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Rules for classification of ships applied to MV MERSol

DEGREE PROGRAMME IN LOGISTICS
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ABSTRACT

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The objective of this thesis was to learn whether the bridge equipment of motor vessel MERSol meets the classification requirements set by Lloyd's Register. The outcome of the thesis will eventually be used in the development of an online learning module, aimed at maritime students and professionals.

As MERSol is stationed in Walvis Bay, Namibia, it was necessary for me to carry out the research remotely. The project manager of MERSol provided me with drawings, pictures, and other technical documents so that I could perform my work. I utilised the quantitative research method and analysed the material that was provided to me and compared it to the rules and regulations defined in Lloyd's Register's Rulefinder.

The outcome of my research shows that MERSol was designed and outfitted to meet the requirements for safe periodic operation under the supervision of a single watchkeeper on the bridge.

Keywords: MERSol, Lloyd's Register, classification society, bridge equipment.

CONTENTS

LIST OF SYMBOLS AND TERMS

IMO	International Maritime Organization
LR	Lloyd's Register
ECDIS	Electronic Chart Display and Information System
SOLAS	Safety of Life at Sea
COLREGs	International Regulations for Preventing Collisions at Sea
MERSol	Name used to identify the vessel used for the research
OOW	Officer of The Watch
LOA	Length over all
EMC	Electromagnetic compatibility
MNC	Main navigation console
EM	Electromagnetic
PS	Port side
SB	Starboard side
RAI	Rudder angle indicator
ROT	Rate of turn
NFU	Non follow up
CPP	Controllable pitch propeller
BNWAS	Bridge navigational watch alarm system
ECR	Engine control room
VHF	Very high frequency
DSC	Digital selective calling
SART	Search and rescue transponder
EPIRB	Emergency position indicating radio beacon
GMDSS	Global maritime distress and safety system
MF	Medium frequency
HF	High frequency
GPS	Global positioning system
AIS	Automatic identification system
CPA	Closest point of approach
ARPA	Automatic radar plotting aid

1 INTRODUCTION

This thesis was commissioned by The Maritime Logistics Research Center, which operates at the Satakunta University of Applied Sciences in Rauma, Finland. The project for which this thesis was commissioned is called MERSol, which stands for Maritime Engine Room Simulator on-line. The MERSol project aims to develop study modules and a new web-based application engine room simulator. The finished service will be particularly suitable for recently graduated marine engineers. Engine room cadets, deck cadets, and for all other mariners already at sea who wish to expand their knowledge of automation and digitalisation.

1.1 Background of the project

The thesis is centred about describing the rules and regulations set by the International Maritime Organization (IMO) and Lloyd's Register's (LR) interpretation of those rules and regulations, concerning navigational arrangements and integrated bridge systems. The findings regarding the rules and regulations are compared to the situation onboard of MV MERSol, and used to determine whether the navigational arrangements meet the standard set by LR. Additionally, the importance of the classification societies and their work is mentioned.

1.2 Research question, objectives, and scope

The question that is answered in the conclusion of this thesis:
Does MV MERSol comply with Lloyd's Registers rules and regulations regarding navigational arrangements and integrated bridge systems?

The main aim of this thesis is to act as a source of information during the creation of a study module for the MERSol project. The study module will cover rules and regulations set by the classification society Lloyd's Register, and their practical application concerning navigational arrangements and integrated bridge systems. The sources of information used in this thesis consist of a multitude of drawings, manuals, certificates, and LR's legislation.

The scope of the study is to produce a document which acts as a theoretical source of information regarding Lloyd's registers rules and regulations, and their practical use. The document contains practical examples and should provide the reader with an understanding of why and how certain vessels are designed and outfitted. The information provided in the study module is of such a level that both maritime students and professional can use it as reference material.

1.3 Research method

The quantitative research method has been used while collecting data for this thesis. The rules and regulations set by Lloyd's Register are technical and often contain numerical specifications. In order to determine whether these rules and regulations are met by MV MERSol, I had to measure and process numerical data, obtained from technical drawings, manuals, and certificates.

1.4 Theoretical framework

The theory shown in Figure 1 was chosen as it is relevant to the thesis subject. Auditing can be described as a inspection or examination of a certain product, service, or account against a predetermined standard. In the case of my thesis, I will perform an audit of MV MERSol's bridge equipment against the standard set by Lloyd's Register.

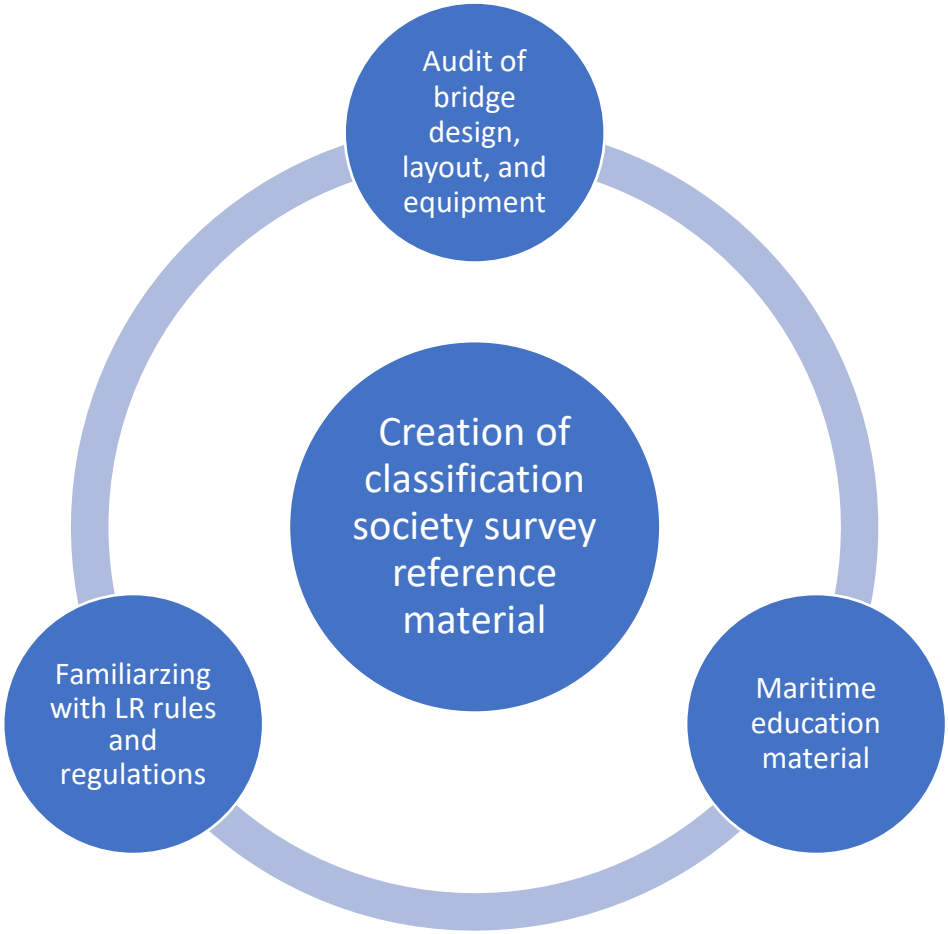


Figure 1. Research framework

2 CLASSIFICATION SOCIETY LLOYD'S REGISTER

Lloyd's Register is a classification society established in 1760, it is the world's first classification society. LR was created with full focus on marine classification but today LR offers additional solutions and services in several different sectors within the maritime industry. Updated rules written by Lloyd's Register are generally published every year. (Lloyd's Register, 2023.)

Maritime classification societies are tasked with the development and application of technical standards for the design of ships. The technical standards are taken into consideration during the construction phase of a ship, and should be maintained during the ships entire serviceable life. The requirements set by the classification societies are periodically checked by means of onboard inspections and surveys. Flag states can authorise classification societies to act on their behalf to carry out statutory survey and certification work of their ships. A classification society can issue a classification certificate, which states that the vessel is complying with the rules of the classification society, but the document does not act as a warranty of safety, fitness of purpose or seaworthiness of the vessel. A ship without a valid certificate of class is not eligible to receive statutory certificates and is therefore severely limited in their ability to operate. Furthermore, a ship without a valid class certificate is unable to maintain its insurance, as it will be declared null and void until the certificate of class has been renewed.

There are 50 classification societies spread across the world, of which only 11 are currently recognised by the European Union. For a classification society to be recognised by the European Union is a big deal, as EU member states can only authorise a classification society with such recognition.
(EMSA, 2023; Navsregs, 2017.)

Different vessels require a different approach when it comes to obtaining a certificate of class, that is why the requirements are tailored based on the ship's type and phase in its serviceable life. For example, there is a distinction between ''new ships'' and ''existing ships''. The difference between these two terms is the day of signing the construction contract, date of keel laying, or delivery date. The rule in question usually dictates which metric is used to decide whether a ship is considered as new ship or not. An existing ship is a ship not considered a new ship. Certain rules may only apply to new ships, while existing ships are exempted.

A good example of rule implementation is related to Electronic Chart Display and Information Systems (ECDIS). In 2008 a rule was adopted by the IMO which made carriage of ECDIS equipment mandatory, according to an implementation schedule which is based on a ship's gross tonnage and whether a ship is considered new or existing, see figure 2. Not shown in Figure 2 but worth mentioning is the fact that ships that are planned to go out of operation within 2 years of the implementation date, are exempted from the rule. This shows that new ships, existing ships, and existing ships at the end of their service life all have different approaches when it comes to IMO rules and class adaptation of those rules.

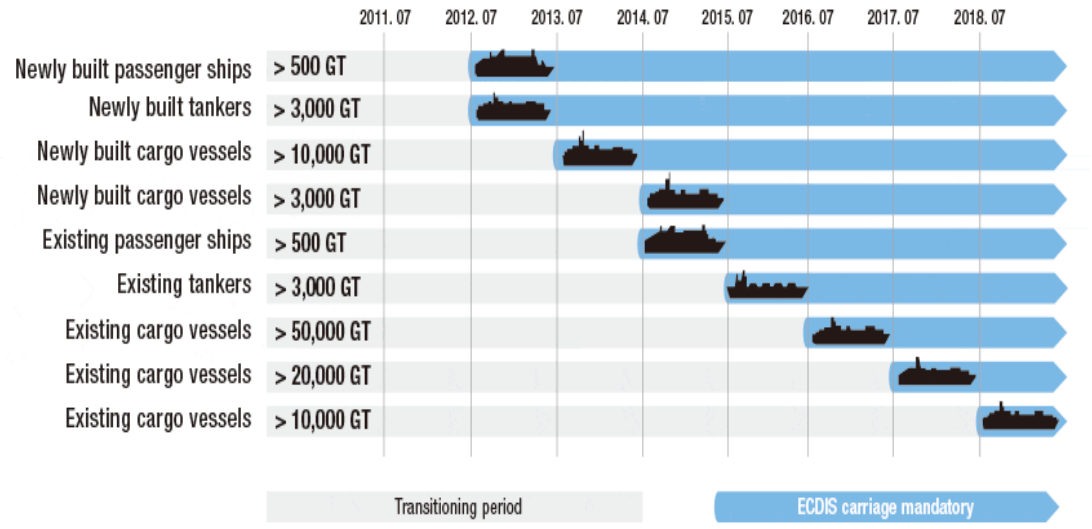


Figure 2. ECDIS implementation schedule (Furuno, 2023)

3 NAVIGATIONAL ARRANGEMENTS AND INTEGRATED BRIDGE SYSTEMS

As I'm tasked with researching the LR classification requirements concerning the bridge equipment of MV MERSol, I decided to start by looking at the general requirements that a vessel needs to obtain a NAV1 notation. This notation will be assigned when the bridge layout and level of equipment are such that the ship is considered suitable for safe periodic operation under the supervision of a single watchkeeper on the bridge. It denotes that the navigational installation has been arranged, installed, and tested in accordance with LR's rules. (Lloyd's Register Rulefinder, 2022.)

The requirements for navigational arrangements and integrated bridge systems are documented in Lloyd's Register's Rules and Regulations for the Classification of Ships, July 2022 - Part 7 Other Ship Types and Systems - Chapter 9 Navigational Arrangements and Integrated Bridge Systems - Section 1 General requirements – Section 2 Physical conditions – Section 3 Workstations – Section 4 Systems. All vessels complying with section 1 to 4 of the requirements of PT 7, Ch 9, will be eligible for the notation NAV1.
(Lloyd's Register Rulefinder, 2022.)

It is important to note that the earlier mentioned sections do not state all performance standards that the equipment is required to meet. The performance standards are documented in e.g. The International Convention for Safety of Life at Sea (SOLAS) Chapter V, Regulation 18: Approval, surveys and performance standards of navigational systems and equipment and voyage data recorder, and in regulation 19 - Carriage requirements for shipborne navigational systems and equipment. (Lloyd's Register Rulefinder, 2022.)

3.1 Part 7 – Chapter 9 – Section 1: General requirements

This section explains the general requirements. The section states to which vessels these rules apply, and on which underlying regulations these rules are

based, such as SOLAS chapter 4 & 5 and the Convention on the International Regulations for Preventing Collisions at Sea (COLREGs). It states the information plans and documentation which needs to be provided to LR in order to start the notation process. Additionally, this section highlights certain definitions which are applicable in other sections of this chapter, such as Workstation, Navigation workstation, Conning position, Main steering position, and Voyage planning workstation. (Lloyd's Register Rulefinder, 2022.)

3.2 Part 7 – Chapter 9 – Section 2: Environment

This section states certain physical requirements to the bridge layout, most of these requirements need to be taken into consideration during the initial design process of the vessel, as it can be hard to alter them at a later stage after construction. The section states the requirements for bridge arrangement, environment, lightning, windows, and fields of vision. In chapters 3.2.1 to 3.2.5 of this thesis, the earlier mentioned topics are explained briefly.
(Lloyd's Register Rulefinder, 2022.)

3.2.1 Bridge arrangements

According to section 2.1, The bridge configuration, arrangement of consoles and equipment locations are to be such as to enable the officer of the watch (OOW) to perform navigational tasks and other functions allocated to the bridge, as well as maintain an effective lookout. The following topics should be taken into consideration during the design of bridge arrangements: navigation and maneuvering, monitoring, manual steering, docking, planning, safety, communications, and conning. The section describes the requirements that the layout should meet, such as having clearly defined workstations for different tasks, having most of the equipment mounted forward facing, the ability to monitor the navigation workstation from different locations on the bridge, as well as requirements to bridge entrance points, width of passageways, doors, and height of ceilings. The bridge arrangement of MV MERSol is shown in Figure 3. (Lloyd's Register Rulefinder, 2022.)

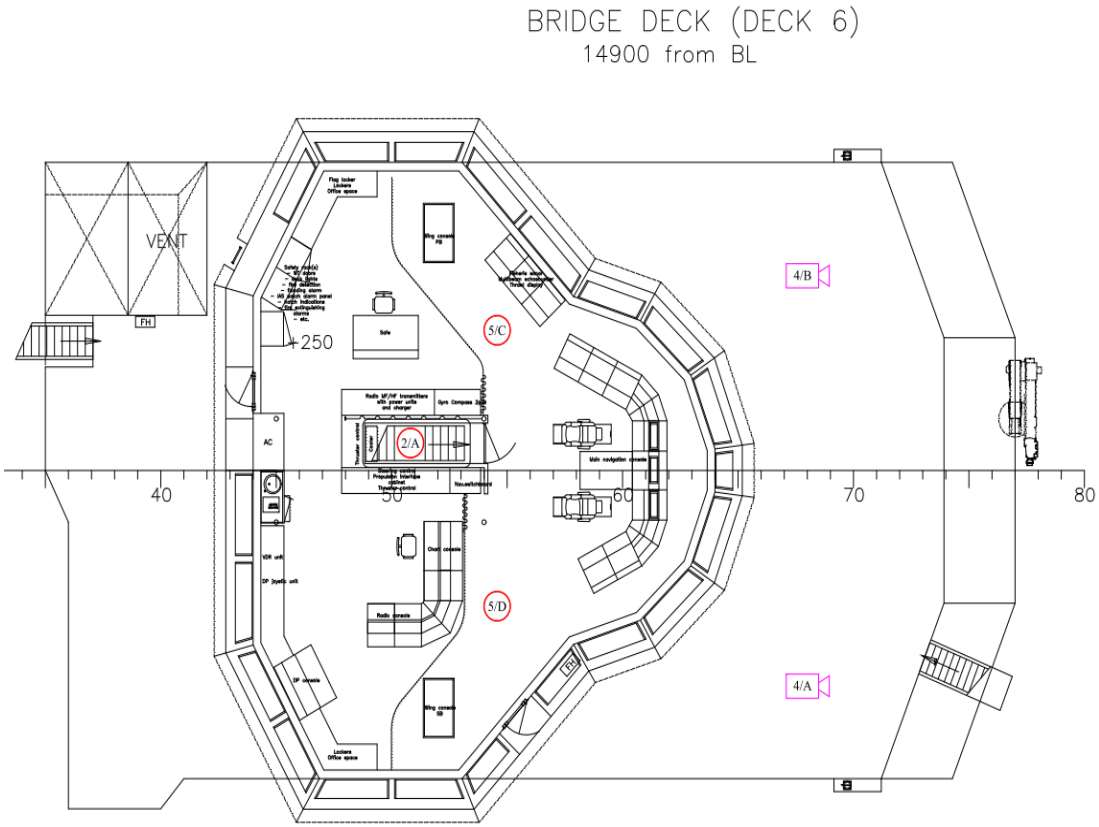


Figure 3. MV MERSol bridge arrangement (GITIESSE s.r.l., 2011)

3.2.2 Environment

Section 2.2 is about creating a safe and efficient working environment for all crew working on the bridge. It describes the requirements to the bridge arrangement and equipment in further detail. For example, it states that there should be sufficient handrails situated on the bridge, availability of adequate seating for the OOW, glare and reflections from surfaces should be minimised, noise levels should be limited to 65 dB, a sound reception system needs to be installed, and an adequate climate control system should be present. Additionally, it states that all permanently installed electrical and electronic equipment should undergo electromagnetic compatibility testing, as to not interfere with the proper function of navigational equipment.
(Lloyd's Register Rulefinder, 2022.)

3.2.3 Lightning

Section 2.3 states that the level of lightning should be adequate enough so that the crew working on the bridge can perform all their tasks, during both day and night-time conditions. To achieve that, the section requires that the lighting is separated in different sections that can be switched on or off individually. (Lloyd's Register Rulefinder, 2022.)

The section also requires that illumination of instruments, such as buttons and controls should be fully dimmable, or otherwise illuminated in a colour that does not compromise night vision, such as dark green or purple. Additionally, it is required to have two separate electrical circuits provided for bridge lightning, as well as emergency lightning on the bridge and its entrance points. Deck and superstructure light as well as navigation lights should be fully controllable from the bridge. Navigation lights are to be provided with an audible and visual alarm. For all navigation and indicator lamp control panels, a test alarm function should be provided. (Lloyd's Register Rulefinder, 2022.)

3.2.4 Windows

This section describes the requirements to the windows surrounding the bridge. The following points are to be taken into consideration:

The windows should be made of shatterproof toughened glass that meets strength requirements recognised by national or international standards, such as International Organization for Standardization (ISO) 21005, Thermally toughened safety glass panes for windows and side scuttles. The windows are to be as wide as possible, the divisions between them should be kept as narrow as possible and may not be placed in the vessel's centreline. The windows need to be placed at in incline between 10 and 25 degrees. (Lloyd's Register Rulefinder, 2022.)

The height of the lower edge of the front windows is to allow a forward view over the bow for a person at the navigation workstation and is not to obstruct

any of the required fields of vision. The height of the lower edge of the front windows above the deck is to be kept as low as possible and, as far as practicable, is not to be more than 1000 mm above the deck surface. The upper edge of the front windows is to allow a forward view of the horizon for a person with an eye height of 1800 mm at the conning position when the ship is pitching in heavy seas and as far as practicable, is not to be less than 2000 mm above the deck surface. (Lloyd's Register Rulefinder, 2022.)

Clear views through the windows in front of the conning position, navigation workstation, and, where applicable, bridge wings are to be always provided regardless of weather conditions. At least two windows are to provide such a view. A removable sunscreen with minimal color distortion is to be fitted. Heavy duty wipers, if possible, with an interval function and freshwater wash system are to be fitted. Additionally, a de-icing and de-misting system is to be fitted. The windows should be safely accessible for external cleaning.
(Lloyd's Register Rulefinder, 2022.)

3.2.5 Fields of vision

This section states that it should be possible to observe all objects necessary for navigation, including other traffic and navigation marks, in any direction from inside the bridge. In this respect there is to be a field of view around the vessel of 360° obtained by an observer moving within the confines of the bridge. The view of the sea surface from the conning position and the navigation workstation is not to be obscured by more than two ship lengths, or 500 m, whichever is less, forward of the bow to 10° on either side, irrespective of the ship's draught, trim and deck cargo. According to the rule, the obstructed distance may not exceed 500m or 2 ship length's, whichever is less. As MV MERSol's length over all (LOA) is 62,4m, that leaves us with a limit of 124,8m. As can be seen from Figure 4, the obstructed view is well within acceptable limits. (Lloyd's Register Rulefinder, 2022.)

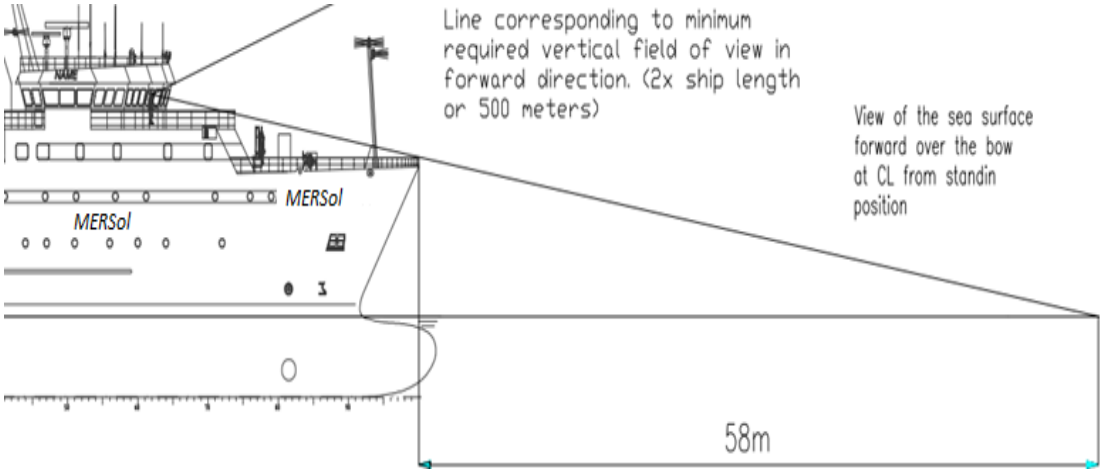


Figure 4. View of sea surface from conning position and navigation work-station, MV MERSol (STX Europe, 2011)

Blind sectors caused by cargo, cargo gear and other obstructions outside the bridge forward of the beam obstructing the view of the sea surface as seen from the conning position and the navigation workstation are not to exceed 10° each. The total arc of blind sectors is not to exceed 20° and the clear sector between blind sectors shall be at least 5°. However, in the view described in the preceding paragraph, each individual blind sector is not to exceed 5°.
(Lloyd's Register Rulefinder, 2022.)

The horizontal field of vision from the conning position and the navigation work-station is to extend over an arc from more than 22,5° abaft the beam on one side, through forward, to more than 22,5° abaft the beam on the other side.
From the main steering position, the field of vision is to extend over an arc from dead ahead to at least 60° on each side. From each bridge wing, the field of vision is to extend over an arc from at least 45° on the opposite bow through dead ahead and then aft to 180° from dead ahead.
(Lloyd's Register Rulefinder, 2022.)

There is to be a line of sight from the port wing to the starboard wing through the wheelhouse. The ship's side is to be visible from the bridge wing.

The height of consoles is not to interfere with the fields of vision defined above and is not to exceed 1350 mm. From workstations for functions other than navigation, the field of vision is to enable an effective lookout to be maintained and, in this respect, is to extend at least over an arc from 90° on the port bow, through forward, to 22,5° abaft the beam on the starboard side. Figure 5 shows the angles of view from MV MERSol's bridge, Figure 6 shows MV MERSol's side view. (Lloyd's Register Rulefinder, 2022.)

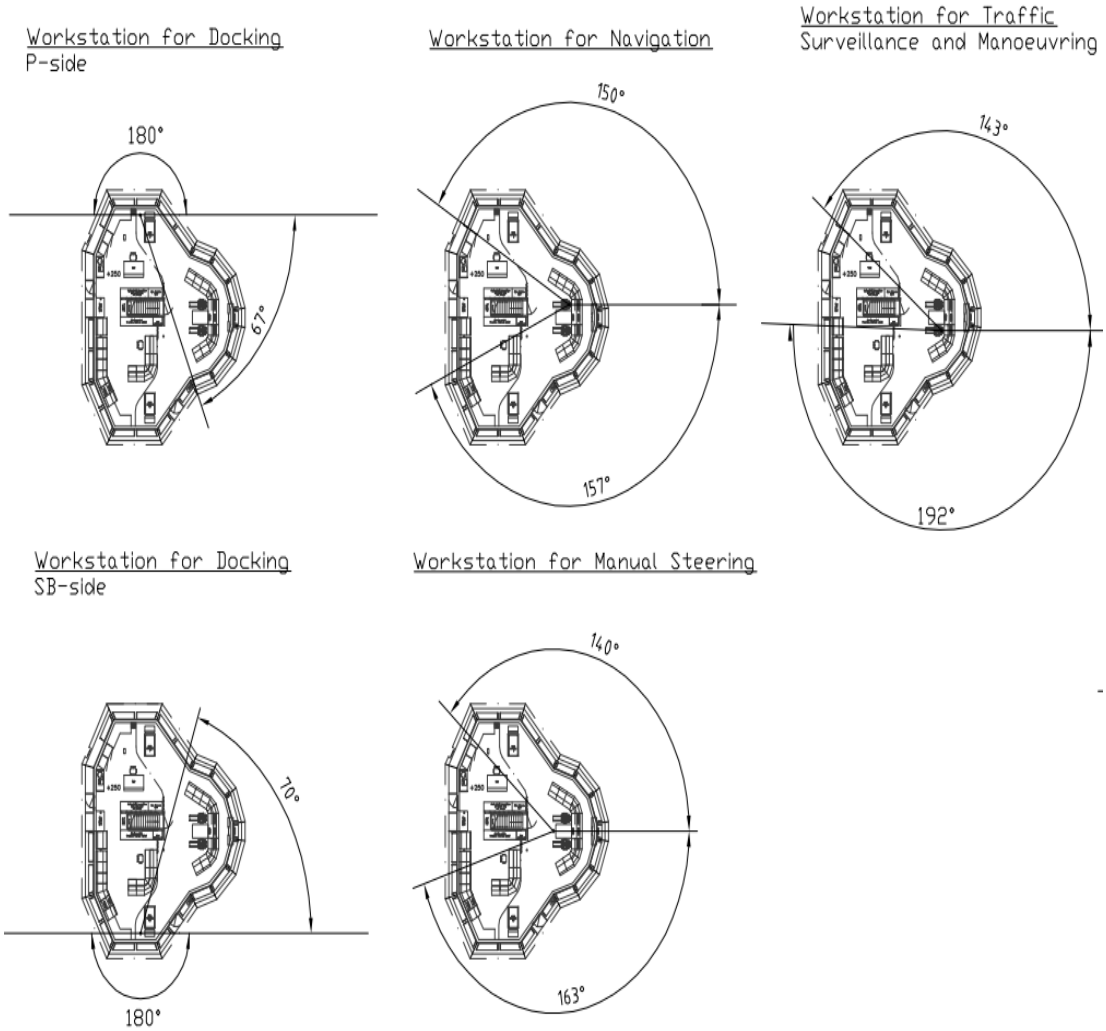


Figure 5. Angles of view, top view from bridge deck, MV MERSol (STX Europe, 2011)

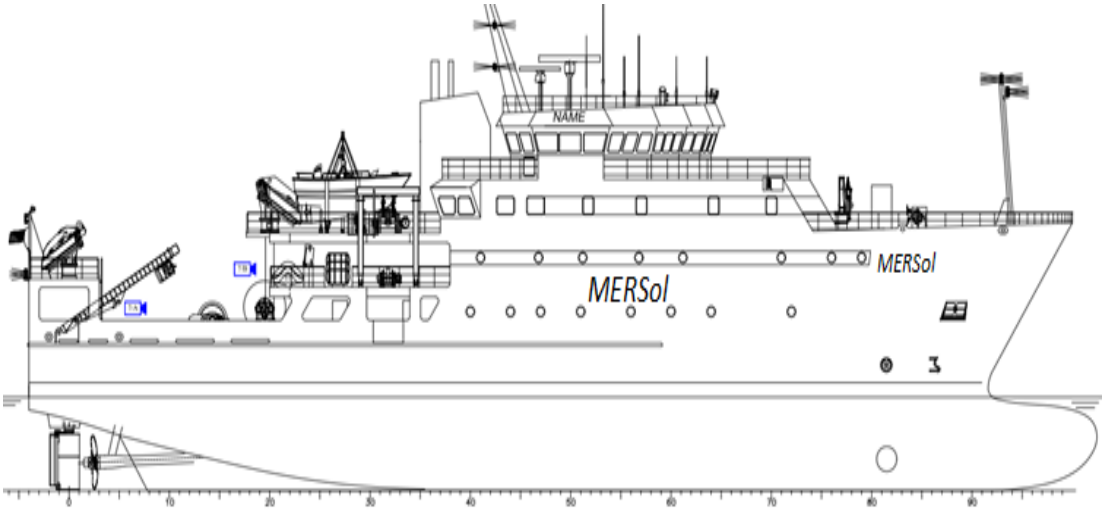


Figure 6. Side view, MV MERSol (GITIESSE s.r.l., 2011)

3.2.6 Section 1 & 2: General requirements & Physical conditions applied to MV MERSol

Based on the drawings, pictures and electrical schematics obtained from the shipbuilder, I have concluded that the bridge is fully in compliance with the requirements of Section 7 Chapter 9 – 1 & 2: General requirements & Physical conditions. (Lloyd's Register Rulefinder, 2022.)

The bridge arrangement of MV MERSol meets the standard as described in chapter 3.2.1 of this thesis. The consoles and equipment are arranged in such a way that the OOW can comfortably and effectively perform their duties. The different workstations are clearly distinguishable, facing the right direction, and located in such a way that the navigation workstation can be monitored remotely. The entrance points to the bridge, distance between bridge wings, distance between consoles, and ceiling height are all in compliance with the regulations. (Lloyd's Register Rulefinder, 2022.)

The requirements stated in chapter 3.2.2 of this thesis are also met by MV MERSol, as all items located on the bridge are without unnecessary sharp edges, non-reflective, and equipped with handrails where possible. Adequate seating is available at the various workstations, equipped with means for securing them during adverse weather conditions.

The bridge has an adjustable climate control system, and the noise levels are within the 65dB limit. According to a noise measurement report by Bureau Veritas, the bridge has a maximum noise level of 60.7 dB, during full navigational speed with normal weather conditions. Electromagnetic compatibility (EMC) tests for the bridge have been carried out by the shipyard, with satisfactory results. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

The requirements stated in chapter 3.2.3 of this thesis regarding the lightning on the bridge are met by MV MERSol. as all workstations on the bridge are equipped with sufficient overhead lightning and illuminated buttons and screens, which are fully dimmable. Navigation lights, and floodlights situated on the bridge deck and monkey island are fully controllable from the bridge, the navigation lights are connected to the bridge alarm system. The bridge is provided with two separate circuits for lightning, including emergency lightning. In Figure 7 the emergency lightning arrangements for the bridge including the type of lightning fitted are shown. Not shown in the picture but obtained from the drawing, is the fact that the emergency lightning on the bridge is red instead of white. Illuminated navigation controls are shown in Figure 8.
(Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

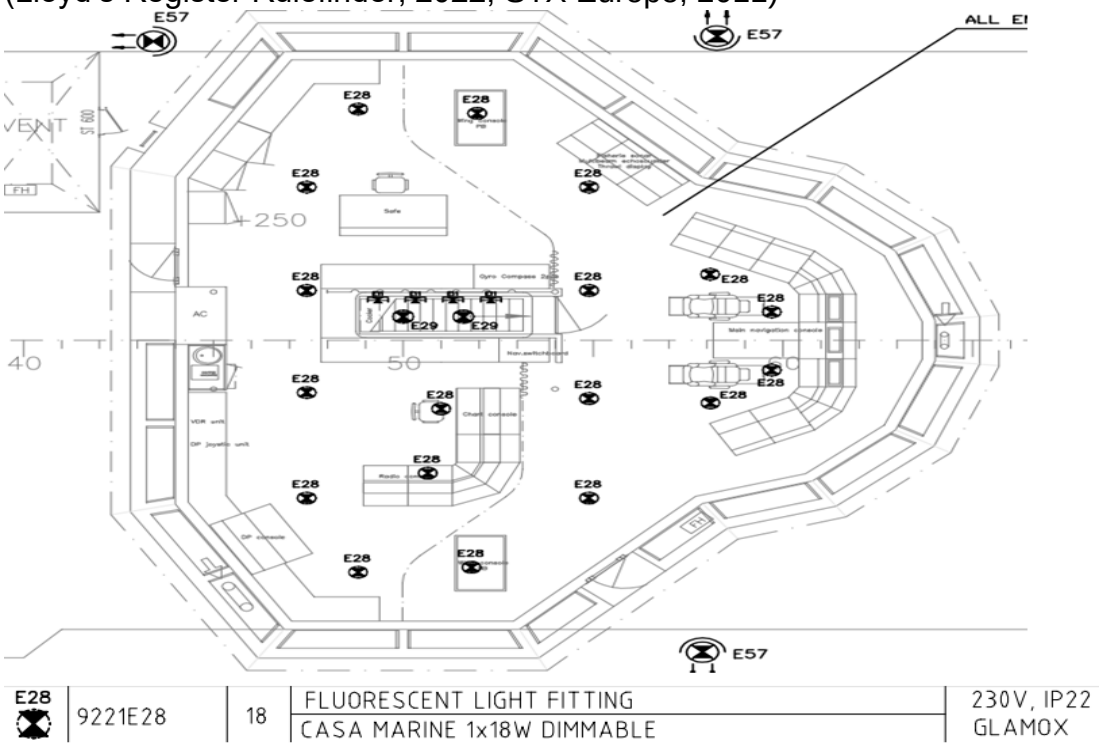
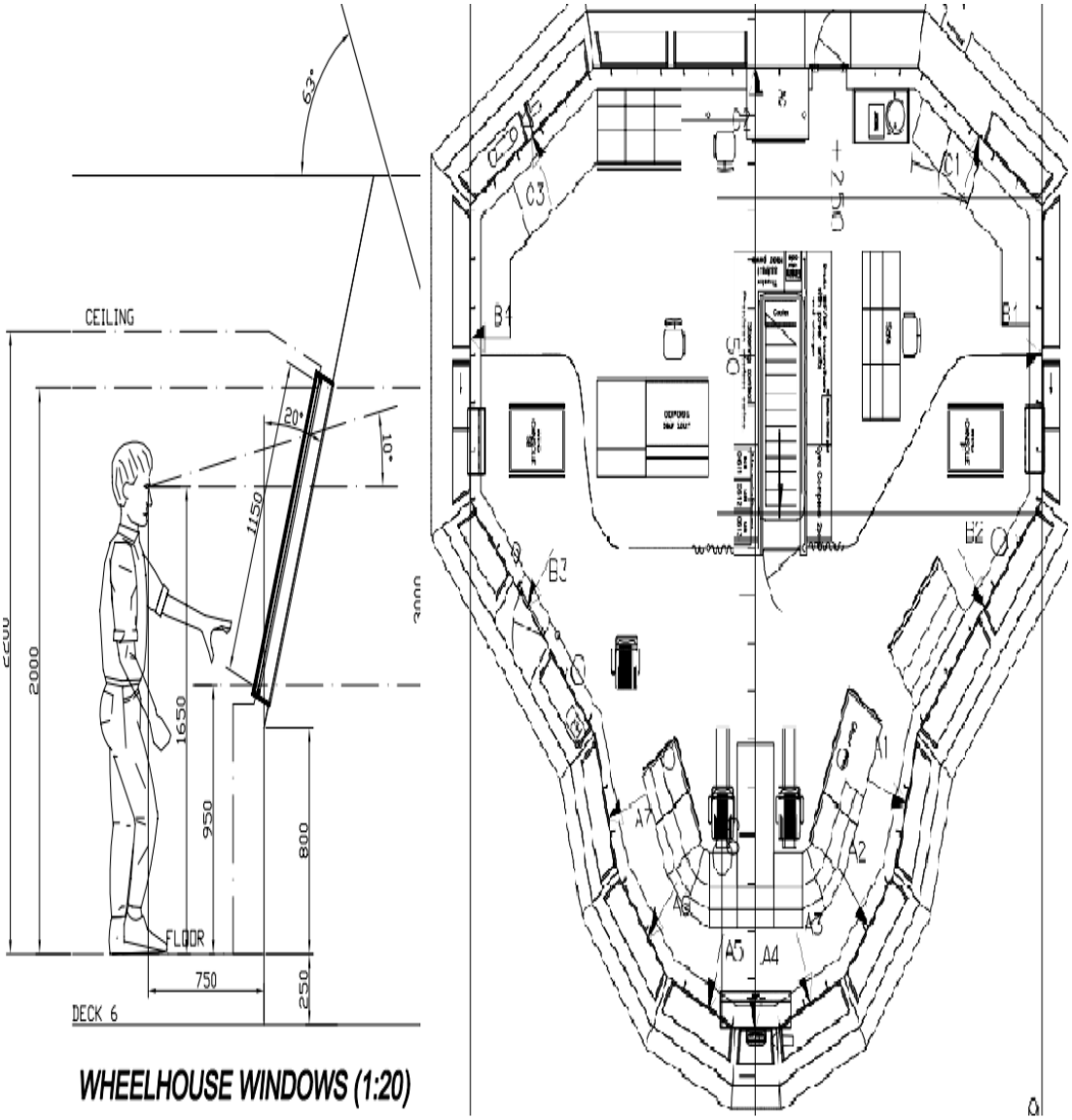


Figure 7. MV MERSol emergency lightning locations on the bridge (STX Europe, 2011)

Figure 8. Navigation workstation with illuminated controls, MV MERSol (Koivisto, 2015)

The requirements stated in chapter 3.2.4 of this thesis regarding the windows on the bridge are met by MV MERSol. All windows are made from thermally toughened safety glass, and they are well within the acceptable limits regarding heights of lower edge, upper edge, and incline. The windows are wide, there is no division directly in the ship's centreline, and the total number of divisions is kept to a minimum. A DECCA heavy duty wiper and washing system is installed which can keep most windows clear of water during adverse weather conditions. The system is also capable of washing the windows using a combination hot/cold potable water, supplied to the windows through a system pressurised by air. In Figure 9 the dimensions of windows, their locations, and specifications are shown. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)



POS	MARS	PCS	TYPE	SIZE W1xW2xH (mm)	GLASS THICK (mm)	GLASS TYPE *)	RETAINING LIST	GLASS HOLDER	FRAME H (mm)	STEEL GLASS	HEATING
1	4731.001	1	SPECIAL WINDOW	1532/1543x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
2	4731.002	1	SPECIAL WINDOW	1743/1563x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
3	4731.003	1	SPECIAL WINDOW	1743/1563x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
4	4731.004	1	SPECIAL WINDOW	832/733x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
5	4731.005	1	SPECIAL WINDOW	1743/1563x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
6	4731.006	1	SPECIAL WINDOW	1743/1563x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
7	4731.007	1	SPECIAL WINDOW	1532/1543x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
8	4731.008	1	SPECIAL WINDOW	1837/1605x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
9	4731.009	1	HORIZONTAL SLIDING WINDOW	1687/1521x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
10	4731.010	1	SPECIAL WINDOW	1937/1766x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
11	4731.011	1	SPECIAL WINDOW	1845/1948x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
12	4731.012	1	SPECIAL WINDOW	1108/1291x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
13	4731.013	1	SPECIAL WINDOW	1281/1109x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
14	4731.014	1	HORIZONTAL SLIDING WINDOW	1687/1521x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
15	4731.015	1	SPECIAL WINDOW	1837/1605x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
16	4731.016	1	SPECIAL WINDOW	1652/1421x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
17	4731.017	1	SPECIAL WINDOW	1661/1558x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
18	4731.018	1	SPECIAL WINDOW	1741/1637x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
19	4731.019	1	RECT. WINDOW	1753/1753x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
20	4731.020	1	SPECIAL WINDOW	1652/1421x1152	12	SINGLE, CLEAR	AISI 304	BV A	120, HOT DIP GALVANIZED	BV A	NO
		20									

*) ALL GLASS PANES ARE MADE OF THERMALLY TOUGHENED SAFETY GLASS

Figure 9. Bridge window specifications, MV MERSol (STX Europe, 2011)

The requirements stated in chapter 3.2.5 of this thesis regarding the fields of vision, are for the most part met by MV MERSol. With the exception of the requirement that states that a straight line of sight between bridge wings is to be realised. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

3.3 Part 7 – Chapter 9 – Section 3: Workstations

This section describes the requirements regarding the navigation workstation and voyage planning workstation. It states the different types of equipment and facilities that should be present, and their specifications. Chapter 9, section 3.1.13 states that the navigational systems and equipment are to be of a type approved by the national administration and in conformity with appropriate performance standards not inferior to those adopted by IMO.
(Lloyd's Register Rulefinder, 2022.)

It is important to note that PT 7 CH 9 Section 3 does not state all performance standards that the equipment is required to meet. The performance standards are documented in SOLAS Chapter V, Regulation 18: Approval, surveys and performance standards of navigational systems and equipment and voyage data recorder, and in regulation 19 - Carriage requirements for shipborne navigational systems and equipment. (Lloyd's Register Rulefinder, 2022.)

3.4 Part 7 – Chapter 9 – Section 3.1: Navigation workstation

PT 7, CH 9, Section 3.1.1, 3.1.2, and 3.1.3 state that a workstation for navigation is to be arranged to enable efficient operation by one person under normal operating conditions. The workstation area is to be sufficient to allow at least two operators to use the equipment simultaneously. The arrangement of instruments and controls is to allow the use of all instruments and controls necessary for navigating and maneuvering in any normal working position. An adequate conning position is to be provided close to the forward center window. If the view in the centerline is obstructed by large masts, cranes, etc. two additional conning positions giving a clear view ahead are to be provided, one on

the port side and one on the starboard side of the centerline, no more than 5 m apart. In addition to the conning position, a second position with a view of the area immediately in front of the bridge superstructure is to be provided close to a forward window or, alternatively, the conning position is to be wide enough to accommodate two persons. The main steering position is to be located on the ship's centerline, unless the view ahead is obstructed by large masts, cranes, etc. In this case, the steering position is to be located a distance to starboard of the centerline sufficient to obtain a clear view ahead and special steering references for use by day and night are to be provided, e.g. sighting marks forward. The navigation workstation is shown in Figure 10.
(Lloyd's Register Rulefinder, 2022.)

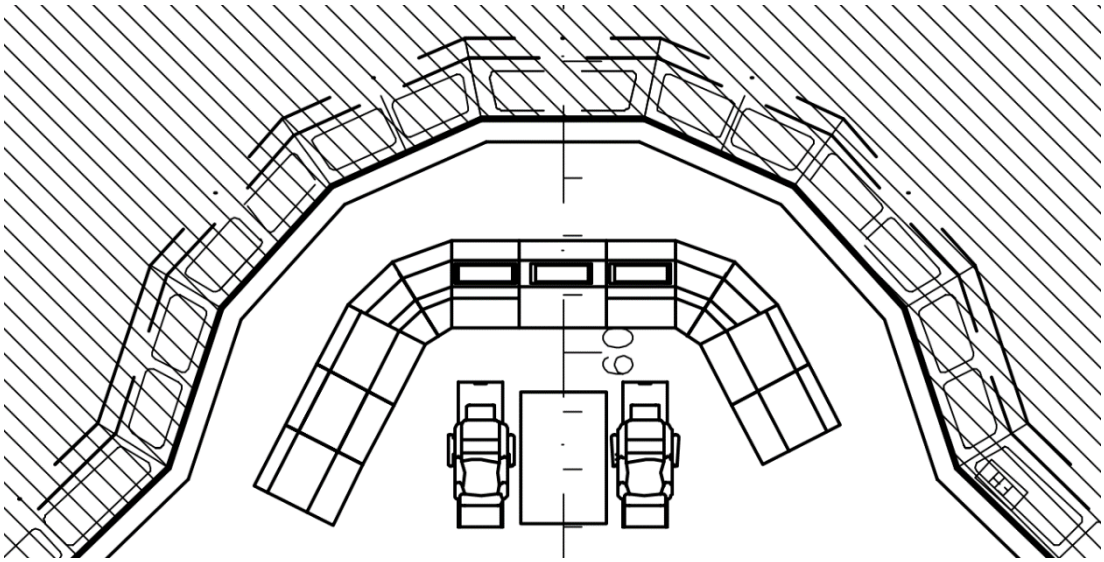


Figure 10. Navigation workstation top view, MV MERSol
(STX Europe, 2011)

As can be seen from figure 10 and figure 11, the physical requirements to the main navigation console (MNC) are met by MV MERSol. The layout allows one officer to operate all necessary equipment by itself, but also allows two officers to work there simultaneously with similar access to equipment. The several conning positions and location of maneuvering equipment and controls ensures that all requirements regard visibility are met. A detailed layout of the main navigation console is shown in Figure 11. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

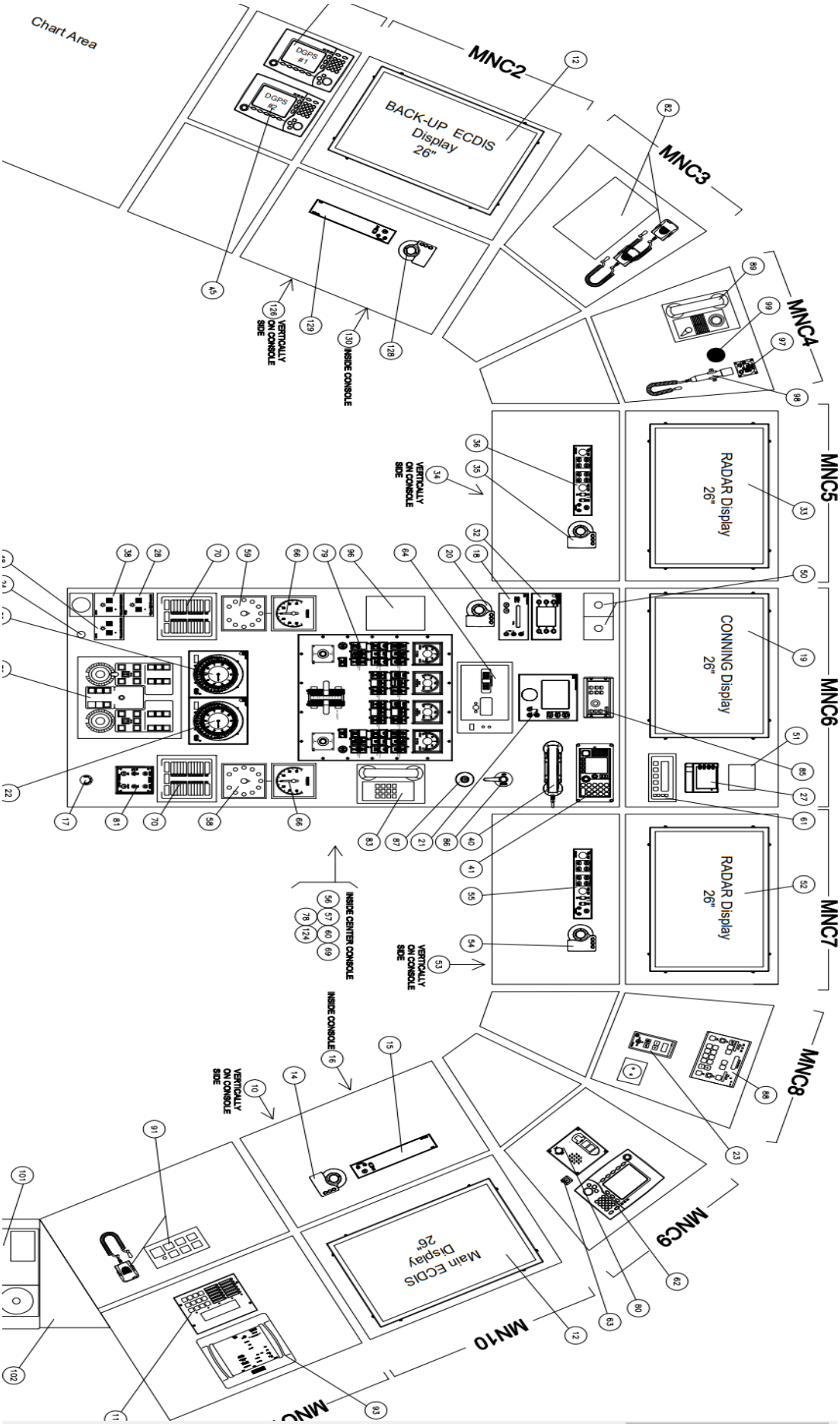


Figure 11. Main navigation console, MV MERSol (STX Europe, 2011)

PT 7, CH 9, Section 3.1.4 states all the equipment and facilities that are to be present at the navigation workstation. Between chapter 3.3.2 and 3.3.25 of this thesis I'll compare the requirements set by LR to the situation onboard of MV MERSol. (Lloyd's Register Rulefinder, 2022.)

3.4.1 Radar and radar plotting facilities

PT 7, Ch 9, Section 3.1.5 of the LR rulefinder states that two functionally independent radars or alternative means are to be provided to determine and display the range and bearing of radar transponders and other surface craft, obstructions, buoys, shorelines, and navigational marks. One of the radars is to operate in the X-band (9 GHz) and the other is to operate in the S-band (3 GHz). (Lloyd's Register Rulefinder, 2022.)

MV MERSol is equipped with an automatic radar plotting aid (ARPA) system. The system is outfitted with two independently operating radars, one 3cm X-band radar which operates in the 8-12 GHz range, and one 10cm S-band radar which operates in the 2-4 GHz range. There are two display units located at the MNC. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

In Figure 12 the navigation system power supply system is shown, the drawing shows that the systems operate independently, and can operate on both main and emergency power sources. (STX Europe, 2011)

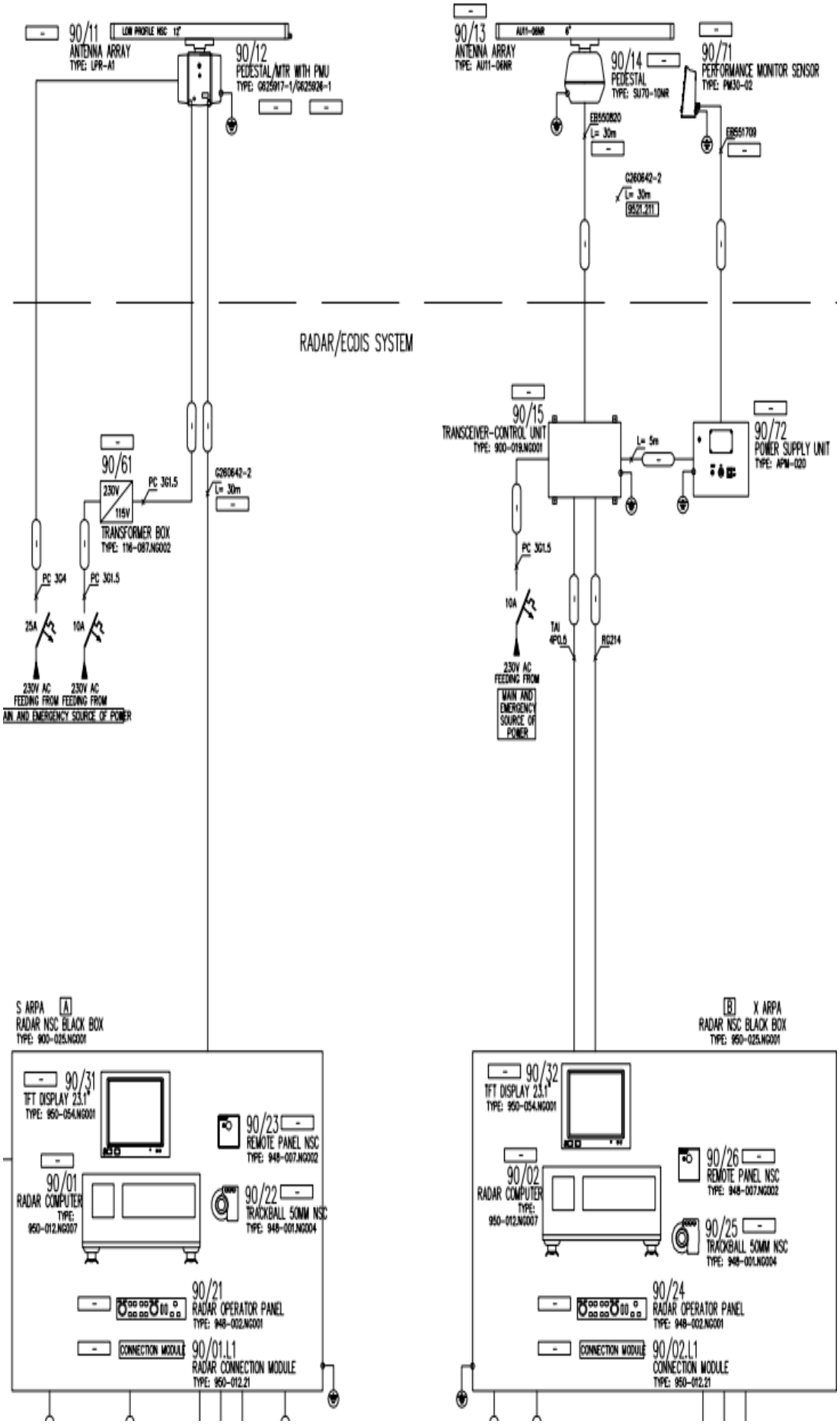


Figure 12. Radars electrical drawing, MV MERSol (STX Europe, 2011)

3.4.2 Position-fixing system displays

PT 7, Ch 9, Section 3.1.6 states that at least two different automatic position-fixing systems giving a continuous display of latitude and longitude are to be provided in the interests of redundancy and diversity. One of these is to be Global Positioning System (GPS) or equivalent. The other is to be a system providing similar global coverage such as GLONASS, where available. When a second GPS receiver is installed to satisfy this requirement, at least one of the receivers is to be provided with differential correction functionality (DGPS) and the receivers are to be arranged to operate independently as far as is practicable. (Lloyd's Register Rulefinder, 2022.)

MV MERSol is equipped with two DGPS systems, and one GPS system.
The DGPS systems are the primary source of position fixing and are connected to all bridge facilities that require a DGPS input to function optimally, such as the ECDIS, VDR, and dynamic positioning system. The GPS system is connected to the Automatic Identification System (AIS) transponder. All (D)GPS systems function independently from each other and are connected to both main and emergency power sources. Figure 13 shows the electric drawing of MV MERSol's (D)GPS systems (STX Europe, 2011)

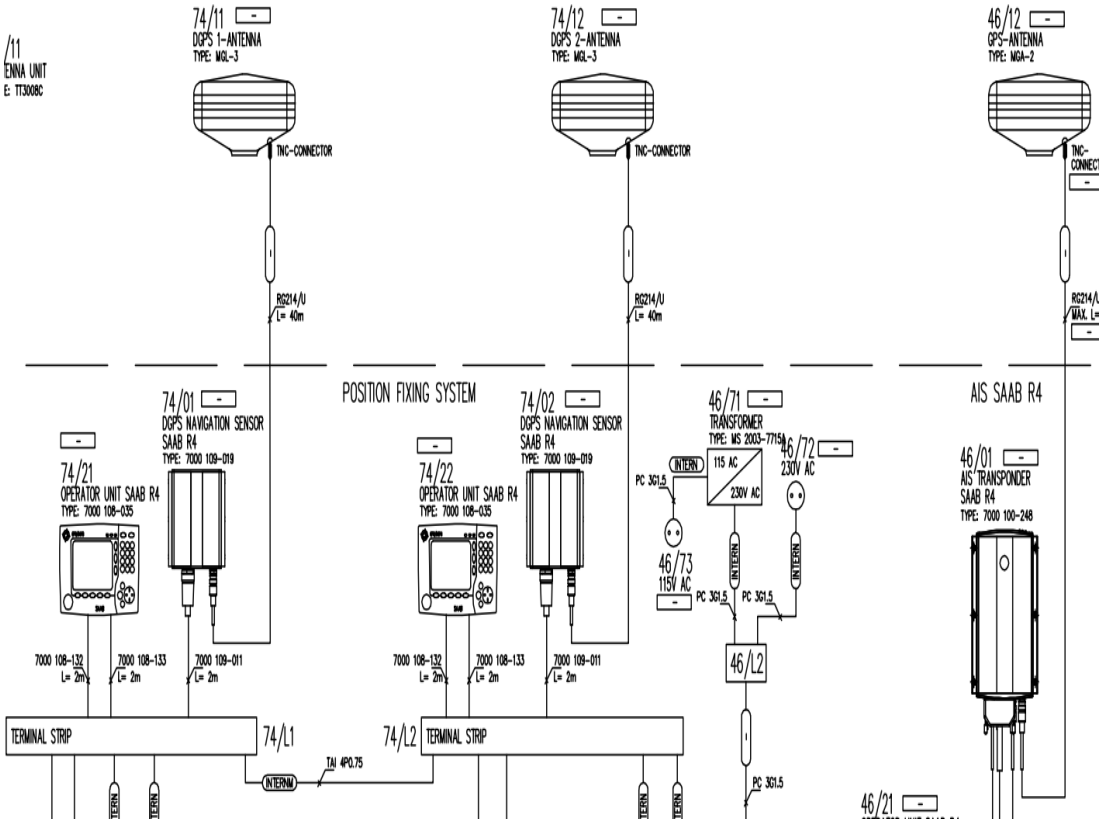


Figure 13. (D)GPS electrical drawing, MV MERSol. (STX Europe, 2011)

3.4.3 Echo sounder display

PT 7, Ch 9, Section 3.1.4 states that an echo sounder display needs to be available on the bridge. MV MERSol is equipped with one echo sounder, which operates in the 50kHz-200Khz range. The OOW can manually select the 50kHz or 200kHz transducer, depending on the depth. Additionally, it is possible for the echo sounder to switch between the transducers automatically, without manual input from the OOW. As show in Figure 14, the echo sounder display, depth indicator, and printer are connected to main and emergency power sources. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

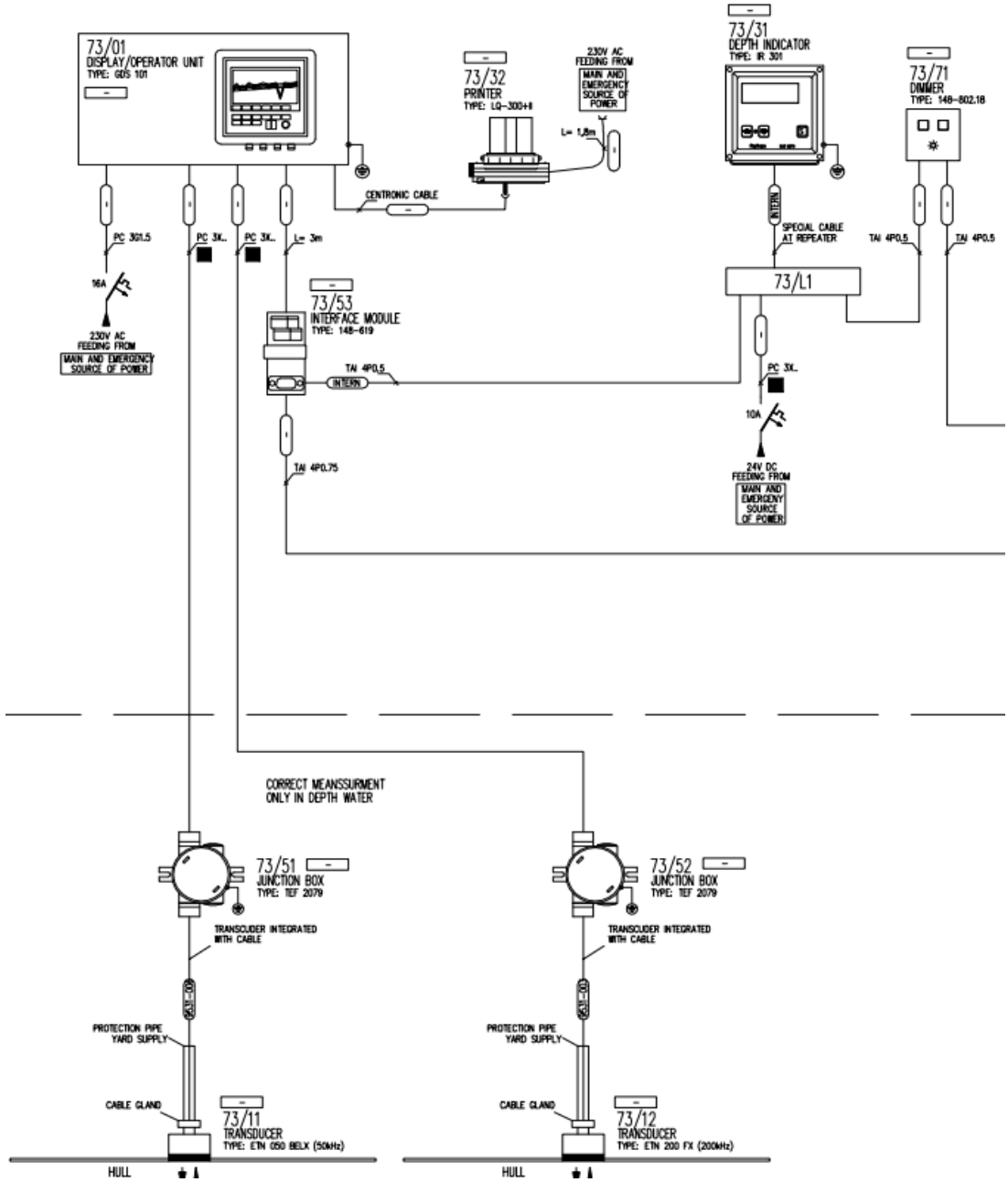


Figure 14. Echo sounder electrical drawing, MV MERSol (STX Europe, 2011)

3.4.4 Speed and distance indications

PT 7, Ch 9, Section 3.1.11 states that a speed log or alternative means of indicating the ship's speed and distance through water is to be provided. The speed through water measurement is to be used directly by the ARPA as an aid to collision avoidance. PT 7, Ch 9, Section 3.1.12 states that a speed log or alternative means of indicating the ship’s speed and distance over ground is to be provided, which is to be separate from the device required by Pt 7, Ch 9, 3.1 Navigation workstation 3.1.11. Speed over ground is to be indicated in both the fore-aft and athwartships directions.
(Lloyd’s Register Rulefinder, 2022.)

To satisfy the requirements of PT 7, Ch 9, Section 3.1.11, MV MERSol is outfitted with an electromagnetic speed log, often referred to as EM log. The EM log can measure the speed of the vessel by using the effects of magnetism in moving water, the EM log has a single transducer mounted inside a gate valve connected to the hull. The EM log is powered by main and emergency power sources and is connected to both X and S ARPA/radars. (STX Europe, 2011)

To satisfy the requirements of PT 7, Ch 9, Section 3.1.12, MV MERSol is outfitted with (D)GPS systems as earlier described in chapter 3.3.3 of this thesis. The (D)GPS systems are connected to both ARPA systems and provide it with information regarding speed and distance measured over ground. Figure 15 shows the electrical drawing of MV MERSol’s speed log system.
(STX Europe, 2011)

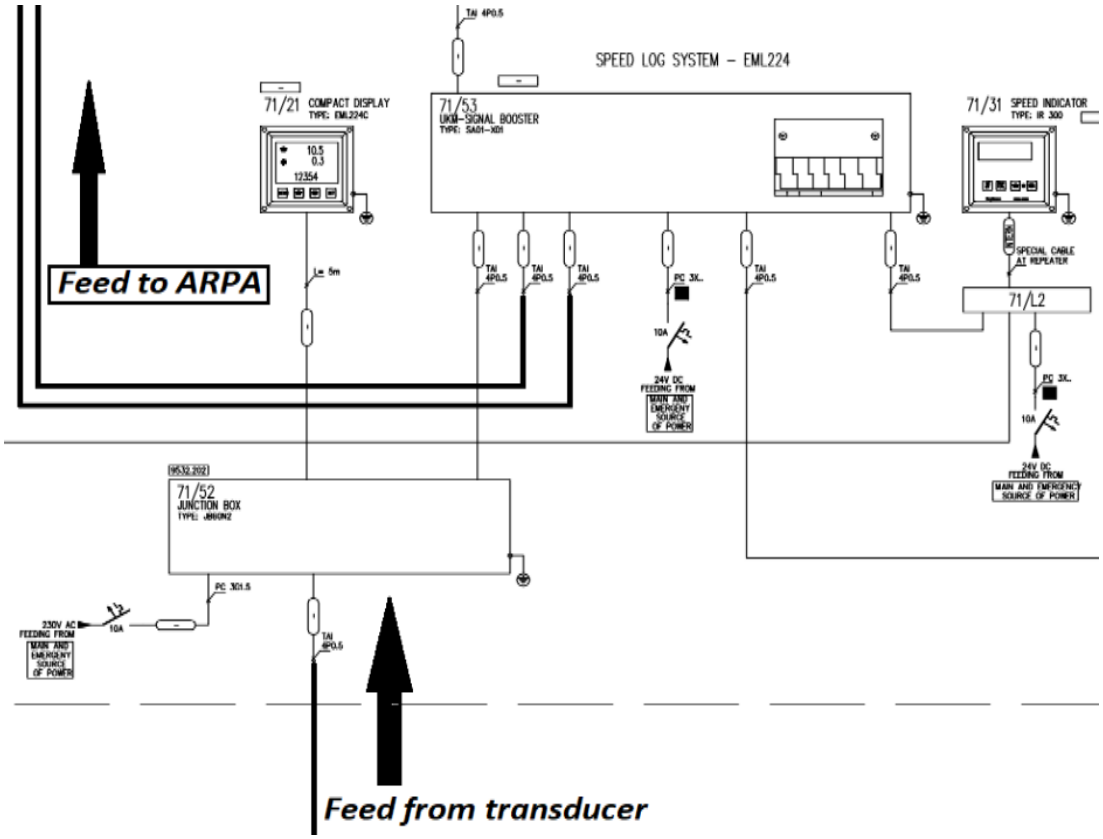


Figure 15. Speed log system electrical drawing, MV MERSol (STX Europe, 2011)

3.4.5 Gyrocompass display

PT 7, Ch 9, Section 3.1.7 states that a gyrocompass or alternative means for determining, displaying, and transmitting the ship's heading by shipborne, non-magnetic means, is to be provided and is to be clearly readable by the helmsman at the main steering position. The heading information is to be used directly by the radars, radar plotting aids and automatic identification system. The gyrocompass is to be provided with a gyrocompass heading repeater located at the emergency steering position in the steering gear compartment and a gyrocompass bearing repeater allowing bearings to be taken over 360°. (Lloyd's Register Rulefinder, 2022.)

To satisfy the requirements of PT 7, Ch 9, Section 3.1.7, MV MERSol is equipped with two gyrocompasses. The information from the gyro's is distributed to various locations and systems. There are four gyro repeaters on the bridge, two of which are heading repeaters primarily used for steering, the other two are heading repeaters on brackets located on the bridge wings, primarily used for taking bearings. There are two heading repeaters located in the steering gear room, which are to be used for emergency steering operations. Digital repeaters and a rate of turn indicators are situated at the center console, bridge wings, and dynamic positioning console. The information provided by the gyro compasses is distributed to various piece of equipment, including but not limited to the radars and AIS system. Main and emergency powers sources are available for the gyro system, as can be seen in Figure 16. (STX Europe, 2011)

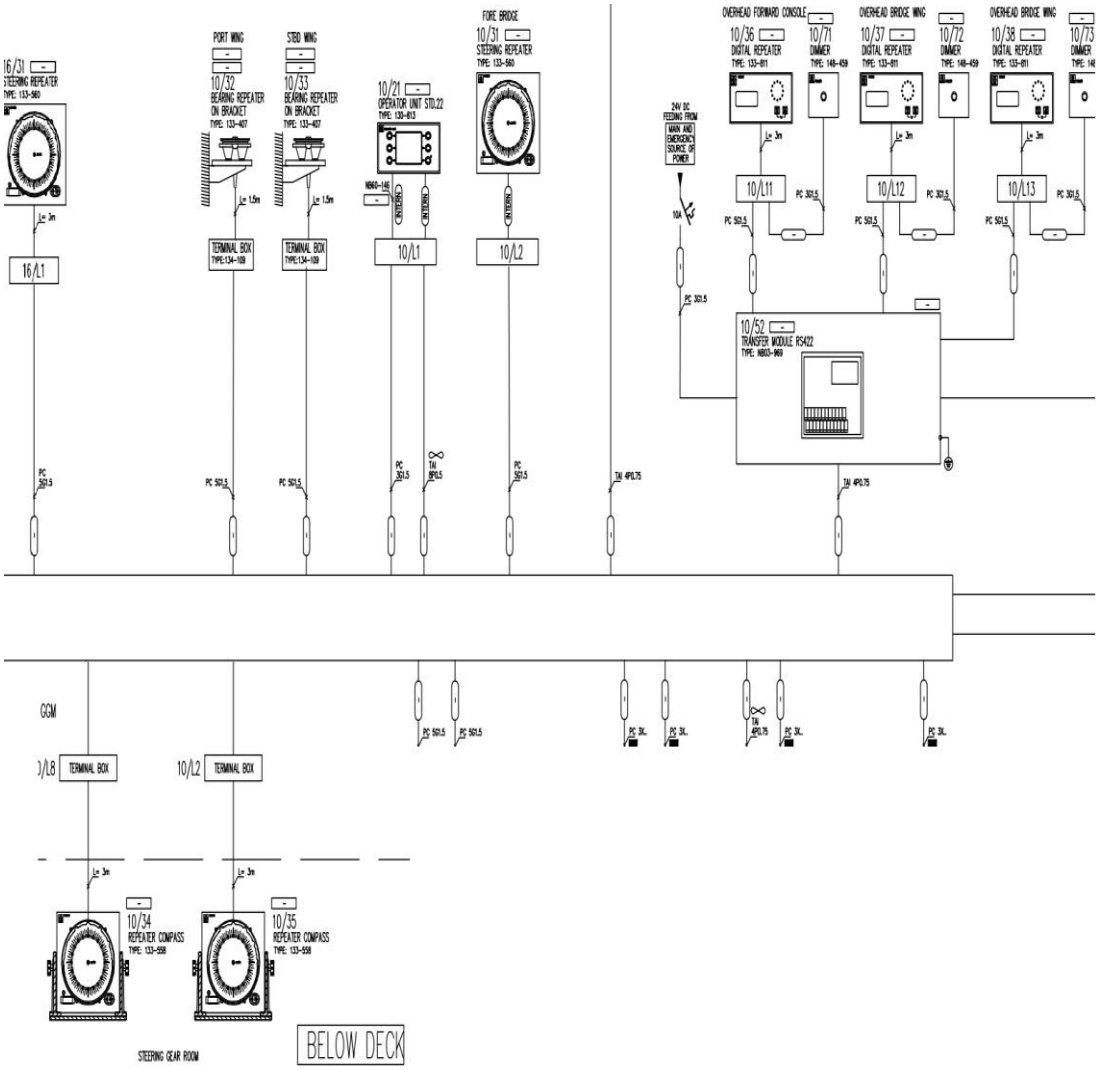


Figure 16. Compass system electrical drawing, MV MERSol (STX Europe, 2011)

3.4.6 Magnetic compass display

PT 7, Ch 9, Section 3.1.4 states that a magnetic compass display needs to be provided at the navigation workstation. To satisfy this requirement, MV MERSol is equipped with a magnetic compass. The heading provided by the magnetic compass can be read from a repeater located at the navigation workstation. The magnetic compass is connected to the autopilot system, the heading information provided by the magnetic compass is displayed there and can be used as heading source, see Figure 17.
(Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

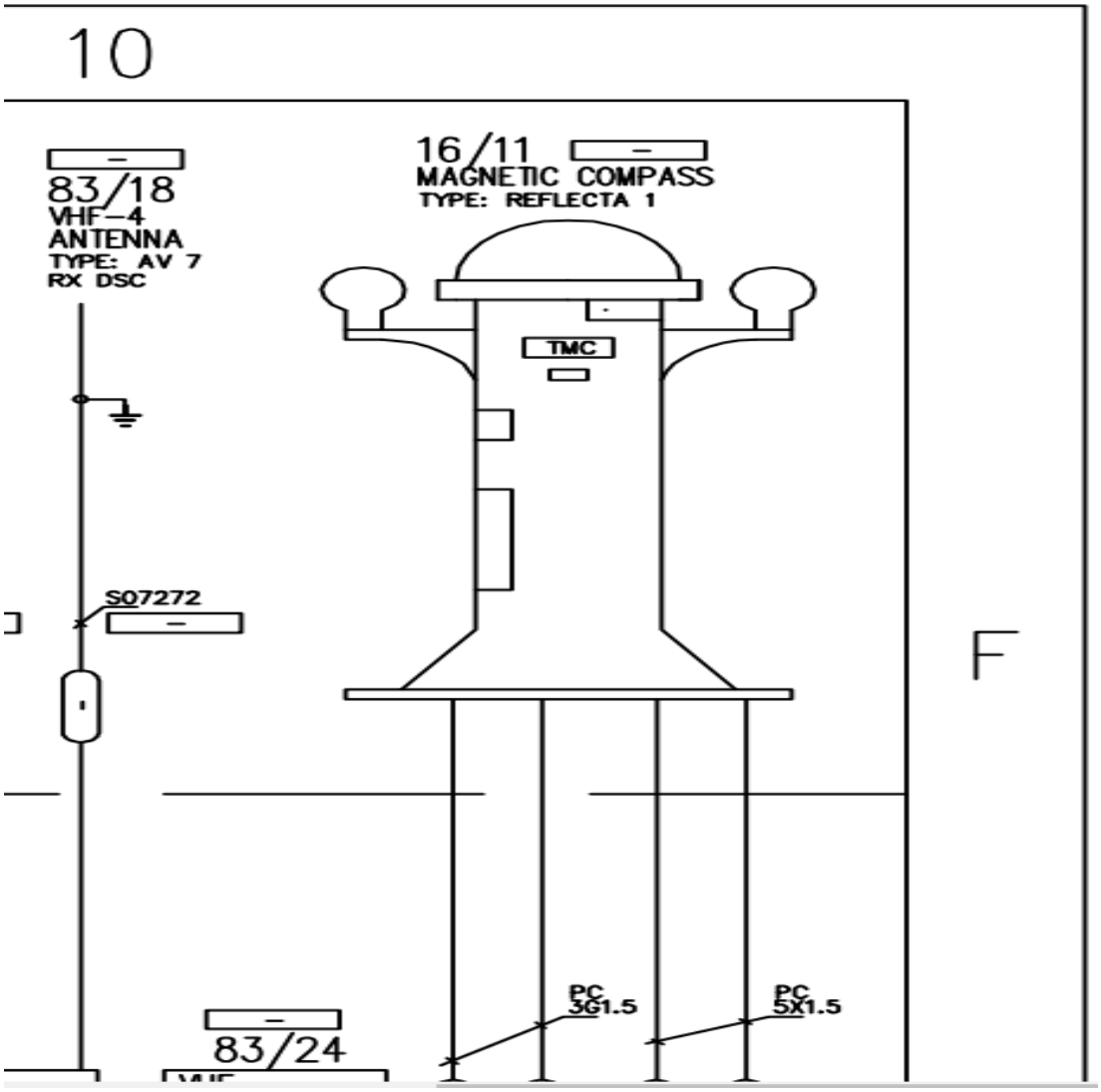


Figure 17. Magnetic compass, MV MERSol (STX Europe, 2011)

3.4.7 Wind speed and direction indication

PT 7, Ch 9, Section 3.1.4 states that a means to determine the wind speed and direction needs to be provided at the navigation workstation. To satisfy this requirement, MV MERSol is equipped with two static wind sensors and an information display. Both wind sensors are mounted on the monkey island, they are connected to an information display which is located at the navigation workstation. The information display shows information such as the wind direction, wind speed, and temperature. See Figure 18.
(Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

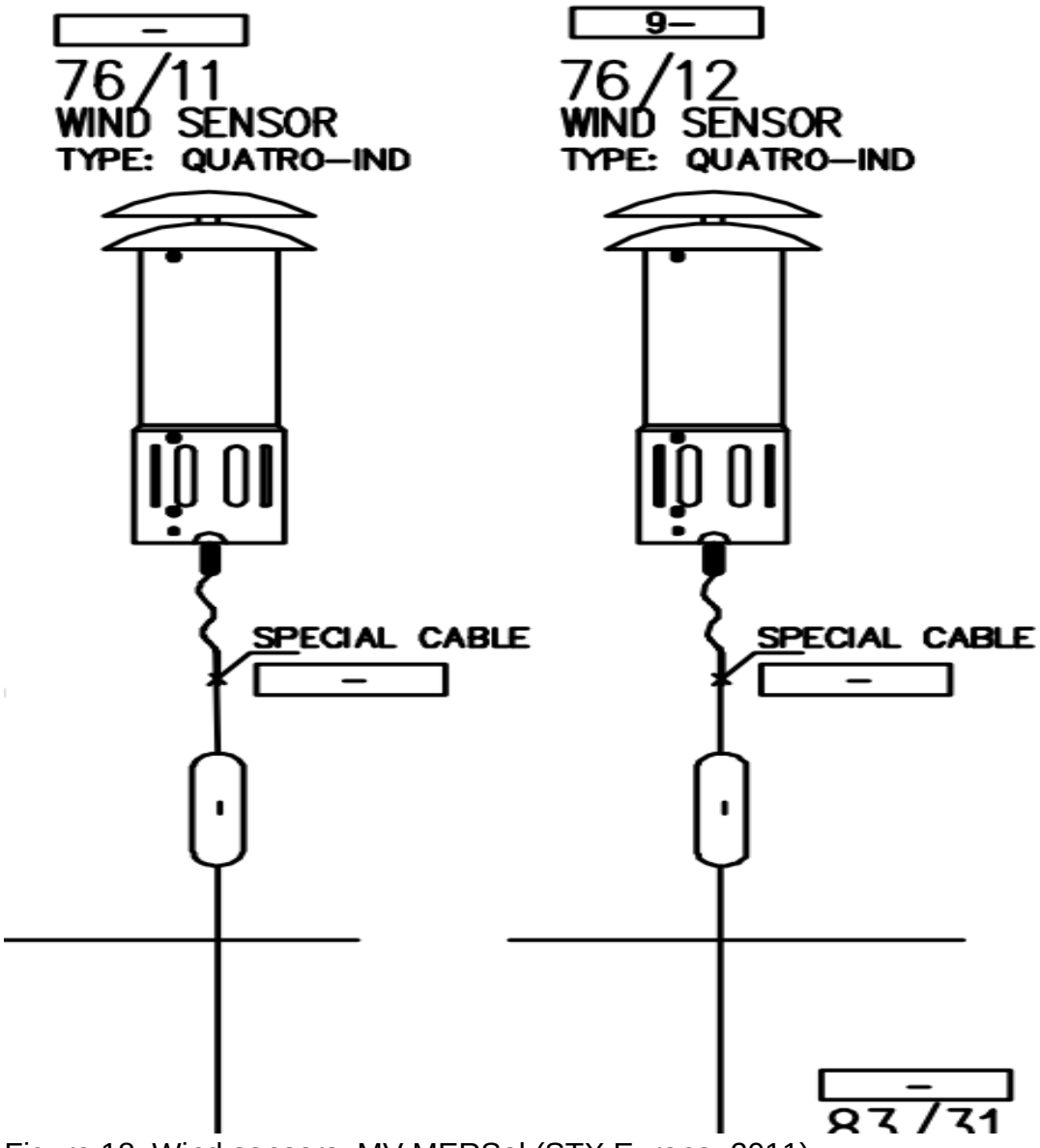


Figure 18. Wind sensors, MV MERSol (STX Europe, 2011)

3.4.8 Steering controls and indication

As this thesis is focused on the bridge equipment, general requirements to steering gear are not taken into consideration in this chapter. Only requirements to the navigation workstation are mentioned in this chapter.
However, it is worth mentioning that MV MERSol is outfitted with two rudders and can operate with only one of them. Both rudders are equipped with both main and emergency steering. In total, there are 4 steering pumps, two of which are connected to the main switchboard, the other two are fed from the emergency switchboard. (STX Europe, 2011)

PT 7, Ch 9, Section 3.1.4 states that steering controls and indication measures are to be provided at the navigation workstation. The requirements to these systems can be found in PT 5, Ch 19, 5 Electric power circuits, electric control circuits, monitoring and alarms. The chapter states the different alarms that should be connected to the steering gear, and that these alarms should be connected to the bridge alarm panel. The alarm panel on the bridge of MV MERSol shows a common alarm whenever an issue occurs to either port or starboard steering gear. PT 5, Ch 19, 5.1.5 states that indicators for running indication of each main and auxiliary motor are to be installed on the navigation bridge and at a suitable main machinery control position. To meet these requirements, MV MERSol's bridge is outfitted with several steering control and indication places. All four of the steering pumps can be switched on/off from the main steering panel at the center console. As both rudders can be operated separately, independent/simultaneous steering can be done from all steering positions, from the main steering panel, portside (PS) wing, and starboard side (SB) wing. There are multiple rudder angle indicators (RAI) situated on the bridge. The main steering panel, PS & SB wings all have their own RAI. Additionally, there is a multifaced RAI mounted on the ceiling above the main control station.
(STX Europe, 2011; Lloyd's Register Rulefinder, 2022.)

3.4.9 Rate of turn indication

PT 7, Ch 9, Section 3.1.4 states that rate of turn indication needs to be present on the bridge. To satisfy this requirements, MV MERSol is equipped with one rate of turn indicator (ROT). The ROT is connected to a distribution box, which is also connected to various other pieces of bridge equipment, such as the magnetic compass, gyro compass, conning display, radars, steering repeaters, and (D)GPS. See Figure 19.
(Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

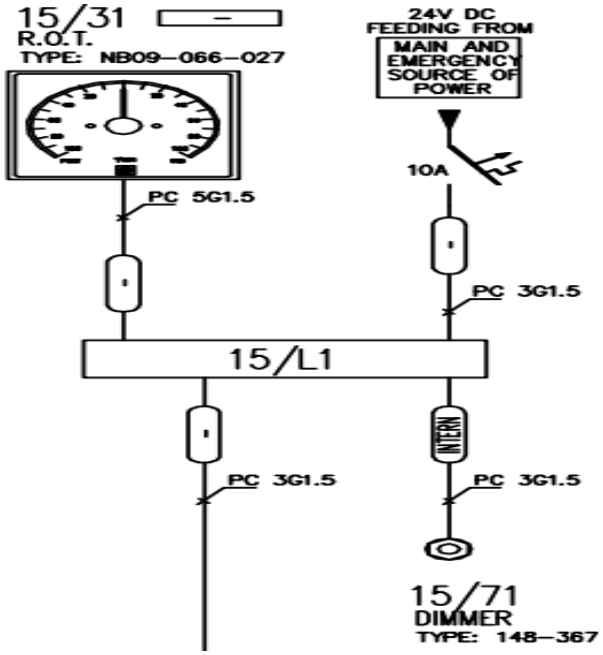


Figure 19. ROT indicator electrical drawing, MV MERSol (STX Europe, 2011)

3.4.10 Course/track controls and indications

PT 7, Ch 9, Section 3.1.8 states that an autopilot, track control system or alternative means of automatically maintaining the ship's heading or a straight track is to be present at the navigation workstation. At any time, it must be possible to immediately restore manual control. To satisfy this requirement, MV MERSol is equipped with an autopilot system. The autopilot is connected to multiple pieces of bridge equipment, such as the gyro compass, magnetic compass, speed log, (D)GPS and ECDIS. The autopilot can perform heading control and track control and has multiple adjustable parameters which can improve the performance of the autopilot. The OOW has the option to manually select whether they want to use the autopilot or manual steering at any time by performing the simple action of flicking a switch. Whenever the autopilot is engaged, there is an override system connected to the non-follow up (NFU) tillers. Whenever one of the NFU tillers is used during autopilot mode, an audiovisual alarm is activated and the autopilot is automatically overruled, and manual steering is engaged. Figure 20 shows an overview of the steering control electrical system. (STX Europe, 2011; Lloyd's Register Rulefinder, 2022.)

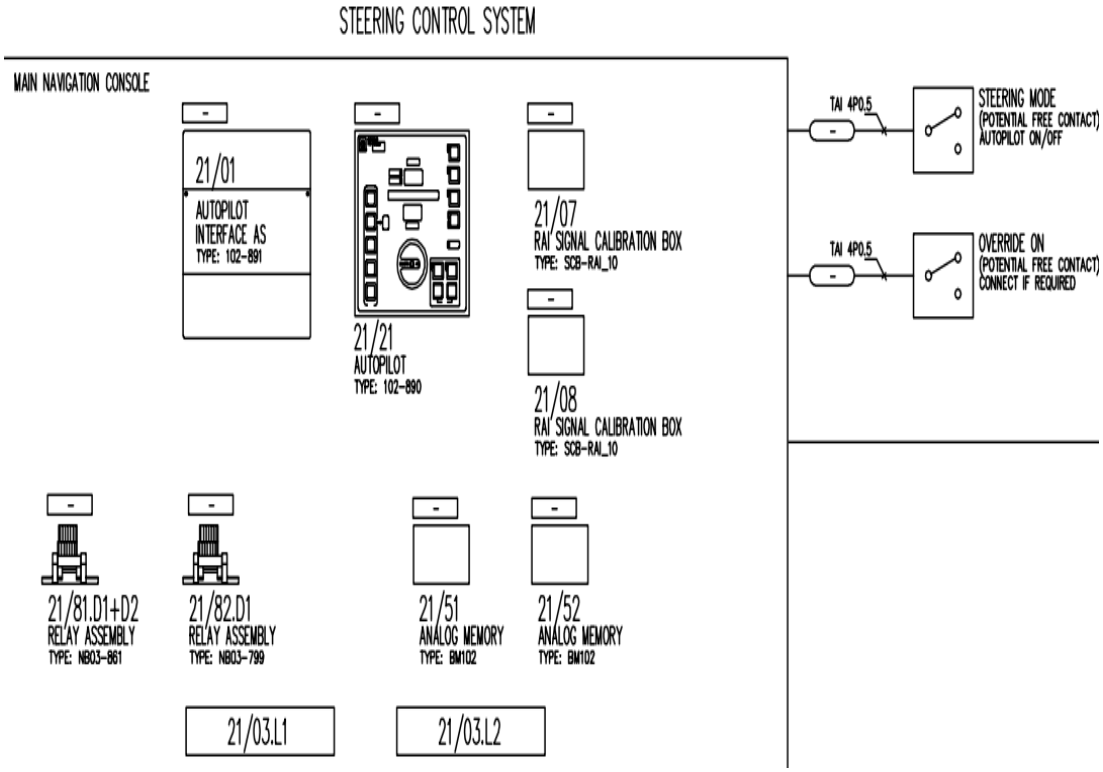


Figure 20. Steering control system electrical drawing, MV MERSol (STX Europe, 2011)

3.4.11 Main propulsion and thruster controls and indication

PT 7, Ch 9, Section 3.1.4 states that main propulsion and thruster controls and indication should be provided at the navigation workstation. The requirements to the controls and indications are listed in PT 6, Ch 1, Section 2.6 Bridge control for main propulsion machinery, and PT 5, Ch 7, Section 5.3 Controllable pitch propellers and transverse thrust units.
(Lloyd's Register Rulefinder, 2022.)

PT 6, Ch 1, Section 2.6.1 & 2.6.2 state that satisfactory control of propulsion from the bridge in both ahead and astern directions should be provided, and that the following indications are to be provided:

- propeller speed
- direction of rotation of propeller for a fixed pitch propeller or pitch position for a controllable pitch propeller
- direction and magnitude of thrust
- clutch position if applicable
- shaft brake position if applicable.

Section 2.6.3 and 2.6.4 state that the propeller speed, direction of rotation and propeller pitch are to be controlled from the bridge under all seagoing and maneuvering conditions. Remote control of the propulsion machinery is to be from only one control station at a time, means are to be provided to facilitate a smooth transfer of command between workstations.
(Lloyd's Register Rulefinder, 2022.)

PT 5, Ch 7, 5.3 Controllable pitch propellers (CPP) and transverse thrust units, section 5.3.2 states that the CPP units for main propulsion of the vessel should be provided with an alternative power source for controlling the pitch of the propeller blades. Section 5.3.4 and 5.3.5 state that transverse thrust units need to be provided with emergency stops at all remote-control stations, the direction and magnitude of thrust and pitch need to be displayed at all control stations. (Lloyd's Register Rulefinder, 2022.)

To satisfy the requirements, MV MERSol is equipped with pitch controls for both propellers, including indicators that state the pitch percentage and direction, as well as propeller RPM. Emergency stop buttons for both main engines and emergency pitch controls are provided at the workstation. The CPP can be controlled locally, in the engine control room, and at the control stations situated on the bridge. See Figure 21 for a picture of MV MERSol's pitch controls and various indicators. (STX Europe, 2011)

Figure 21. Pitch controls and various indicators, MV MERSol (Koivisto, 2015)

3.4.12 Watch safety system

PT 7, Ch 9, Section 3.1.4 states that the bridge should be outfitted with a watch safety system. The meet this requirement, MV MERSol is equipped with a bridge navigational watch alarm system (BNWAS). The alarm control panel is situated at the navigation workstation, there are 5 alarm reset buttons scattered around the bridge. The BNWAS alarm can be set to a certain time interval, such as 6 or 12 minutes. The alarm knows 4 stages, at stage 0 the alarm reset buttons start blinking on the bridge, 15 seconds later a buzzer starts

producing noise on the bridge, 30 seconds later a buzzer starts producing noise at the master's cabin, 90 seconds later a buzzer starts producing noise at other crew cabins. MV MERSol's BNWAS is constructed as per regulations of SOLAS chapter V section 19. See Figure 22 for an overview of the BNWAS electrical system (STX Europe, 2011; Lloyd's Register Rulefinder, 2022)

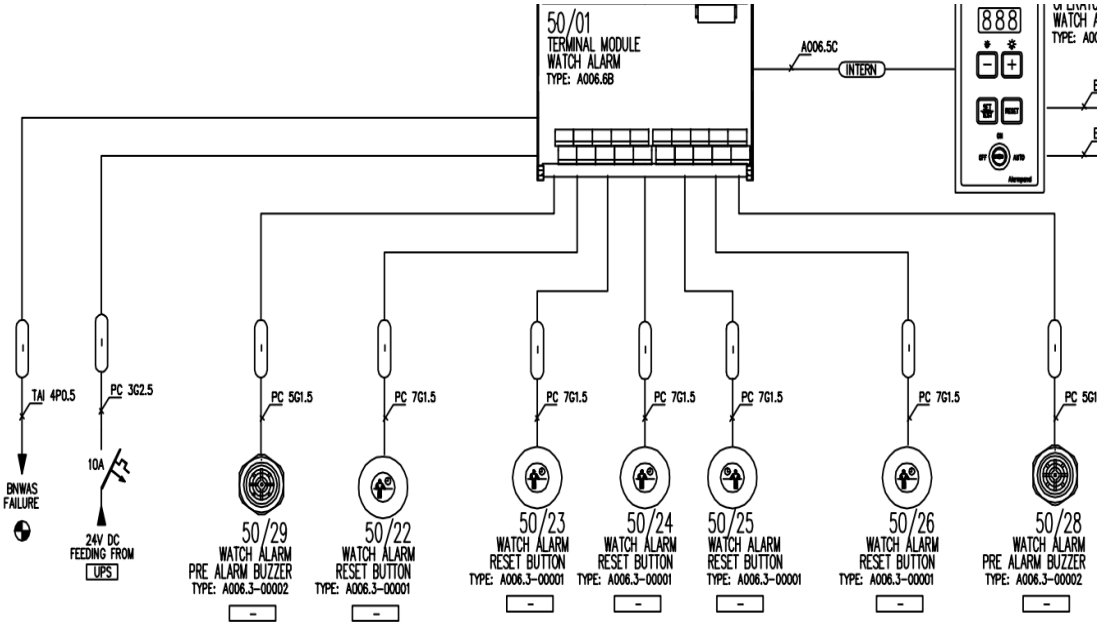


Figure 22. BNWAS electrical drawing, MV MERSol (STX Europe, 2011)

3.4.13 Internal communications systems

PT 7, Ch 9, Section 3.1.4 states that the main navigation workstation needs to be outfitted with an internal communications system. To meet this requirements, MV MERSol is equipped with a public address system (PA), an internal telephone communication system, and a talk back system. The internal telephone system runs through the entire vessel, there are 61 locations connected to the system which reaches from the bridge to the engine control room (ECR), cabins, machinery spaces, workshops, and all other relevant locations onboard. Out of the 61 locations, 4 of them are located on the bridge. (STX Europe, 2011; Lloyd's Register Rulefinder, 2022)

The talk back system on MV MERSol, connects the bridge between the ECR, Boat deck forward, and Main deck aft. The public address system runs through the entire vessel, the peripherals belonging to the system are located at all relevant locations, in similar fashion to the internal communication system. The PA system can be used to broadcast spoken messages and alarms.
(STX Europe, 2011)

3.4.14 Global Maritime Distress and Safety System

PT 7, Ch 9, Section 3.1.4 states that the main navigation workstation needs to be equipped with a very high frequency (VHF) radiotelephone. To meet this requirement, MV MERSol is equipped with a VHF digital selective calling (DSC) control unit and handset at the center console. The location of the VHF DSC unit is highlighted in Figure 23. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

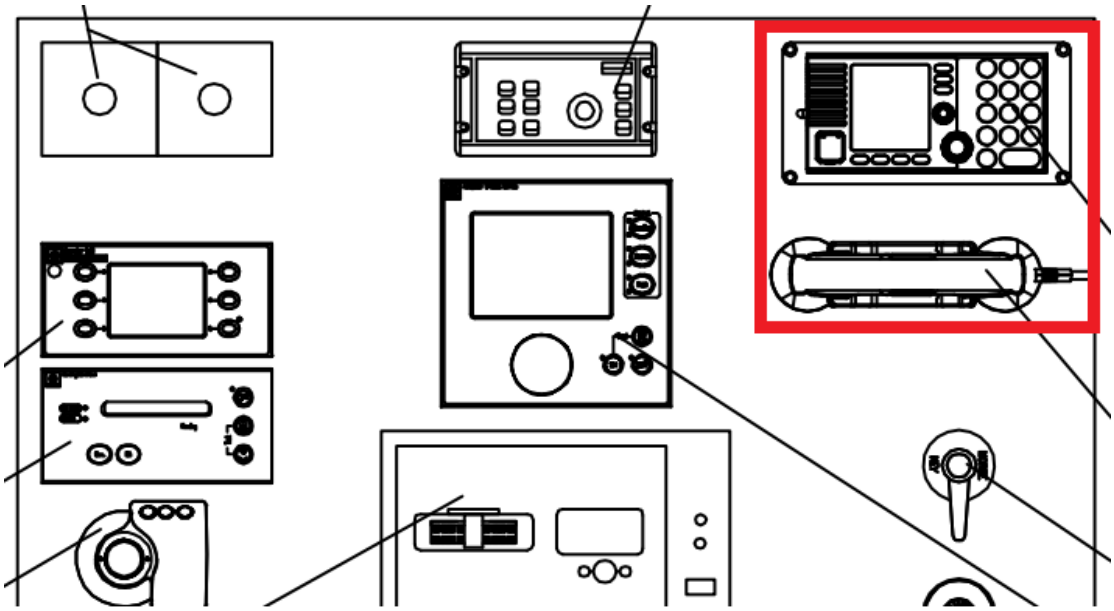


Figure 23. VHF DSC unit at MNC, MV MERSol (STX Europe, 2011)

The VHF radiotelephone is part of the GMDSS outfit. The minimum carriage requirements for the GMDSS outfit of MV MERSol are defined by SOLAS Chapter IV, regulation 7. The GMDSS outfit of MV MERSol contains the following equipment:

- 4x VHF DSC
- 2x SART (Search and rescue transponder)
- 3x GMDSS VHF handheld
- 1x EPIRB (Emergency Position Indicating Radio Beacon)
- 2x Inmarsat C
- 1x MF/HF DSC (Medium frequency/High frequency)
- 1x Navtex

The available equipment dictates in which sea area a vessel may operate. (STX Europe, 2011)

3.4.15 Time indication

PT 7, Ch 9, Section 3.1.4 states that a way of time indication should be present at the navigation workstation. MV MERSol complies with this regulation, as both (D)GPS units are the primary source of time indication. Additionally, the (D)GPS units are connected to multiple other pieces of bridge equipment, essentially turning all connected displays into accurate time indicators. Figure 24 shows one of MV MERSol's GPS interfaces.
(Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

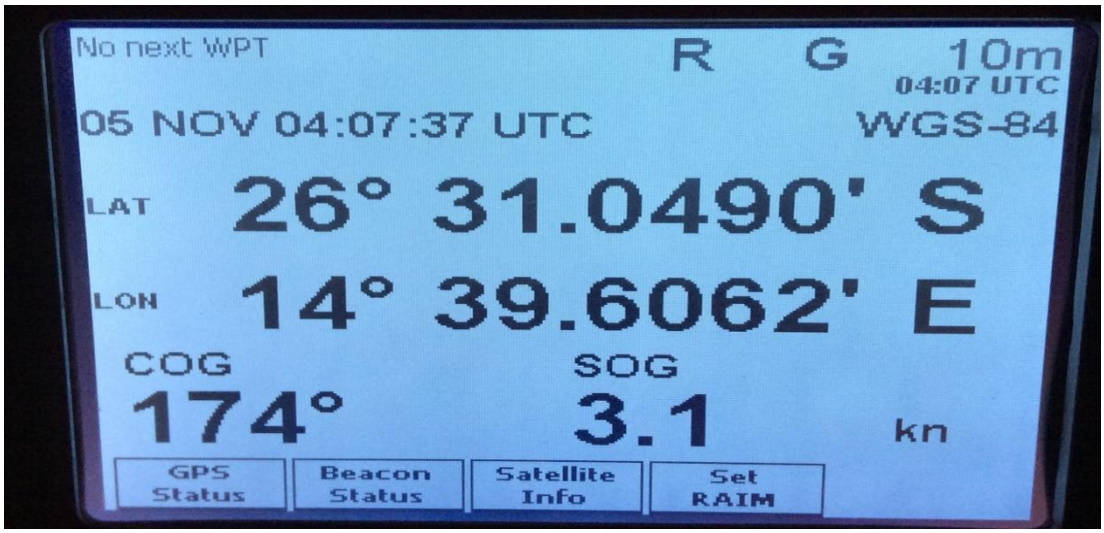


Figure 24. (D)GPS display MV MERSol (Koivisto, 2015)

3.4.16 Window clear view controls

PT 7, Ch 9, Section 3.1.4 states that controls for the window cleaning system should be present at the navigation workstation. As mentioned earlier I this thesis at chapter 3.2.6, a window washing and heavy-duty wiper system is installed. The controls of this system are situated at the PS wing console, SB wing console, and main navigation console, which means that MV MERSol meets the requirement. The location of the window clear view controls is highlighted in Figure 25.
(Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

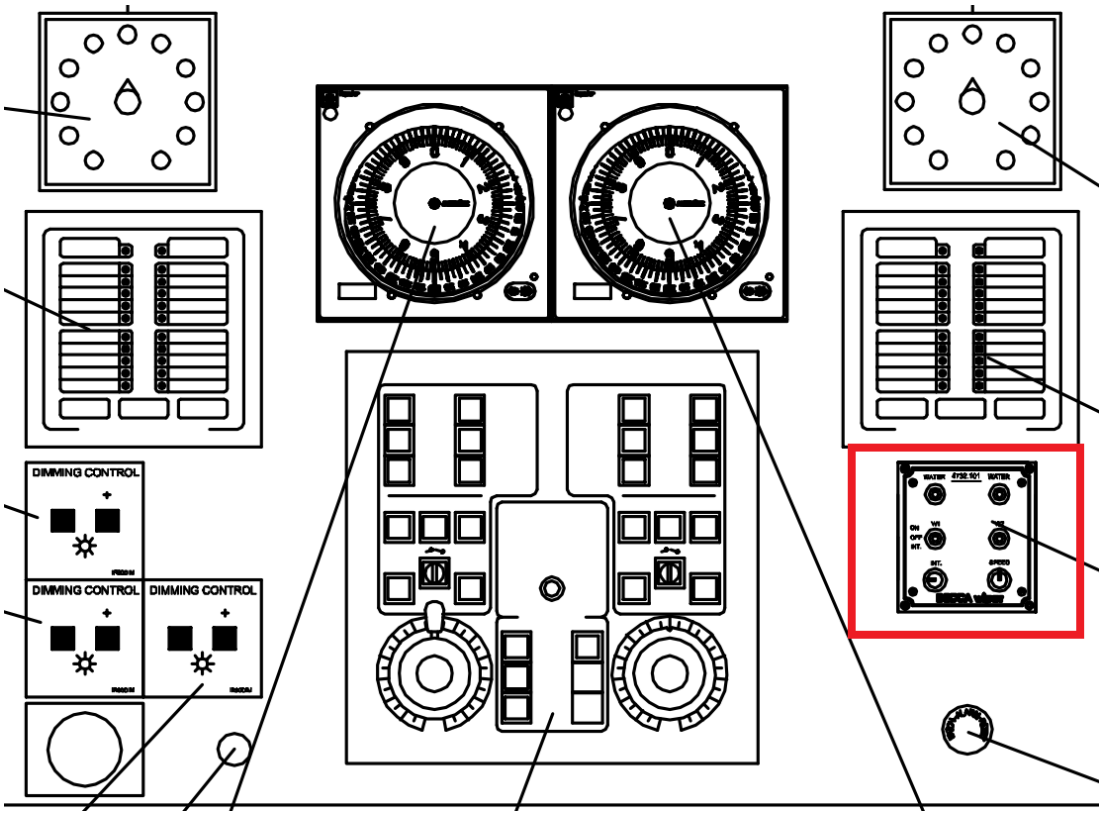


Figure 25. Window clear view controls at MNC, MV MERSol.
(STX Europe, 2011)

3.4.17 Navigation lights controls

PT 7, Ch 9, Section 3.1.4 states that navigation light controls need to be present at the navigation workstation. The navigation light control panel onboard

of MV MERSol is situated at the main navigation console, starboard side. (Lloyd's Register Rulefinder, 2022; STX Europe, 2011)

3.4.18 Miscellaneous controls

PT 7, Ch 9, Section 3.1.4 states that control buttons for the whistle, morse light key, and bridge/equipment need to be present at the navigation workstation. A pushbutton for the whistle, the morse light key, and searchlight controls are situated at the main navigation console. Dimmers for equipment and buttons are situated at multiple different locations on the main navigation console. The locations miscellaneous controls are highlighted in Figure 26.
(STX Europe, 2011; Lloyd's Register Rulefinder, 2022)

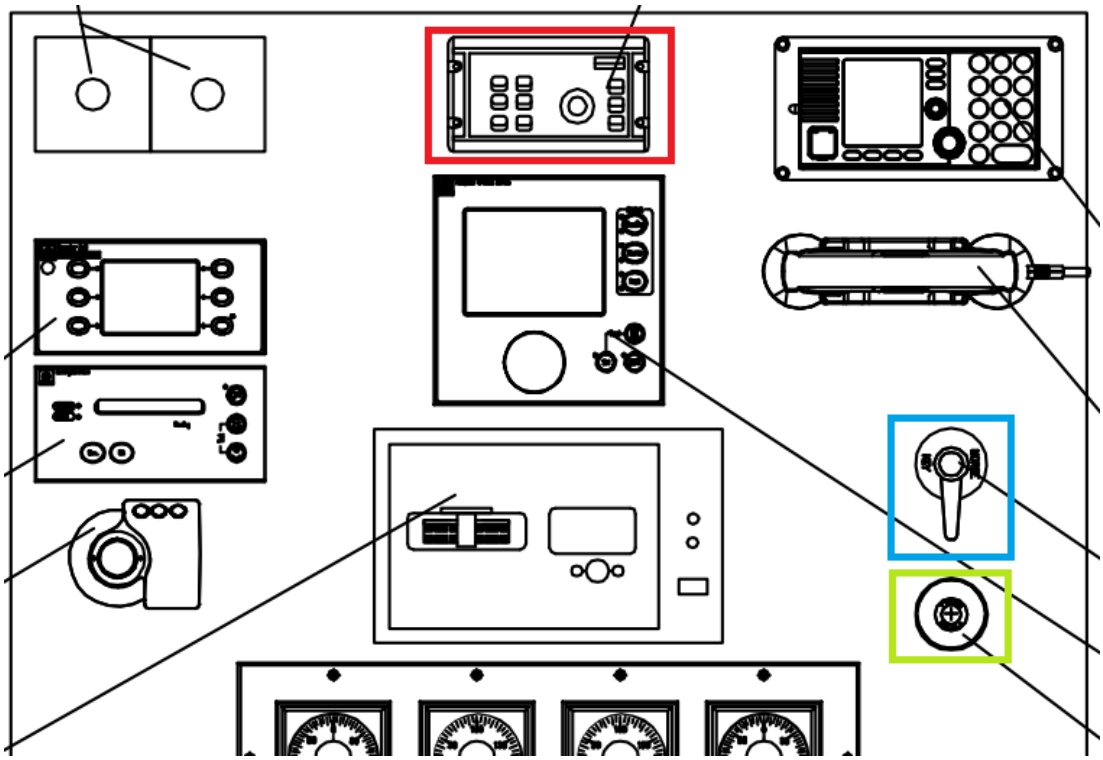


Figure 26. Miscellaneous controls at MNC, MV MERSol (STX Europe, 2011)

3.4.19 Wheelhouse/equipment lighting controls

PT 7, Ch 9, Section 3.1.4 states that bridge ambient and bridge equipment lightning controls should be present at the navigation workstation. Dimmers for equipment situated at the MNC are located nearby the relevant equipment or integrated into the various control panels. Outdoor lightning controls are

located on a separate panel which is situated at the aft bulkhead of the bridge. (STX Europe, 2011; Lloyd's Register Rulefinder, 2022.)

3.4.20 Automatic ship identification system

PT 7, Ch 9, Section 3.1.4 states that an AIS information display should be present at the main navigation workstation. To meet this requirement, an AIS display and control unit has been installed at the MNC. Additionally, AIS information can be displayed on the ECDIS, as the system are connected. Transmitted AIS information parameters can be edited by the OOW at both the AIS unit and ECDIS. The location of the AIS unit is highlighted in Figure 27. (STX Europe, 2011; Lloyd's Register Rulefinder, 2022.)

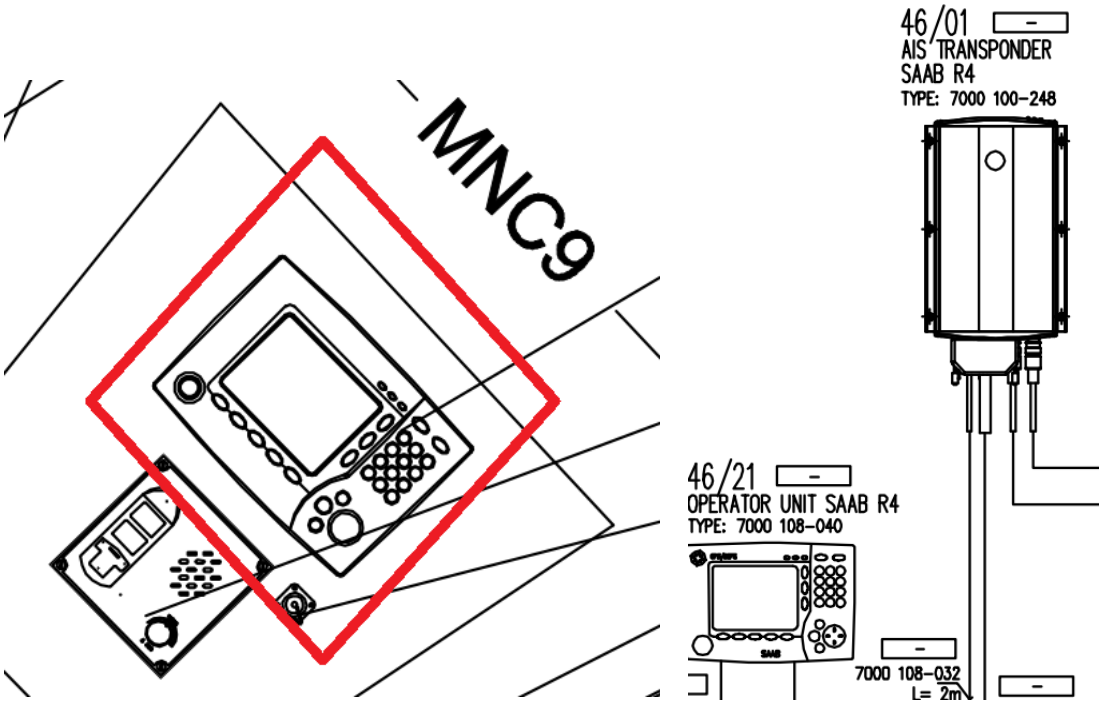


Figure 27. AIS display at MNC, MV MERSol. (STX Europe, 2011)

3.4.21 Sound reception system

PT 7, Ch 9, Section 3.1.4 states that a sound reception system should be present at the main navigation workstation. The sound reception system control panel is located at the MNC. The sound reception system onboard of MV MERSol consists of a microphone unit located at the monkey island, that receives sound signals and re-produces these incoming signals electrically inside the bridge. MV MERSol is required to carry this system onboard, as the bridge is fully enclosed. The sound reception system allows the OOW to perform their lookout duties as per International Regulations for Preventing Collisions at Sea, 1972 and SOLAS 2002(resolution A. 694(17)) revisions. The location of the sound surveillance microphone is highlighted in Figure 28.
(STX Europe, 2011; Lloyd's Register Rulefinder, 2022.)

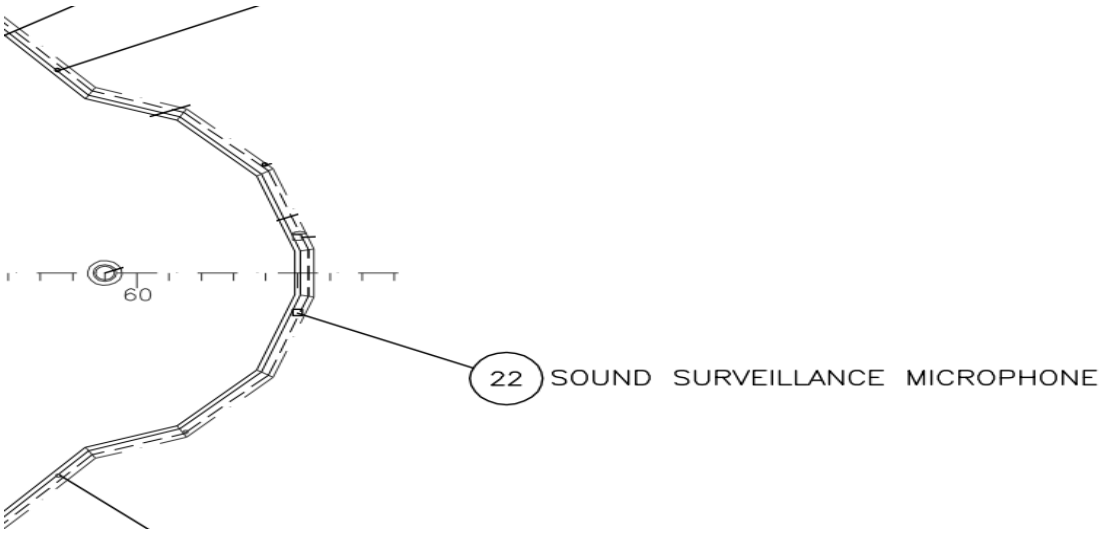


Figure 28. Sound surveillance location, MV MERSol. (STX Europe, 2011)

3.4.22 Voyage planning workstation

PT 7, Ch 9, Section 3.2.1 states that a voyage planning workstation is to be provided at which the following facilities are available: chart display and information facilities, position-fixing systems, and time indication. The time indication and chart table are subject to further requirements as stated in PT 7, Ch 9, Section 3.2.2 and 3.2.3. The time indication at the voyage planning station is to be derived from the same system as used at the navigation workstation. If a vessel uses paper charts, further requirements to the size of the chart table and provided illumination are to be met. (Lloyd's Register Rulefinder, 2022.)

To meet the requirements of 3.2, MV MERSol is outfitted with an ECDIS system. Both ECDIS displays are located at the MNC, one of them is situated right next to the chart table and (D)GPS units. Considering MV MERSol uses ECDIS, paper charts do not have to be carried onboard. The fact that paper charts are not present onboard exempts MV MERSol from the additional requirements to the chart table and its specifications as mentioned in 3.2.2.
Time indication is provided by (D)GPS, the display units are located right in between the chart table and one of the ECDIS displays. The (D)GPS is connected to the ECDIS, which means that time indication is also provided at the main ECDIS display. Figure 29 show the chart area at the MNC.
(STX Europe, 2011)

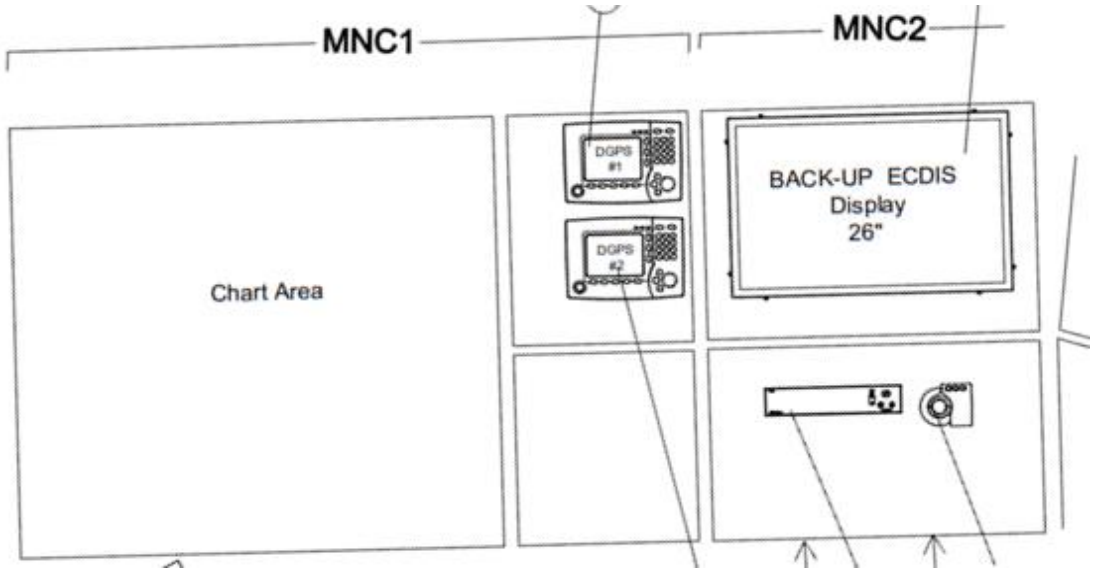


Figure 29. Chart area at MNC, MV MERSol. (STX Europe, 2011)

3.5 Part 7 – Chapter 9 – Section 4: Systems

This section states the requirements to alarms, watch safety systems, intra ship communication, and power supplies. (Lloyd's Register Rulefinder, 2022.)

3.5.1 Alarm and warning systems

PT 7, Ch 9, Section 4.1. states that alarms associated with navigation equipment are to be both audible and visual and are to be centralized for efficient identification. Repeater displays may be fitted on the bridge wings and at other appropriate positions on the bridge where necessary.
Section 4.1.2 states that the following alarms are to be provided:

- Closest point of approach
- Shallow depth
- Waypoint approaching (if automatic track following is used)
- Off-course
- Off-track (if automatic track following is used)
- Steering alarms
- Navigation light failure alarms
- Gyrocompass failure
- Watch safety system failure
- Failure of power supply to distribution panels

(Lloyd's Register Rulefinder, 2022.)

MV MERSol is equipped with multiple alarm panels located at the MNC. These alarm panels include a central panel, dedicated GMDSS alarm panel, and a dedicated steering gear alarm panel. Alarms are triggered on individual pieces of equipment/machinery before being relayed to one of the alarm panels. Individual equipment will sound an alarm based on the parameters set by the OOW or Master, not all alarms trigger at a static value. For example, the OOW can decide which under keel clearance value should trigger the alarm on the echo sounder. A similar example is that the OOW can decide which distance should trigger an alarm for the closest point of approach (CPA), depending on

multiple variables. There are certain static alarms related to the navigation lights, steering gear, and general equipment failure. For example, an alarm is relayed to the GMDSS alarm panel when a distress alert is received via Inmarsat-C. In conclusion, all applicable alarms as stated in section 4.1.2. are sounded on the bridge. Further requirements to the exact selection of alarms can be found in part 5, 6, and 7 of Lloyd's Register Rules and Regulations - Rules and Regulations for the Classification of Ships, July 2022. (STX Europe, 2011; Lloyd’s Register Rulefinder, 2022)

3.5.2 Watch safety system

PT 7, Ch 9, Section 4.2. states that a BNWAS needs to be present. The BNWAS of MV MERSol has been mentioned in this thesis, see chapter 3.3.13. (STX Europe, 2011; Lloyd’s Register Rulefinder, 2022)

3.5.3 Communications

PT 7, Ch 9, Section 4.3. states that a telephone system is to be provided to certain locations onboard. The communication system has been mentioned in this thesis, see chapter 3.3.14.
(STX Europe, 2011; Lloyd’s Register Rulefinder, 2022)

3.5.4 Power supplies

PT 7, Ch 9, Section 4.4. states that local distribution panels are to be provided for all items of electrically operated navigational equipment, the telephone system, the watch safety system, and the clear view systems. These panels are to be supplied by two exclusive circuits, one fed from the main source of electrical power and one fed from an emergency source of electrical power. Each item of equipment is to be individually connected to its distribution panel. The power supplies to the distribution panels are to be arranged with automatic changeover facilities between the two sources. As can be seen in Figure 30, the bridge equipment is connected to both main (MS) and emergency (EM)

switchboards. Automatic changeover is facilitated in the event of a blackout. (STX Europe, 2011; Lloyd’s Register Rulefinder, 2022)

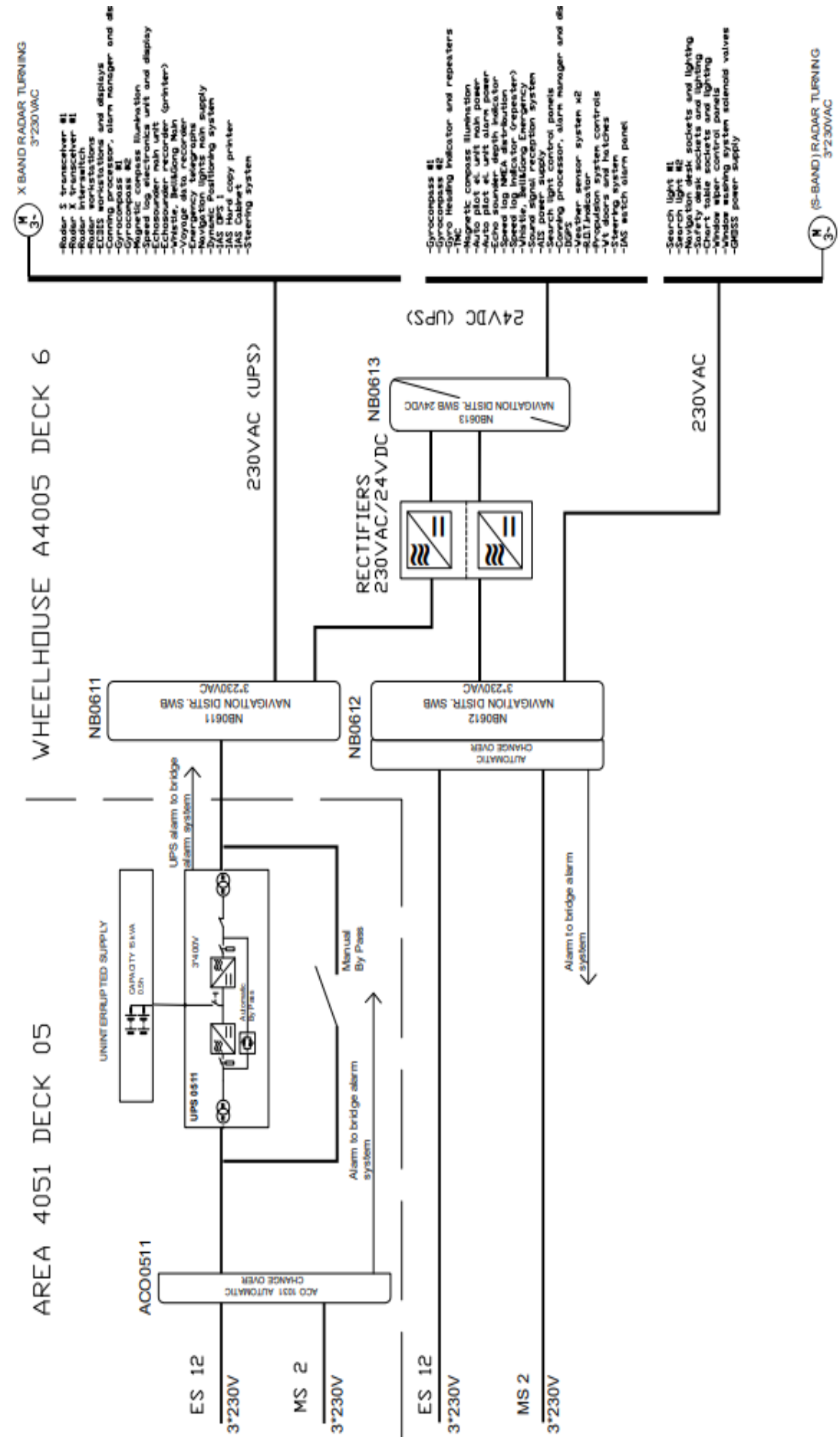


Figure 30. Power supply for navigation systems (STX Europe, 2011)

4 CONCLUSION

The aim of the thesis was to find out whether MV MERSol complies with Lloyd's Registers rules and regulations regarding navigational arrangements and integrated bridge systems. In order to reach this objective, an audit of MV MERSol's bridge design, layout, and equipment was conducted.

4.1 Compliance of the bridge design, layout, and equipment

MV MERSol meets the requirements of section 1 to 4 of the Lloyd's Register's Rules and Regulations for the Classification of Ships, July 2022 - Part 7 Other Ship Types and Systems - Chapter 9 Navigational Arrangements and Integrated Bridge Systems. Therefore, MV MERSol is eligible for the notation NAV1, which means that the bridge layout and level of equipment are such that the ship is considered suitable for safe periodic operation under the supervision of a single watchkeeper on the bridge.

4.2 Evaluation of the results

The results of the thesis are evaluated based on reliability, validity, and limitations in chapter 4.2.1 and 4.2.2

4.2.1 Reliability and validity of the results

I consider the results of my thesis to reliable and authentic, as the data obtained from the shipbuilder is trustworthy and verified by the classification society overseeing the construction of the vessel, Bureau Veritas.

4.2.2 Limitations of the results

The fact that I carried out my research remotely and not onboard MV MERSol can be considered a limitation. Because of that, I have been unable to physically verify whether all sources of information obtained from the shipyard are exactly the same as the actual design onboard of MV MERSol.

4.3 Recommendations for future research

I recommend that future research of similar nature is carried out on-site as much as possible. Performing an audit onboard of the vessel that is being researched can speed up the process significantly, and allows for more reliable results as compliance with theoretical legislation and figures obtained from drawings can be checked physically on location.

4.4 Self-reflection

As the research done for the thesis consisted mainly of analyzing technical documents, drawings, and legislation, human error cannot be ruled out. For example, the LR legislation can sometimes be written in a rather vague way, the way it is interpreted varies per person, and is up to discussion. LR legislation is very dense and, finding the right rules and regulations that apply to MV MERSol has proven to be quite challenging.

Going through all the different documents provided by the shipyard was not an easy task. It took me a lot of time to make sense out of all the different drawings and documents, and to organize them. Finding the right drawing or document to match with the LR legislation was time consuming.

Despite the challenges, I'm satisfied with the outcome of my thesis and I'm confident that my work will contribute positively to the MERSol project. On a personal level, researching this topic has been a great learning experience and I believe that the lessons learned will be useful throughout my career.

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