Concept Design of a Station Keeping Vessel Dedicated to Maintenance of the Far Shore Wind Farm

Yue WU

Master Thesis

presented in partial fulfillment
of the requirements for the double degree:
“Advanced Master in Naval Architecture” conferred by University of Liege
"Master of Sciences in Applied Mechanics, specialization in Hydrodynamics, Energetics and Propulsion” conferred by Ecole Centrale de Nantes

developed at West Pomeranian University of Technology, Szczecin
in the framework of the

“EMSHIP”
Erasmus Mundus Master Course
in “Integrated Advanced Ship Design”

Ref. 159652-1-2009-1-BE-ERA MUNDUS-EMMC

Supervisor:	Prof. Zbigniew Sekulski, West Pomeranian University of Technology, Szczecin
Company tutor:	Mr. Vincent Seguin, Bureau MAURIC, Nantes, France
Reviewer:	Prof. Dario Boote, University of Genoa

Nantes, February 2015

ACKNOWLEDGMENTS

With one year experience in yacht design in Qingdao Xuan hang Yacht Architecture & Engineering Studio, Shandong Province, China, aiming to improve my level of computer operations and my understanding to the mathematical roots of ship, I began last year my Master in Advanced Ship Design offered by EMSHIP (University of Liège, Ecole Centrale de Nantes, Zachodniopomorski Uniwersytet Technologiczny w Szczecinie.).

This report is my master thesis during my studies and my internship at Bureau Mauric.

I really appreciate all the help from the president of the Bureau Mauric Mr. Pascal Lemesle, the Chief Engineer of studies and the technical internship tutor Mr. Vincent Seguin, Prof. Zbigniew Sekulski at West Pomeranian University of Technology, Szczecin and all my colleagues in Bureau Mauric for their valuable comments and for moving forward this work.

This thesis was developed in the frame of the European Master Course in “Integrated Advanced Ship Design” named “EMSHIP” for “European Education in Advanced Ship Design”, Ref.: 159652-1-2009-1-BE-ERA MUNDUS-EMMC.

Yue WU – Szczecin, 2015

DECLARATION OF AUTHORSHIP

I declare that this thesis and the work presented in it are my own and have been generated by me as the result of my own original research.

Where I have consulted the published work of others, this is always clearly attributed.

Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.

I have acknowledged all main sources of help.

Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma.

Szczecin，

Yue WU

ABSTRACT

The thesis together with the attached General Arrangement drawing is focused on the concept design of a station keeping vessel Mauric Far shore Wind farm Station Keeping Vessel (MFWSV) dedicated to maintenance of offshore wind farms, with an integrated friendly environment energy architecture. The design was developed during the three-month research program at BUREAU MAURIC, Nantes, France. The offshore wind farm supply vessel coupled with the green energy propulsion system and met all IMO (International Maritime Organization) regulations on offshore vessels.

The report is divided into 3 parts. Part 1 describes the essential project background, design assumption, choice of specification and theoretical background, while Part 2 goes into more details on the procedure of the project MFWSV, including the general arrangement, calculation, propulsion system and dynamic positioning system of the vessel. Part 3 relates to research and introduction of special systems in this vessel.

The MFWSV is a 75m monohull designed to operate in far shore of Southern North Sea wind farms where significant wave heights reach to 3.25 meters and the water depth is about 50 m. The vessel varies from the current wind farm support vessels and will provide accommodation, safer transfer for technicians and warehouse facilities during the service period. In the same time, it is designed for ease of maintenance as it has a diesel - electric propulsion advantageous for the Dynamic Positioning System to avoid necessity of maintenance in the rough seas and longer transits.

AUTOCAD computer system was used for design of general arrangement of the ship, MS Excel to estimate weight of vessel and electric consumption in different statue of the vessel propulsion system.

RÉSUMÉ

Cette thèse avec le plan d'ensemble concerne le concept design de navire Mauric Far Shore éolienne parc maintenance navire (MFWSV) à poste dédié à la maintenance des parcs éoliens offshore, avec une architecture qui prend en compte l'environnement énergétique. Le design a été développé au cours du programme de recherche de trois mois à BUREAU MAURIC, Nantes, France. Le navire de ravitaillement des parcs éoliens offshore couplé avec le système de propulsion de l'énergie verte et satisfait à tous les textes de l'OMI (Organisation maritime internationale) des règlements sur les navires offshore.

La thèse est divisée en 3 parties. La partie 1 décrit le contexte de projet essentiel, hypothèse de conception, prise en compte de la spécification et du contexte théorique, tandis que la partie 2 va dans plus de détails sur la procédure du projet MFWSV, y compris la disposition générale, le calcul, la description du système de propulsion et du système de positionnement dynamique du navire. La partie 3 concerne la recherche et l'introduction des systèmes spécial dans ce navire.

MFWSV est un monocoque de 75m conçu pour fonctionner dans les parcs éoliens dans la partie sud de la mer du Nord où la hauteur de houle significative atteint à 3, 25 mètres et la profondeur de l'eau est d'environ 50 m. Le navire change des navires actuels de soutien de parcs éoliens. Il fournira l'hébergement et le transfert plus sécurisé pour les techniciens et les installations d'entreposage au cours de la période de service. Dans le même temps, il est conçu pour faciliter la maintenance car il a un moteur diesel - propulsion électrique avantageux en système de positionnement dynamique pour l'approche et le stationnement sur site.

Le logiciel AUTOCAD a été utilisé pour la conception du général arrangement du navire, MS Excel pour estimer le poids du navire et la consommation électrique dans différentes situations du système de propulsion du navire.

摘　　要

這篇碩士論文是本人在法國船舶設計公司Bureau Mauric三個月實習工作成果。全篇論文圍繞遠洋風能发電群供應船初步設計經行描述。本船舶設計不僅符合相關法規，而且更符合國際海洋組織提出的最新綠色船舶的概念，采用柴油機電力推進系統，不僅節能而且經濟性能高，力求為未來遠洋風機发電事業貢獻微薄之力。

本文分為三部分：第一部分簡要介紹項目背景，項目設想，和提供相關理論依據。第二部分深入描述了本船的設計過程。第三部分介紹了本船的特殊系統。本文將配合總布置圖設計圖紙进行讨论。

本船船長75米，船寬17米，設定為德國北海南部遠洋風機发電群設計的供應船舶，相關水域深度為50米，波高達到3.25米。本船按船東的要求提供相關服務。基于安全等考慮，本船設計足夠的電力餘量提供動力定位系統正常工作于遠洋航區。

CONTENT

LIST OF FIGURES

BUREAU MAURIC'S BIOGRAPHIE

BUREAU MAURIC, which organized my 3rd semester engineering internship of EMSHIP (Erasmus Mundus Master Course in Integrated Advanced Ship Design), is a company in the domain of naval architecture and marine engineering located in Marseille and Nantes, France. Founded in 1945 by Naval Architect André MAURIC in Marseille, this company became famous very quickly by its designs and construction of sailing boats "France I "and" France II" which won the international competition of America's Cup, Pen Duick VI, First 30, commandant boat Cousteau (Alcyone). The company is a company very professional in naval architecture and marine engineering with a rich experience special in design small ship of dimension between 11 and 46 meters.

Today, BUREAU MAURIC diversifies its activities and plays an important role in the field of work vessel design in Europe. It accepts more and more challenging projects and is widely known by its high level of technical assistance in the domain of naval architecture and marine engineering. In the same time, it does important investigation for France nationality marine military.

BUREAU MAURIC group not only provides high quality technique support and service for customs from concept design to detail design, including project research, project survey, technical assistance, but also provides service like comparative studies, offers analysis, budget quotation, consultancy and building supervision, advice to ship-owner and synthesis of tank tests, supervision and analysis of sea tests. All engineers and architects in the group have more than 10 years maritime design experience. With the lead of Mr. Jean Charles Nahon- general director and Mr. Pascal Lemesle- president, its turnover reached 3.2 million euro.

At Bureau Maurice, we do consider ships as a fully global system. This philosophy consists of looking forward and aim to find the best optimized solutions with the most acceptable compromises.

PART 1 DATA COLLECTION, ANALYSIS, INTERPRETATION AND EVALUATION

1.1. INTRODUCTION

My mission in the internship was to design a wind farm station keeping vessel that vary from the current wind farm supply vessels according to the requirements to the ship owner. It provides comfort accommodation, a safer transport for technicians and warehouse facilities during the service period. At the same time, the design is eco-friendly and reasonably economic.

After doing the researches, I knew that the current wind farm station keeping vessels is not appropriate for accessing far shore wind farms because of the nature conditions and because of the size of turbines which are quite different from far shore and offshore, therefore there weren't much references about this kind of vessels. So I began this project by collecting and analysing data.

1.2. RELATIVE RULES

The design of MFWSV will be observe the following rule and convention:

- DNV (Det Norske Veritas) related to vessel serves for wind turbine offshore.(OS-C102, Structural design of Offshore Ships - Minor technical and editorial updates)
- The BV rule of Steel Ship NR 467 related to HULL, MACH, Special Service, Unrestricted navigation, AUT-UMS, DYNAPOS AM/AT-R, ALM, COMF3. (Rules for the Classification of Steel Ships - January 2015 edition.)
- All the living facilities will be according with ILO (International Loadline Convention) 1966 and subsequent amendments.
- General design and safety will be compliant with SOLAS 1974 and subsequent amendments.
- The exhaust emission system relate to Marpol 73/78 and subsequent amendments (Regulations for the Prevention of Air Pollution from Ships 1997, MARPOL 73/78 and Annex VI)

1.3. PROJECT BACKGROUND

Today, global energy availability and sustainable development is an important issue and a big challenge. Several industries invest in renewable energies with a view to promote a cleaner world are well developing. The offshore wind industry is the fastest growing market segment. For economizing the space and wind energy, companies in Europe invest huge funds in the construction of new wind parks in the sea. In German North and Baltic Sea, until now, offshore wind farms with a total capacity of about 2400 MW are being constructed. Wind farms with a capacity of around 9000 MW received an authorization. Moreover, about 40000MW are in the planning stage.

The challenges weren't only bearing the wind farms techniques but also the operations and maintenance techniques.

BUREAU Mauric as an important naval architecture & engineering firm established in the French maritime landscape recognized for its achievements in the field of small vessel (<75 m) office has already finished its Wind Farm Support Mother Vessel design and high performance deep sea SWATH TRIMATAN wind farm operation vessel design. I tried to participate in this vessel design during my internship at Bureau Mauric taking advantage of the company's thriving experience.

1.4. PROJECT APPROACH

1.4.1. The Environment Operation Assumption.

(Confidential)

1.4.2. The Main Assumption of the Vessel

The following points describe the main assumption of this ship design.

a) It has been assumed that this vessel is designed for far shore perform corrective and preventive maintenance and to transport and storage equipment to the wind turbines.

b) It has been assumed that this vessel is designed for a deep water operation and it'll maintain a good performance in any extreme nature condition.

  - Extreme condition means the signification wave high up to 3.25m, current speed up to 3 knots, and wind speed up to 30 knots.

c) It's supposed that this vessel will be ensuring the safety of techinicians and crew.

d) It’s suppose that this vessel will be able to help out finishing the research mission under the water.
e) It’s supposed that this vessel have enough weather deck space for repairing wind turbine component by technician.
f) It’s supposed to be able to embark and debark of technicians and material easily from the vessel to the deep sea wind turbine.
g) It’s supposed that this vessel will save energy and protect the maritime environment.
h) It’s supposed that this vessel can put out fire on the deck or on the wind turbine.

1.4.3. The Design Philosophy and Operational Requirements.

a) To provide maximum safety of technicians and crew.
  - The design of layout of spaces, entrances, stairs, railings, hand-grips, instructions and signs (visual and acoustic) etc. will be strictly according to convention SOLAS requirement.
b) To design a vessel with an integrated eco-friendly architecture.
  - The propulsion system design will be following the MARPOL Annex VI regulations to reduce harmful emissions from ships propose by The Marine Environment Protection Committee (MEPC).
c) To design a vessel while minimizing the building price and the operation costs. Her function interrelated with the future development of the wind farm.
d) To provide an acceptable comfort for the technicians and the crew during sailing in adverse sea conditions up to sea state 5 (SS5).
  - The SS5 means that this vessel’s acceleration midship will be maximum $1.00\ \mathrm{m}/s^2$ (significant single amplitude), which is a reduced acceleration level in relation to the requirements specified in ISO Standard 2631/3-1985, evaluation of human exposure to whole body vibration.
e) To minimize the environmental risks.
  - A DP2 system which automatically maintain her position and heading by using its own propellers and thrusters in this vessel for locking to a fixed point over the bottom in the wind farm to avoid colliding.
f) To ensure the ease of the following operation, the use and maintenance of systems, installations and the equipments, without forgetting the simple operating of those systems and installations.
  - By designing an electric drive, it’ll be more easy and convenience to control the

propeller speed and direction of rotation.

g) To design a vessel that accepts many wind mills machines operating at the same time, where they'll not be interacting together. In other words, the crane, the deck workplace, the container loading, the transfer access system, the superstructure and helicopter deck will be all installed on the deck but without interacting together.

1.4.4. The Theoretical Supporting in the Design

a) Is that necessary to use helicopter in the vessel?

- Based on experiences made by the operators of Germany's Offshore Wind Farm Alpha Ventus, in the first years of operation, 20% of the days in a year are favorable enough weather-wise as for the service ships to approach the plants as near as possible without harm.

  The figure 1 shows significant wave height in the typical wind farm in a year. We distinguish from the figure that more than 5 months in a year that we hardly access the wind turbine by small boat with the significant wave height more than 1.5 meter, at this time, we are only able to use the helicopter to transport staff and material.

  So it's necessary to install a helicopter deck in the vessel.

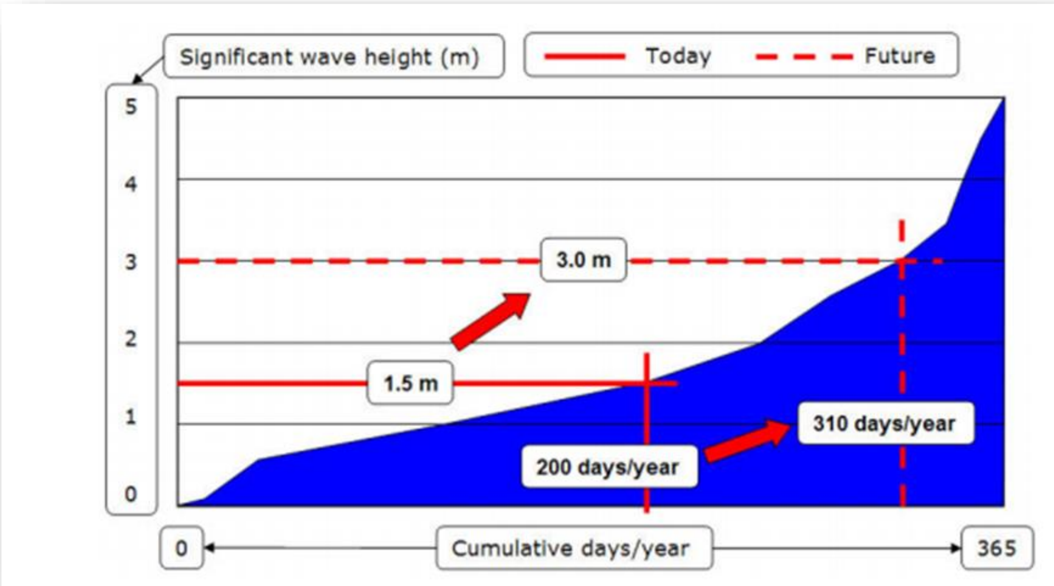

Figure 1 significant wave height in target sea zone in a year
Source: Carbon Trust.

b) What are the works for a wind turbine maintenance?

Works for a wind turbine involve in major repairs and regular maintenance.

- Major repairs:

- Disassemble blowing machine for cleaning and checking use crane in the vessel, In the same time, measure the gap of bearing
- Assemble blowing machine use crane in the vessel.
- Check if airtight.
- Check if spilled oil.

- Regular maintenance:

The data from The Federal Maritime and Hydrographic Agency shows that at least 25 percent of the plants of a wind farms have to be maintained on location annually. In the same time, this organization explicitly asks for regular visual maintenance checks, that is, Periodic Check-Ups on location. The plants and all components should be examined on location. Special focus is being placed on cracks and corrosions with the materials (rotor blades, fundaments).

c) What will be the mode of operation?
(Confidential)

1.5. REFERENCE VESSELS

The MFWSV design refers to following vessels.

1.5.1. BUREAU MAURIC Wind Farm Support Mother Vessel WSMV

This SWATH Trimaran operation and Maintenance Boat integrated DP2 system, wind farm access system, helicopter system and two 12 m high speed turbine access boat launching & recovering system represents a compromise between conflicting ship requirements. Her wind farm access system can be operated on the rough sea where sea state up to SS 5 combined with its superior sea keeping and maneuverability provided by its special hull design. A computer rendering of the MAURIC WSMV can be seen in Figure 2.

Figure 2 MAURIC wind farm support mother Vessel WSMV computer rendering
Source: Bureau Mauric

1.5.2. BUREAU MAURIC Combi Catamarans

Mauric high speed transfer operation and Maintenance Boat design of service velocity of 22-27 knots with superior sea keeping. Her safe operation up to Sea State (SS) 4. A computer rendering of the MAURIC Combi Catamarans can be seen in Figure 3.

Figure 3 MAURIC Combi Catamarans computer rendering
Source: Bureau Mauric

1.5.3. BUREAU MAURIC (65m Multipurpose Navy)

Figure 4 BUREAU MAURIC 65m Multipurpose Vessel computer rendering
Source: Bureau Mauric

This project was developed as a multipurpose vessel for the French navy. A computer rendering of the MAURIC Multipurpose Navy Vessel can be seen in Figure 4.

1.5.4. BUREAU MAURIC Multipurpose Supply vessel MSV 75

This project was developed has a multipurpose supply vessel for the maintenance of Offshore platform. Two vessels were built for the Bourbon group. A picture of the MAURIC MSV 75 can be seen in Figure 5.

Figure 5 BUREAU MAURIC Multipurpose Supply vessel MSV 75 picture

Source: Bureau Mauric

1.5.5. Other Work Vessels Longitudinal of About 60m.

1.6. BRIEF SUMMARY

During my first month, my work focused on learning and analysing all the data that I've collected for this project. Immediately, I organized it into coherent categories as following:

- The Structures and arrangements of offshore wind mill fields in North Sea;
- The support structures and foundations for offshore wind turbines.
- The relative rule.
- Wind farm operations and maintenance.
- The marine environment of the North Sea.
- The systems of station keeping vessel (transfer access system, DP2 system, diesel-electric propulsion system…)

I wrote down the important points, and then I arranged them in paragraphs including the design philosophy and the assumptions in this report.

After that, I drew the main homologous type vessels of my design. I've analysed at least 40 supply vessels, and I've made a very thoughtful analysis of the four vessels that I've mentioned at Bureau Mauric. With these four vessels, I focused on the following points:

- The arrangement of the deck workspace and the deck machinery of MAURIC wind farm support mother Vessel WSMV.
- The mode of access to a wind turbine from the vessel to wind turbine plant of MAURIC Combi Catamarans.
- The general arrangement plan and the technical document of BUREAU MAURIC 65m Multipurpose Vessel
- The general arrangement plan, the propulsion arrangement plan and the technical document for calculating the center of gravity and for estimating the electric consumption of BUREAU MAURIC Multipurpose Supply vessel MSV 75.

At Last I brought it all together and made the right decisions about the specifications of my upcoming vessel.

PART 2 DESIGN AND CALCULATION

2.1. PROJECT PROCEDURE

A ship design process can be broken down into conceptual design and detailed design .In this stage, my major job is to draw general arrangement plan and to decide the principal ship dimensions and the power to meet the real service in offshore wind turbine. I will try to make sure there is no significant change in detailed design step.

The contents which covered the MFWSV conception design process are shown in Figure 6, it affects many aspects such as powering, the mid ship structures, the stability, the safety and the environment.

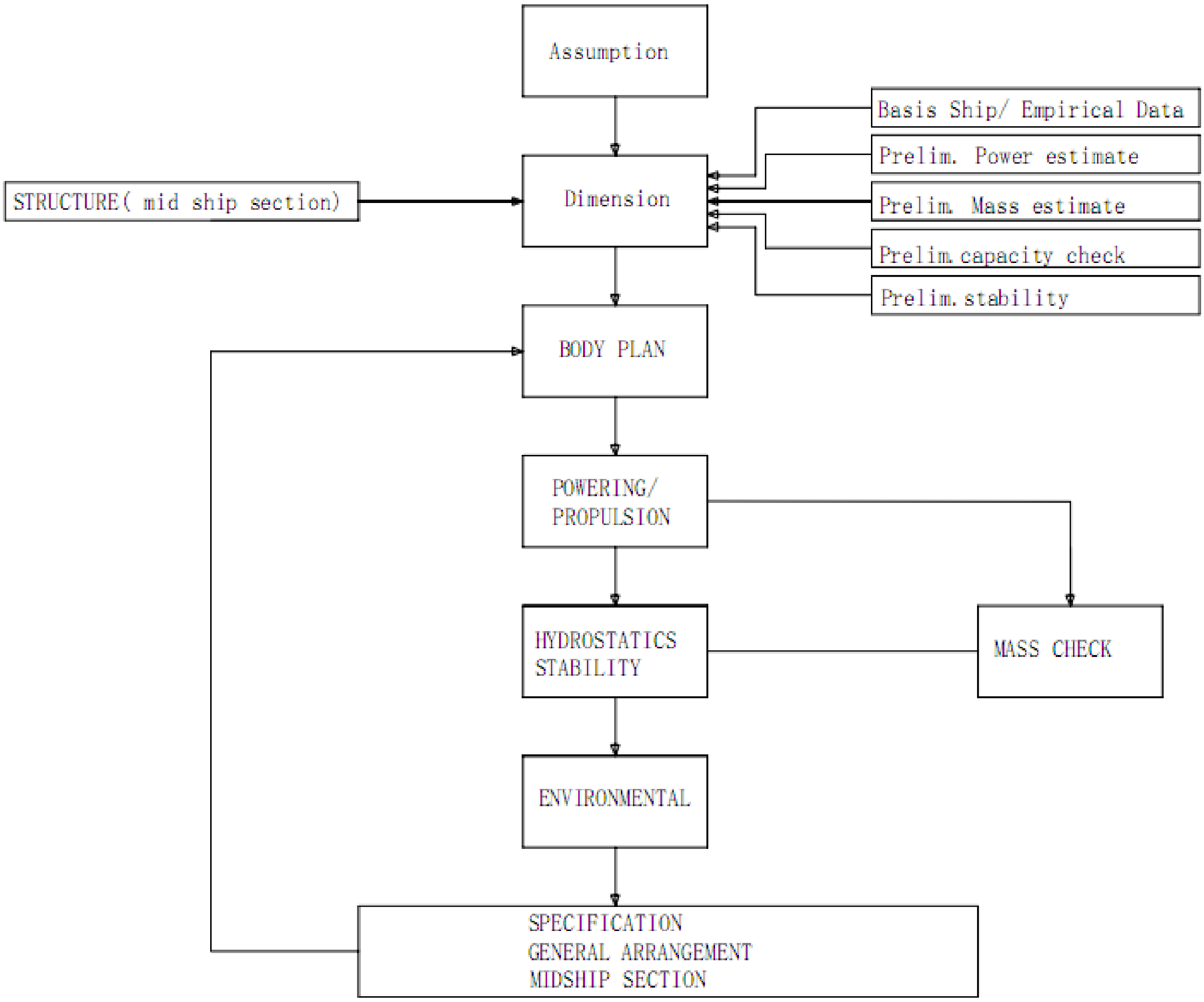

Figure 6 MFWSV concept design process

During the next two months, I centered my attention on the following points:

- Defining the specification of the vessel;
- Defining the dimension of the vessel
- Analysing the completed weight of the vessel;
- Analysing the electrical load of the vessel;
- Estimating the propulsive power and choosing the engine for the vessel;
- Drawing general arrangement plan of the vessel.

2.2. GENERAL DESCRIPTION

(Confidential)

2.3. SPECIFICATION OF VESSEL:

(Confidential)

2.4. CALCULATION OF THE VOLUME OF TANKS.

(Confidential)

2.5. THE PRINCIPAL DIMENSION

(Confidential)

2.6. FACILITIES FOR TECHNICIANS AND CREWS

(Confidential)

2.7. GENERAL ARRANGEMENT PLAN

(Confidential)

2.7.1. Basic equipment of the vessel

a) Mooring arrangement:

There will be nine bollards in the deck, four in stern of 02 deck and five in bow of 03 deck. Two stud-link-chain cables with two chain-stoppers divided to port and starboard side with swivel and shackle, one electro-hydraulic anchor windlass suitable for cables with one hawser drum, one warping head in bow of 03 deck. The anchor windlass can be local controlled as well as controlled from the wheelhouse.

b) Signaling equipment

The navigation mast with climbing rungs will be completely fitted out with navigation lights and shapes as for the rules.

c) Auxiliary engine

The vessel auxiliary engine consisted of compressed air system, oily bilge water separator, purifiers, hydraulic systems etc. Compressed air system including: two air compressors, two air receivers, one oil/water separator and Assorted pressure gauges, pressure reducing valves, relief valve etc.

2.7.2. The systems in the vessel.

a) Ventilation system

There are two inlet ventilation casings respectively in propeller room, auxiliary engine room, engine room and local electric propulsion room. Air - Outlet ventilation casings is respectively in back of container room of deck 02, in the head of engine room of deck 02, in the funnel, in the back of cooking room of deck 02 and superstructure of deck 03. All vent outlets will be fitted with adjustable dampers capable of closing completely.

Figure 9 shows an initial modeling of MFWSV

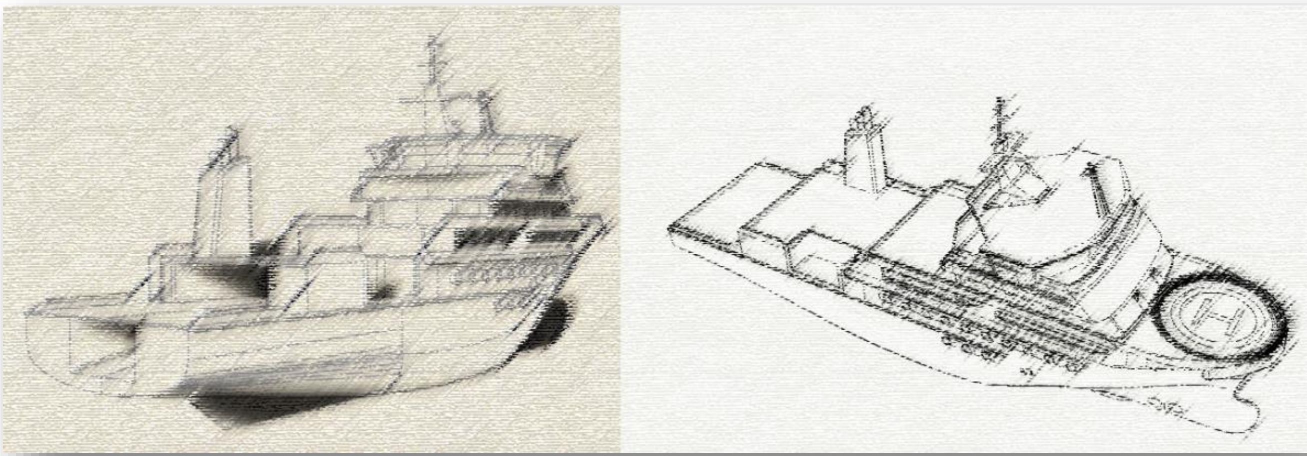

Figure 7 an initial modeling of MFWSV

b) Water system

There are fresh water system, black water system and sewage system in the vessel.

Fresh water and black water treatment plants are in the bottom from section 35 to section 43. A set of evaporated water maker have capacity to make 20 tons fresh water per day and it associated with the fresh water tanks offers sufficient clean and fresh water. The fresh water goes to each cabinet, sanitary room, hospital and cooking room through lines connected with fresh water tanks. Discharges from washbasins, showers, sinks, internal scuppers and from the air conditioning compartment will be grouped into a common piping cross to lead to overboard. Discharge from W.C. will be lead to a sewage treatment plant. Waste water from the refrigeration will be lead to the bilges.
Seawater for the general and wash deck is to be supplied from the fire pump to hydrants. All the tanks are fitted with filling, suction and sounding.

c) Air conditioning system

Three centralized air-conditioning system in this vessel deck 01 deck 03 and 05. Air conditioned is going through air duct and grating to switchboard room, gymnasium room, navigation rooms, salons, hospital, TV room, offices, meeting rooms, workshops and all the cabinets.

d) External fire-fighting system

External fire-fighting equipment for Fi-Fi Class 1 shall be installed. It'll be installed: two units' seawater pumps, two units' fire monitors which controlled from wheelhouse, fixed water spraying system for protecting all bulwarks in each side of 05 deck behind the superstructure. There are other equipment and foam system for firefighting inside the vessel.

e) Lifesaving equipment:

There is one (or two if necessary) high speed rescue boat in starboard of 02 deck. And two 7 meters wind farm access high speed boats respective in portside of 02 deck and the stern of 01 deck.

f) Fuel oil system

The fuel oil bunkers and daily tanks are arranged as shown in engine room of general plan .Each tank fits sounding and air pipes. We are able to fuel it with a bunkering line from the main deck. The fuel transfer pump together with the manifold and valves will transfer fuel oil from one pair of tanks to others, also this system help transferring the fuel oil to daily service tanks. Each daily service tank is provided with supply, filling and overflow pipes, drain valves, sight glass to meet classification requirement.

g) Windows & scuttles and door system.

All the window, scuttles, door and passage according to the SOLAS convention requirement. Side scuttles are steel frame type with aluminum deadlight.

The Wheelhouse external doors to be aluminum type, while all other external doors to be of steel with coaming heights according to the loadline requirement.

h) Single cabinet:

There are total 56 single cabins in the vessel, the arrangement of them presents as following:

- 1 berth with drawers under
- 1 wardrobe
- 1 kneehole desk with drawers
- 1 desk chair
- 2 hat and coat hooks
- 4 spare power sockets
- 1 window with dead light and curtain

Module type washrooms attached to each cabin are fitted out identically as follow:

- 1 shower fitted with curtain, soap dish and grabrail
- 1 stainless steel washbasin with hot/cold water supplies
- 1 extractor fan
- 1 spare power point
- 1 pedestal WC (European type) with seat, lid & toilet roll holder & grabrail.

i) Captains and Chief Technician’s Cabinet:

The Captains and Chief Technician’s Cabinet arranged to be fitted with the following:-

- 1 berth with drawers under
- 1 settee and 2 sofas.
- 1 kneehole desk with drawers
- 2 desk chair
- 1 wardrobe
- 1 coffee table
- 1 small refrigerator

- 1 book case
- 3 hat and coat hooks
- 2 windows with dead light and curtain
- 4 spare power sockets

Attached Toilet

- 1 washbasin (hot and cold water)
- 1 water closet and grab rail
- 1 shower with plastic curtains on rail, hot and cold water
- 1 mirror cabinet
- 1 extractor fan

j) Sick bay

Sick bay shall have enough medical supplies in accordance with Class requirements for the number of personnel on board.

- 1 treatment table
- 1 hospital type bed
- Medical Chest in accordance to Class
- 1 4-drawer steel cabinet
- 1 attached wash room

2.7.3. The marine electrical arrangement in the vessel.

There is one main switchboard room in the bottom and one auxiliary switchboard room in the front of deck 03.These two switchboard rooms will be connected and controlled all the electric equipment in vessel. There is a 500mm height space for cables under the deck of wheel house.

2.7.4. The station keeping system arrangement in the vessel.

Because the vessel will be operated in far offshore wind farm where not only the nature environment condition is cruel but there are at least 160 wind turbines floating in the sea. It means the vessel hull has great chances collide with the mast of wind turbine in the period of strong wind if the vessel hasn't a system for make it fixing in one point precise in the middle of sea. So a dynamic positioning system (DP) or a special anchor fixation system is necessary for the vessel.

Considering the requirement of ship owner and the total price of vessel, I plan to install DP2 system in it. A DP 2 system is composed of the same modules as a DP 1 system, but the number of modules have been increased for redundancy in order to comply with class 2 rules. MFWSV DP 2 systems including the following parts.
The connection of these part as show in figure 10:

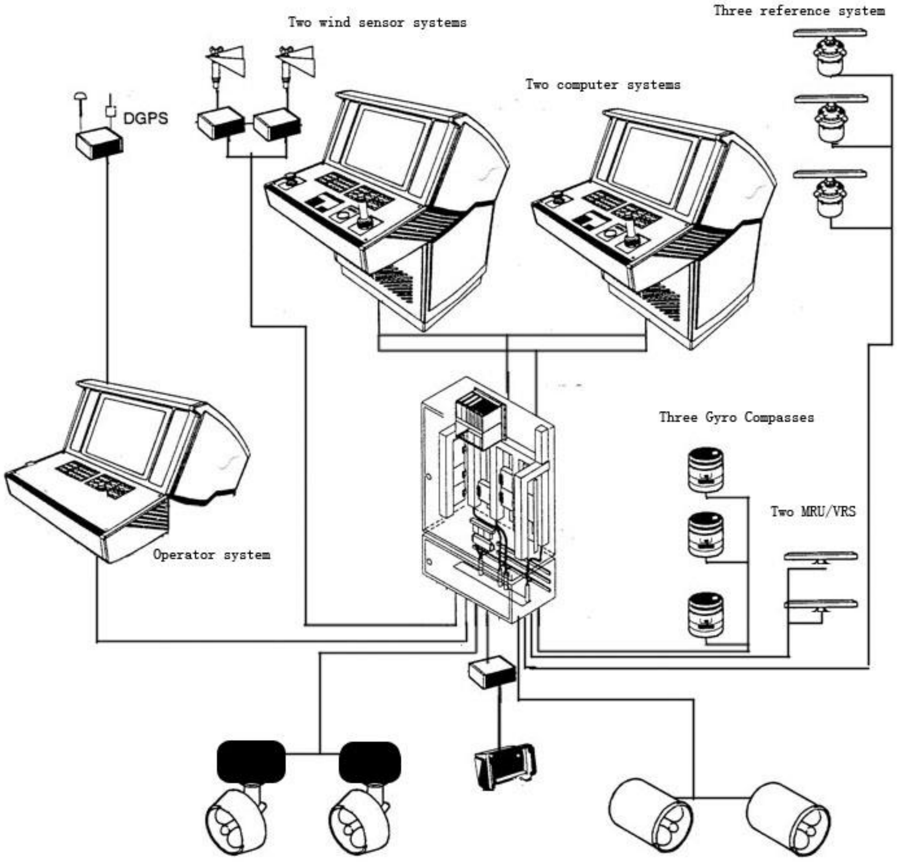

Figure 8 MFWSV Dynamic positioning 2 systems component

- Two computer systems
- Operator system
- Three positioning reference systems
- Two wind sensor systems
- Associated cabling
- Two MRU (Motion Reference Unit) /VRS (Vessel Reference System)

- Three Gyro Compasses
- One Printer

We distinguish from the figure 18 that there are two tunnel thrusts in bow of hull, controlled by sensor and computer system. When operates the DP system, sensors feedback to computer according to the real sea state, and computer control automatically of tunnel thrusts and propellers to let the vessel have a very good preferment in the sea.

2.7.5. The propulsion system arrangement in the vessel.

Corresponding to the requirement of Regulations for the Prevention of Air Pollution from Ships by IMO, I chose diesel –electric propulsion system for my vessel. Because the system not only offers lower fuel consumption and emission due to the possibility to optimize the loading of diesel engines/gensets, but also is especially suitable for DP vessel which have a large variation in load demand divides its time between transit and station keeping operation. The Figure 11 shows a standard diesel-electric propulsion transform ratio:

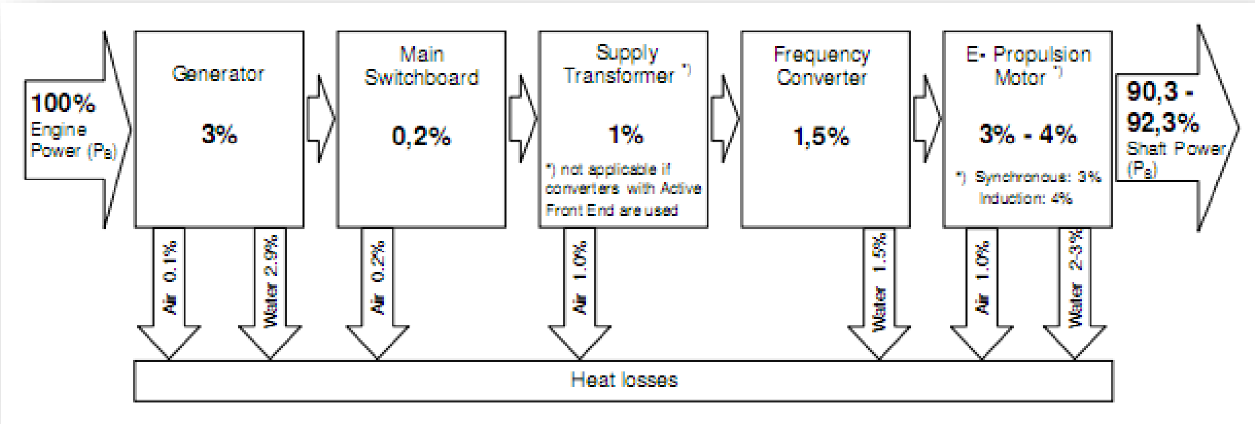

Figure 9 standard diesel-electric propulsion transform ratio
Source:MAN Diesel-electric Propulsion Plants

From Figure 11, we realize that the diesel-electric propulsion transformation ratio reaches to 90%, it's much higher than the traditional propulsion transformation ratio (60%-70%).
In the same time, this system ensure the vessel in safe. This ship have enough space to install three engine, each electricity group is independent of each engine, it means this vessel is able to navigate in the best states even one engine is broken, or keep safe and supply for the people in middle of sea even two engine broken.

I assume that there are two main diesel engines with generators and one rescue engine in the diesel-electric propulsion system of MFWSV with two groups switchboards, four frequency converters/drives (VSD) , four electric propulsion motors(M) control two schottel rudder propellers and two bow thrusters. Figure 12 shows the arrangement of MFWSV diesel electric propulsion system.

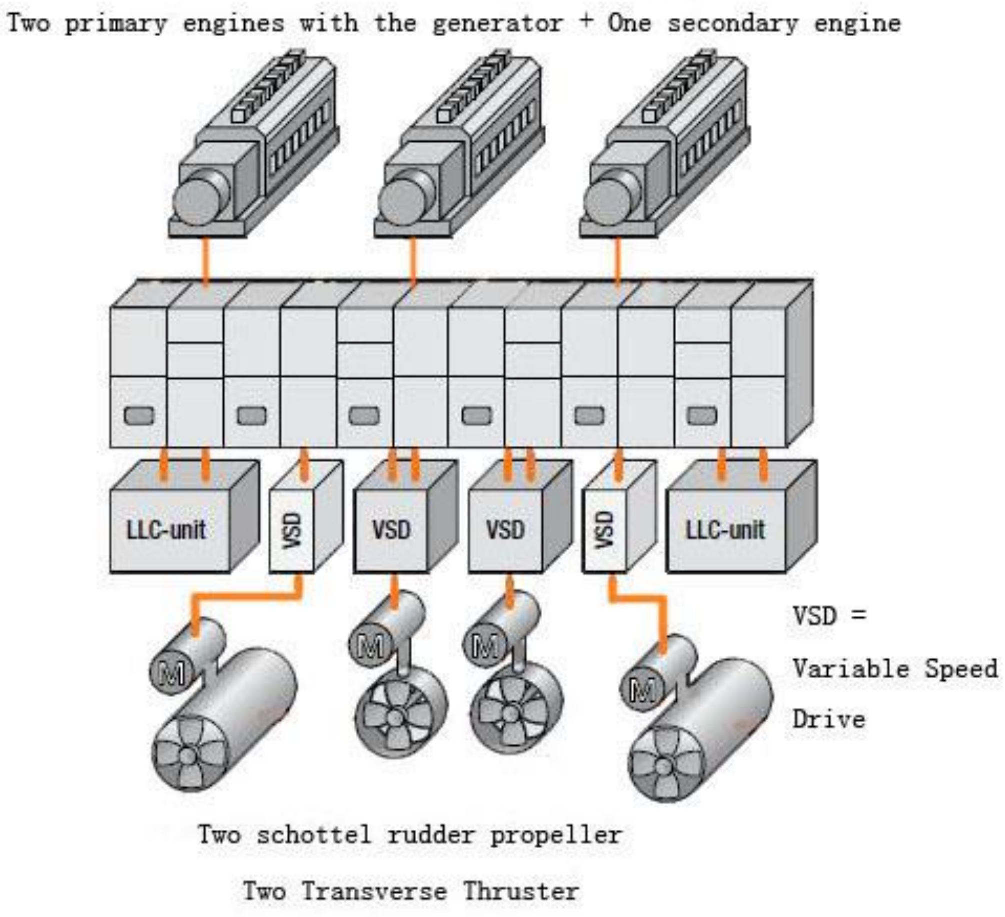

Figure 10 MFWSV propulsion system

The engine room houses all machinery and equipment at convenient locations. Steel checkered plates is used for flooring secured. All moving parts to be provided with guards or rails or both. This engine room will be allowed to go into four people at the same time when in service.

Components of piping system in propulsion:

- One bilge pump.

Suctions is fitted to forepeak sea water ballast tank, forepeak sea water ballast tank, engine room, propeller room, fresh water. /sea water ballast. tanks.

- One cooling sea water pump for air conditioning and refrigeration plant.
- One fire pump. It connected to bilge, ballast and fire system. And one emergency fire pump.
- One fuel transfer pump.
- One dirty oil / sludge pump
- One recovered oil pump
- One fresh water pressure set and one sea water pressure set
- Exhaust Pipes & Silencers for the pipes from main and auxiliary engines to top of funnels
- Two Engine-room fans.

2.8. INITIAL CALCULATION OF THE VESSEL SYSTEM

2.8.1. General description of the calculation process

- To choose the engine:

a) Based on approximation, I estimated the displacement of this vessel by setting up a file for the center of gravity involving all the vessel's elements.

b) I estimated the vessel's power consumptions in different navigation velocities.

c) I chose an engine for the vessel depending on its power to provide the optimal navigation velocity.

d) I've entered the weight of the engine in the file then I estimated again the power consumption of the vessel varying with different navigation velocities to see if the power provided by the engine is suitable for the vessel or not.

e) If the chosen engine doesn't go well with the vessel, I keep repeating the steps above until finding out the good engine.

- To calculate the stability:

a) I estimated the weight and the center of gravity of the ship in different cases.

Case 1: A displacement of the light vessel with margin.

Case 2: During the departure condition, the ship is with a full ballast tank, full cargo and full stores and fuel

Case 3: The ship without cargo, but including full stores and fuel and total number of passengers with their luggage

Case 4: A ship in ballast during the arrival condition, without cargo and with 10% remaining storage and fuel.

b) I estimated the hydrodynamic data and the stability of the vessel in these different cases with the MAAT Hydro 7.10 software in its demo version.

2.8.2. Calculate resistance and chose engines.

(Confidential)

2.8.3. Calculation of the Stability of the Vessel:

(Confidential)

The result of the calculation shows that all the items satisfied by the requirement of BV.

2.8.4. Concept design the overall perspective of the vessel in three dimensional plan:

To give the readers a total idea about the vessel, I modeled it in Rhinoceros 5.0 software using all the accurate dimensions.

The figure 13 shows the 3D view of MFWSV

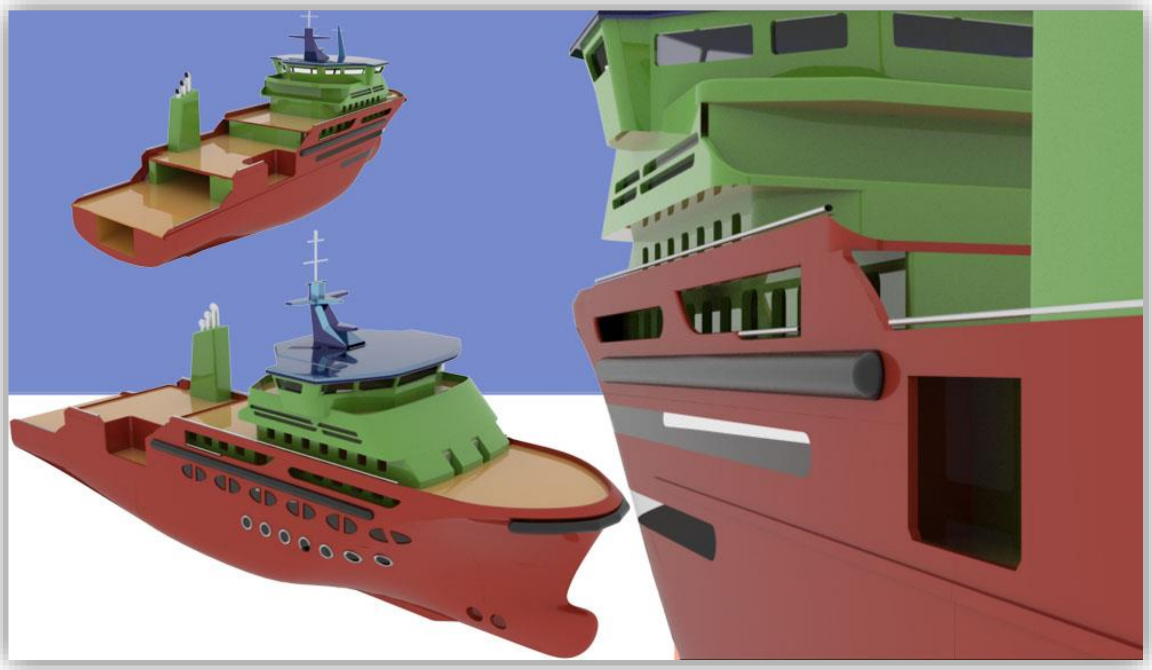

Figure 11 MFWSV 3D overall perspective

2.9. BRIEF SUMMARY

During this period, I centered my attention on learning about the system and the machines in the vessel and on drawing the general arrangement plan. To reach the exact weight and the center of gravity, it took me too much time. Despite that I've already done the biggest part in the conception design, but I know that there's still such a long way to refine and master the conception design of this vessel.

In my future professional activity, I should pay attention to the following points:

- I should adjust the position the center of gravity.
- The estimation of electric consumption during the navigation in the sea must bring into play more detailed analyses.
- The seakeeping analysis.

Until now, what I've presented remains the basic process and the usual machines design in vessels. The next part will be presenting the special systems in vessels that provide the service operation in a sea wind farm.

PART 3 INTRODUCTION OF SPECIAL SYSTEMS IN VESSEL

(Confidential)

CONCLUSION

The author pursue research in initial research and preliminary concept design for Mauric Far shore Wind farm Station Keeping Vessel (MFWSV) in this report. The MFWSV is a 75m service naval designed to operate in far shore of Southern North Sea wind farms where significant wave heights reach up to 3.25 meters and the water depth is about 50 m. The vessel varies from the current wind farm supply vessels and will be providing accommodation, safer transfer for technicians and warehouse facilities during the service period. In the same time, the author considering the environment condition at present and economy in a long term, improving the design from the aspect of propulsion, reduce the water resistance, performance to save energy.

The following points sum up the point in the report of how to arrive environment friendly in the same time, make this construction prix economic.

1. Propulsion:

This vessel use diesel – electrical propulsion,

- Provide higher transmission loss by a better match between the prime mover capacity and power demand. In other word. To achieve the maximum economy use of fuel. In the other word, we can choose the number of engine work depend on the loading of electricity for ensure each engine work in the most efficiency zone in any time.
- Although the initial investment of diesel – electrical propulsion is high, but with the longer time of operation and the more machine install in the vessel, it'll more economy than the traditional propulsion.

2. Speed:

With reference of about 50 vessels in the similar dimension, this vessel use 12 knots as its service speed. This speed is the optimist economy speed. Economy speed means the best distance of navigate with unit sum of fuel.

3. The hull design:

As I mentioned before, the hull of the similar the hull of 65m Multipurpose Vessel. General speaking, the smaller block coefficient (CB), the smaller viscous resistance. In addition, the design bulbous bow also reduce the resistance of wave. The CB of this vessel is 0.65 without cargo.

4. Propeller:

The schottel rudder propeller combine of propulsion and steering.it's no need for a rudder that it reduce the Frictional resistance of water. The 360 °rotation of these propellers with the two traversal thrust make this vessel have maximum manoeuvrability.

Realization of a vessel is not a work easy, it need to research and practice in every step including design, manage, choose material and construction. Three months were really short for me to master the conception design. It still requires considerable researches and improvements, as well as a design and a calculation effort, to be at the end able to reach the required maturity to serve the increasing number of far shore wind farms.

REFERENCES

1. **Loic Berthelot,Bureau Mauric.** *B2M bilan électrique prévision.* Nantes : s.n., Septembre 2013. N12607 indice B.

2. **V.Seguin,Bureau Mauric.** *MSV 75 General arrangement.* octobre 2007.

3. **Warsaw.** *State of the art: offshore access systems.* s.l. : Iberdrola, 2010.

4. **Vincent Seguin,Bureau Mauric.** *B2M études de stabilité prévisionnel.* Nantes : Document N 12718 indice A, septembre 2013.

5. **Loic Berthelot,Bureau Mauric.** *B2M note propulsion manœuvrabilité.* Nantes : 243 AV 211 indice A, Septembre 2013.

6. —. *B2M devis de poids prévisionnel.* Nantes : s.n., Septembre 2013. N12604 indice B.

7. **Vincent Seguin,Bureau Mauric.** *MSV 75 devis de poids.* Nantes : s.n., Janvier 2009 . N 11109 indice F.

8. **L.Berthelot,Bureau Mauric.** *B2M Plan d'ensemble.* septembre 2012.

9. **DNV.** *DP system class slide.*

10. **M Jupp, R Sime and E Dudson,BMT Nigel Gee.** A next generation windfarm support vessel. *Design & operation of offshore supply vessel.* 30 Jan 2014.

11. **BMT Nigel Gee Ltd.** The effects of length on the powering of large slender hull forms.

12. **MAN.** Diesel-electric Drives.

13. **Kare Adnanes.** Maritime electrical installations and diesel electric proppulsion. BB-AS.

14. **E.ON Climate & Renewables.** E.ON offshore wind energy factbook. December 2011.

15. Operating and maintenance manual for Fans Type KK&K.

16. **SAMEN.** W2W vessel brochure.

17. **L.Harrington, Roy. s.l. :** The society of naval architects and marine engineers. Marine Engineering.

Internet

www.pole-mer-bretagne.com

https://www.abeking.com/What-is-SWATH.23.0.html?&L=1

http://www.offshore-windenergie.net/en/wind-farms

APPENDIX