exemplar vs IGF Code Requirements
From inspection of the GA in Annex B, it is assumed that: (i) the depicted TCSs contain all LNG/gas-containing equipment and pipework; (ii) any pipework within the FSHS but outside of a TCS is of double-wall construction; and, (iii) the TCSs and annulus of double-walled pipework serve as a secondary barrier to contain leakages. Hence, the requirement for a secondary barrier is satisfied.

4.3 Hazardous Area Classification (Zoning) and Access Requirements – IGF Code 5.11 & 12.5

To minimise the potential for ignition of an unintended gas release, the FSHS must be designated as either a:

.1 'non-hazardous' space
This means: (i) all gas containing equipment (located in the FSHS) is enclosed within a full secondary barrier (or pressure vessel, Type C tank) and there is no direct access from the FSHS to this equipment; (ii) direct access to the FSHS is from a non-hazardous space, or from a non-hazardous area on open deck, or access is via an air-lock from a Zone 2 space or area; and (iii) if the Tank Connection Space (TCS) is located in the FSHS then access from the FSHS to the TCS is via an air-lock that leads to a bolted hatch space on the TCS;

.2 Zone 2 space
This means: (i) all gas containing equipment located in the FSHS is contained within a full secondary barrier and any access to this equipment (e.g. to a Tank Connection Space) is via a bolted hatch; and, (ii) access to the FSHS is directly from an open area on deck that is designated as 'non-hazardous' and/or access is via an air-lock;

.3 Zone 1 space
This means that some or all gas containing equipment located in the FSHS is <u>not</u> within a full secondary barrier. This would apply to Type B tanks and membrane tanks.

Importantly, if the FSHS is designated as Zone 1 or Zone 2, then all installed equipment within the FSHS, such as lighting and ventilation fans, must be 'electrically protected' and non-sparking (i.e. equipment is to be suitable for the hazardous area in accordance with an appropriate international standard). That is, the equipment is not considered an ignition source because it is

manufactured, installed and maintained to an appropriate standard recognised by the National Administration (i.e. 'flag').

EXEMPLAR VS IGF CODE REQUIREMENTS

With reference to the GA given in Annex B, and assuming secondary barrier requirements are satisfied (refer to Section 4.2, above), the following statements can be made:

1. the FSHS can be classed as Zone 2 provided access to the TCS is via a bolted hatch and access to the FSHS is via an air-lock. This requires the sliding doors between the FSHS and Engine Room, and between the FSHS and Pod Room, to be replaced by a suitable air-lock;
2. the FSHS can be classed as 'non-hazardous' provided access to the TCS is via a bolted hatch, the hatch is within a dedicated 'hatch space', and the hatch space is entered via an air-lock.

4.4 BILGE REQUIREMENTS – IGF CODE 5.9

The FSHS must be provided with a bilge that drains to a safe place and one that is segregated from the bilge system of spaces where LNG fuel cannot be present. However, a bilge is not required if the LNG fuel tank is a pressure vessel (Type C)[12] and the FSHS is classed as 'non-hazardous' (refer to Section 4.3, above).

EXEMPLAR VS IGF CODE REQUIREMENTS

If the FSHS is classed as Zone 2, a segregated bilge that drains to a safe placed is required. However, if the FSHS is classed as 'non-hazardous' then a bilge is not required.

12. Refer to footnote 6.

5. TANK CONNECTION SPACE (TCS)

Equipment that is in direct contact with LNG and/or gas inside the LNG fuel tank must be enclosed within a full secondary barrier, referred to as a Tank Connection Space (TCS)[13]. Typically, the equipment includes pipes, valves and instruments that are directly connected to the tank, and the TCS is located within the Fuel Storage Hold Space (FSHS).

Importantly, TCS requirements also apply to a:

.1 Fuel Storage Hold Space (FSHS)
where gas-containing equipment and pipework within the FSHS is <u>not</u> enclosed within a secondary barrier (or a pressure vessel of Type C)[14] (IGF Code 2.2.15.1); and,

.2 Fuel Preparation Room (FPR)
where the FPR is located below deck. An FPR is a space that contains pumps, compressors or vaporizers for LNG fuel preparation (IGF Code 2.2.17 & 5.8).

It is not uncommon for a TCS to also serve as an FPR, as per the exemplar vessel given in Annex B of this document.

5.1 Hazardous Area Classification (Zoning) and Access Requirements – IGF Code 12.5.2.1, 12.5.2.2, 12.5.2.3, 12.5.2.4, 12.5.3.1, 5.11.2 & 5.11.3

To minimise the potential for ignition of an unintended gas release, the TCS must be designated as a Zone 1 space. This means that all installed equipment within the TCS must be 'electrically protected' and non-sparking (i.e. equipment is to be suitable for the hazardous area in accordance with an appropriate international standard). That is, the equipment is not considered an ignition source because it is manufactured, installed and maintained to an appropriate standard recognised by the National Administration (i.e. 'flag'). In addition, ventilation must be taken from and exhausted to an open-deck area. This area must be designated as Zone 1 to a radius of 3 m from the inlet/outlet, and Zone 2 for 1.5 m from the Zone 1 extent.

Access to a TCS (and an FPR below deck that contains tank connections) must be:

.1 independent and direct from open deck; or

.2 through a bolted hatch, where the space with the hatch is Zone 2; or

.3 through an air-lock leading to a bolted hatch.

Access to an FPR (that does not contain tank connections) must be via an air-lock.

13. International Code for Safety of Ships Using Gases or Other Low-flashpoint Fuels (IGF Code).
14. Refer to footnote 6.

EXEMPLAR VS IGF CODE REQUIREMENTS

To satisfy the IGF requirements, it is assumed that each TCS would be classed as Zone 1 and access to each TCS would be:

1. through a bolted hatch from a Zone 2 classed FSHS; or
2. through a bolted hatch that is located in a 'hatch space' (classed as Zone 2) that is entered via an air-lock located in a 'non-hazardous' FSHS.

From inspection of the GA given in Annex B, it is assumed that the TCS also serves as the FPR.

5.2 VENTILATION REQUIREMENTS – IGF CODE 13.4.1, 13.6.1 & 13.6.2

To minimise the potential for a flammable atmosphere, the TCS must have forced extraction that provides a minimum of 30 air changes per hour (ACH). Less than 30 ACH is permissible if alternative explosion protection is provided.

Alternatively, if supported by risk assessment and agreed by the National Administration (i.e. 'flag'), to minimise the potential for a flammable atmosphere the TCS can be provided with a controlled atmosphere if there is suitable ventilation for access (e.g. via a bolted hatch) and suitable ventilation in the case of failure of the controlled atmosphere. Examples of controlled atmospheres include inerting with nitrogen or maintaining a low-oxygen content so that a flame cannot be sustained.

EXEMPLAR VS IGF CODE REQUIREMENTS

The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

5.3 PROBABLE MAXIMUM LEAKAGE REQUIREMENTS – IGF CODE 5.8, 6.3.4, 6.3.7 & 6.3.8

The purpose of a TCS is to safely manage a Probable Maximum Leakage (PML). That is, given a PML within the TCS, the TCS withstands (without loss of integrity) the maximum pressure generated within the space (as LNG vaporises), the lowest temperature it could be subjected to, and the weight of any accumulated liquid. This is typically achieved through structural design, use of materials resistant to cryogenic temperatures, and the venting to a safe location any gas and generated vapour.

Currently, there is no regulatory agreement on what constitutes a PML nor guidance on how it can be determined. Therefore, if the TCS can be designed for a worst-case leakage and this worst-case is clear (e.g. a full-bore rupture of the largest pipe within the TCS) then it is likely to be readily agreed with the National Administration (i.e. 'flag'). However, if the PML is taken as less than the

worst-case, then the likelihood of leakage, leakage rate, leakage quantity, and the time to detect and isolate a leakage must be considered and agreed with the National Administration (i.e. 'flag').

In addition to the above PML requirement, the TCS must be thermally isolated from surrounding structure to prevent damage due to excess cold temperature. This can be achieved via physical separation and insulation.

> EXEMPLAR VS IGF CODE REQUIREMENTS
>
> The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

5.4 LEAKAGE DETECTION REQUIREMENTS – IGF CODE 15.3.2, 15.8.1.1 & 15.8.1.4

To ensure rapid identification of an LNG or gas leakage, the TCS must be provided with liquid-level, low-temperature and gas detection (i.e. sensors).

Liquid detection must result in an alarm, and low temperature detection must close all tank outlet and inlet valves. For gas detection, an audible and visible alarm must be activated at a gas vapour concentration of 20% of the lower explosion limit (LEL) and the safety system activated at 40% of LEL.

> EXEMPLAR VS IGF CODE REQUIREMENTS
>
> The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

5.5 FIRE-FIGHTING REQUIREMENTS – IGF CODE 11.3.1

To rapidly extinguish fire, a fixed fire-extinguishing system must be provided within the TCS where fuel preparation equipment is installed (e.g. pumps and compressors)[15]. The fire-extinguishing system must comply with the provisions of SOLAS II-2/10.4.1.1.

> EXEMPLAR VS IGF CODE REQUIREMENTS
>
> The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

15. International Association of Classification Societies (IACS) Unified Interpretation (UI), GF3, Dec -2017. A TCS with only vaporisers or heat exchangers for fuel preparation (i.e. no pumps or compressors) does not require a fixed fire-extinguishing system.

6. MASTER GAS FUEL VALVE (MGFV)

The Master Gas Fuel Valve (MGFV) is the principal means of isolating gas supply to a consumer (e.g. engine or boiler). Isolation is either from remote actuation or automatically when the safety system is activated.

6.1 LOCATION AND INVENTORY REQUIREMENTS – IGF CODE 9.4.2

To ensure MGFV protection from leakages, fires and other events that could involve or impact fuel consumers, the MGFV must be located outside of spaces containing fuel consumers (e.g. located external to the Engine Room).

To optimise MGFV operation in the event of an emergency, the MGFV must be operable from a safe location on an escape route within the space containing the gas consumer, within the engine control room (for gas consuming engines), and from the navigation bridge.

To minimise the inventory of gas within the line from the MGFV to the consumer, the MGFV must be as close as possible to the installation used to heat the LNG/gas (e.g. the vaporisers).

EXEMPLAR VS IGF CODE REQUIREMENTS
The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

7. GAS VALVE UNIT (GVU)

The Gas Valve Unit (GVU) is the principal means of controlling and regulating gas flow to the consumers and is located downstream of the MGFV.

7.1 LOCATION REQUIREMENTS – IGF CODE 13.8.2

To minimise the likelihood of leakages from valves to the space containing the consumer, the GVU must be located within a TCS (or a space meeting TCS requirements). Alternatively, the GVU can be located within the space housing the consumer (e.g. Engine Room) provided the GVU is within a gas-tight secondary barrier and supplied with independent ventilation (e.g. ventilation is separate from the ventilation used for the Engine Room).

EXEMPLAR VS IGF CODE REQUIREMENTS
The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

8. PRESSURE RELIEF VALVES (PRVs)

All LNG fuel tanks must be fitted with two pressure relief valves (PRVs). These valves protect against internal over-pressurisation that could result in catastrophic tank failure.

8.1 PRESSURE RELIEF VALVE (PRV) SEPARATION REQUIREMENTS – IGF CODE 6.7.2.7, 6.7.2.8 & 6.7.2.9

Physical separation of Pressure Relief Valve (PRV) outlets is required from certain spaces and items to: (i) facilitate safe dispersion of gas; (ii) minimise the likelihood of LNG/gas entering spaces that are not designed for the presence of LNG/gas; and, (iii) limit potential ignition of gas. As such, the outlet from PRVs must be located vertically clear of all super-structure, with a minimum separation of:

.1 B/3 or 6 m, whichever is greater, above the weather deck
that is, one third (33%) of the greatest moulded breadth (B) of the ship or 6 m;

.2 6 m above working areas and gangways;

.3 10 m from non-hazardous areas (including semi-enclosed spaces on open deck);

.4 10 m from air intakes to, outlets from, and openings to accommodation, service and control spaces; and

.5 10 m from exhaust outlets from machinery installations (e.g. exhausts from engines).

EXEMPLAR VS IGF CODE REQUIREMENTS

From inspection of the GA in Annex B:

1. the PRV outlet exceeds the minimum separation requirement of 6.4 m (i.e. B/3) from all weather decks. The smallest separation is to Deck E, at approximately 12 m;

2. the PRV outlet exceeds the minimum separation requirement of 6 m from working areas or gangways and 10 m from non-hazardous areas (i.e. the platform for access to the vessel's navigation equipment is approximately 10 m from the PRV outlet); and

3. the PRV outlet exceeds the minimum separation requirement of 10 m from: air intakes to, outlets from, and openings to accommodation and service control spaces; and exhaust outlets from machinery installations.

Notes

(a) PRV outlet is via a vent mast. The vent mast is assumed to be the 'ventilation mast' shown on the GA.

(b) It is assumed that the vertical extent of the 'ventilation mast' is as shown on the GA in the starboard view (i.e. side elevation) and not the reduced elevation depicted in the aft view.

EXEMPLAR – ADDITIONAL NOTE

From inspection of the GA in Annex B:

1. equipment items that may present an ignition source are located on, or near to the ERRV's mast and within 10 m of the vent mast outlet (e.g. lights, antennas, communication equipment). It is probable that classification societies and the National Administration (i.e. 'flag') would require these equipment items to be manufactured, installed and maintained to an appropriate standard to limit the likelihood of ignition[(a)] or located greater than 10 m from the vent mast outlet; and

2. the helideck is greater than 10 m from the vent mast outlet. However, a helicopter is an obvious and unique ignition source with an 'influence' on the surrounding air (i.e. creates turbulence). Therefore, on approach to the helideck and once on the helideck, the helicopter must remain at a specified distance from the vent mast outlet. This distance should be determined by risk assessment/modelling in agreement with the National Administration (i.e. 'flag'). The specified distance may limit helicopter operations or the location of the helideck.

Note

(a) e.g. Lloyd's Register. Rules and Regulations for the Classification of Ships using Gases or other Low-flashpoint Fuels (LR 12.5-02c & LR 12.5-04): within 6 m of the vent mast outlet and between 6 m and 10 m from the vent mast outlet, the areas are designated as Zone 1 and Zone 2, respectively.

9. BUNKER STATION (BS)

The Bunker Station (BS) is a dedicated space or area with connections and lines to transfer LNG from an external supply to the ships' LNG fuel tanks (e.g. supply from LNG truck, LNG port-side storage or LNG bunker vessel). Either located on-deck or below deck, it is not uncommon to have two bunker stations, one port-side and one starboard.

9.1 SEPARATION REQUIREMENTS – IGF CODE 5.2.1.4, 5.7.2, 5.7.3 & 5.11

To minimise the potential for leakage during bunkering and to ensure availability of bunkering, the Bunker Station (BS) must be adequately protected from physical impact. Therefore, the BS must be located outside of areas encompassed by deck handling, lifting and crane operations.

In addition, to minimise the potential for ignition of leakages and to protect persons from harm, bunkering lines must avoid accommodation spaces, service spaces, electrical equipment rooms and control stations.

EXEMPLAR VS IGF CODE REQUIREMENTS
The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

9.2 CLASS DIVISION REQUIREMENTS – IGF CODE 11.3.6

To protect from fire, bunkering stations must be physically separated or structurally shielded from accommodation, service areas, control stations and spaces of high fire risk. For BS boundaries that face or adjoin accommodation spaces, service spaces, control stations, escape routes, engine rooms and machinery spaces, A-60 class division is required. A-0 class division is permissible for spaces such as tanks, voids, sanitary spaces, and auxiliary machinery spaces of little or no fire risk.

EXEMPLAR VS IGF CODE REQUIREMENTS
The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

9.3 HAZARDOUS AREA CLASSIFICATION (ZONING) AND ACCESS REQUIREMENTS – IGF CODE 12.5.2.3, 12.5.2.5 & 5.11

To minimise the potential for ignition of an unintended gas release within the BS, Zone 1 classification is required to a radius of 3 m from: bunker manifold valves and their spillage coamings (to a height of 2.4 m on open deck); other fuel valves; and, fuel pipework flanges. In addition, a further 1.5 m of Zone 2 is required from the Zone 1 extent. This means that all installed equipment within these zones must be appropriately 'electrically protected' and non-sparking (i.e.

equipment is to be suitable for the hazardous area in accordance with an appropriate international standard).

Access to bunker stations located below deck (or enclosed on-deck) must be via an air-lock. This is to limit leakages reaching other spaces and areas, and to minimise potential for gas ignition.

EXEMPLAR VS IGF CODE REQUIREMENTS
The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

9.4 VENTILATION REQUIREMENTS – IGF CODE 8.3.1.1 & 13.7

To minimise the potential for a flammable atmosphere, if the BS is located below deck (or the BS is enclosed on three or more sides) it must be provided with forced ventilation of at least 30 air changes per hour.

EXEMPLAR VS IGF CODE REQUIREMENTS
The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

9.5 LEAKAGE PROTECTION AND DETECTION REQUIREMENTS – IGF CODE 8.3.1.3 & 8.3.1.5

To protect the BS from cryogenic leakages of LNG a drip tray is required under the bunker manifold (i.e. under the connection to the external LNG supply) and other connections that are considered a source of LNG leakage. The tray must maintain integrity at the low temperatures expected given leakage, and to be sized to contain a probable maximum leakage[16].

The hull of the ship must also be protected from cryogenic LNG leakage. This can be achieved by the provision of a water curtain or plating/sheathing that is resistant to low temperatures.

In addition to gas detection within the BS, to facilitate rapid leakage detection, a low temperature detector must be fitted in the drip tray.

EXEMPLAR VS IGF CODE REQUIREMENTS
The design information given in Annex B is insufficient to make specific comments on the Exemplar's design.

16. Refer to Section 5.3 on how to consider a Probable Maximum Leakage (PML) .

10. CONCLUSION

It is feasible to use liquified natural gas (LNG) as fuel for an Emergency Response and Rescue Vessel (ERRV). However, there are a number of design challenges to satisfy the requirements of the IGF Code[17]. This review has summarised these challenges and highlighted, in particular:

.1 the provision of appropriate access to the Fuel Storage Hold Space (FSHS) and Tank Connection Space (TCS). This may prove difficult due to limitations on available space below deck;

.2 ensuring certain equipment items, such as lights, antennas and communication equipment are not a potential ignition source. This may prove difficult due to the required location of such equipment for navigation and ERRV operations, or the requirements for manufacturing, installation and maintenance of such equipment; and

.3 helicopter operations in relatively close proximity to the vent mast outlet. This will require additional consideration and modelling to determine safe helicopter approach/departure and helideck location.

Other challenges may transpire when design details are known, and these are subjected to risk assessment and the application of classification approval.

17. International Maritime Organisation (IMO).
International Code for Safety of Ships Using Gases or Other Low-flashpoint Fuels (IGF Code).

ANNEX A

REVIEW TEAM

DR PAUL DAVIES (PROJECT LEAD)
TECHNICAL MANAGER FOR RISK ASSESSMENT, LNG & ALTERNATIVE FUELS, LLOYD'S REGISTER (LR)

Paul is a chartered engineer with an honours degree in Mechanical Engineering from Wolverhampton University, and a research degree in risk assessment and transportation from Loughborough University.

With 30 years' experience, Paul has helped governments and industry to better protect workers and the public from major accident hazards. This has covered production, transport and storage of hazardous materials via quantitative risk assessment, software development, workshop facilitation, public consultation and accident investigation.

Paul is currently focused on the safe use of alternative fuels for marine propulsion at LR.

Over the last few years Paul's work has included:

- special advisor to the UK Maritime and Coastguard Agency on LNG as fuel;
- chair of the International Association of Classification Societies' group on risk assessment required by the International Maritime Organisation for low-flash point fuels in shipping;
- chair of the Cruise Ship Safety Forum's sub-group on safety for LNG as fuel;
- an invited high-level expert to the European Maritime Safety Agency on LNG bunkering, safety distances and simultaneous operations;
- lead for the risk assessment of two UK demonstration projects using hydrogen as fuel for ships (HyDIME & Hyseas);
- Royal Academy of Engineering Visiting Professor in Risk Assessment and Marine Technology at Liverpool John Moores University, England (2016-2019); and
- development of the risk assessment unit for the masters' degree in 'Advanced Skills in Safety, Environment and Security at Sea' delivered at Trieste University.

MARCO NARDO
ENGINEERING SYSTEMS TEAM LEADER, TRIESTE TECHNICAL SUPPORT OFFICE, LLOYD'S REGISTER (LR)

Marco has a Degree in Mechanical Engineering from the university of Padova. After nine years' of experience in machinery and piping systems ship design, in January 2009 Marco joined LR in the role of engineering plan approval specialist. He also acts as a Subject Matter Expert in technical workshops drawing from his experience in conducting risk assessment work (HAZID and HAZOP) for LNG projects. Marco also assists with LR rule development whilst supporting with advice, interpretations and guidance on IGF Code development.

FABRIZIO CADENARO
GAS FUELLED SHIPS SENIOR SPECIALIST, TRIESTE TECHNICAL SUPPORT OFFICE, LLOYD'S REGISTER (LR)

Fabrizio is a chartered engineer in both the UK and Italy, is a member of RINA, and holds a Masters' Degree (with distinction) in Mechanical Engineering from the University of Trieste, Italy.

With over ten years' experience he has been involved in the marine industry first in the design of ships and related systems, focusing on 'gas-as-fuel' projects, then with LR working to ensure the safety of ships and floating installations.

Over the last few years Fabrizio's work has included:

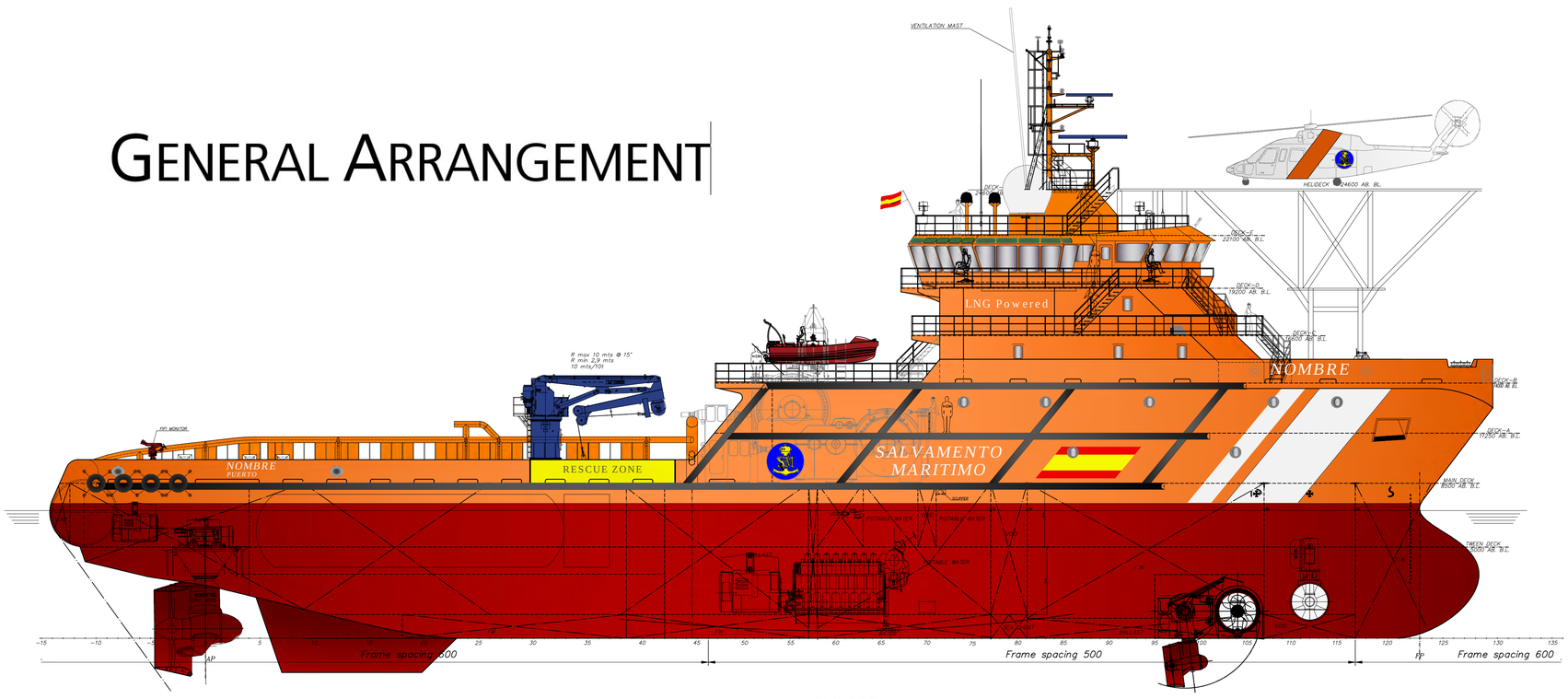
- plan approval, consultancy and subject matter expert advice on many LNG as fuel and Hydrogen as fuel projects;
- member of the International Association of Classification Societies (IACS) machinery panel 11901 for IGF Code;
- technical coordinator within LR for LNG and H2 fuel matters;
- author and presenter of hydrogen fuel papers at RINA and NAV 2018;
- managing the EU-funded ReSHIP project for the development of a hydrogen powered vessel; and
- delivering lectures at the ASSESS Masters at the University of Trieste, Accademia Nautica Trieste.

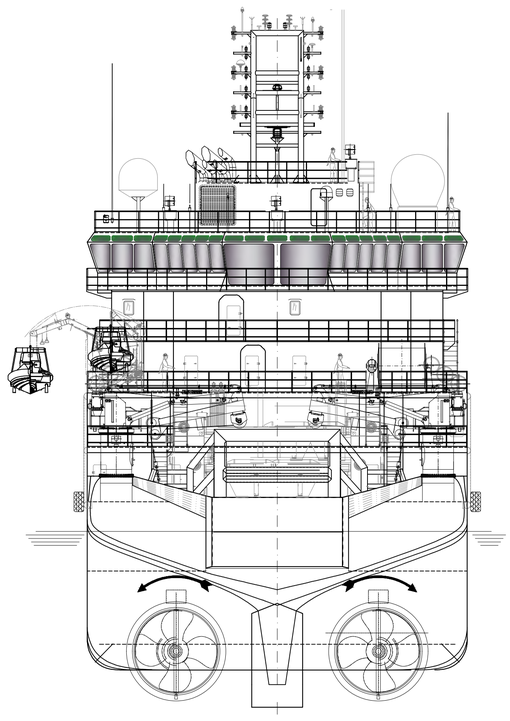
ANNEX B

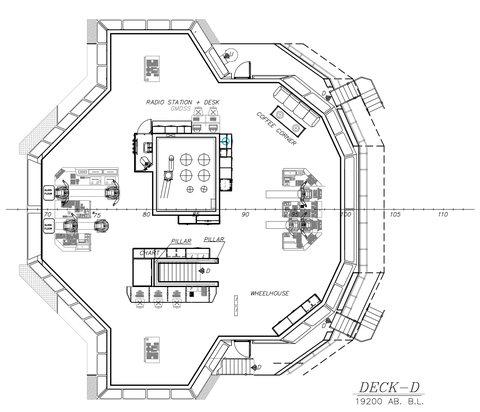
EMERGENCY RESCUE & RECOVERY VESSEL (ERRV)

GENERIC EXEMPLAR

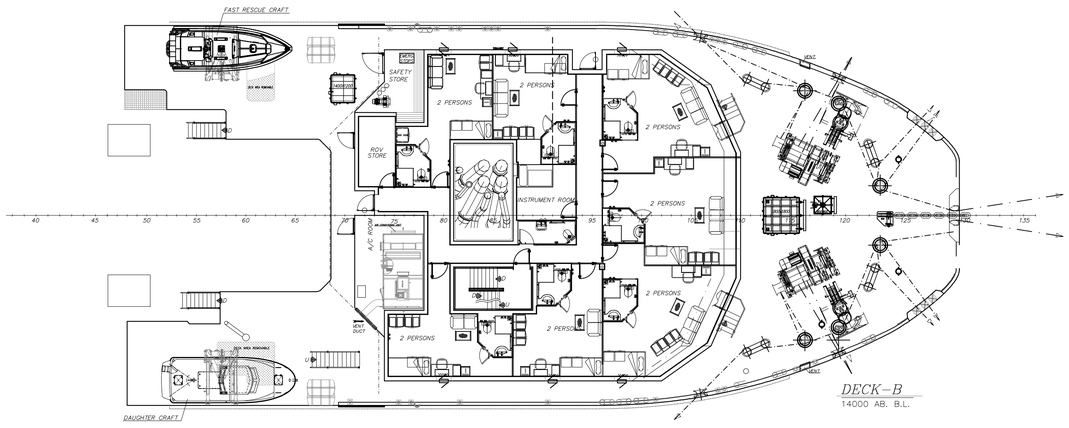
GENERAL ARRANGEMENT



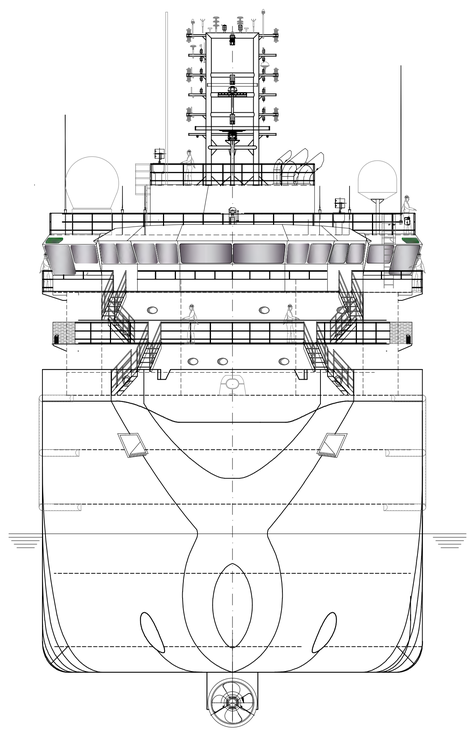


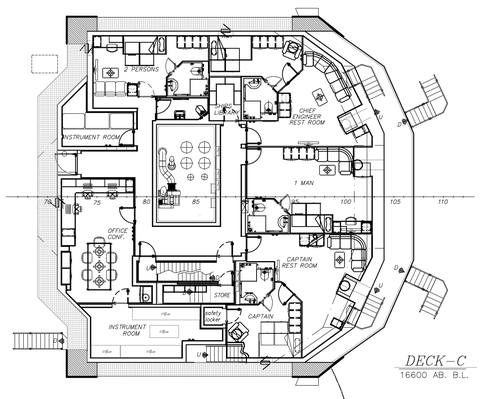


DECK–D
19200 AB. B.L.

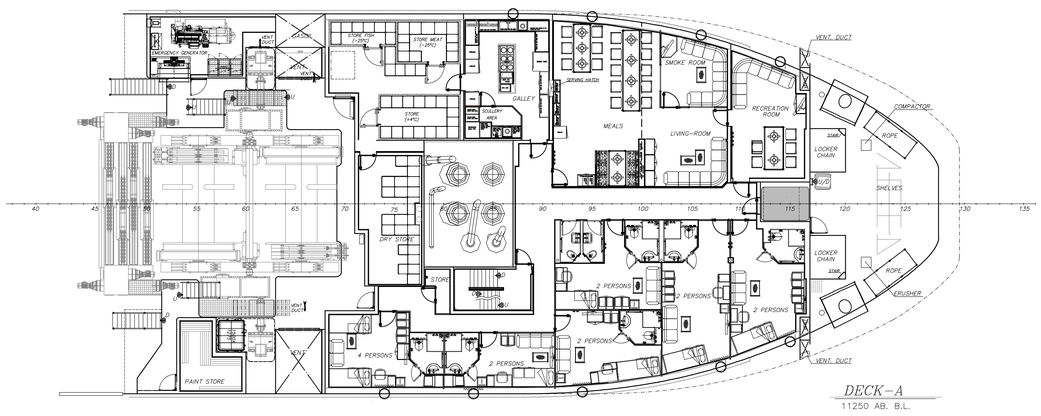


DECK–B
14000 AB. B.L.

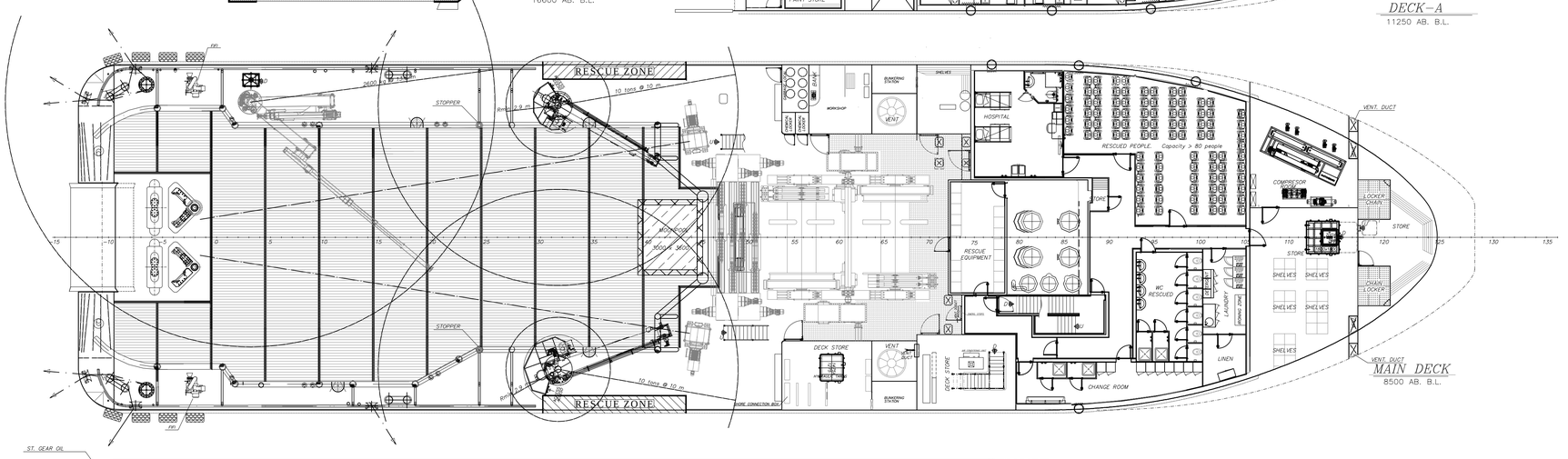




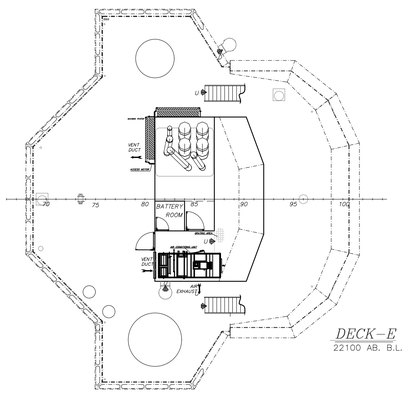
DECK–C
16600 AB. B.L.



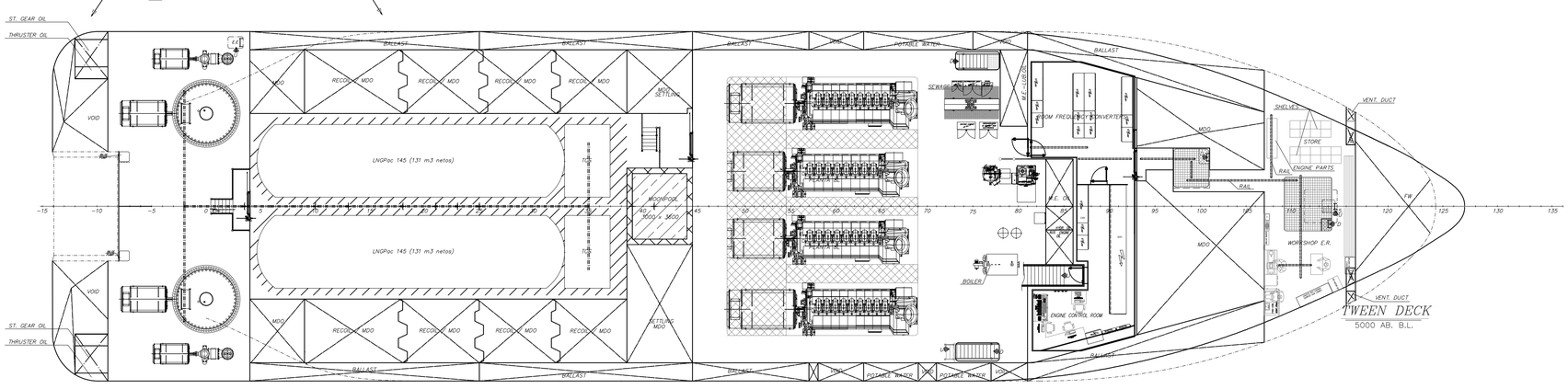
DECK–A
11250 AB. B.L.



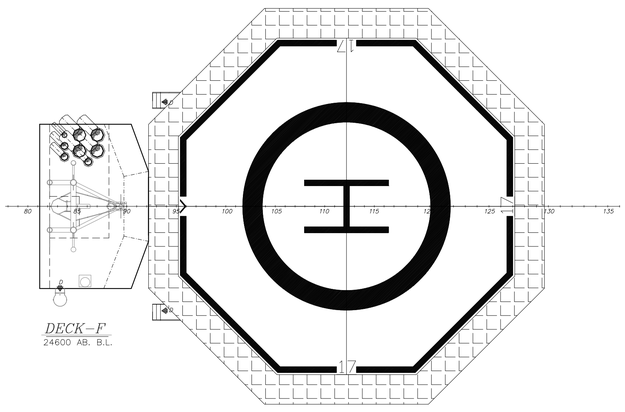
MAIN DECK
8500 AB. B.L.



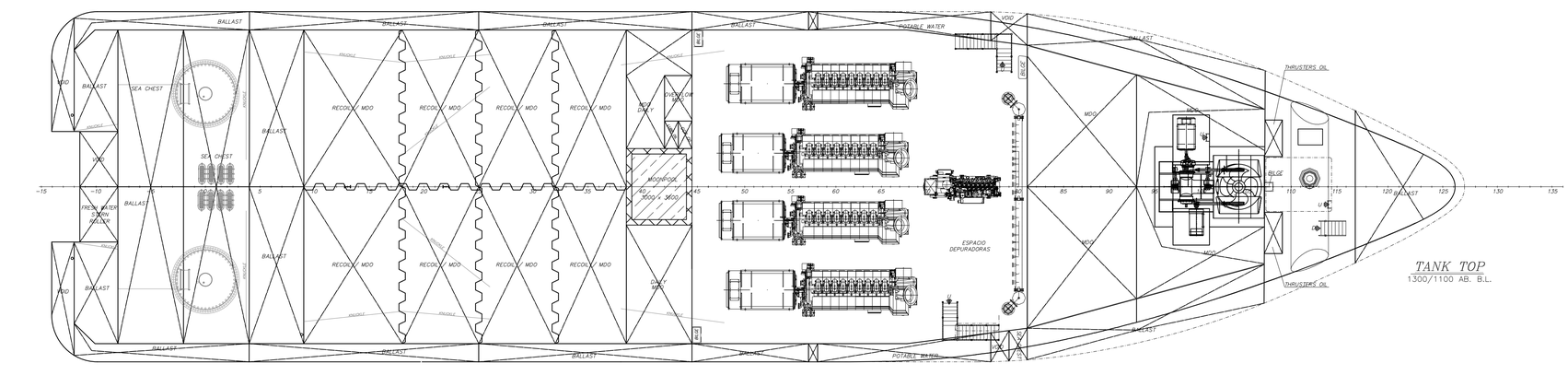
DECK–E
22100 AB. B.L.



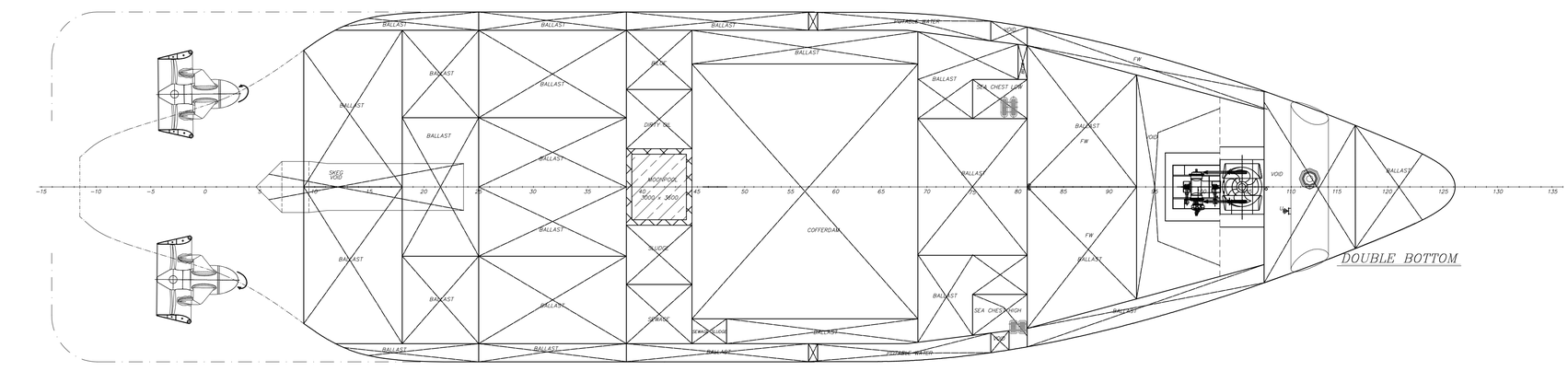
TWEEN DECK
5000 AB. B.L.



DECK–F
24600 AB. B.L.



TANK TOP
1300/1100 AB. B.L.



DOUBLE BOTTOM

MAIN PARTICULARS

LENGTH OVER ALL.....: 79.20 m
LENGTH BETWEEN PERP. .....: 66.63 m
BREADTH MOULDED.....: 19.20 m
BOLLARD PULL.....: 235 tons
MDO CAPACITY.....: 812 m3
OIL RECOVERY.....: 1295 m3
LNG CAPACITY.....: 260 m3
HELIDECK..... D17

Modif.	Fecha	Nombre	Observaciones:

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

	Fechas	Nombres	Observaciones
Dibujado	17-09-2018	J.López-Fando	
Comprobado	20-09-2018	A.N.	

Buque: PR-119-18 - REMOLCADOR SASEMAR

Constr. Nº: PR 119-18

Escala: 1:150 e indicadas

Designacion: DISPOSICIÓN GENERAL

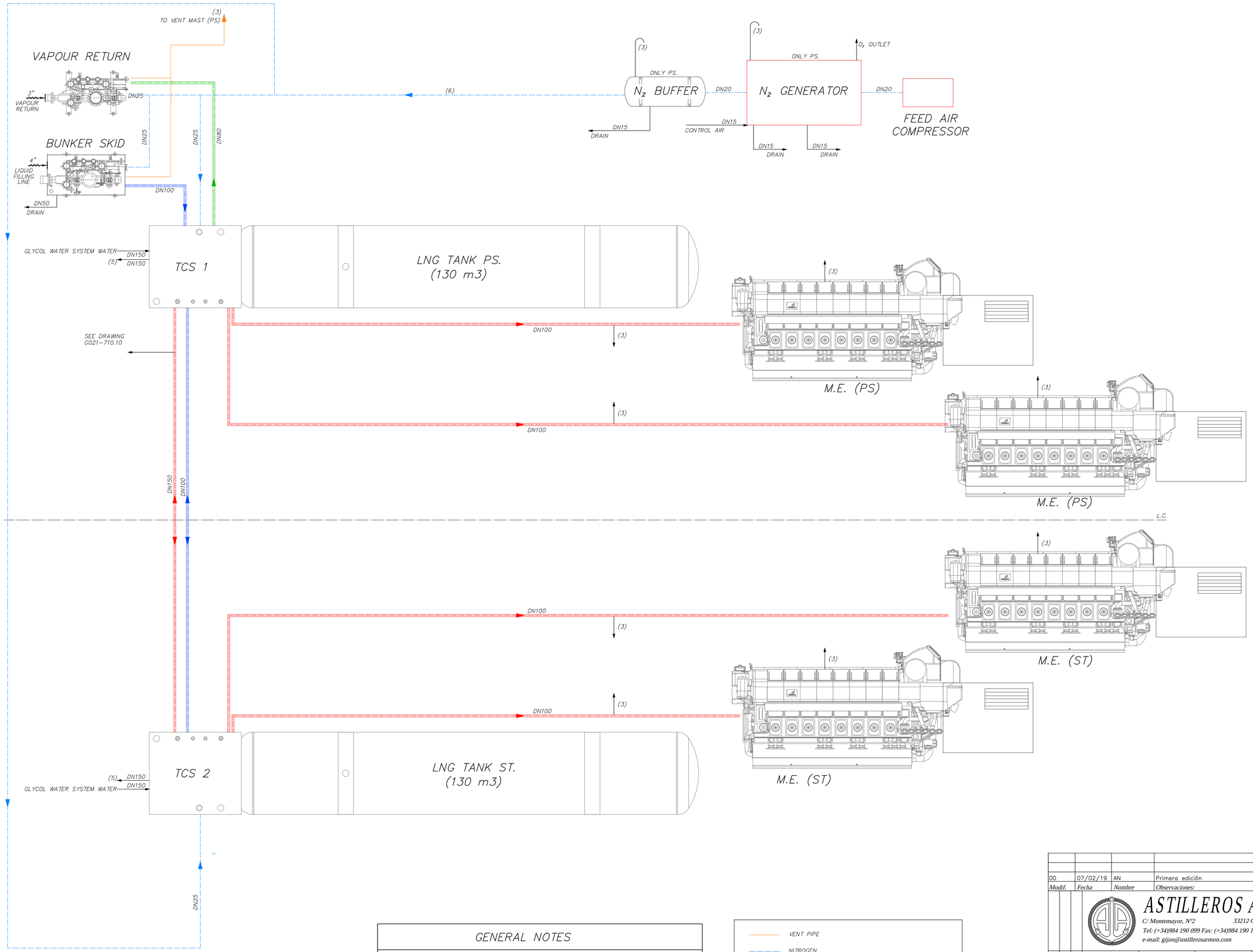
Plano Nº: GA-119-18-100

Sustituye a:

Nº de hojas: 01 Hoja Nº: 01

ARMADOR / CLASIFICACION / AUTORIDADES / APROBADO

Documentación propiedad de ASTILLEROS ARMON GIJON, S.A.
Su contenido no puede ser copiado, reproducido, entregado a terceras personas, ni usado con fines no autorizados sin permiso escrito del propietario.



GENERAL NOTES

(1) ALL DIAMETERS SHOWN REFER TO ØINT.

(2) GAS VALVE UNIT (GVU) OF THE MAIN ENGINES ARE INCLUDING IN THE CORRESPONDIG TCS

- VENT PIPE
- NITROGEN
- DOUBLE WALLED PIPE VACUUM INSULATED +MLI (LNG)
- DOUBLE WALLED PIPE AIR VENTILATED (NG)
- DOUBLE WALLED PIPE AIR VENTILATED (NG COLD)

Modif.	Fecha	Nombre	Observaciones:
00	07/02/19	AN	Primera edición

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

	Fechas	Nombres	Observaciones
Dibujado	22-01-2019	L.G.F.	
Comprobado	22-01-2019	P.V.F.	

Buque: BUQUE MULTIPROPOSITO

Constr. Nº: Pr 119-18

Escala: S/E e indicadas

Designacion: LNG & GAS System Diagram

Plano Nº: G021 - 710.00

Sustituye a:

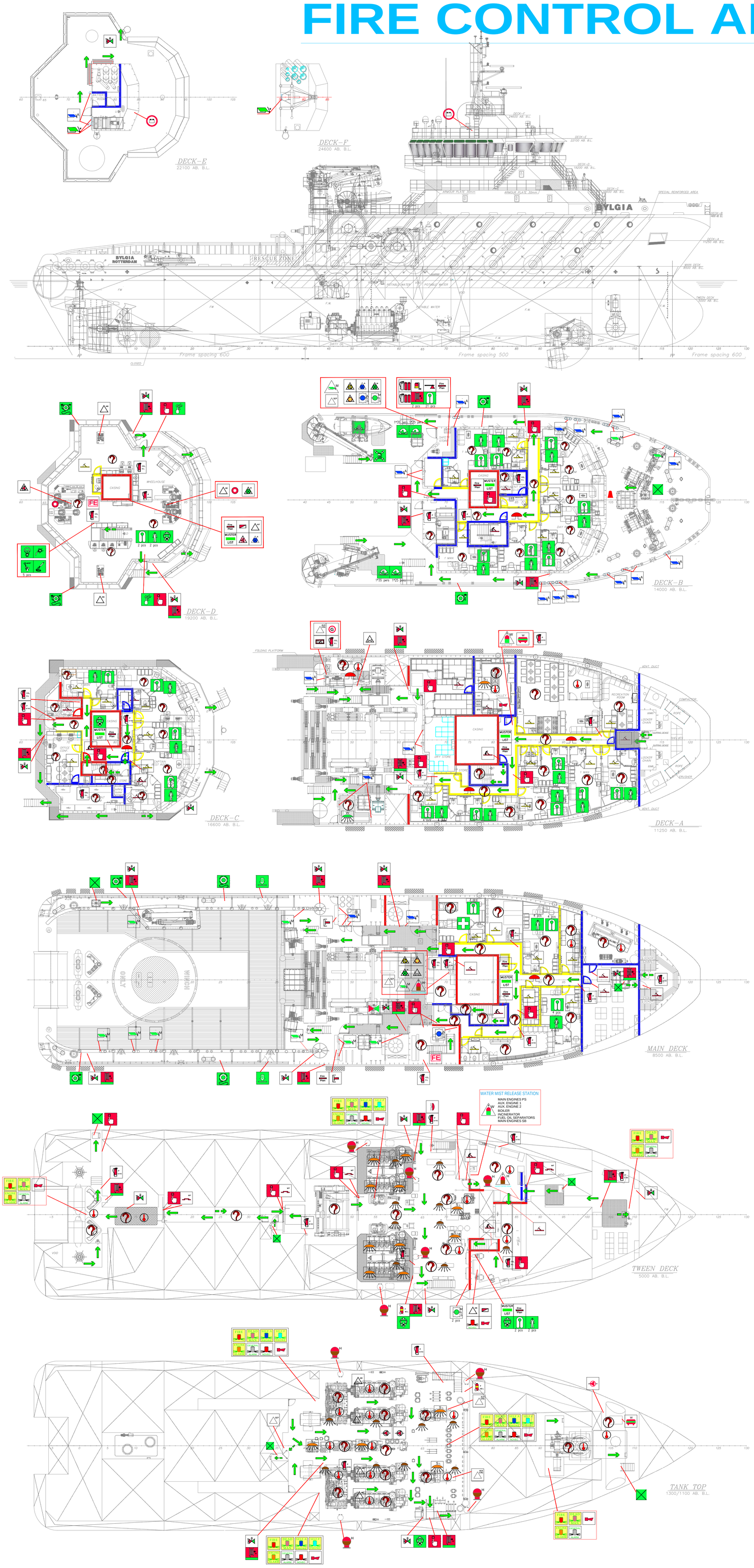
Nº de hojas: Hoja Nº:

ARMADOR / CLASIFICACION / AUTORIDADES / APROBADO

Documentación propiedad de ASTILLEROS ARMON GIJON, S.A.
Su contenido no puede ser copiado, reproducido, entregado a terceras personas, ni usado con fines no autorizados sin permiso escrito del propietario.

A1

FIRE CONTROL AND SAFETY PLAN



SYMBOL	DESCRIPTION	DECK - E	DECK - D	DECK - C	DECK - B	DECK - A	MAIN DECK	TWEEN DECK	TANK TOP	TOTAL	
LIFE SAVING APPLIANCES											
	FAST RESCUE BOAT				1					1	
	LIFERAFT, 2 LIFERAFT FOR 25 PERSONS LIFERAFT, 2 LIFERAFT FOR 35 PERSONS				4					4	
	LIFE BUOY W/ LINE						2			2	
	LIFE BUOY W/ LINE AND LIGHT				2		2			4	
	LIFE BUOY W/ SMOKE/LIGHT AND LINE		2							2	
	EMBARKATION LADDER						2			2	
	IMMERSION SUIT		2	4	7	9	8	2		32	
	LIFEJACKET		2	4	28	9	11	2		56	
MUSTER LIST	MUSTER LIST		1	1	1	1	1	1		6	
	MUSTER STATION				1					1	
	PYROTECHNIC DISTRESS SIGNALS 4 ROCKET PARACHUTES 6 HAND FLARES 2 BUOY SMOKE SIGNALS		1							1	
	ROCKET PARACHUTE FLARES 12 RED PARACHUTE		1							1	
	LINE THROWING APPLIANCE UNIT (ROCKET + LINE)		1							1	
	TWO-WAY VHF RADIOTELEPHONE APPARATUS		3							3	
	EMERGENCY POSITION INDICATING RADIO BEACON (EPIRB)		2							2	
	SEARCH AND RESCUE TRANSPONDER (SART)		2							2	
	HOSPITAL						1			1	
	EMERGENCY ESCAPE BREATING DEVICE (EEBD)		1	1				2	2	6	
	BELL				1					1	
	MAIN ZONE (A60 INSULATED BULKHEAD)										ON PLANS
	A0-CLASS (A0 BULKHEAD)										ON PLANS
	B-CLASS (B15 INSULATED BLKH'D) OTHER ACC. BHDS										ON PLANS
	A-CLASS HINGED SELF-CLOSING FIRE DOOR										ON PLANS
	WATERTIGHT SLIDING DOOR							4		4	ON PLANS
	B-CLASS HINGED FIRE DOOR (ALL, U.N.O.)										ON PLANS
MEANS OF ESC											
	PRIMARY MEANS OF ESCAPE										
	SECONDARY MEANS OF ESCAPE										
	EMERGENCY EXIT				1		2		2	4	ON PLANS
FIRE DETECTION SYSTEM FIRE SIGNALS & ALARMS											
	FIRE ALARM PANEL		1					1		2	
	PUSH-BUTTON FOR GENERAL ALARM		1							1	
	MANUAL CALL POINT		2	2	3	3	3	7	1	21	
	SMOKE DETECTOR TO BE CHECKED WITH FIRE DETECTION ENGENIER		3	13	13	15	15	11	12	81	
	HEAT DETECTOR TO BE CHECKED WITH FIRE DETECTION ENGENIER					3	2	6	11	22	
	FIRE ALARM HORN / SIREN					1		4	4	9	
	FIRE ALARM BELL TO BE CHECKED WITH FIRE DETECTION ENGENIER			1	1	3	1			6	
	EMERGENCY GENERATOR					1				1	
	EMERGENCY SWITCHBOARD					1				1	
	EMERGENCY BATTERIES	2								2	
	CLOSING DEVICE FOR VENTILATION, ACCOM. SPACES	1			15	5	4			25	
	CLOSING DEVICE FOR VENTILATION, MACH. SPACES	2			3		9			14	
	VENTILATION REMOTE CONTR. OR SHUT-OFF MACHINERY				1		1			2	
	FIREDAMPER,MACH. SPACES						2			2	
	REMOTE CONTROL FOR CLOSING DEVICES FOR VENTILATION INLET AND OUTLET				3		1			4	
	VENTILATION REMOTE CONTR. OR SHUT-OFF ACCOMODATION		1		1					2	
	FIREDAMPER, ACCOMONDATION SPACES						1			1	
STRUCTURAL FIRE PROTECTION											
	REMOTE CONTR. FOR WATERTIGHT DOORS		1							1	
	EMERGENCY STOP, ENGINES		3				1	4		8	
	EMERGENCY STOP, AUX ENGINES		1			1		1	2	5	
	EMERGENCY STOP, SEPARATORS				1		1		1	3	
	REMOTE CONTROL FOR FIRE PUMPS		1							1	
	REMOTE CONTROL EMERGENCY FIRE PUMP		1							1	
	FUEL PUMPS REMOTE SHUT-OFF				1		1			2	
	LUBE OIL PUMPS REMOTE SHUT-OFF				1		1			2	
	REMOTE RELEASE STATION FO & LO QUICK CLOSING VALVES					1	1			2	
	FIXED FIRE WATER BASED LOCAL APPLICATION SYSTEM					1				1	
	SPACE COVERED BY NOVEC 1230 FLOODING							9	8	17	
	APPLICATION WATER MIST SYSTEM (FW)					1		10	4	15	
FIRE PROTECTION APPLIANCES											
	BILGE AND FIRE PUMP, 55 m³/h - 8 BAR								2	2	
	EMERGENCY FIRE PUMP, 35 m³/h - 6 BAR								1	1	
	MAIN FIRE SECTION VALVE						1			1	
	RELEASE RELEASE STATION FOR WATER MIST					1		1		2	
	STATION FOR WATER MIST					1			1	2	
	NOVEC 1230 BOTTLES							5	4		
	INTERNATIONAL SHORE CONNECTION						2			2	
	FIRE HYDRANT	0	2	2	3	2	7	4	2	23	
	FIRE HOSE, WITH JET AND FOG NOZZLE MAX. 20M IN GENERAL SPACES	0	2	1	5	2	7	4	2	24	
	FIRE EXTINGUISER, POWDER 12 KG	0	1	2	2	3	5	6	2	21	
	FIRE EXTINGUISER, CO2 5 L		2	2	1	1	2	1		9	
	WHEELED FIRE EXTINGUISHER, FOAM, 45 LTR							1	1	2	
	PORTABLE FOAM APPLICATOR UNIT 200 L FOAM CONST.				1					1	
	SPARE: POWDER 12 KG: + N2 CH.UNIT 6L				16					16	
	SPARE: CO2 6L				9					9	
	LOCATION OF FIRE AND SAFETY PLAN		1	1	2	1	3(*)	1		9	(*) 1 IN CYLINDER
	FIREMANS OUTFIT		1				1			2	
	FIREAXE				1					1	
SYMBOL	DESCRIPTION	DECK - E	DECK - D	DECK - C	DECK - B	DECK - A	MAIN DECK	TWEEN DECK	TANK TOP	TOTAL	

WATER MIST BACK-UP PUMP

S: RELEASE STATION FOR TOTAL FLOODING IN ECR

BOWTHRUSTER-ROOM WATERMIST: LOCAL APPLICATION ZONES

Z1: 4 NOZZLES MAIN ENGINE NO.1
Z2: 4 NOZZLES MAIN ENGINE NO.2
Z1: 4 NOZZLES MAIN ENGINE NO.3
Z2: 4 NOZZLES MAIN ENGINE NO.4
Z3: 2 NOZZLES AUX. ENGINE NO.1
Z4: 2 NOZZLES AUX. ENGINE NO.2
Z5: 1 NOZZLE BOILER
Z6: 4 NOZZLES FO SEPARATORS
Z7: 1 NOZZLE INCINERATOR:

SPACE/EQUIPMENT PROTECTED BY FIRE LINE
H1 PAINT STORE

COLUMNE ALARM DEVICE IN MACHINERY SPACES WITH AUDIBLE SOUNDER

PRINCIPAL DIMENSIONS:

L.O.A. .....APPROX.. : 79,20 m
BREADTH MOULDED ..... : 19,20 m
DEPTH TO MAIN DECK..... : 8,5 m
DRAUGHT, SCANTLING... : 7,0 m

Rev.	Date year-month-day	Drawn by	Checked by	Approved by	Description
00	07/02/2019	–	AN	–	Primera edición

ASTILLEROS ARMON GIJON, S.A.
C/ Montemayor, Nº2 33212 GIJON
Tel: (+34)984 190 099 Fax: (+34)984 190 100
e-mail: gijon@astillerosarmon.com

Vessel: BUQUE MULTIPROPOSITO

Hull Nº PR-119-18

Scale: 1/175

Designation: LIFE SAVING AND SAFETY ARRANGEMENT
PLANO DE SALVAMENTO

Document Code: 346-132-10-DG-0001

Total sheets: 1 | sheet Nº: 1

Documentation SHIPYARD property ARMON GIJON, SA
Its contents may not be copied, reproduced, given to third parties or used for purposes unauthorized without written permission from the owner.

BUQUE MULTIPROPOSITO SASEMAR

Bollard Pull 230 tons

Referencia Proyecto:	**PR 119-18**
Armador:	**SALVAMENTO MARÍTIMO**
Constructor:	**ASTILLEROS ARMON GIJON SA**

Montemayor, 2
33212 Gijón - Asturias - España
Tel: (34) 984 190 099
www.astillerosarmon.com

This is a Commercial Technical Data Sheet subject to changes. If any further information is required please contact to the Commercial Department (comercial@astillerosarmon.com) of ARMON. Property of ARMON SHIPYARDS.

BREVE DESCRIPCIÓN DEL PROYECTO:

Diseño conceptual proyectado por ASTILLEROS ARMON para SALVAMENTO MARÍTIMO (SASEMAR).

Es un buque multipropósito que dispone de una moderna y eficiente propulsión dual LNG-MDO y gran capacidad para realizar tareas de búsqueda y salvamento. Entre las principales características se destaca el moonpool para el apoyo a actividades submarinas, capacidad de remolque, Oil Recovery, Clean Design, Fi-Fi II, DP 2, amplia cubierta de carga, espacios para rescatados y helipuerto.

CARACTERÍSTICAS PRINCIPALES:

Dimensiones principales:

- Eslora total ..... 79,20 m
- Manga máxima ..... 19,20 m
- Puntal a cubierta ppal. ..... 8,50 m
- Calado de proyecto ..... 7,00 m
- Superficie cubierta ..... > 400 m2

Capacidad de tanque (aprox.):

- MDO 812 m3
- Oil recovery 1295 m3
- LNG (vol. geométrico) 260 m3
- Lastre 1050 m3
- Agua potable 50 m3

Operatividad buque (aprox.):

- Bollard Pull (100% MCR) ..... 230 tons (incluyendo azimuth de proa)
- Velocidad máxima ..... 17 nudos
- Tripulación ..... 33 personas
- Autonomía ..... 9000 mn en vel. económica.

MATERIALES:

- Casco, superestructura y puente: Acero Naval calidad A.
- Otros elementos: de acuerdo a Estándares Europeos y buena práctica en construcción naval.

EQUIPO PROPULSIÓN (Diésel-eléctrica + Dual-Fuel):

- 2x Grupos electrógenos duales de 4000 kW, Wärtsila 8L34DF o similares.
- 2x Grupos electrógenos duales de 4500 kW, Wärtsila 9L34DF o similares.
- 2x Propulsores acimutales 6000 kW SCHOTTEL SRP 800 o similares + 2x motores eléctricos 6000 kW.
- 2x Hélices de maniobra en proa accionadas eléctricamente:
  - 1x Acimutal abatible de 2000 kW Rolls Royce TCNS/C 100 o similar.
    (Esta hélice puede operar también como túnel de maniobra, adecuada también para navegar a baja velocidad o mantener la posición sin necesidad del uso de los propulsores principales).
  - 1x Túnel de 900 kW.

GENERADORES AUXILIARES:

- 1x Generador de Puerto de 500 kW SIEMENS SGE-36SL o similar (opera en LNG)
- 1x Generador Emergencia de 100 kW (opera en MDO).

EQUIPO AUXILIAR PROPULSIÓN:

- 2x Tanques LNG de aproximadamente 130 m3 cada uno + 2x TCS + GVUs para grupos electrógenos.
- Bombas auxiliares: Servicios generales & firefighting, Sentinas, MDO Transfer, Oil transfer, Bombas de lastre, Aceite sucio, Oil Recovery, etc…

EQUIPAMIENTO EXTERIOR FIRE FIGHTING:

- 2x Bombas 3600 m3/h + 2x motor eléctrico accionador.
- 2x Cañones de agua 3600 m3/h.

MAQUINARIA DE REMOLQUE y FONDEO:

- Winche principal remolque con dos tambores dispuestos en cascada.
- 2x Whinches auxiliares de cubierta.
- 2x Molinetes de anclas y cabrestantes para amarre.
- 2x sets de Towing pins y shark jaws.

GRÚAS:

- 2x Grúas 10 tons @ 10 m con AHC y brazo para Oil Recovery.
- 1x Grúa plegable 2300 kg @ 13.6 m.

OTROS EQUIPOS RELEVANTES:

- Helipuerto.
- Moonpool.
- Posicionamiento dinámico (DP2).
- 1x Fast Rescue Craft.
- 1x Daughter Craft.
- 1x Dacoon Scoop.
- Sistema de Rec-Oil.
- Equipos de navegación y radio según GMDSS A3 y el necesario para el cumplimiento de la normativa aplicable
- Equipos de salvamento para el cumplimiento de la normativa aplicable.

< Disposición General en la siguiente página>

PAGE 4 CONTAINS A 'LOW RESOLUTION' GENERAL ARRANGEMENT (GA) AND THIS HAS BEEN PURPOSELY REMOVED FROM THIS ANNEX.
A 'HIGH RESOLUTION' GA IS GIVEN ON THE FIRST PAGE OF THIS ANNEX.

Lloyd's Register

Lloyd's Register Marine & Offshore
Global Technology Centre
Boldrewood Innovation Campus
Burgess Road, Southampton
SO16 7QF, UK

T: +44 1625 538 928
E: paul.davies@lr.org
W: www.lr.org

www.lr.org

Lloyd's Register Group Limited, its subsidiaries and affiliates and their respective officers, employees or agents are, individually and collectively, referred to in this clause as 'Lloyd's Register'. Lloyd's Register assumes no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided, unless that person has signed a contract with the relevant Lloyd's Register entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.

Lloyd's Register and variants of it are trading names of Lloyd's Register Group Limited, its subsidiaries and affiliates.
Copyright © Lloyd's Register EMEA. 2019
A member of the Lloyd's Register group.