BACHELOR THESIS & COLLOQUIUM – ME184841

INTEGRATION OF MACHINERY SYSTEM TO SUPPORT DAMAGE CONTROL FLOODING SYSTEM (DCFS) IN ORDER TO FULFILL UNATTENDED MACHINERY SPACE (UMS) NOTATION APPLIED TO 80 METER OFFSHORE PATROL VESSEL

MUHAMMAD IRSYAD SAIHILMI

NRP 04211541000030

SUPERVISOR

Ir. Agoes Santoso, MSc., MPhil.

Indra Ranu Kusuma, ST., MSc.

DOUBLE DEGREE PROGRAM

DEPARTMENT OF MARINE ENGINEERING

FACULTY OF MARINE TECHNOLOGY

INSTITUT TEKNOLOGI SEPULUH NOPEMBER

SURABAYA

2019

BACHELOR THESIS & COLLOQUIUM – ME 184841

INTEGRATION OF MACHINERY SYSTEM TO SUPPORT DAMAGE CONTROL FLOODING SYSTEM (DCFS) IN ORDER TO FULFILL UNATTENDED MACHINERY SPACE (UMS) NOTATION APPLIED TO 80 METER OFFSHORE PATROL VESSEL

Muhammad Irsyad Saihilmi
NRP 04211541000030

SUPERVISOR
Ir. Agoes Santoso, MSc., MPhil.
Indra Ranu Kusuma, ST., MSc.

DOUBLE DEGREE PROGRAM OF
DEPARTEMENT OF MARINE ENGINEERING
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2019

SKRIPSI – ME 184841

SISTEM PERMESINAN TERINTEGRASI UNTUK MENDUKUNG SISTEM PENGENDALIAN KERUSAKAN KARENA KEBOCORAN (DCFS) DENGAN TUJUAN MEMENUHI NOTASI KAPAL TANPA AWAK (UMS) YANG DIAPLIKASIKAN PADA KAPAL PATROLI LEPAS PANTAI 80 METER

Muhammad Irsyad Saihilmi
NRP 04211541000030

Dosen Pembimbing
Ir. Agoes Santoso, MSc., MPhil.
Indra Ranu Kusuma, ST., MSc.

PROGRAM DOUBLE DEGREE
DEPARTEMEN TEKNIK SISTEM PERKAPALAN
FAKULTAS TEKNOLOGI KELAUTAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2019

APPROVAL FORM

INTEGRATION OF MACHINERY SYSTEM TO SUPPORT DAMAGE CONTROL FLOODING SYSTEM (DCFS) IN ORDER TO FULFILL UNATTENDED MACHINERY SPACE (UMS) NOTATION APPLIED TO 80 METER OFFSHORE PATROL VESSEL

BACHELOR THESIS

Submitted to Comply One of The Requirements to Obtain a Bachelor of Engineering Degree in Double Degree of Marine Engineering (DDME) Program Department of Marine Engineering – Faculty of Marine Technology

Institut Teknologi Sepuluh Nopember
Departement of Maritime Studies

Hochschule Wismar, University of Applied Sciences

Submitted by:

MUHAMMAD IRSYAD SAIHILMI

NRP 04211541000030

Approved by Bachelor Thesis Supervisors:

1. **<u>Ir. Agoes Santoso MSc., MPhil.</u>** ( )
   NIP. 1968 0928 1991 02 1001

2. **<u>Indra Ranu Kusuma ST., MSc.</u>** ( )
   NIP. 1979 0327 2003 12 1001

iii

"This page is intentionally left blank"

APPROVAL FORM

INTEGRATION OF MACHINERY SYSTEM TO SUPPORT DAMAGE CONTROL FLOODING SYSTEM (DCFS) IN ORDER TO FULFILL UNATTENDED MACHINERY SPACE (UMS) NOTATION APPLIED TO 80 METER OFFSHORE PATROL VESSEL

BACHELOR THESIS

Submitted to Comply One of the Requirements to Obtain a Bachelor of Engineering Degree

Laboratory of Marine Fluid Machinery and System

Double Degree of Marine Engineering (DDME) Program Department of Marine Engineering – Faculty of Marine Technology

Institut Teknologi Sepuluh Nopember

and

Department of Maritime Studies

Hochschule Wismar, University of Applied Sciences

Submitted by:

MUHAMMAD IRSYAD SAIHILMI

NRP 04211541000030

Approved by

The Head Department of Marine Engineering:

Dr. Eng. M. Badrus Zaman, S.T., M.T.

NIP. 1977 0802 2008 02 1007

"This page is intentionally left blank"

APPROVAL FORM

INTEGRATION OF MACHINERY SYSTEM TO SUPPORT DAMAGE CONTROL FLOODING SYSTEM (DCFS) IN ORDER TO FULFILL UNATTENDED MACHINERY SPACE (UMS) NOTATION APPLIED TO 80 METER OFFSHORE PATROL VESSEL

BACHELOR THESIS

Submitted to Comply One of the Requirements to Obtain a Bachelor of Engineering Degree

Laboratory of Marine Fluid Machinery and System (MMS)

Double Degree of Marine Engineering (DDME) Program Department of Marine Engineering – Faculty of Marine Technology

Institut Teknologi Sepuluh Nopember

and

Department of Maritime Studies

Hochschule Wismar, University of Applied Sciences

Submitted by:

MUHAMMAD IRSYAD SAIHILMI

NRP 04211541000030

Approved by

The Representative of Hochschule Wismar in Indonesia:

Dr. –Ing. Wolfgang Busse

vii

“This page is intentionally left blank”

DECLARATION OF HONOUR

I hereby who signed below declare that:

This thesis has been written and developed independently without any plagiarism act. All contens and ideas drawn directly from internal and external sources are indicated such as cited sources, literatures, and other professional sources.

Name	: Muhammad Irsyad Saihilmi
Student ID Number	: 04211541000030
Thesis Title	: Integration of Machinery System to Support Damage Control Flooding System (DCFS) in Order to fulfill Unattended Machinery Space (UMS) Notation Applied to 80 Meter Offshore Patrol Vessel
Departement	: Double Degree of Marine Engineering

Surabaya, July 2019

Muhammad Irsyad Saihilmi

"This page is intentionally left blank"

INTEGRATION OF MACHINERY SYSTEM TO SUPPORT DAMAGE CONTROL FLOODING SYSTEM (DCFS) IN ORDER TO FULFILL UNATTENDED MACHINERY SPACE (UMS) NOTATION APPLIED TO 80 METER OFFSHORE PATROL VESSEL

Name	: Muhammad Irsyad Saihilmi
Student Number	: 04211541000030
Departement	: Double Degree of Marine Engineering ITS
Supervisor	: Ir. Agoes Santoso MSc., MPhil.
	Indra Ranu Kusuma ST., MSc.

ABSTRACT

Indonesia known as archipelago country that own thousand islands. The worthy treasures must be protected properly from any maritime disturbances such pirate, hijack, terrorist, illegal fishing, illegal logging, and any crimes acts. The internal ship also needs to be protected from any disaster at sea caused by natural and attacking. Modern OPV need upgrade to the capability of warship in term of safety and security system. One of the feature is DCFS (Damage Control Flooding System). The system assure the ship could intact from hull damages in any recoverable scale. DCFS works automatically under integration of the VIAS (Vessel Integrated Automation System). This research works built a sub-program of DCFS that capable of automatics switch on/off all ship alarms and sensors systems, fire and bilge pumps systems, even main engines and auxiliary engines when the emergency call situation declared. Integrated automation will work faster than any human responses so the sources of disaster can override much earlier. All integrated DCFS can be monitored in a progressive LCD screen by interactive windows and menus.

Keywords: PLC Module, Damaged Control Flooding System, OPV, Integrated Automation System, VIAS

“This page is intentionally left blank”

SISTEM PERMESINAN TERINTEGRASI UNTUK MENDUKUNG SISTEM PENGENDALIAN KERUSAKAN KARENA KEBOCORAN (DCFS) DENGAN TUJUAN MEMENUHI NOTASI KAPAL TANPA AWAK (UMS) YANG DIAPLIKASIKAN PADA KAPAL PATROLI LEPAS PANTAI 80 METER

Nama : Muhammad Irsyad Saihilmi
NRP : 04211541000030

Departemen : Gelar Ganda Teknik Sistem Perkapalan ITS

Dosen Pembimbing : Ir. Agoes Santoso MSc., MPhil.

Indra Ranu Kusuma ST., MSc.

ABSTRAK

Indonesia dikenal sebagai negara kepulauan yang memiliki ribuan pulau. Kekayaan harta karun harus dilindungi dengan baik dari gangguan aktifiitas maritim seperti bajak laut, pembajak, teroris, penangkapan ikan ilegal, pembalakan liar, dan segala tindak kejahatan. Kapal internal juga perlu dilindungi dari segala bencana di laut yang disebabkan oleh alam dan serangan. OPV modern perlu ditingkatkan ke kemampuan kapal perang dalam hal sistem keselamatan dan keamanan. Salah satu fiturnya adalah DCFS (Damage Control Flooding System). Sistem memastikan kapal dapat utuh dari kerusakan lambung dalam skala yang dapat dipulihkan. DCFS bekerja secara otomatis di bawah integrasi VIAS (Vessel Integrated Automation System). Penelitian ini membangun sub-program DCFS yang mampu secara otomatis mengaktifkan / menonaktifkan semua alarm dan sistem sensor kapal, sistem pompa kebakaran dan lambung kapal, bahkan mesin utama dan mesin bantu ketika situasi panggilan darurat diumumkan. Otomatisasi terintegrasi akan bekerja lebih cepat daripada respon manusia mana pun sehingga sumber bencana dapat ditindak lebih awal. Semua DCFS terintegrasi dapat dipantau dalam layar LCD progresif dan menu interaktif.

Kata Kunci: PLC Module, Damaged Control Flooding System, OPV, Integrated Automation System, VIAS

"This page is intentionally left blank"

PREFACE

Alhamdulillah Thanks to Allah SWT the God of the world. I prayed to You, because of His grace blessings auhor can complete this bachelor thesis entitled **"Integration of Machinery System to Support Damage Control Flooding System (DCFS) in Order to Fulfil Unattended Machinery Space (UMS) Notation Applied to 80 Meter Offshore Patrol Vessel"** in a timely manner. To submitted the requirements to be graduated in bachelor degree of Double Degree program at Marine Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember Surabaya Indonesia.

Within this opportunity author want to give appreciation speech for those who involved and helped the author accomplish this bachelor thesis:

1. My parent and brothers for the prayers given, financial, support, gratitude, and else
2. Ir. Agoes Santoso MSc., Mphil. as Supervisor 1 and Indra Ranu Kusuma ST., MSc. as Supervisor 2 for the kindness and great advises on routine assistance.
3. Dr. Eng. M. Badrus Zaman, S.T., M.T. as the Head of Marine Engineering Department Faculty of Marine Technology ITS for the motivation to keep conquer the dreams
4. All the lecturers and staff in Marine Engineering Department FTK-ITS during courses taken since first semester until eight semester
5. Jerome Lin as Marketing Manager, Adi Wu as Technical Director, Tan Si Lex as Assistance Automation Engineer, and other employees from Praxis Automation Technology Far East Pte Ltd Singapore for the data receive and guidance to running, simulating, developing this thesis as plan was arranged
6. MMS Laboratory Members
7. Rafiqi Zulfauzi Pribadi, Rifqi Assidiqi, Fairuz Fajri Utomo, Muhammad Rifqi Ramadhan, Gusti Ngurah Putu Wibhu Ary Martha, Faris Misbahul Muhammad as Author's best Friends while in campus life and hope until future
8. Double Degree Marine Engineering Batch 2015 and Salvage 15 author's friends
9. And any accompany whom author cannot mention but very helpful for author

Thanks to those who have supported author in every way and day by day, so that the bachelor thesis can be solved. May Allah reward all their kindness. Amin. Author realize that this bachelor thesis is far from perfect, therefore appreciate and suggestions from all readers that are built for the perfection of this bachelor thesis. Helpful and beneficial for similar research with this thesis.

Surabaya,   July 2019

Muhammad Irsyad Saihilmi

TABLE OF CONTENT

"This page is intentionally left blank"

LIST OF FIGURE

LIST OF TABLE

"This page is intentionally left blank"

CHAPTER I
INTRODUCTION

1.1. Motivation Background

Maritime accidents always happen and repeat all the time in the shipping history. Modernized ships look likely only reduce the number but not eliminate the accidents totally. Some maritime accidents are sunk, capsize, fire, crash or collision, grounded, etc (*Zaman,2015*). Moreover in military vessels, they face on damage cause by mine, torpedo, bomb, and missile that possibly cause flooding and fire (*Hiltz,2006*). In order to overcome those potential accidents such as sinking of ship in maritime operations, application of DCFS (Damage control flooding system) can be implemented (*Carabresse,2012*).

DCFS capable to overcome damage of ships. DCFS is usually used in Military vessels but rarely applied on commercial/merchant ships (*Santoso,2017*). The function of DCFS is to detect of flooding, to support decision making for counteract solutions when the flooding happen. This system can also take action to improve the stability of the ship when flooding is occured in ship by regulating the relationship among equipment.

The application of DCFS is to reduce accidents; it is quite common that the sources of the accidents judged for two reasons only. There are technical error and human error. Technical error may be caused by mal-function of the parts, equipment, or the total system. Human error may be caused by miss-understanding, miss-interpretation, miss-focus, and many reasons caused by humanity weaknesses. Even though trained-well and experienced operators may still be able to do error during their duty. It is because human has limit and fragile from obstruction to their mentality, psychology, tiredness, emotion, boring, conflict in work or family, etc.

Unfortunately, for easy assessment some case of accident investigation laid up that human error is the reason (*Santoso,2019*). Human behaviors are always difficult to be modeled mathematically. Limiting the participation of human onboard a ship may possible and already approved by any Class Society. The scheme from UMS till Autonomous Vessel may be an evident to reduce human error as the ship operator.

In this research, the technology DCFS has been proposed to overcome and close the gap. These problems much interest so encourages studying all of these knowledge and contributing the optimal solution. This thesis will study to all the pumps and piping system that particularly support the damage flooding control. But some related features such as alarming and monitoring system will be also discussed. Fire main system as important part during flooding control will be also involved in the discussion. Therefore, the auxiliary system is a main part on the design philosophy for damage flooding control, and the integration automation is a tool to easier solving the problems (*Santoso,2018*).

1.2. Problem Statement

In this research, it concerns about new design prototype of DCFS. It will be applied for an 80 meters Offshore Patrol Vessel (OPV) as shown in Figure 1.1. The ship designing by using conventional fire, bilge, ballast system. For proposing the new prototype of DCFS under VIAS, then the problem is stated as follow:

- How to re-design of the existing systems for optimum integration automation (VIAS) with additional new DCFS feature by following UMS Notation for final complement.

1.3. Assumption and Limitation

The sub-program and feature for such DCFS application not available yet in the factory (*Lin,2017*). Hopefully, the mutual corporation can perform new built-in system that will be proven not only for academic purpose but also for industrial level. The main reason of the application for the type of a ship is the safety level that required by any ocean-going military operations, also usually initial costs may not restriction for military rather than safety and security issue. The new sub-program is generated related to the DCFS specifically for 80 meters OPV which will be develop in the form of virtual MIMIC. The final results are fully work when the hardware DAQ module installed on-board the ship. In this final project, validation system will be carried out by using dummy data installed in console bridge available at the factory. In the end of the activity, the discussion and analysis will be face to the relation how to implement the DCFS module for complying both the UMS Notation and the related SOLAS Regulations.

Adopting the UMS Notation may be acceptable for any owner. Technically speaking, OPV relatively occupied large space of engine room compared with any other type of vessel. It is a good challenge to accommodate proper design of the DCFS by arrange the available sea water pumps and its piping installation system and possible additional equipment that must be installed on-board the ship. The use of any existing systems are recommended so this study may need some engineering considerations to build a comprehensive and efficient new proposed DCFS system. It is also part of the study here.

Fig. 1.1. Visualisation of the 80 Meters Offshore Patrol Vessel

UMS will be the final focus on this study. Damage Control Flooding System (DCFS) as a part of the semi-military type vessel therefore will be designed and analyzed for the 80 meters OPV based on the requirements code to achieve UMS Notation for the type of the ship. Therefore, the topic of this research is how the most efficient pumps and their system arrangements of the automated new DCFS to fulfil the minimum requirements of UMS Notation applied to the 80 meters OPV.

1.4. Purpose of Study

Some of the purposes of this study can be stated as follows:

1. Maximum use of the existing systems and minimalizing new installation when adopting DCFS
2. Maximum use of the existing systems and minimalizing new installation when proposing UMS Notation
3. Design of the optimal use for integration automation for the DCFS and UMS achievements
4. Complete and effective built-in MIMIC for DCFS

1.5. Benefits of the Results

Main benefit for the study result is the capability of the ship to improve its safety level event adopting UMS Notation. Some of the others benefits for general can be stated as follows:

- Using existing system to conduct efficient engineering works for new building and conversion.
- Spread good information that the era of electronics is already exist globally, it should be aware by Indonesian engineers to study this technology and no doubt to apply this to their design.
- Module of VIAS may applied commercially and then may become benefits to the student for future knowledge and involvement for any real projects after graduation from the university.

"This page is intentionally left blank"

CHAPTER II
LITERATURE REVIEW

To give more data and information then in this part will be explore some knowledge to support the idea of the works. The literature study consists of UMS Notation requirements, damage control flooding system (DCFS), and the knowledge of the vessel integration automation system (VIAS). As the source of the case study then the general arrangement drawing of the 80 meters offshore patrol vessel is enclosed in Figure 2.1. The vessel made from the combination of marine high tension steel AH-36 grade for main hull and marine aluminum 5083 for superstructure and it was designed for operation in all Indonesia territory. By using 2 x 5400 HP diesel engines, the vessel designated to run at maximum speed of 20 knots and capable of for Sea State 5. Modern features of the vessel still remain unsatisfactory when all of the system still under stand-alone scheme. It is become well intention for owner and user to upgrade them using the integrated automation system in the next few futures.

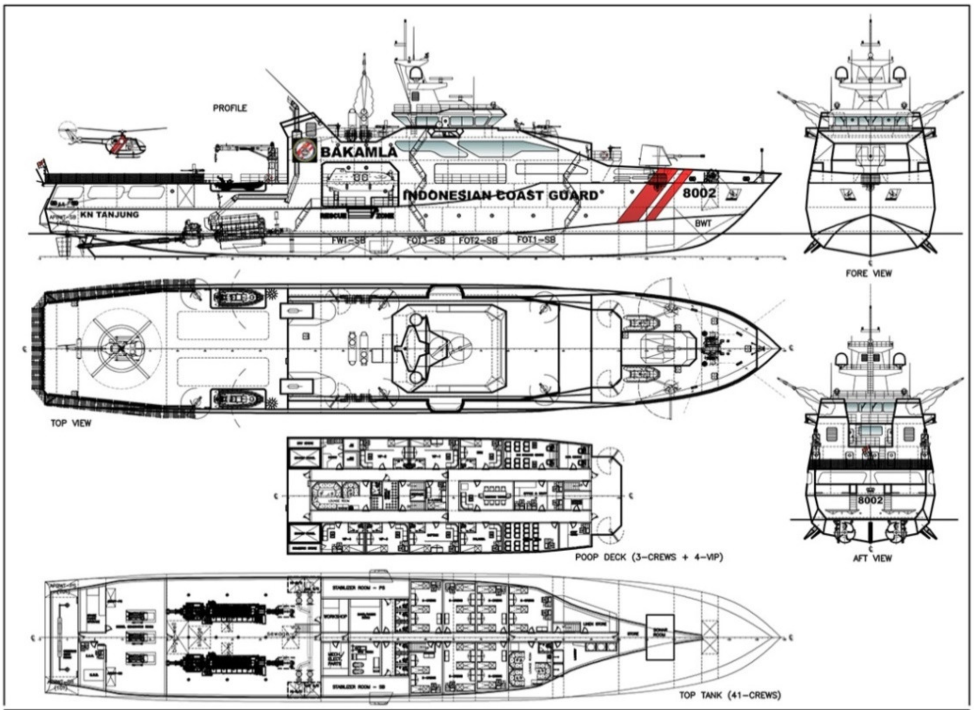


Fig. 2.1. General Arrangement of the 80 Meters Offshore Patrol Vessel

2.1. SHIP ACCIDENTS

Ship accidents become a catastrophic event that change the rule of the game in the shipping industry from ancient age to this modern era. Ship accident always happen and repeat all the time in the shipping history. This disaster always happens as look likely unavoidable situation as a simple thinking about unlucky or lucky matter for the ship. Milestone of the technology development to avoid ship accident came when the famous Titanic sank hundred years ago (*Wilkipedia,2019*). Then learning from this deadliest disaster during peacetime, subsequent evaluation recommended to changes maritime regulations, leading to the establishment of the International Convention for the Safety of Life at Sea (SOLAS) in 1914.

The regulation always improves and upgrades refer to the marine disaster occurred in the yearly events. But revised SOLAS regulations and modernized ships look likely only reduce the number but not eliminate the accidents totally. Some maritime accidents such as sunk, capsize, fire, explosion, crash or collision, grounded, etc (*Zaman, 2015*) still happens every year. Moreover in military vessels, they face on risk damage cause by mine, torpedo, bomb, and missile that possibly cause flooding and fire (*Hiltz, 2006*). Ridiculously, this might be happened due to human error during peacetime.

2.1.1. Historical Review

It is an acceptable idea that accident happens when more than one cause occurs in the same time. More the number of cause may increase the risk of the disaster and less opportunity to avoid them. Natural factor such as bad or even extreme weather, high sea-wave, wind and storm, fog, heavy rain, etc. contribute high risk of disaster. This decade called as global warming era cause severe weather and worst sea and ocean phenomenon. From November to February, series of ship accident coming take turns and fatality been occurred unavoidable. But conversely, even in the clear weather and very calm water the accident still possible happens, for example the craziest case of the 297-foot (90.6 meter) MS Caledonian Sky that route to Philipine crashed into the reefs at Raja Ampat on March 4 (*CNN.com*).

Nearly 140,000 square feet (more than 13,000 square meters) of reef were destroyed. The ship crashed into one of the best diving areas and stuck more than 10 hours. Study show that it’s caused by human error when the accident happened, the captain of the ship decided to make a route out of the plan. Technically speaking, the captain of the ship knows that he has a full weight vessel should not pass through above the shallow water.

Fig. 2.2. Grounded of MS Caledonian Sky into Raja Ampat reefs

Second example is accident of a passenger cruise Royal Caribbean were left panicking peoples when the ship flooded during their 10th days holiday, leading to an emergency detour. Many tourists were left in the dark and without any supply.

Fig. 2.3. Royal Caribbean passengers cruise flooded after leaving port

Royal Caribbean passengers were left shocked when water began to appear onboard the ship they were travelling on (*Source: Kara Godfrey, web-*

published Nov 1st 2018). The ten-day excursion had just left Southampton port when the incident occurred. The cruise faced bad weather cause flooding into decks and passenger rooms. Big size ship such as cruise liner doesn't means resist from bad weather. It is also learning point to be understood that ship accident still possible for any kind of ships. Protection and prevention systems must be placed in the paramount design ideas by also comply with the safety rules and regulations.

In many cases, the ship accidents were caused by flooding and fire. Flooding commonly caused by the broken outer part of the hull constructions due to crash, grounding, hit hard structure, even caused by enemy weapons in the military ships. Modern war not imply only country to country but also the system against terrorism and pirates. In the peacetime, enemy can also in the form of any illegal acts in maritime areas.

Flooding and sinking accident of the ship have a long list almost in all countries around the world. Table 2.1. shows the list from Marine Accident Report from National Transportation Safety Board (NTSB) happened only in a developed country such as USA. It is believed that more accidents may occurs in so many under development countries.

Table 2.1. List of accident caused by flooding

Flooding	Accident Date
Flooding and Sinking of Towing Vessel Ms Nancy C	03/06/2018
Flooding and Sinking of Fishing Vessel Ben & Casey	10/30/2017
Flooding and Sinking of Towing Vessel Savage Ingenuity	09/05/2017
Flooding and Sinking of Fishing Vessel Lady Damaris	06/22/2017
Flooding and Sinking of Fishing Vessel Ambition	07/23/2016
Flooding of Towing Vessel Atlantic Raider	10/28/2016
Flooding and Sinking of Small Passenger Vessel Maximus	05/12/2016
Flooding of Dive Support Vessel Hammerhead	06/07/2017
Flooding and Sinking of Fishing Vessel Capt. David	02/15/2016

Fire and explosion may be caused by several reasons such as smoking, mechanical spark, electric short, gas leakages, flammable cargo, explosive materials, chemical material, and certain situation such as sabotage and terrorism. In military vessel the fire and explosion come from enemy weapons. Fire prevention and extinguisher already stated as ship safety standard from long time ago. Fire prevention system is the best option to be provided for any type of ship. Well understanding the basic science of the fire formation such as fire triangle is an important knowledge to setup equipment and system.

Table 2.2. shows the list of ship accident caused by fire that has been reported by NTSB in United States. Fire still known as the most frightening horror when occurs on board a ship. The existence of a large quantity of fuel onboard make any small fire become a catastrophic accident that may destroy completely a ship. Fire accident also produces toxic smoke and heat that easy kill anyone inside the burned ship. Fire can be formed by a simple reason that unexpected by crews and passengers, for example smoking.

Table 2.2. List of international accident caused by Fire

Fire	Accident Date
Engine Room Fire Aboard Towing Vessel J.W. Herron	12/13/2017
Fire On Board US Small Passenger Vessel Island Lady	01/14/2018
Engine Room Fire Aboard Towing Vessel George King	01/24/2018
Fire Aboard Sailing Vessel Best Revenge 5	07/11/2017
Fire aboard Roll-on/Roll-off Passenger Vessel Caribbean Fantasy Atlantic Ocean, 2 Miles Northwest of San Juan, Puerto Rico	08/17/2016
Fire aboard Vehicle Carrier Alliance St. Louis	01/16/2017
Fire aboard Vehicle Carrier Honor	02/24/2017
Engine Explosion and Fire Aboard Towing Vessel The Admiral	07/14/2016
Fire aboard Passenger Vessel Tahoe Queen	08/16/2016
Fire aboard Fishing Vessel American Eagle	02/10/2016
Fire aboard Towing Vessel Thomas Dann	07/22/2016
Fire Aboard Vehicle Carrier Courage	06/02/2015
Engine Room Fire Aboard Cruise Ship Carnival Liberty	09/07/2015
Fire aboard Towing vessel Jaxon Aaron	08/13/2016
Fire aboard Commercial Fishing Vessel Raffaello	01/17/2016
Fire aboard Container Gunde Maersk	12/08/2015
Fire Aboard Towing Vessel San Gabriel	02/26/2016
Fire Aboard Freighter Alpena	12/11/2015
Fire on board Fishing Vessel Northern Pride, with Subsequent Capsizing	04/21/2015
Engine Room Fire on Board Commercial Fishing Vessel Miss Eva, with Subsequent Sinking	12/01/2014

In Indonesian maritime activities also noted some ship fire accidents listed by the Ship Accident Investigation Agency or KNKT as shown in Table 2.3. below. Electrical short and engine room burning sources become the most frequently accidents in this national shipping industry. Some case cause total loss of the ship and fatality to the passenger and crews inside the vessel.

Indonesian ship usually uses of conventional system for fire main and the fire prevention equipment. Any fire accident can only be known under visual or attendance of human in the scene area. In many cases, the fatality happens due to the late of extinguishing the initial un-hazard fire. Best solution for handle fire is extinguishing in the early time (*Bitrovic,2014*). Sensors and alarms not working well or event not available in many scene areas. Maintenance and repair works may be neglected and less control for routine inspection whether by crews and owner. Some cases also happened when the fire extinguisher and its control system are un-sufficient to handle the fire. Improper design can also contribute the fail of the fire-fighting effort due to less number of equipment or difficulty in access to them.

Table 2.3. List of national accident caused by Fire

Fire	Accident Date
Burnt Dharma Kencana II	29-Oct-17
Burnt SPOB Srikandi 511	25-May-18
Burnt Engine Room Pekan Fajar	12-Jul-17
Burnt Steering Gear Room Amelia-1	13-Jun-17
Burnt Asia Prima I	17-May-17
Explosion and Burnt Engine Room Layar Samudra	21-Apr-16
Burnt Pump Room Carrier Kapuas	25-Apr-16
Burnt Motor Ship Asia Raya	15-May
Burnt SB. Bintang Fajar	15-Oct-16
Burnt FSO. CILACAP/PERMINA SAMUDRA 104	15-Sep-14
Burnt KM. Cantika Lestari 77	14-Mar-17
Burnt KMP. Caitlyn	21-Feb-17
Burnt KM. Zahro Express	01-Jan-17
Burnt Engine Room MV. Divine Success	16-Sep-16
Burnt Engine Room MT. Nusa Bintang	20-Nov-15
Burnt Generator Set KM. New Glory	15-Nov-15
Burnt KM. Otong Kosasih	20-Sep-15
Burnt KMP. Gelis Rauh	17-Jul-14

2.1.2. Overview Technology to Eliminate Ship Accidents

Many literatures states technical overview about the technology to prevent and fighting of the fire. Preventing for formation of fire is much advantage than fighting formed fire. Modern ship mostly provided with a sophisticated fire prevention system and high capability of fire-fighting system (*Sen,2015*). The combination system will keep firmly the life of the ship in the whole of the designed operational time. Wise owner should think that the (may never been used) expensive equipment for fire system is not costs but an investment. Lacks in provide the fire system can ruin the investments in very short time.

2.2. DAMAGE CONTROL FLOODING SYSTEM

The costs associated with personnel and maintenance taking into account for approximately 70% of the total operating costs of a ship. Of these costs more than 50% are associated with personnel expenses. The costs also face a problem even in military fleet. For example, Canadian Forces have made the reduction of the total operating costs of ships a priority, approaches to the reduction in crewing levels without obstruct operational capabilities and safety (*Hiltz,2006*). As a specific task is their effort to run the damage and fire control by using less number of crew. This project has several objectives including a state-of-the art review of damage and fire control technologies, modeling and simulation of damage control activities and the evaluation of how automation will affect crewing levels required to maintain damage and fire control capabilities, identification of materials with enhanced damage and fire resistance, and the evaluation and demonstration of wireless condition monitoring systems.

Varela (2014) also explain how the important a ship simulation system to support emergency planning decision when ship flooding occurs. Flooding times and stability parameters are measured, allowing for the crew to take the adequate measures, such as isolate or counter-flood compartments, before the flooding takes incontrollable proportions. The simulation is supported by a Virtual Environment in real-time, which provides all the functionalities to evaluate the seriousness and consequences of the situation, as well as to test, monitor and carry out emergency actions. Being a complex of physical phenomena that occurs in an equally complex structure such as a ship, the real-time flooding simulation combined with the Virtual Environment requires large computational power to ensure the accuracy of the simulation results. Therefore, the availability of automation system onboard a ship not only functioning for real damage and fire accidents but also can be used for training and exercises situations.

Detect of flooding in ship, by require sensor or tranducer will automatically send notification to system to take an action. Progressive flooding inside a damaged ship can seriously endanger the safety (*Pitana,2017*). Level sensors can be used to detect the flooding, and based on this data the breach can be estimated. For decisison support the prediction of flooding extent and the intermediate phases is necessary. For this purpose a new simplified, but still reasonable accurate, flooding prediction method has been develop.

Concerning the ship flooding simulation, *Varela* and *Guedes Soares* (*2007*) describe a VR based Decision Support System to assist the coordination of damage control teams and to take the appropriate counter-measures in case of flooding fire or contamination onboard military vessels. For the specific case of progressive flooding, fast-forward simulation allows the operator to check which compartments will be flooded, the order by which they will flood, and how much time they will take to be flooded. Ideally, the simulation must complete in time for the operator to take the adequate counter measures before the ship enters into an irreversible capsize or sinking situation. Within this scope, the simulation ends when the stability is recovered or when the ship capsizes. The current paper presents an on-board decision support system for ship flooding emergency response. The system runs a fast-forward simulation of the progressive flooding of ship compartments given an initial condition, which includes the current load and damage conditions of the ship. As the way system decide to improve or control when the flooding happen. Controller or micro controller will contribute. System will take an action to improve the flooding, by implement Data Aquisition (DAQ) later the real sensors will automatically notify to the real operation. Actuator will work to turn off the valves on and to turn on or off the pump. DAQ system capable of handling multi-detectors securely (*Dey,2013*).

Relationship between equipment, when the ship's hull broken for example, caused by hit missile from enemy during duty, it may make leak damages to the construction and seawater will come inside the ship, then low-level sensor detector triggered and the emergency alarm will on (*Bulitko,1999*). Signal then sent to run the pump automatically, some of pumps can operate, then crews will reconstruct those damaged hull immediately. During emergency condition, it can be arranged that the system will run another seawater pumps such as ballast or general service pump to support the effort to remove leak water overboard.

Figure 2.4. shows the scheme of the ship DCFS. DCFS planned mainly to overcome flooding in engine room and accommodation room where placed in the lower part of the main deck. There are two option provide for the DCFS, series of reaction components group to determine the situation and series of action components group to overcome the situation.

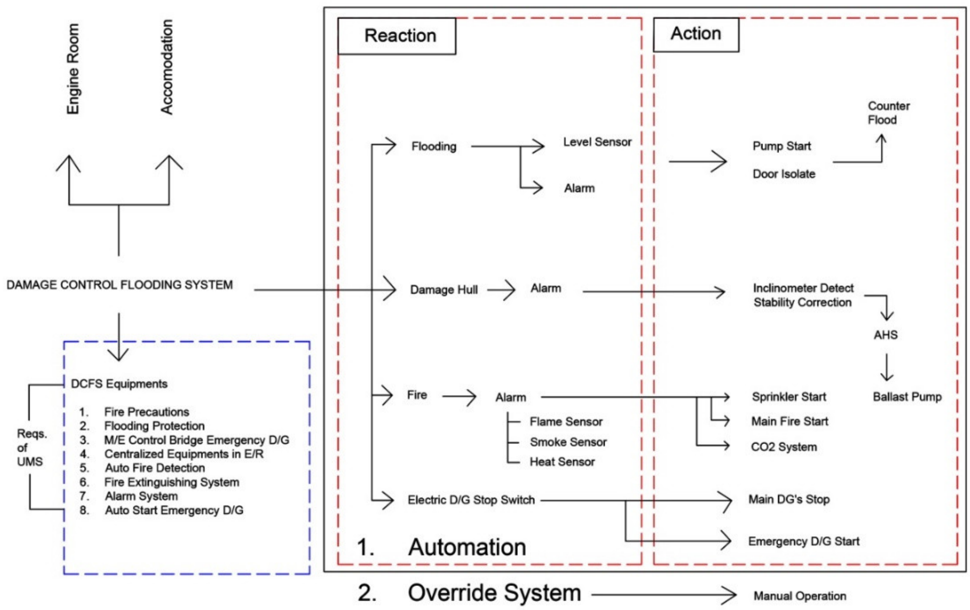


Fig. 2.4. Scheme of the Damage Control Flooding System

DCFS reacts to the four problems of the potential accidental situation. Each of them can be explained as below:

- Flooding accident in any scale can be detected by level sensor installed in the certain position in the engine room and some compartments in the lower main deck. Achieving the position of the critical level then the alarm will on and buzzing noise.

- Damage hull accident in any position of underwater level will be detected if there is the change of transverse inclination of the ship. This situation will on the available alarm system installed on-board.
- Fire accident can be detected by using three types of sensor; flame sensor, smoke sensor, and heat sensor. The sensor will on the available alarm system.
- Diesel generators will provide with auto-stop switch. When one of the accident above happens then system will cut power of the generators. It is purposed to protect electrical generator to be shorted by flooding. This feature is important because of their position mostly located in the tank top of the engine room. Some design that placed the generators in the upper platform may not necessary to provide auto-stop switch.

The command system produces by reaction block then managed to be direct response as actions to overcome of every single problem caused by accident. Detected flooding by level sensor that setup alarm then automatically counteracts by starting fire pumps. If the alarm buzzing because of the damaged of ship's hull then inclinometer will detect the changes of trim conditions. Anti Heeling System (AHS) will control the ballast pumps to counteract the condition of the ship. Fire detected by sensors will respectively switch on the fire main system, sprinkler system, and if necessary the CO_2 flooding system. The activation of CO_2 flooding system need to double check to ensure there is nobody stay inside the engine room and even engine control room. The capability to switch off the main diesel generators under emergency situation will connect directly with the capability to switch on the emergency generator in simultaneously (*Santoso,2019*).

2.3. VESSEL INTEGRATED AUTOMATION SYSTEM

Vessel Integrated Automation System (VIAS) is a unique term that has been developed by Praxis Automation Far East Ltd. in Singapore branch office. This scheme of the automation system may found in any brand/maker of ship/platform electronic and automation system. Conventional ship electronic is term when each of the electronic equipment works individually or stand alone. Basically in this modern technology, mostly ship's equipment such as pump, compressor, valves, engines, etc. already provides with electronic control system. VIAS integrate each of the ship's equipment in one module control system so every system can work automatically. VIAS has features such as IPMS (Integrated Power Management System) that consist of PCS (Propulsion Control System), PMS (Power Management System), Fire detection system, Engine control and monitoring system, extension alarms system, Damage Control Flooding system (DCFS), Tank gauging system, CCTV system, etc.

2.3.1. Overview Technology Automation

All military and commercial vessels are required to establish safe ship management procedures. One of the model is Safety Management System (SMS) that should be implemented by the shipping companies to ensure safety of the ship and marine environment. One of the solution to improve safety onboard the ship by eliminate as much human involvement as possible by adopt the automation system. Moreover, vessel integrated automation system (VIAS) may offers many benefits for the ships and all cargo inside. Because of the VIAS not only offers safety matter but also easiness operation, improving reliability and redundancy, saving electric energy, and contribute to the long life of the ship.

Theoretically, there are hierarchy in the application of electronic and control system for ship. Figure 2.5. shows the structure of the systems. Integrated electronic system applied onboard a ship growing from stand-alone system, integrated system, automation system, intelligence system, and nova technology called as autonomous system. In respectively the system offers higher and higher level in sophisticated electronic technology both hardware and software. Complexity of the system is not big issue when the modern GUI (Graphical User Interface) adopted by software developer. Engineer or programmer does not need deep knowledge about programming language but graphically they can work as built a puzzle using ready use which is represent by icons and connector.

The basic system actually is a manned ship where the master control ship movement by using a conventional hand-wheel. Master work in the wheel-deck and using his visual to navigate the ship and even it is the simplest system but in this modern age, generally, it is already supported by several navigational equipment such as RADAR, ECDIS, etc. Second level may be called as generic alternatives where the system offers two ways in navigate the ship. First is remote ship. This technology applied for only unmanned very small boat or toys due to limited range of the radio transmission used. Second is automated ship where this technology capable of setup certain route and early programmed to navigate the ship from a start point to another destination. Automated means a specific system works self-acting as the purpose of the duty. Then, integrated automation means all specific systems may work interconnected to perform a duty to navigate the ship but still under attending a master in wheel-deck. And finally, autonomous ship can be translated technically as a ship without master or driver. It should be obvious if the model called as without crew because of existence crews still in demand for ship service rather than an effort to navigate the ship.

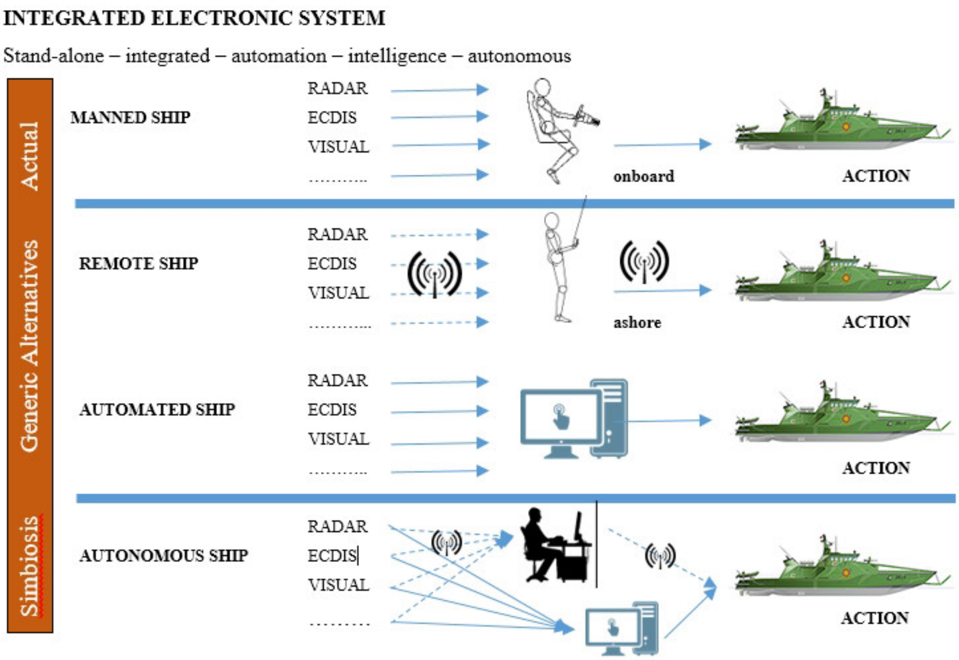


Fig. 2.5. Hierarchy of Integrated Electronic System *(Santoso,2017)*

Refer to the review then the advantages of the integrated automation system such as VIAS in order to improve safety can be listed as follows:

- Fully protect of ship to avoid from any potential collision (*Shtay,2009*)
- Less Crews means less human errors
- Easy ship operations and maintenance
- Total VIAS for machinery automation can reduce fuel and energy
- Green VIAS performs low emission level and environmental friendly
- One solution for UMS Notation
- One step to Vessel Autonomous System

In conversely, there are also common disadvantages in the application of the integrated automation system as listed below:

- Initial costs quite high depend on the level
- Complexity onboard electronics system

In this research works, some features of the existing VIAS modules will be developed to the specific purpose of DCFS by integrated all of the relevant equipment and system especially fire system and sea water bilge system onboard the ship. The desired condition of the new ship system is the capability of damage control flooding system to integrate all equipment under one virtual console. It will improve ship safety by optimize existing pumps and their installations and also all related supporting system, such as alarming and sensors system. Figure 2.6. shows the basic schematic diagram of the DCFS that will be generated for designated ship.

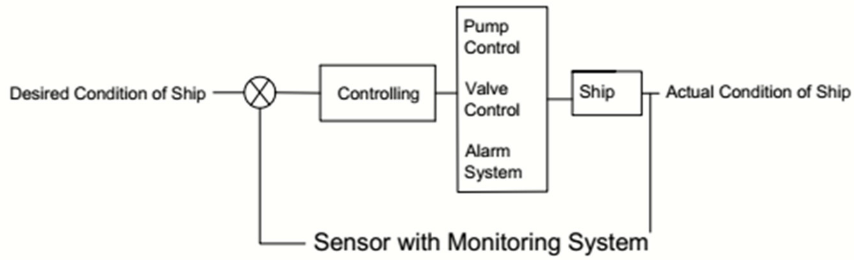


Fig. 2.6. Desired Condition of the Ship

2.3.2. Application On-board - Review

Implementation of the common integrated automation systems already establish a long time ago. It is not a new technology in the ship industry. Most of the ships even small boat already installed by this technology. Anyway, integrated automation rarely applied in local and national shipyards. Growing the advanced electronic technology and conversely decreasing initial costs to invest such of technology, it is a time to encourage any local ship-owner, user, and shipbuilder to adopt the automation technology and if possible the integrated one. Shipyard may compete the international market if the know well the technology.

The parts of the complete system of the integrated automation can be explained one by one as follows. Based on the budget then ship-owner can also determine their priority in adopting part of the system listed. It is quite flexible and no issue technically when the ship uses partial part and upgrade in the next time.

Remote Control/Operation

- Monitoring
- Machinery Control
- Navigation & Piloting
- Operation of Payload Systems
- Stability control and improvements
- Remote operation and may developed autonomous system

Condition Monitoring
- Intelligent Systems – Self Diagnosis
- Smart Maintenance Schemes
- Remote Support
- Satellite and Online
- Maintenance by Robots

Decision Support
- Navigation (Routing)
- Situational Awareness
- Collision Avoidance
- Safety Support

Operations Optimisation
- On-board Energy Optimisation
- Fleet Optimisation
- Revenue Optimisation

On-board Automation
- Automatic Reporting
- Automatic Mooring
- Full Autonomous Operation

2.4. UNATTENDED MACHINERY SPACE NOTATION

The developments of electronics and automation system will grow fast toward higher level called as intelligent system, integrated automation, and autonomous system that all systems will refer to the any single marine machinery and system (*Santoso,2017*). Class Society already give opportunity to any vessel for establish UMS (*Unattended Machinery Space*) Notation as stated by SOLAS 1974 Chapter II-1, Regulation 46 to 53. This notation challenges the owner of the ship to give more valuable and level for their ships. The benefits come not only in technical aspects such as less crews, safer ship, less human error, easier operation and maintenance, etc., but also in economical aspect when the existence of the crews is second dominant portion in the ship operation costs.

2.4.1. Basic Philosophy of UMS Notation

Ship that fulfill the requirements will be awarded by *Notation E0* from Class DNV and AUT from Class GL. For ships that requires this additional Notation then its operational must adopt Rules SOLAS Chapter II-1 relevant to the Regulation 46, stated as:

"The arrangements provided shall be such as to ensure that the safety of the ship in all sailing conditions, including maneuvering, is equivalent to that of a ship having the machinery spaces manned. ... Measures shall be taken to the satisfaction of the Administration to ensure that the equipment is functioning in a reliable manner and that satisfactory arrangements are made for regular inspections and routine tests to ensure continuous reliable operation. ... Every ship shall be provided with documentary evidence, to the satisfaction of the Administration, of its fitness to operate with periodically unattended machinery spaces."

2.4.2. Requirements of UMS Notation

Essential requirements for any unattended machinery space (UMS) ship to be able to sail at sea are enumerated in the SOLAS 1974 Chapter II-1, regulations 46 to regulation 53. The main points discussed in this chapter are discussed in this SOLAS article. Therefore, to achieve the UMS Notation and its certificate, then the ship must be provides at least by this list of equipment and system. It is minimum requirements that may need more qualifications to fulfill or comply with the Notation. It requirements depend on the type and size of the ship planned to be built.

The list of the requirements for UMS achievement are stated as below. In this research works, the list will be followed to comply with based on the developed new module of DCFS-VIAS program.

- Fire Precaution
- Protections against flooding
- Control of Propulsion Machinery from Bridge
- Centralized Control & Instruments are required in Machinery Space
- Automatic Fire Detection
- Fire Extinguishing system
- Alarm System
- Automatic start of Emergency Generator

Fire Precaution

A) Arrangement should be provided on the proposed UMS ship to detect and give alarm in case of fire.

a) In the boiler air supply casing and uptake.

b) In scavenge space of propulsion machinery.

B) In engines with the power of 2250 KW and above or engine cylinders having the bore diameter more than 300 mm, they should be provided with oil mist detector for crankcase or bearing temperature monitor or either of two.

Protection against Flooding

Bilge well in UMS ship should be located and provided in such a manner that the accumulation of liquid is detected at normal angle of heel and trim and should also have enough space to accommodate the drainage of liquid during unattended period.

In the case of automatic starting of the bilge pump, the alarm should be provided properly to indicate that the flow of any liquid pumped is assured more than the capacity of the particular pumps. It is clear and always ben stated in any Bilge pump arrangement under Class Approval.

Control of Propulsion Machinery from Navigation Bridge

The ship should be able to be controlled from bridge (navigation room) under all sailing mode conditions. The crews in the bridge should be able to control the speed, direction of thrust, and should be able to change the pitch in case of controllable pitch propeller. Emergency stop should be provided on the navigating bridge and complemented with certain independent of bridge control system.

The remote operation of the propulsion should be possible carried out from one location at a time, and at such connection the interconnected control position be permitted.

The number of consecutive automatic attempt which fails to start the propulsion machinery shall be limited to a safeguard sufficient starting air pressure.

Centralized control & instruments are required in Machinery Space

Centralized control system should be there so that engineers may be called to the machinery space during emergencies from wherever they are.

Automatic Fire Detection

Alarms and detection should operate very rapidly and effectively. It should be placed at numerous well sited places for quick response of the detectors.

Fire Extinguishing System

There should be arrangement for fire extinguishing system other than the conventional hand extinguishers which can be operated remotely from machinery space. The designated station must give control to the emergency fire pumps, generators, valves, extinguishing medium, etc.

Alarm System

A comprehensive alarm system must be provided for control room & accommodation areas. Modern electronic technology capable of integrate and interconnect them based on the automation system from sensor monitoring to acting devices such as sprinkler system and monitor fire guns.

Automatic Start of Emergency Generator

Arrangement for starting of emergency generator and their automatic connection to bus-bar must be provided in case of blackout condition. Apart from that following points are also to be noted.

1) Local hand control of essential machineries like steering, emergency generator starting, emergency start for main engine etc.
2) Adequate settling tank storage capacity.
3) Regular testing & maintenance of machinery alarms & instruments.

Within implement those Requirements Ship will be Comply with the UMS Notation.

2.4.3. Rules and Regulations Related to UMS Notation

All particular ships commonly built by following certain Rules and Regulations that are established by any Class Society. Almost all Class Society have the Rules and typically similar Regulation in control the UMS adoption. This Notation is not a new issue and already adopt in many ships operated today world-widely.

2.4.4. Application of UMS Notation for Patrol Ships

Patrol ships especially the combat type for military has main duty in warfare condition. Damaging hull of such the ships, off course not only caused by natural disaster but also by combat accident such as bullet, torpedo, and missile. It is one of the reason why DCFS become the feature of the military vessel.

It is understandable that opinion about "Safety & Security" in the Indonesia shipping industry is still weak, publicly known that in this country should be develop more of tighten rules to prevent any potential risks to accident at sea. Safety and security awareness must be stated clearly in both the international and local rules and regulations for any eligible types of ships. The rules and regulation not only applied on standard operational procedures but also on any equipment installed on board a ship. For example, ship navigation technology such as radar, AIS, NAVTEX, etc. growing fast following the fast development of electronic and control technology. The conventional system basically stand-alone, but nowadays all of them already in integrated system and possibly in the future they might be construct in automation technology, moreover can build autonomous. Called as an unmanned navigation system.

The automation and advanced autonomous system can encourage the ship navigate safer (*Zaman,2015*). It is caused by capability of minimize any possible human errors. Sea drone or event driverless technology not only a lifestyle but more important is improvement of safety at sea.

"This page is intentionally left blank"

CHAPTER III
METHODOLOGY AND DATA

This final project will be carried out by setup a model called as VIAS (Vessel Integrated Automation System) especially contains of a safety improvement system to overcome flooding on-board a ship that may be caused by flooding. In an offshore patrol vessel as used as case study model on this final project, flooding may be caused by not only natural sources but intensively due to attack of the another vessel. Main duty of this patrol vessel should overcome any confrontation using weapons from enemy, illegal fishing, and pirates. Bullet and rocket can break any kind of this type of military vessels. In the peaceful era the technology may also benefits for merchant ships when the flooding accident possibly occurs in condition of crash, wreck, grounding, and any other accident.

This chapter will intent to establish strategic and plan in order to structure the comprehensive methodology for easy analysis and perform setup conclusion as the objectives of this works.

3.1. STRATEGIC AND PLAN

Strategic means steps or procedures in efficiently will be used to develop the new model of DCFS of the OPV 80 Meter. Plan means time frame based activities to execute the works effectively in the certain limited duration of study. It is need good management in order to satisfy all of the problems and establish its solution in this final project.

3.1.1. Strategic

Modelling works will be carried out in Singapore with corporation of PRAXIS Automation Far East Ltd (*Lin,2017*) as counterpart. The sub-program and features for such application not available yet in the factory. The new sub-program related to performance of DCFS. For 80 meters OPV will be develop in the form of virtual model called as MIMIC. The results is fully work when the hardware called as DAQ installed onboard the ship.

In this final project, validation system will be carried out by using dummy data installed in console bridge available at the factory. In the end of the activity, the discussion and analyze will be face to the relation how to implement the DCFS module for fulfill both the UMS Notation and the related SOLAS Regulations. Hopefully, the mutual corporation between ITS student and this qualified industry, such as PRAXIS, can perform a new built-in system that will be proven not only for academic purpose but also can be extended for the industrial level.

It is possible and a one part of our strategic to patent this works. New module with the specific function such as DCFS-VIAS can be a part of ship equipment both in forms of virtual and physical module. The author and his institution, The Department of Marine Engineering ITS, will make effort to intent registration for national patent in term of the idea and the physical new DCFS module.

3.1.2. Plan

The flowchart of the activities steps during this research works will be explained in the Figure 3.1. Main model related to the new module of DCFS is Fire and Bilge pumps system. But to perform a complete standard of the such UMS Notation then some additional features must be established here.

In part of the flowchart step, it can be seen that VIAS performances can be developed in 4 (four) systems; pumps system, control and monitoring, alarms system, and main engines & auxiliary engines control system. All the proposed systems will be wrapped inside the one new module of DCFS-VIAS created in this final project.

The results of the research works are validated the systems of DCFS in simulation from developing MIMIC and its functional tested when several scenarios of fire accident in all of the ship's compartments are generated. All provided sensors in each of the compartments should capable of send alarms to the system and DCFS-VIAS should generate proper location and indication of the sources of the fire. Ship's crews can effectively know the sources of the exact position of the fire or smoke and make any counteracts efforts to extinguished the fire even in initial form as a smoke. Actually VIAS designed to conduct automatic counteracts such as operate fire pumps and start the sprinkler system but much better if ship's crews can monitor the sources of fire by visual CCTV or dim alarm and signal in the TFT screen located in the navigation bridge.

The fulfilled new module DCFS-VIAS system can be used to arrange UMS Notation and any SOLAS requirements as base data in analyze and discussion step of work. Finalized them make easier reporting and publishing.

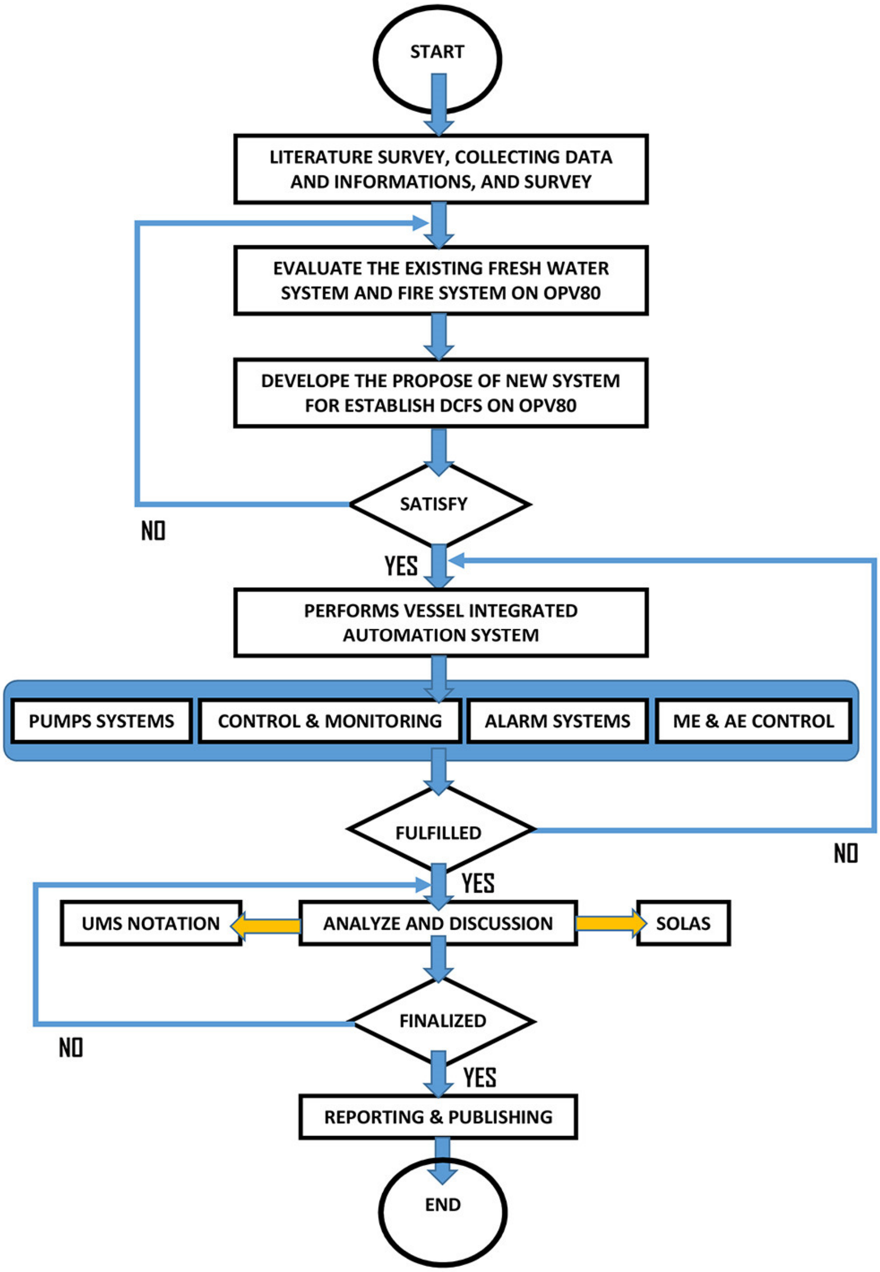


Fig. 3.1. Flowchart of the Research Activity

3.2. SHIP PARTICULAR AND DATA

Main function of this 80 meter Offshore Patrol Vessel is a floating/mobile base that have capability for unlimited patroling task for surveillance and security in order to protect Indonesian sea territorial from any ilegal activities and securing national sovereignty. OPV 80 meter is designed by using combination of high tensile steel (AH-36 type) as main hull and aluminum 5086 as superstructure. The design ship powered by 2 (two) units medium speed marine diesel engine with rating of Continous Heavy Duty, and capable of operated remotely from the wheelhouse. The ship particulars and data can be listed as below:

PATROLI BAKAMLA 80 METER	
LOA	: 80.00 meter
LWL	: 72.25 meter
LPP	: 71.15 meter
B (mld)	: 14.00 meter
H (mld)	: 7.95 meter
T (drought) Max.	: 2.50 meter
Speed (max)	: 22 Knots
Main Engine	: 2 x 4400 HP
Crews	: 60 persons
VIP Room	: 4
Doctor + Medical Team	: 2 + 8
Passangers	: 26 persons
Main Gun Cannon 76mm	: 1 unit
12,7 mm Gun	: 6 units
Water Cannon 300m3/hr	: 4 units
Helicopter medium size	: 1 unit
Fuel Oil capacity	: 280.000 Liter
Fresh Water Tank	: 60.000 Liter
Endurance (Jelajah)	: 3000 NM

Fig. 3.2. Ship Particular and Data

Figure 3.2. show the ship particular and data of the OPV 80 Meter that will be used as a case study on this research works. More detail data can be taken from the Figure 2.1. called as General Arrangement. Some others drawings that will be compulsory for this final project are stated as below:

- Fire and Safety Plan
- Decks Construction and Layout Equipment
- Fire Main Arrangement and System
- Bilge Arrangement and System
- Engine Room Layout
- Ship sensors and alarms system
- Etc.

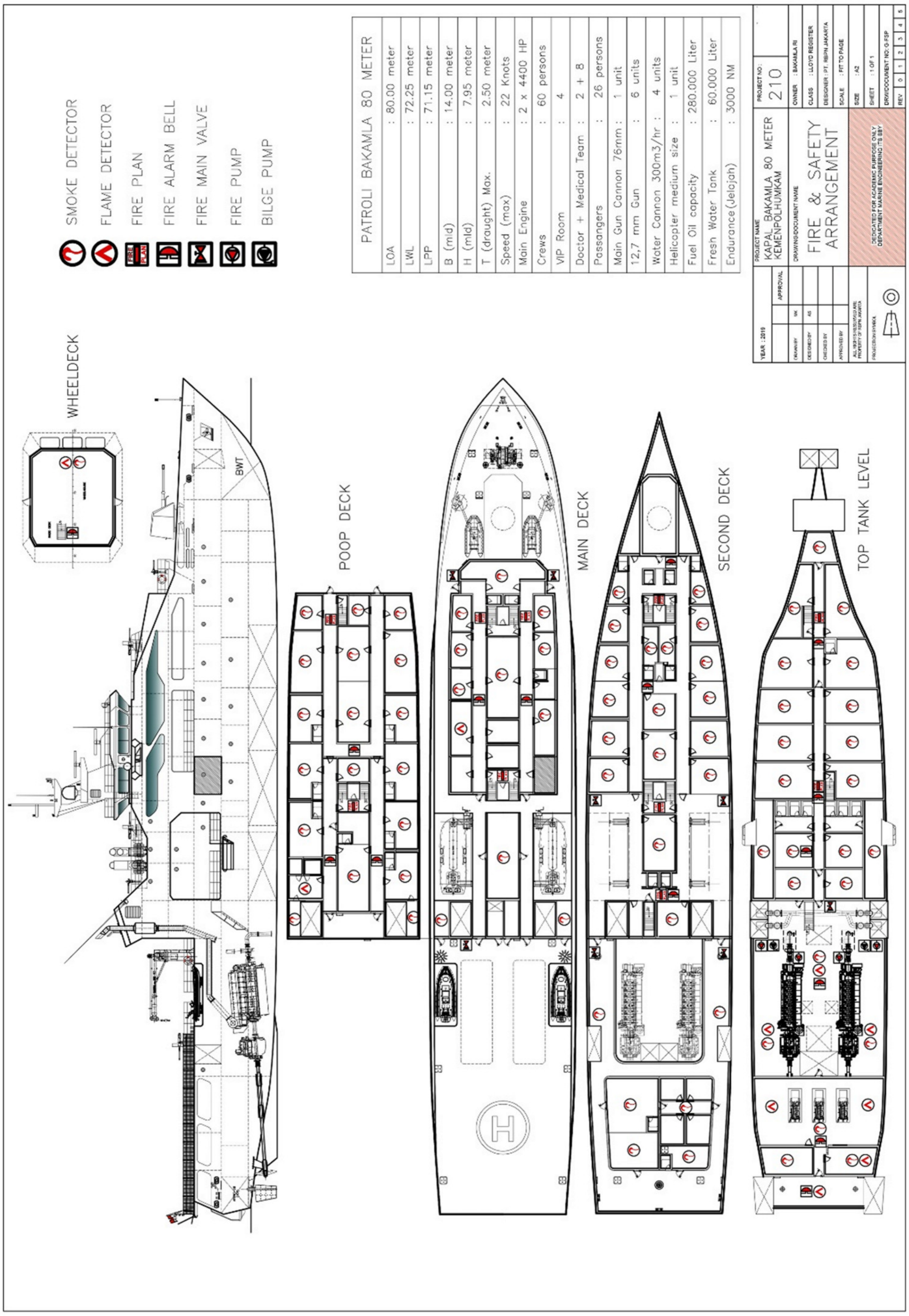


Fig. 3.3. Fire and Safety Plan Arrangement

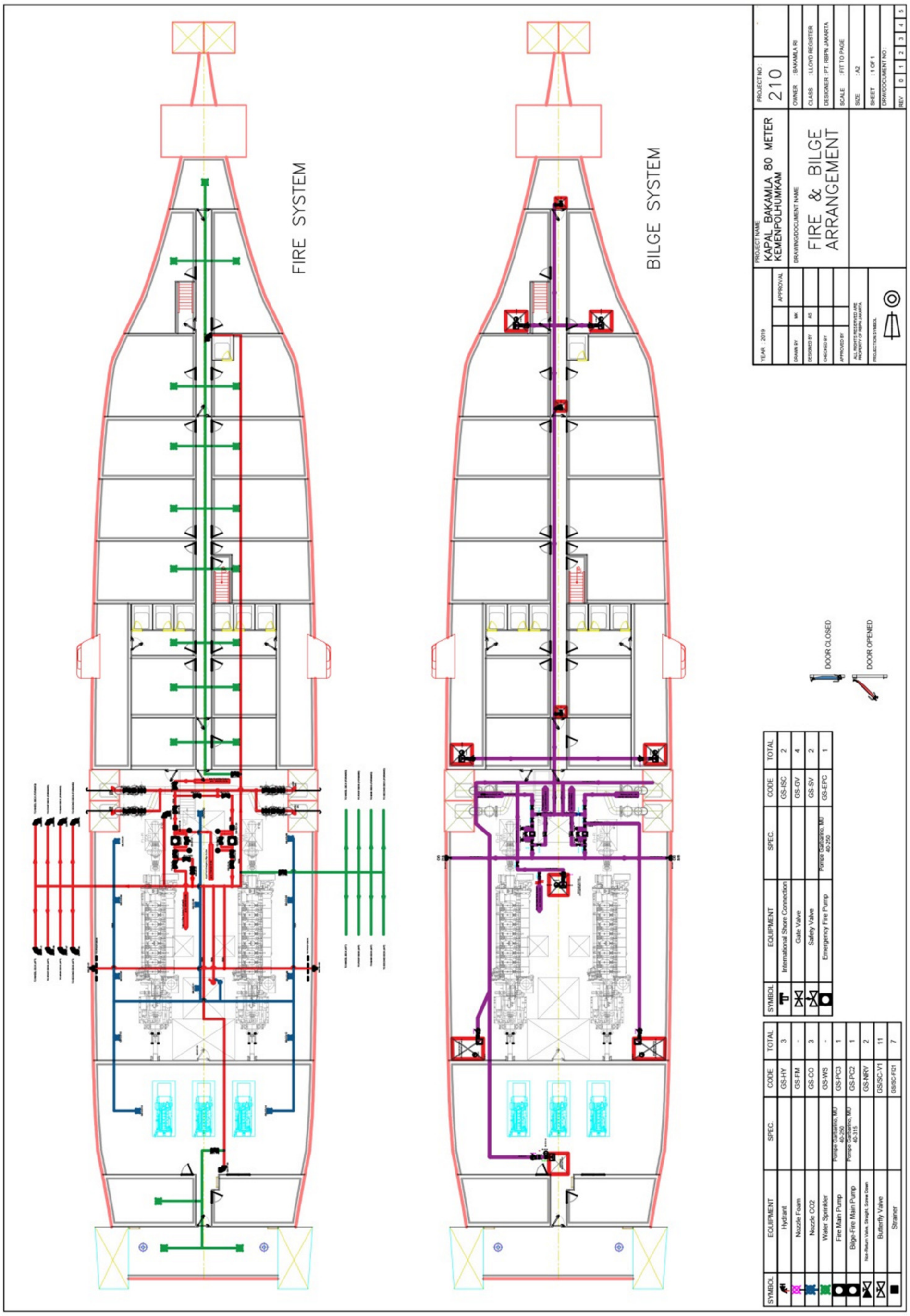


Fig. 3.4. Fire and Bilge Arrangement

Figure 3.3. shows designed Fire and Safety Plan Arrangement for 80 Meter OPV. Detailed equipment on the above drawing will be a precious data to develop integrated automation fire and safety system on-board the OPV. The drawing is special developed for this relevant project. So there are only fire and alarm system notice on the drawing. In conjunction with the process of fire extinguishing then a bilge system also provided. The system contains of smoke detector, flame detector, fire alarm bell, fire plan, fire main valve, fire pump, and bilge pump.

Figure 3.4. shows the detail arrangement of the fire main system and bilge system. Fire main system divided by three types of arrangement. First is main fire piping diagram to accommodate sea water as extinguisher medium. Second is piping diagram for automatic sprinkler system. Third is CO_2 flooding arrangement to fight fire on engine room areas. Figure 3.4. also determine watertight doors position. Fire only been formed when the fire-triangle, existence of the component of air, heat, and fuel, available in the same time at specific space. Isolate at least one of the component could extinguish the fire. Therefore, it is good data to simulate automatic door opening and closing, especially when fire occurs during ship operation time.

3.3. MODELLING DATA

The availability of data will be key performances to build a sophisticated engineering model. Data operational of the equipment on-board the ship and the sequence operational information will be collected and re-arranged to perform DCFS in the mode VIAS. VIAS become efficient tools to handle the engineering solution for effective protection from the risk of fire and flooding. The existence of sub-program will be developed specifically to DCFS. Final model that is formed based on the GUI (Graphical User Interface) can be used to simulate any scenario of fire disaster on-board a ship. Especially 80 meter OPV which is used as case study in this final project.

3.4. TIME SCHEDULE

Depend on the ITS and Department academic schedules, this bachelor thesis will be planned to be finish under one semester or effectively is about 4 months. Therefore, some modelling and simulation are carried specifically to fulfil the objectives of this project only. Scope of works limited by representative systems. In this project the arrangement of DFCS limited based on the quantity and quality performances due to time consideration. More complex and complete system can be generated in the real project to show fully operational of the integrated automation system.

"This page is intentionally left blank"

CHAPTER IV
ANALYSIS AND DISCUSSION

This chapter will be the main activities of this final project. All available data as explain in the previous chapters will be analyse using the application of the VIAS based system that finally purpose to create a new integrated system called as DCFS module.

4.1. OVERVIEW DESIGN OF THE DCFS

An automatic fire alarm system based on wireless sensor networks is designed and developed here with emphasis on the network architecture and communication protocol. Prototype system tests show that the system provides early extinguishing of a fire disaster so that damages will be reduced effectively (*Zhang, 2009*). Accident can overcome with less damages depend on the time. Quicker act can safe material and human life. Modern ships improve own safety system by using integrated automation. Ship must be capable of know its potential accident and acts as soon as possible to counteracts. Due to existence of the various sources and type of fire then the integrated automation system must be programmable to identify the fire condition and location. Sensor and alarms system become initial equipment to predict and identify the fire. Even the ship's crews do not necessary to involve the dangerous situation but it is important that they know all of the situation so can fast arrange certain effective evacuation plan if necessary.

Ship accident caused by fire need special attention. Physical properties of fire that can be form as hot flames and dark smoke (even poisonous) must be aware by crews and some condition it is not recommended to extinguishing directly. Extinguishing fire must be done in the safe area. Fire only occurs when three source exist on the same time and place. It is commonly called as *fire triangle*. Eliminate one of them can stop fire, but capability to eliminate two or three source together can effectively stop big fire. For example, keep a room or compartment tight from air supply. Therefore, automatic closing/opening door become necessary for certain ship's compartment such as engine room and galley. Anyway, ship's crews in many circumstances face difficulty to handle the fire due to his position and the location of the conventional fire equipment. Then modern ships equipped with automatic sprinkler for accommodation room and automatic CO2 flooding system for engine room. Both the modern systems easily integrated with this new module of DCFS-VIAS and provide more benefits for overall fire extinguishing system on-board.

DCFS commonly known as standard system on-board a military vessel. But related to the benefits of the system then DCFS also offered to the commercial ship. Many kinds of Offshore support vessel operate daily with high risk oil and gas and other combustible material. Even all kinds of ships in many size can face accident like crash and grounding. Damages of shell and bottom constructions may cause the ship capsizing and sinking. Depend on the damages scale, now, there is a technology to quick stop the flooding. Crew may patch up the broken shell or bottom by using pre-form plate then make quick fastening by nailing using specific tools. This attempt may not be happened when the flooding comes in big volume. The bilge system should overcome the flooding quickly. If necessary system can be integrated so the all available seawater pumps can be operated together.

Logic flow of DCFS, when leakage/flooding happen Virtual MIMIC as the first to receive information and recognize something wrong already made within decision. DCFS will notify by voice out alarm, then water-tight door will automatically close and flame detector take action by fire system as the plan was arrange, in order to reduce flooding and electricity burns.

4.2. TECHNICAL CONSIDERATIONS

In the development of model VIAS there some technical considerations must be taken into account. As shown in the 80 meter OPV as the object of the modelling work is a relatively big ship with many compartments.

4.2.1. General Arrangement Review

Figure 4.1. shows top view of the engine room layout of the 80 meter OPV. As a patrol vessel with relatively high speed demand then this ship use engine power of 2 x 5400 HP. The ship arranged to use medium speed diesel engine to achieve duty rating of continuous heavy duty because the ship should capable to operate in un-restricted area in the Indonesia territorial that known as a huge sea area. A medium speed diesel engine with the big power has a big dimension. By the length, the engine room take more than 1/3 of the total ship length.

Figure 4.2. shows side view of the engine room of the ship. It is a representation of the engine room and surrounding areas.

Both the figures will be setup as a window feature in the MIMIC display. All icon and interconnected logical data appear on the screen. Some notifications will also be appeared under any circumstances condition. For example, sound alarm or audible blinking icon. This mode will also be used to identify whether a certain door is open or close. Isolating compartment using tight-door is important for fire prevention. Mall-function door will recognise by blinking and can also provide with sound alarm.

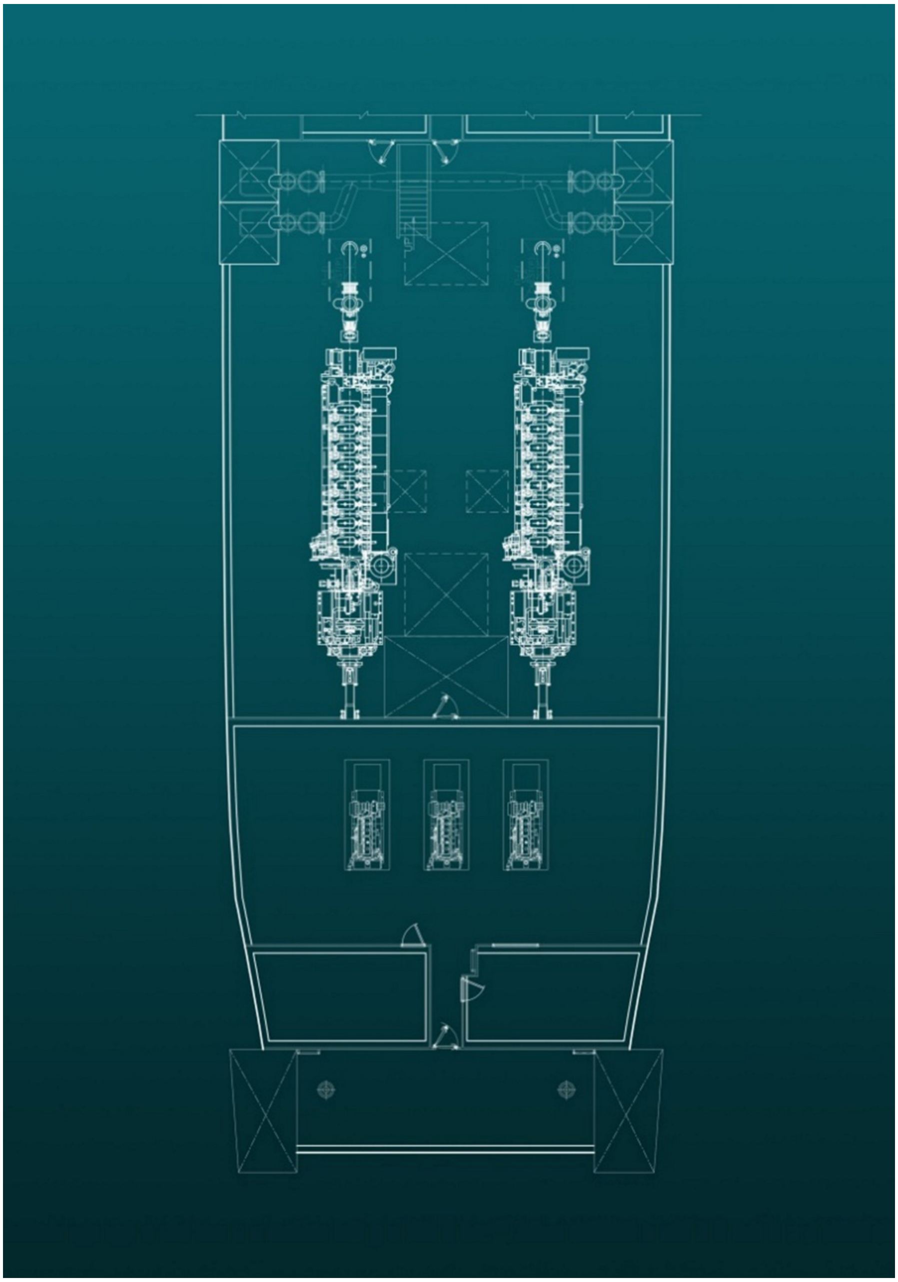


Fig. 4.1. Windows illustrating the layout of Engine Room Areas (top-view)

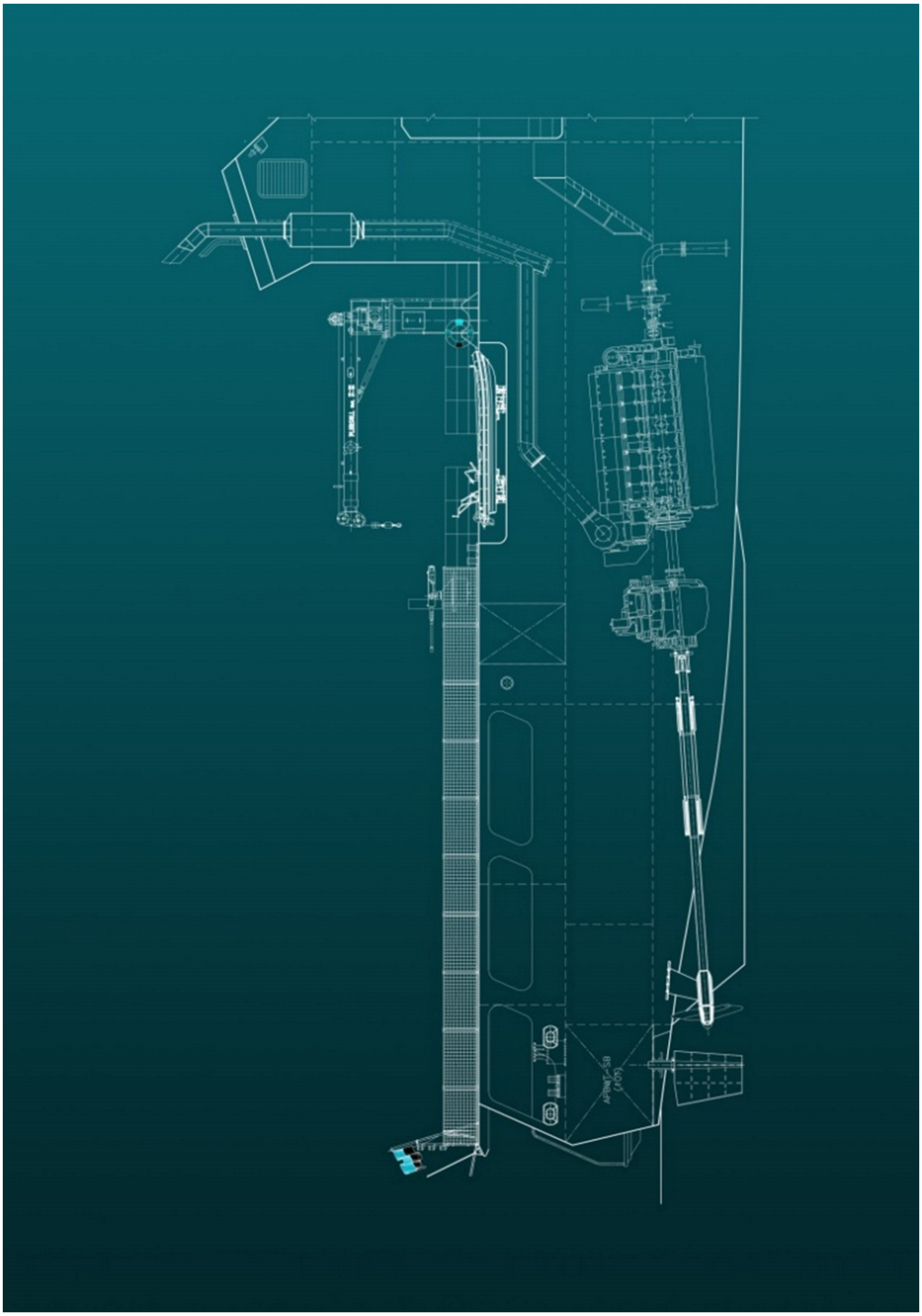


Fig. 4.2. Windows illustrating the layout of Engine Room Areas (side-view)

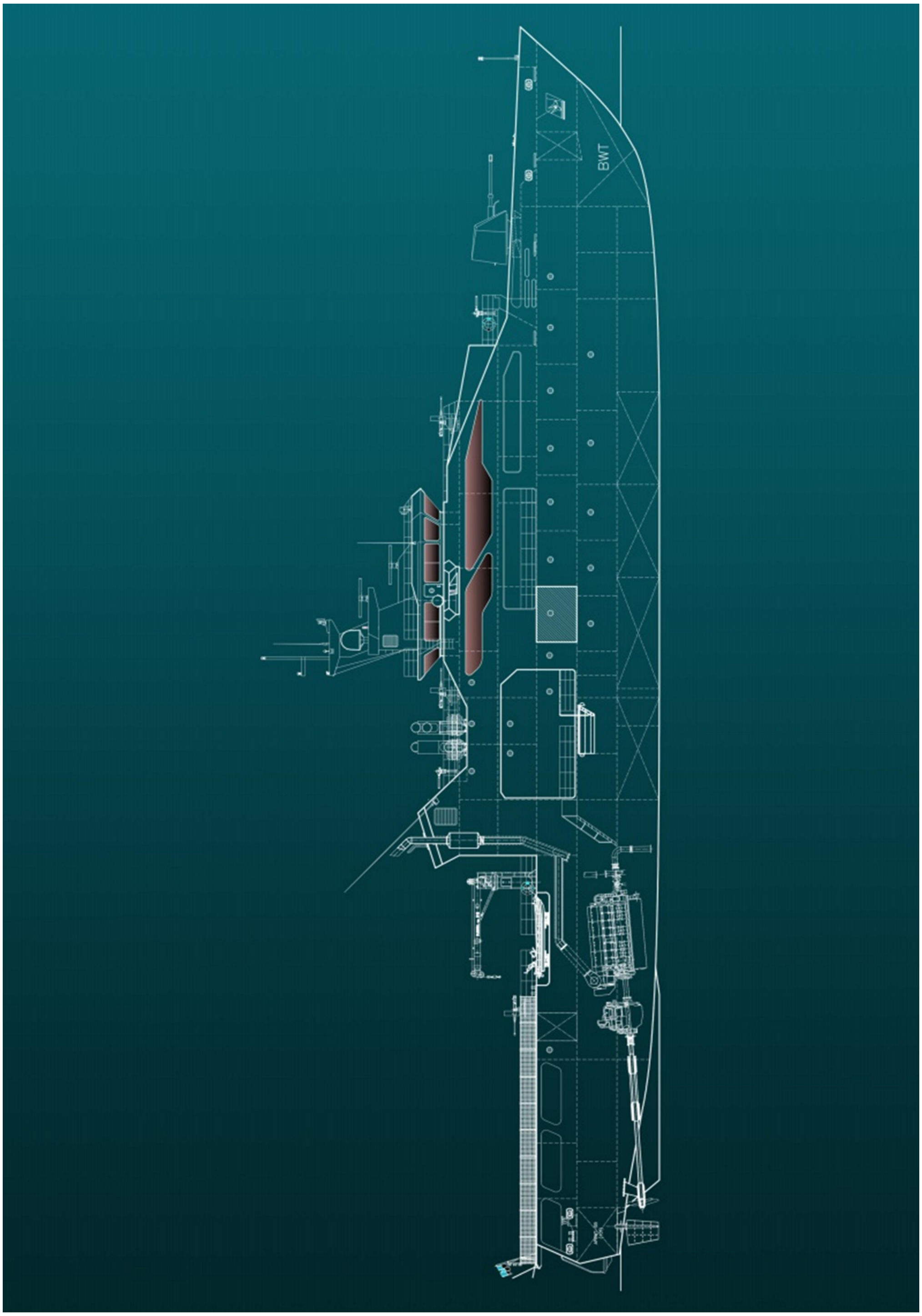


Fig. 4.3. Windows illustrating the Profile of the 80m OPV

4.2.2. Fire and Safety Plan Review

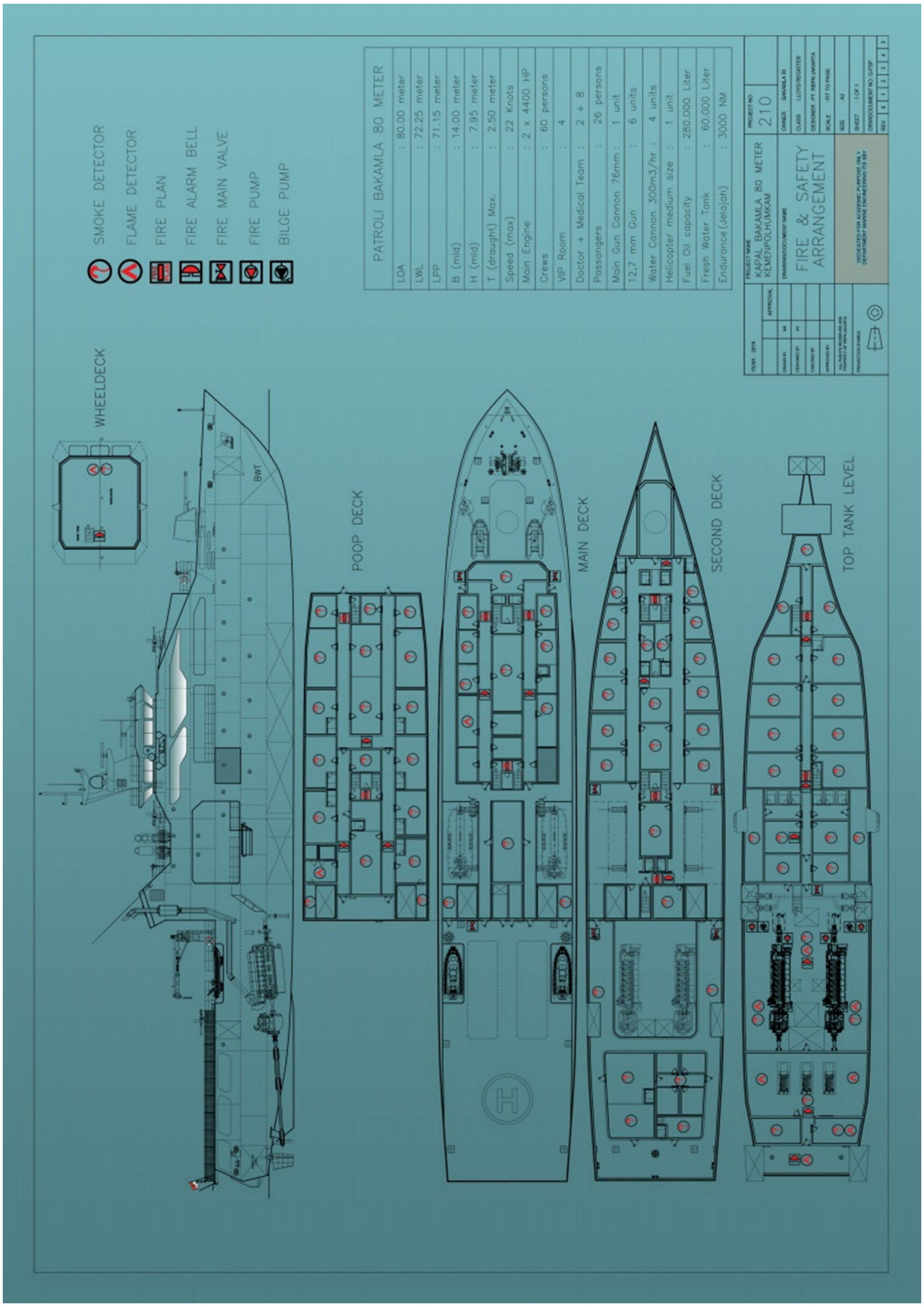


Fig. 4.4. Windows illustrating the layout of Fire and Safety Plan

Figure 4.3. shows the arrangement of side-view of the ship. It should be more attractive if the information can also be illustrated in the figure. It will be performed in the MIMIC of the new module DCFS developed by this final project.

Figure 4.4. shows windows menu that contains information and the data of both the fire system and safety system. The drawing in Figure 4.4. is taken from standard Fire & Safety Plan but exclusively only contains the alarms system.

4.3. STRATEGIC AND DEVELOPMENT OF DCFS

The sequence of the modelling works can be built in certain strategic ways in order to develop a simple and easy structure of Damage Control Flooding System or DCFS. First step is to define the scope of works then mark the limitation that should be determined early.

4.3.1. Integration Scope and Limitation

Involve fire system when detect flooding occurs. Bilge. Automatic water-tight door will open and close to safe each room components inside, as previous discussion water-tight door will automatically close and flame detector take action by fire system as the plan was arrange, in order to reduce flooding and electricity burns.

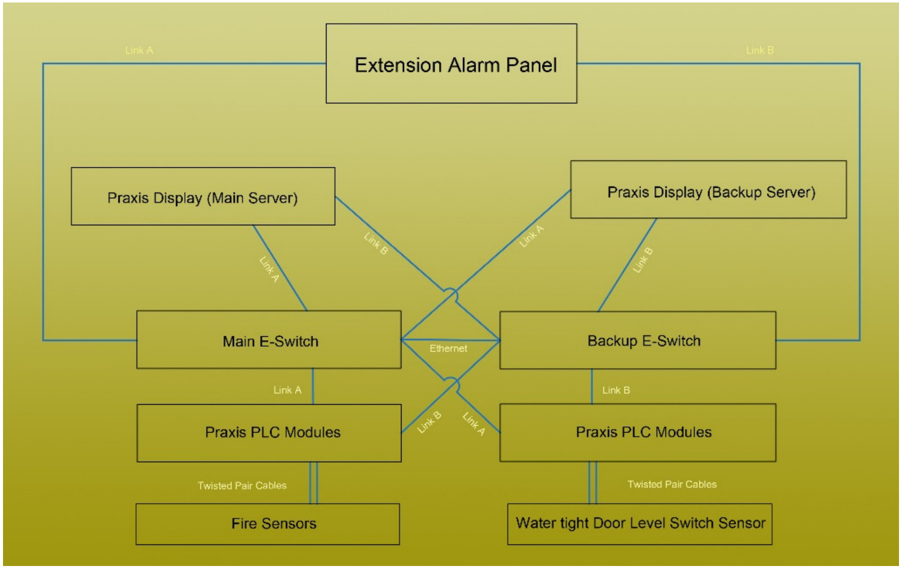


Fig. 4.5. Schematic Diagram link for Fire System

Figure 4.5. shows the schematic diagram in linking process and steps of the fire system. For redundancy system there are two display provided, one occupy main server and other called as backup server that will be used to transmit data to the extension alarm panel. Progressive links can be seen on the Figure 4.5. Every server has E-switch tools that in the connection with single PLC Module. PLC based control are proven technology in ship usage (*Sheena,2016*). Specific new PLC based module has been developed based on the DCFS output data such as fire sensors and watertight door level switch sensor. Additional new module may be installed in the future.

4.3.2. Logic Controller Adoption

MIMIC overview page consist of all of the information created by researcher. Due to in limited time of study, there are only 3 (three) days in develop the MIMIC, taking count from initial learning of the overall MIMIC system that already spent almost 2 (two) days.

Researcher just able to reach the making of the watertight door simulation while flooding occurs in that first round of study in Praxis workshop. The design purpose to visible identify and recognize case, green notification means clear or watertight door close and red as marker that the watertight doors are open. During initial running, from the developed program we got great feedback, when almost all system work properly, except one of the water-tight door is still in trouble.

Sensor of module got fasten by using jumper then alarm will show up, when the jumpers get pull out then the sensor of module become green again. It is means normal situation and red lights stop blinking. Report of alarm history in alarm page menu include tag which tell specific injured watertight door number, channel inform same as tag, date, time, report type alarm occurs, description within more specific name, status alarm or normal, and below alarm page still have more menu to click.

Figure 4.6. illustrated the installation of fire and bilge system in form of piping arrangement and system. There also shows the position of the watertight doors that in the next work identified as a part of the new DCFS module. It is important to successive system refer to the Fire Triangle that oxygen on or from other compartment will cause backdraft that make more dangerous fire accident. Contained the compartment such as engine room must be done, especially when the ship also adopts the CO_2 flooding system for extinguishing any fire occurs.

Fig. 4.6. Windows illustrating the Watertight door in the Tank top deck (top-view)

As shown in Figure 4.7. the arrangement of fire system in DCFS module applied to the 80 meter OPV top tank level contains of 10 automatic watertight doors. Separated in different compartment, Water-tight door (WTD) 01 located in the most front of ship, WTD 02 near Linen Store, WTD 03 near Lounge Room and 6-Crews, WTD 04 Stabilizer Room – PS, WTD 05 Stabilizer Room – SB, WTD 06 in the middle of Gangway, WTD 07 close to workshop, WTD 08 near Sewage – 2, WTD 09 close to Diesel Generator Room, and the WTD 10 next to Steering Gear Room.

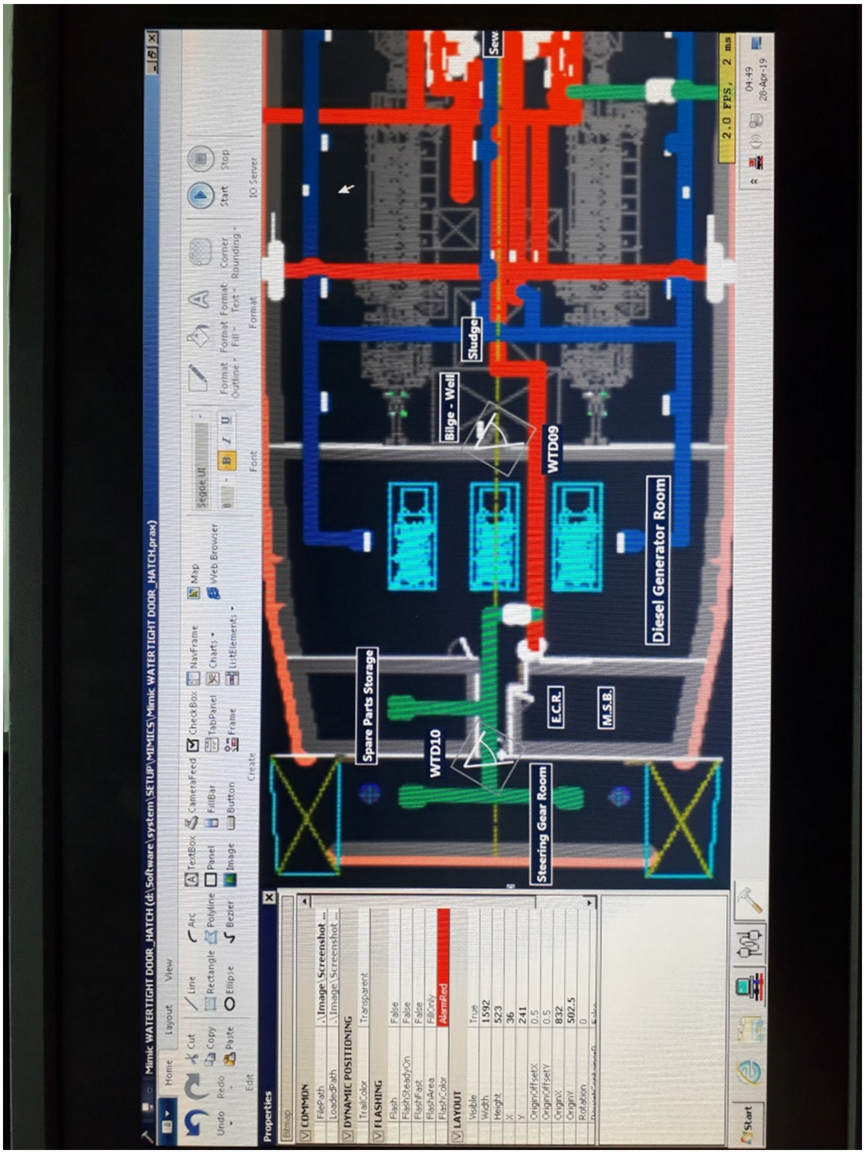


Fig. 4.7. Position of Automatic Watertight Door Placed in the MIMIC Display

Figure 4.8. shows the position of the automatic watertight door in the middle part of the ship. There are four watertight doors can be seen on the figure.

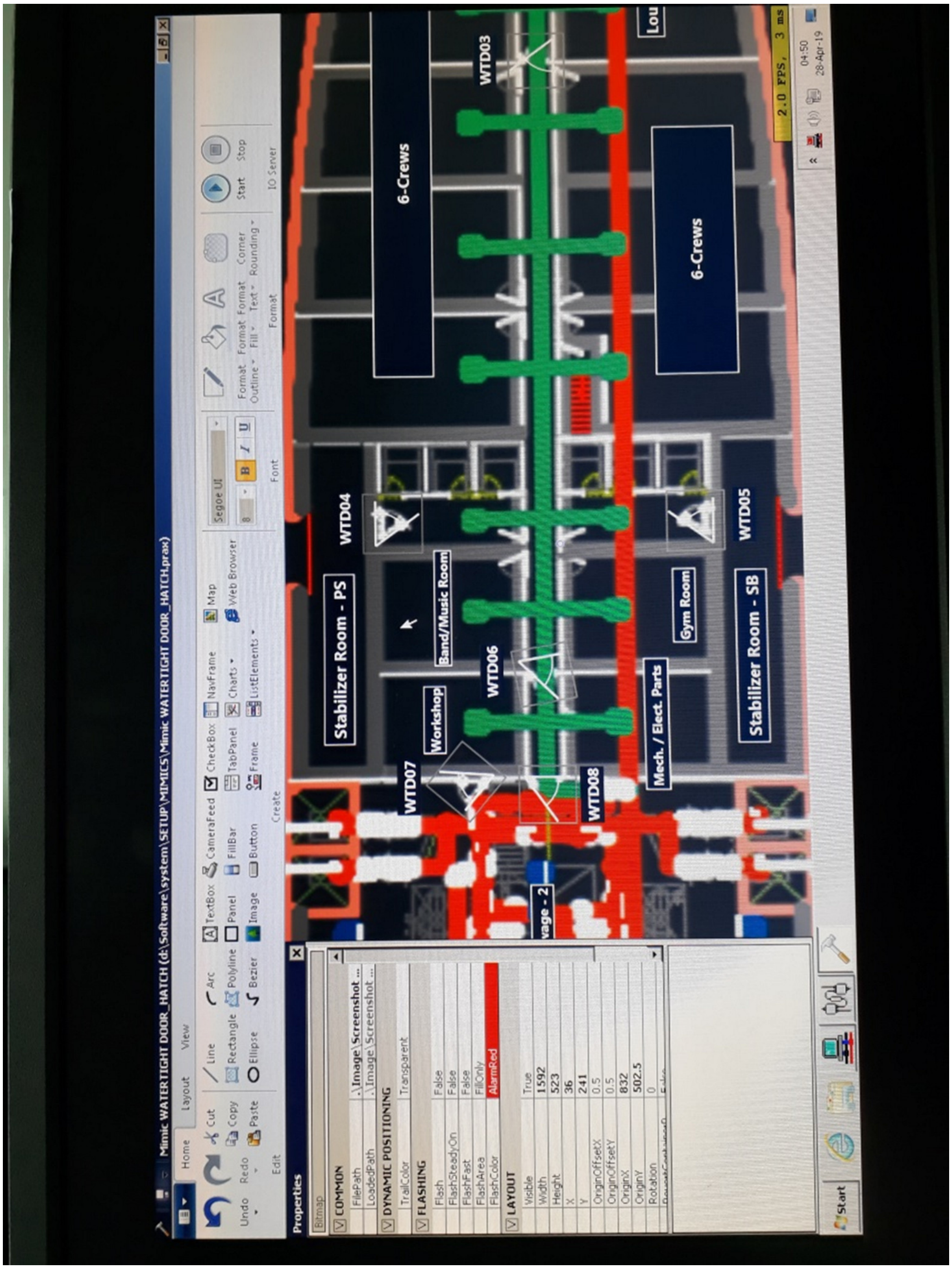


Fig. 4.8. Position of Automatic Watertight Door Placed in the MIMIC Display

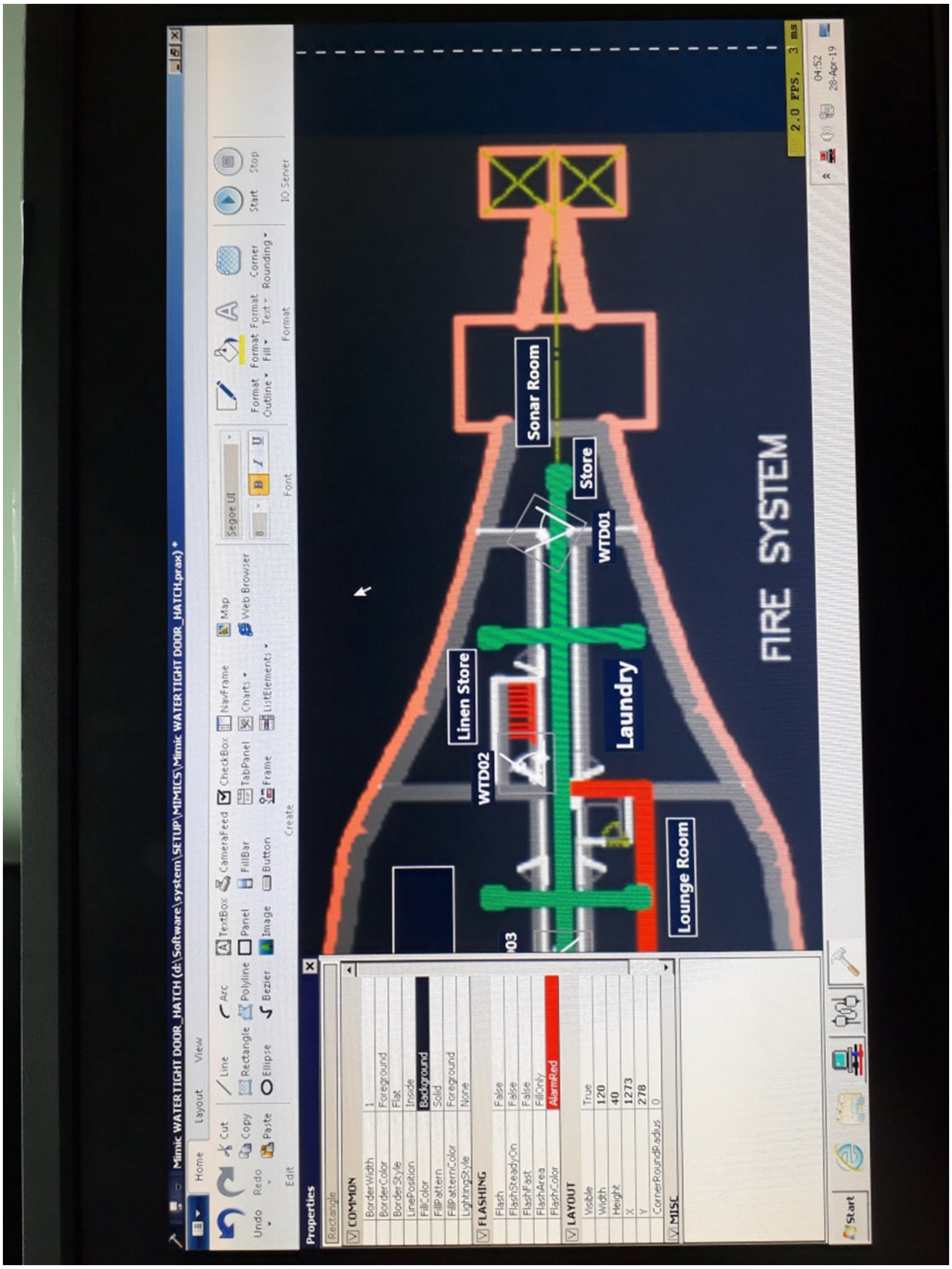


Fig. 4.9. Position of Automatic Watertight Door Placed in the MIMIC Display

Figure 4.9. shows the position of the automatic watertight doors in the area of fore ship. There are two watertight doors will be displayed in the MIMIC screen for fully controlled by DCFS system.

4.3.3. Link and Match of the Systems

Integrated system meaning an implementation of a correlated way among any component to build certain purpose of mission work. It is important to provide link and match capability for the system and its component involved.

Fig. 4.10. Reaction of Notification While Open and Close Watertight Door Occurs in the MIMIC Display

Briefly shown in the Figure 4.10. when the automatic water-tight door in duty responsive. Jumper simulate the situation of condition when they attached to the module alarm then will notify and keep red lights blinking, jumper pull out alarm change into normal. Alarm history menu will detect the specific data for alarm position and status.

Any false alarm can be easily override after visual check whether from CCTV or direct visit to the indicated location has been done. It is safety matter to be done. In automation system there will be certain scenarios in determining between fact or false situation safely. Improper extinguishing works may damage ship properties. Logical control should be developed accurately to perform satisfy system. Both react status and act status may be programmed based on the logical programming system and eliminate any possible faults by detailed data available.

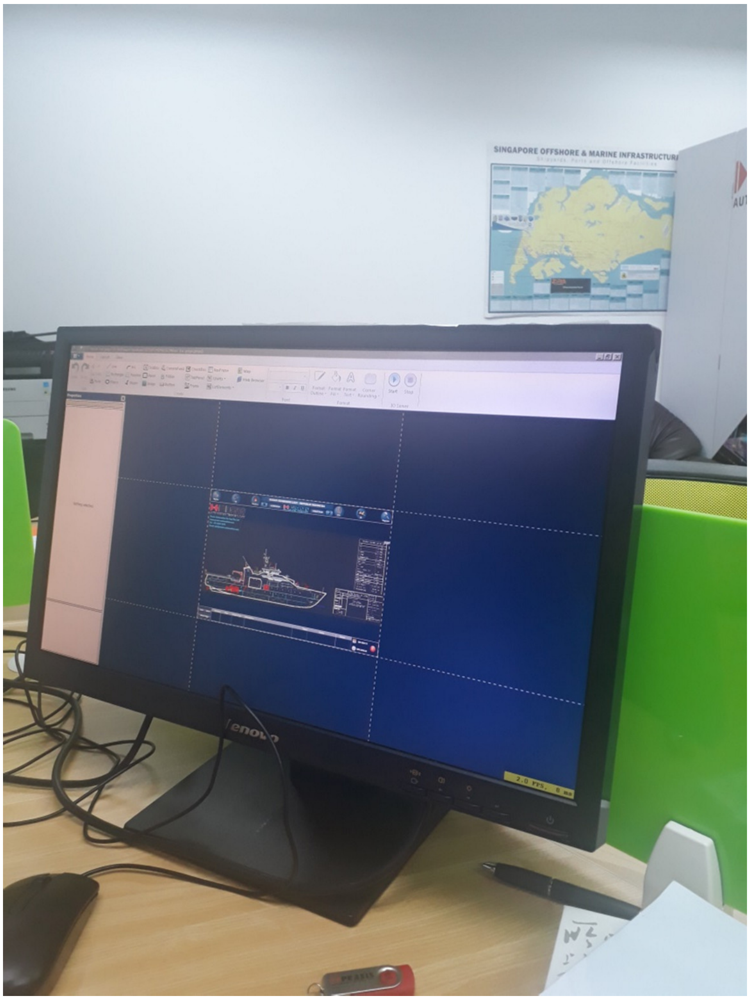


Fig. 4.11. Learn MIMIC Overview System

Diagnostic menu as shown in Figure 4.11. above is generated to make sure the healthy condition of any related components with the built system. Here, one control processor or called as XP01 can support up to 5 (five) modules. One new module of DCFS generate based on the link and match configuration and structured by GUI based programming.

It is use a specific computer software program developed by Praxis Automation in Netherland. But basically such of the module can also be developed by any student when they know well the advanced language programming such as MATLAB and SIMULINK or LabVIEW developed by National Instrument USA. Graphical User Interface (GUI) become more usable for academic and commercial purposes.

4.3.4. Integration Works

New module of DCFS can be integrated with the existing Integration Automation system called as VIAS. It is a part of the programming works. Established components and their connection based on the DCFS module has been integrated to perform one new system and linked with the existing modules of VIAS. It should be understood that VIAS consists of many features module. Not all of the module need to be integrated with the DCFS module. An easy consideration is to purpose the new system for UMS Notation.

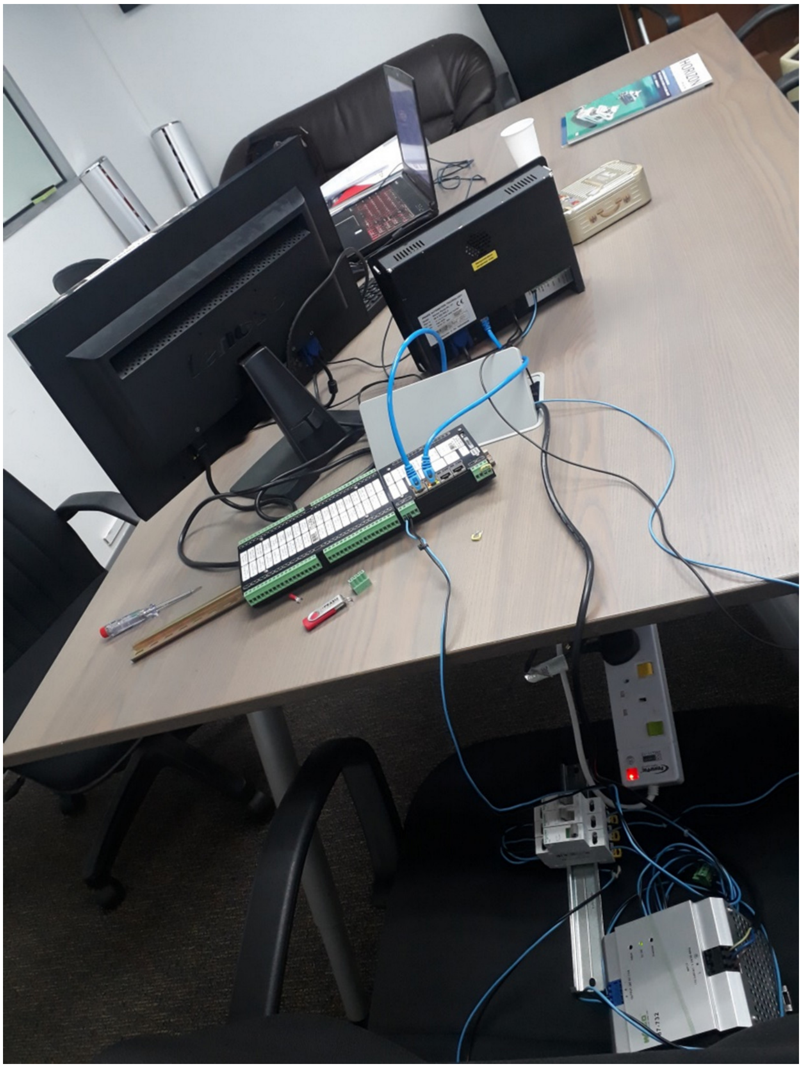


Fig. 4.12. Relation of Components to Support Fully DCFS in the MIMIC Display

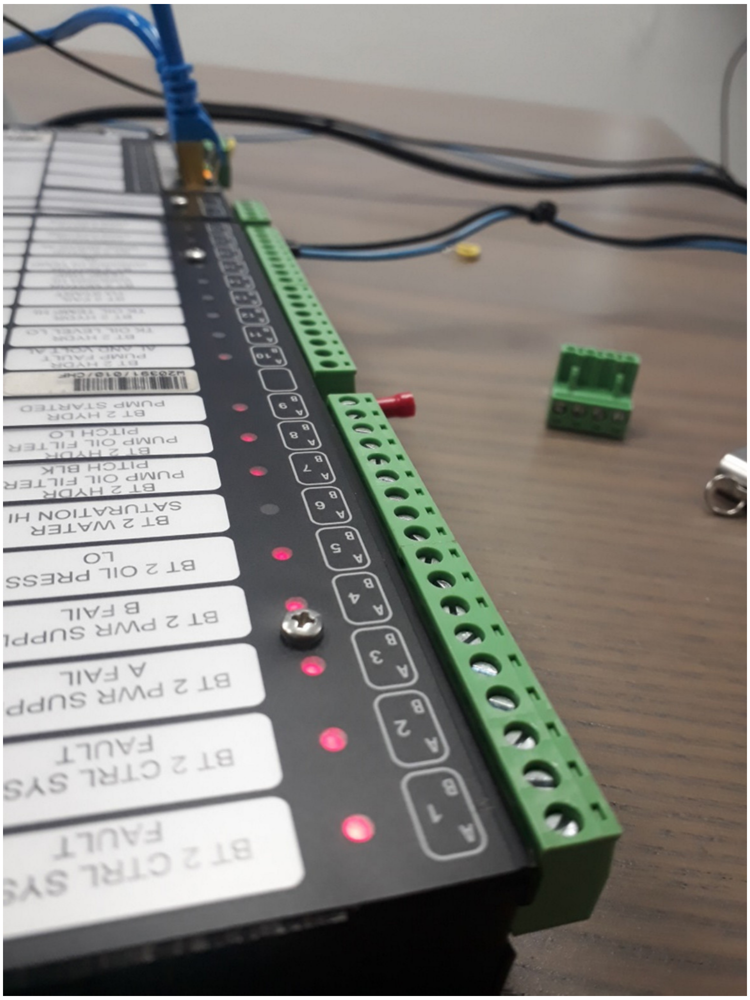


Fig. 4.13. Sensor Module of Automatic Watertight Door

Figure 4.13. shows the input/ouput board for sensor module using in the automatic watertight doors.

During simulation work, WTD 06 sensor cannot react while the jumper is plug in, so there is no blink of the red lights happens. After try several times, we go back to graphic builder properties to ensure everything right, but still have no any solutions. In temporary conclusion there is nothing wrong with the WTD 06 that has been created, and decided that maybe the problem caused by the hardware. New fresh module be used in the next trial and give successive results.

To clean the alarm history in the bottom of WTD menu, click *ack* or known as acknowledge and for *nack* or not acknowledge that respond stop flash figure then the system still flashing. Logic flow of the new DCFS module divide by several actions that on this model consist of level 1 notification, level 2 alarm, and level 3 normal.

4.4. MODELLING DCFS

In the form of GUI as a graphical modelling, it is only the way to express the mathematical calculations in order to understanding physical phenomenon such as logical programming and cause and effect problematic in this modelling works. VIAS also a type of numerical model that also useful to generate mathematical expression in graphical rather than sub-listing logic structure programme. It is much useful and easier to be developed as many types of modern software.

4.4.1. Developing MIMIC

MIMIC is the representation of any process plant for which is displayed on the Panel or Control Desk. This representation makes it easy to monitor the whole plant from one location and is also used as a second level backup accompanying the conventionally panel board which commonly an analogue type. These expensive physical board commonly still exist beside the digital MIMIC.

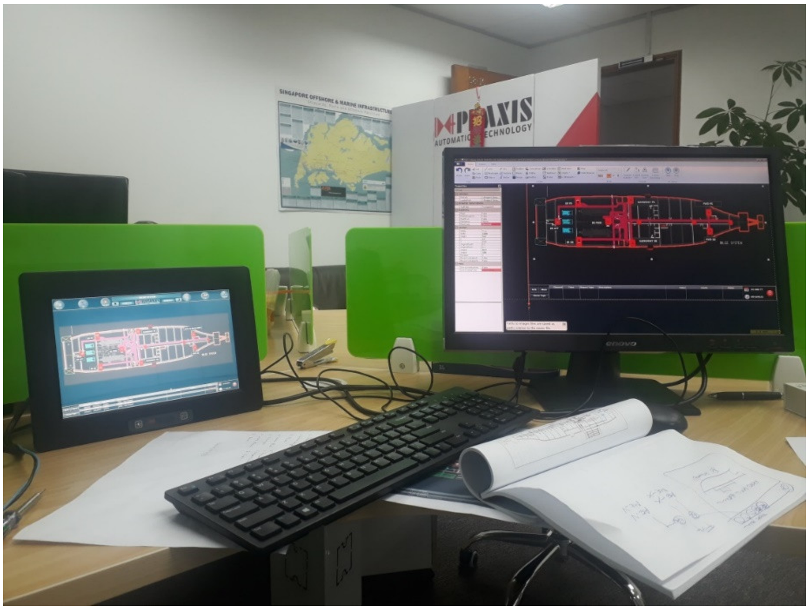


Fig. 4.14. MIMIC Display Features

In the second visit to Praxis Automation Far East office in Singapore during 24 - 26 April 2019, all experimental works using their facilities was finalized this project and completion of the previous modelling works during 18 to 20 June 2019, then all of the thesis data needs has been finalized.

Figure 4.15. shows the final result of this final project in the form of MIMIC that displayed the fire system (red line) and the bilge system (green line). In case of flooding due to damaged hull in any compartment, then several bilge well provided in the certain position in the compartments. All of the branched piping in the compartment will flow to the main piping that located in the main longitudinal gangway. Every single bilge well designed capable of contain more water than normal leakages cause by daily activities on the certain compartment and provided by a high-level sensor that also capable of automatically start bilge pump. High-level sensor will start alarming visually and sound-able when initial flooding on the specific compartment may happen.

In case of fire happens, the spray water from sprinkler system and monitor guns will also fill up the bilge well then when the water level reach the high-level sensor then the bilge pump will also react to emptying the flooding compartment automatically.

Bilge system commonly called as a part of the fire prevention system when designed as emergency well and bilge pump system. Extinguishing fire by using sea water must risk in the ship flooding. The emergency bilge system that commonly have pumps capacity similar to the fire system can overcome the risk of flooding. In many case the arrangement slight more difficult when applied to the engine room area due to the large volume of the engine room compartments. It is a good arrangement when the sea water types pumps interconnected each other to support many scenario of work.

Related to the emptying work using bilge pumps and filling work using fire pumps then more sophisticated ship adopt or use existing AHS (anti heeling system) in integrated automation system to make sure ship stability and trim always maintain in the perfect condition. Inclining position of ship tends to make worst situation in any kind of accident, at least will down human physicological.

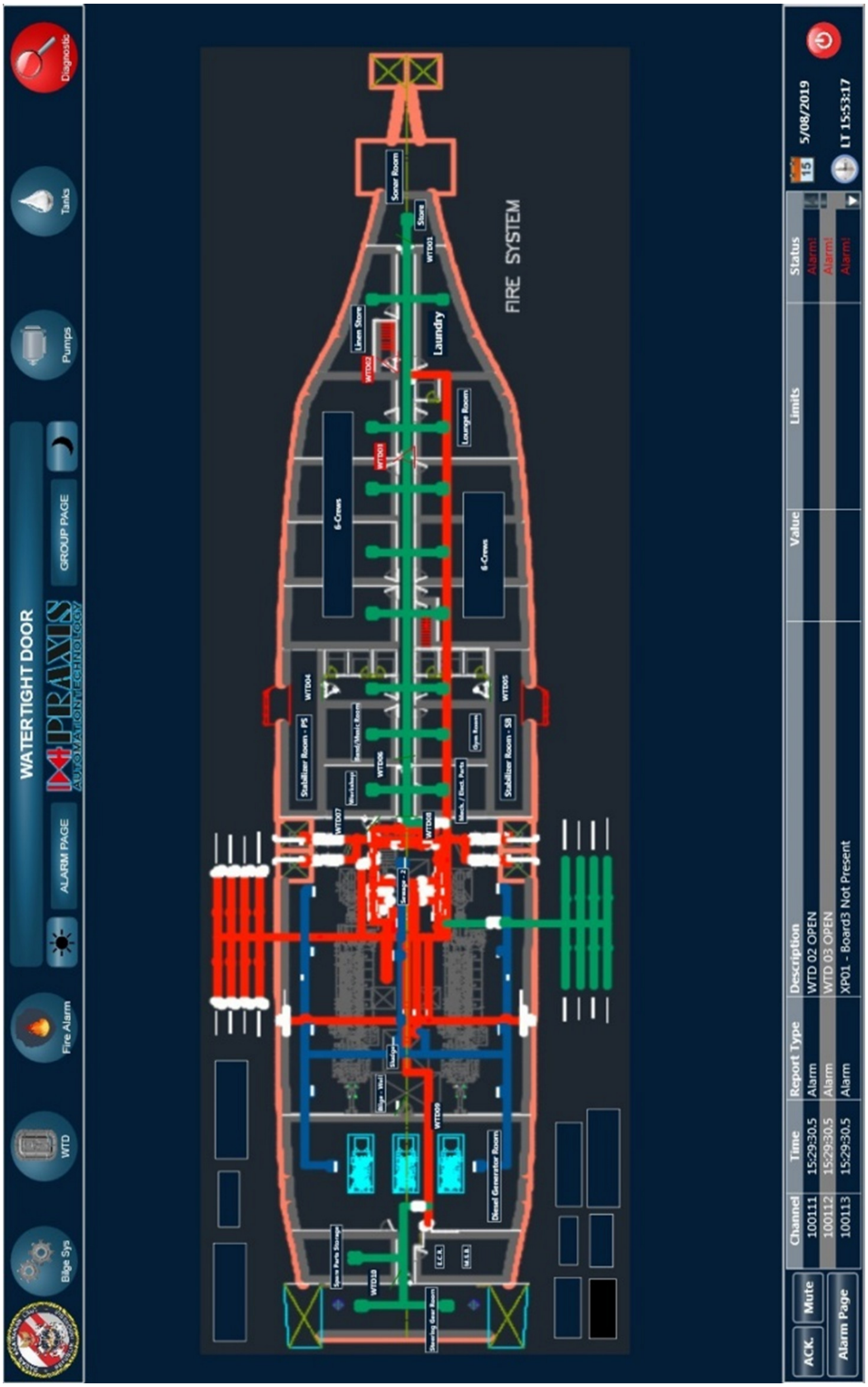


Fig. 4.15. Alarm Occurs in the MIMIC Display

The features from MIMIC Display show alarm for WTD 02 open alarm and WTD 03 open alarm and also showing in the alarm list at the bottom of the MIMIC. Available menu of MIMIC Display is Ship Illustration, Home, Bilge Sys, WTD, Fire Alarm, Pumps, Tanks, Diagnostic, Alarm Page, Group Page, Day Mode, Night Mode, Acknowledge, Mute, On-Off Button.

Fig. 4.16. Auxiliary Engine dashboard in MIMIC Display

Figure 4.16. shows the MIMIC of the auxiliary engine display in the ship dashboard. Capability to control the operation generator sets and the main engines is an important feature of the DCFS-VIAS module. Flooding in engine room compartment may immerse all equipment inside the compartment. Electric current from generator set make highly hazard to shock all of the machinery and human life in the compartment when immersed by water. This feature also one of part assessment insisted by UMS requirement. Authors set special module for this emergency safety device (ESD) and plan to develop one in the next pursue study.

Design within two auxiliary engines as shown in MIMIC Display above, as generator engine set in port side and starboard side. Various parameters in purpose to make colourful and visible to imagine while system may react differently, for example battery modelled to be recognized at 80 Volts which may over from red sign that stated 70 Volts and the minimum of 20 Volts reached they can see in that orange sign. Rpm set at value of 1600 means normal indicator after increase red point or dangerous rpm then detector will shut down automatically according to the ship safety. In the two auxiliary engines, GE PS and GE SB designed using many indicators such as Engine RPM, Coolant, Oil, Fuel, Battery, and Generator.

Auxiliary machinery monitoring and control covers several systems like: main sea & fresh water cooling system – pumps, system pressure, temp. etc., Potable and fresh water control, Air compressors, Bilge & sludge control – Tank level, pumps, Fuel oil system – Tank levels, temp., viscosity, flow, purifiers, heaters etc., Other cooling systems, Boiler/steam system – pumps, valves, pressure temp. etc., Air Conditioning, ballast water treatment, exhaust gas treatment equipment. All items can be displayed in MIMIC depend on the requirements by owner. More setting will make consequences in price. But for some big project the value commonly for this minor items may not much affect the granted price delivered by the vendor.

Good design is necessary to make balance of the technical and economic aspects. Practical use and easiness must effectively be arranged so the main purpose can be satisfied for many reasons.

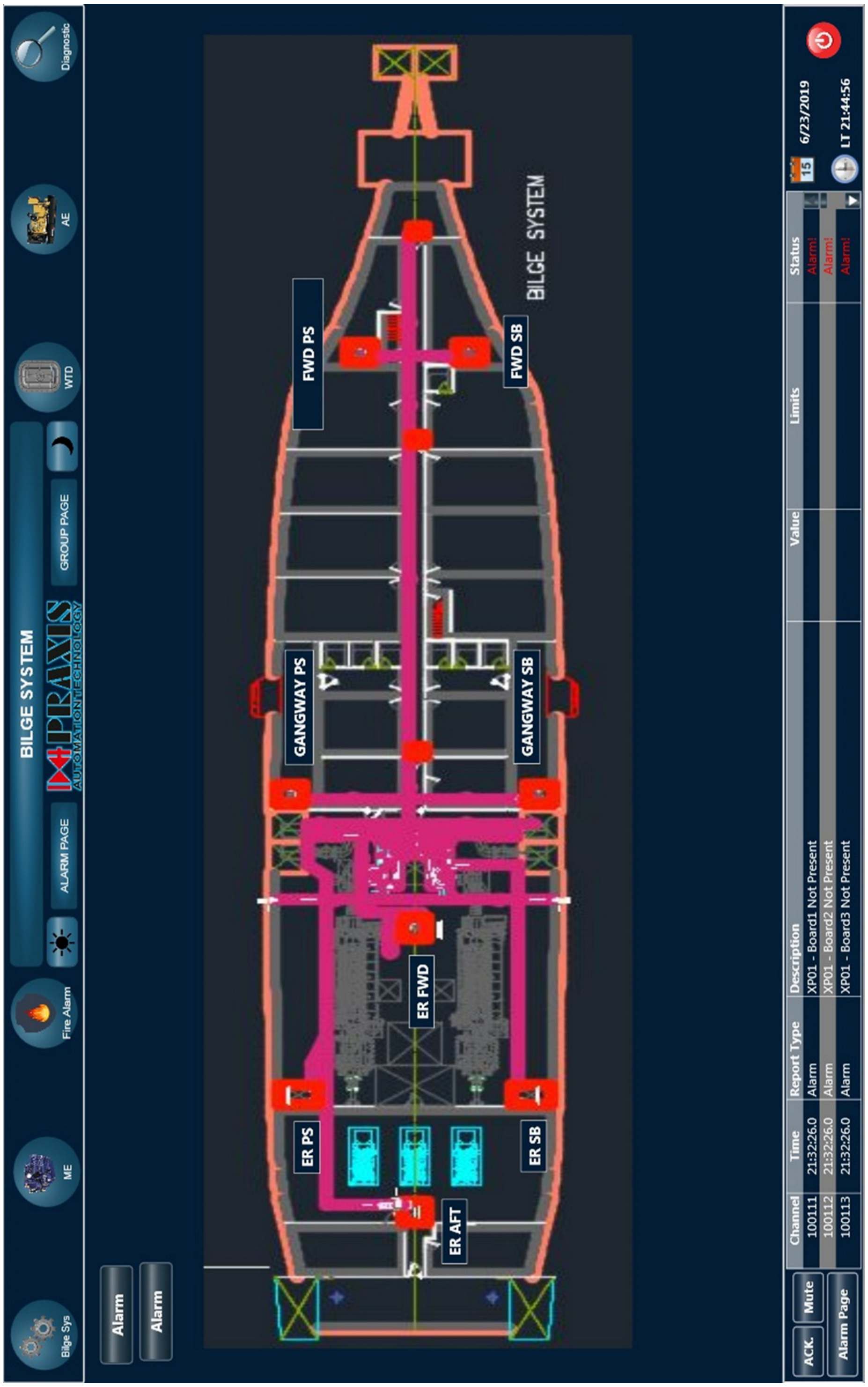


Fig 4.17. Bilge System dashboard in MIMIC Display

Bilge System menu contains within the 8 separate locations consist of FWD PS, FWD SB, GANGWAY PS, GANGWAY SB, ER FWD, ER PS, ER SB, ER AFT. The name of each positions is purpose to show specific address in the historical menu. On this menu while any flooding happen later on will send the red blink alarm. All compartments inside has been connected to the main system. 8 locations were integrated then when flooding happen it automatically will open the bilge system valve to start their duty quick through the damage location in order to make ship stability responsive in short or long time.

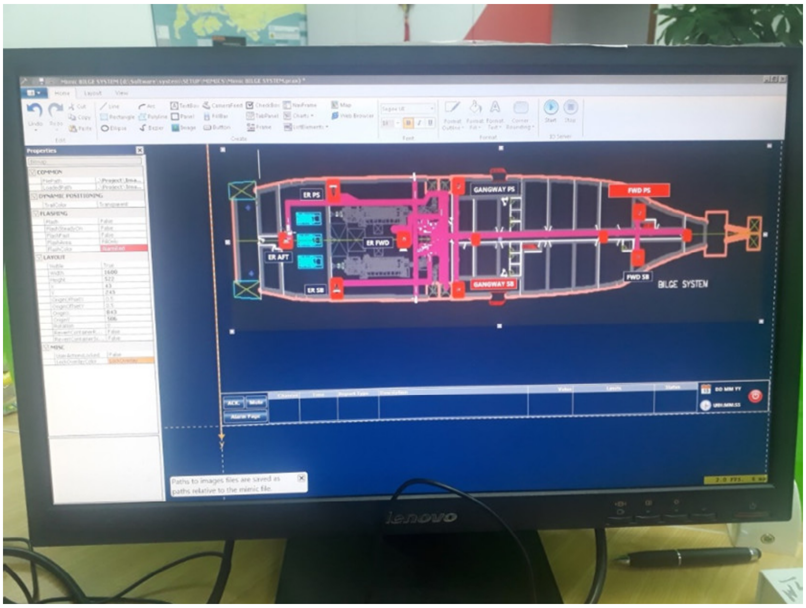


Fig. 4.18. Inside software arrangement (Graphic Builders) that later will show in MIMIC Display

Simulation test of the bilge system be illustrated at FWD PS and GANGWAY SB has been proven run well. While red blink or alarm show up, it means something went wrong with the specific location. Fire fighting systems or Pump Systems should be able to start automatically upon the request of the system or the operator. Means crews override should be provided in order to prevent any inadvertent starting of fire fighting systems. In other way, can be stated that the existence of crews may necessary.

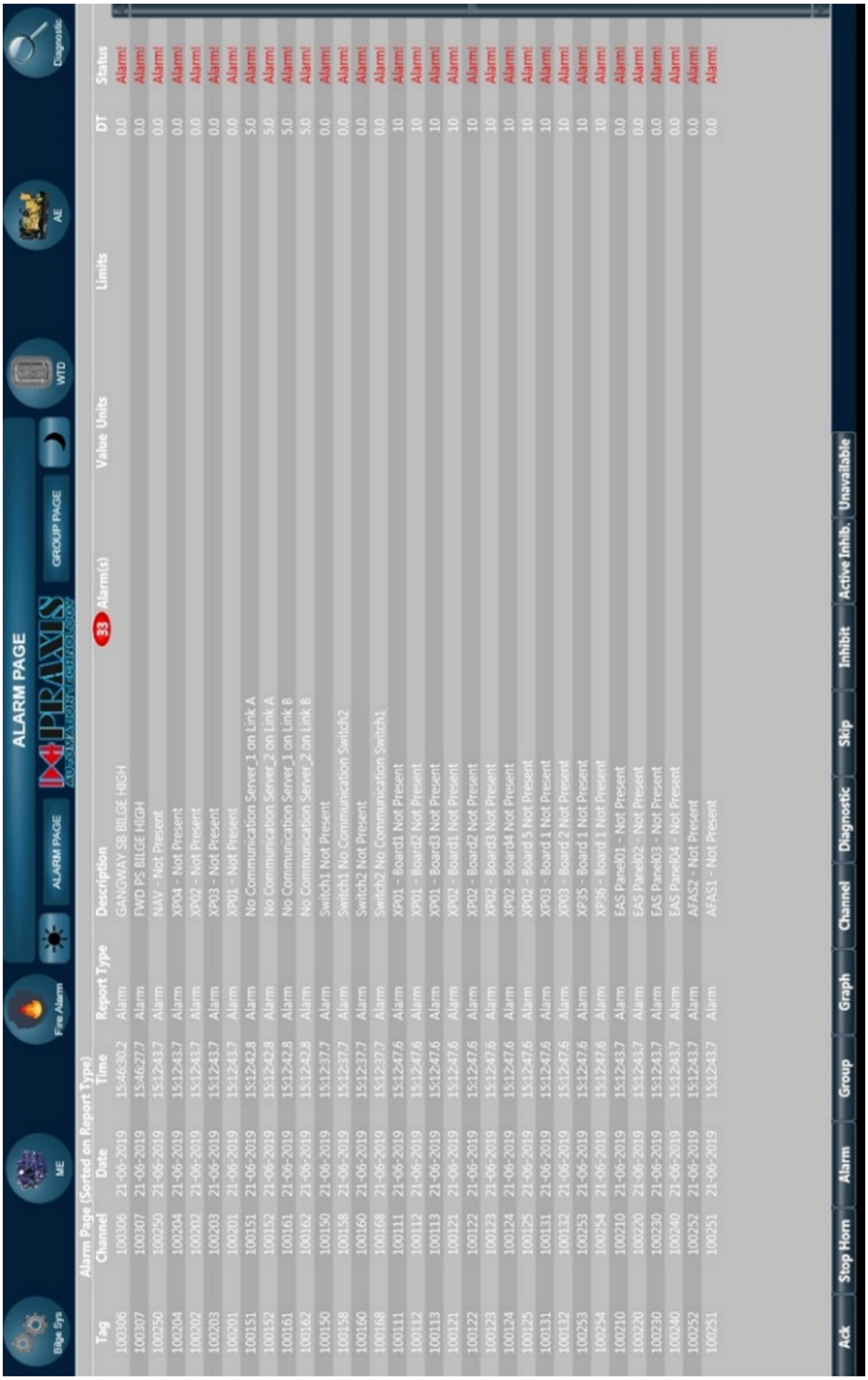


Fig. 4.19a. Alarming menu in MIMIC Display

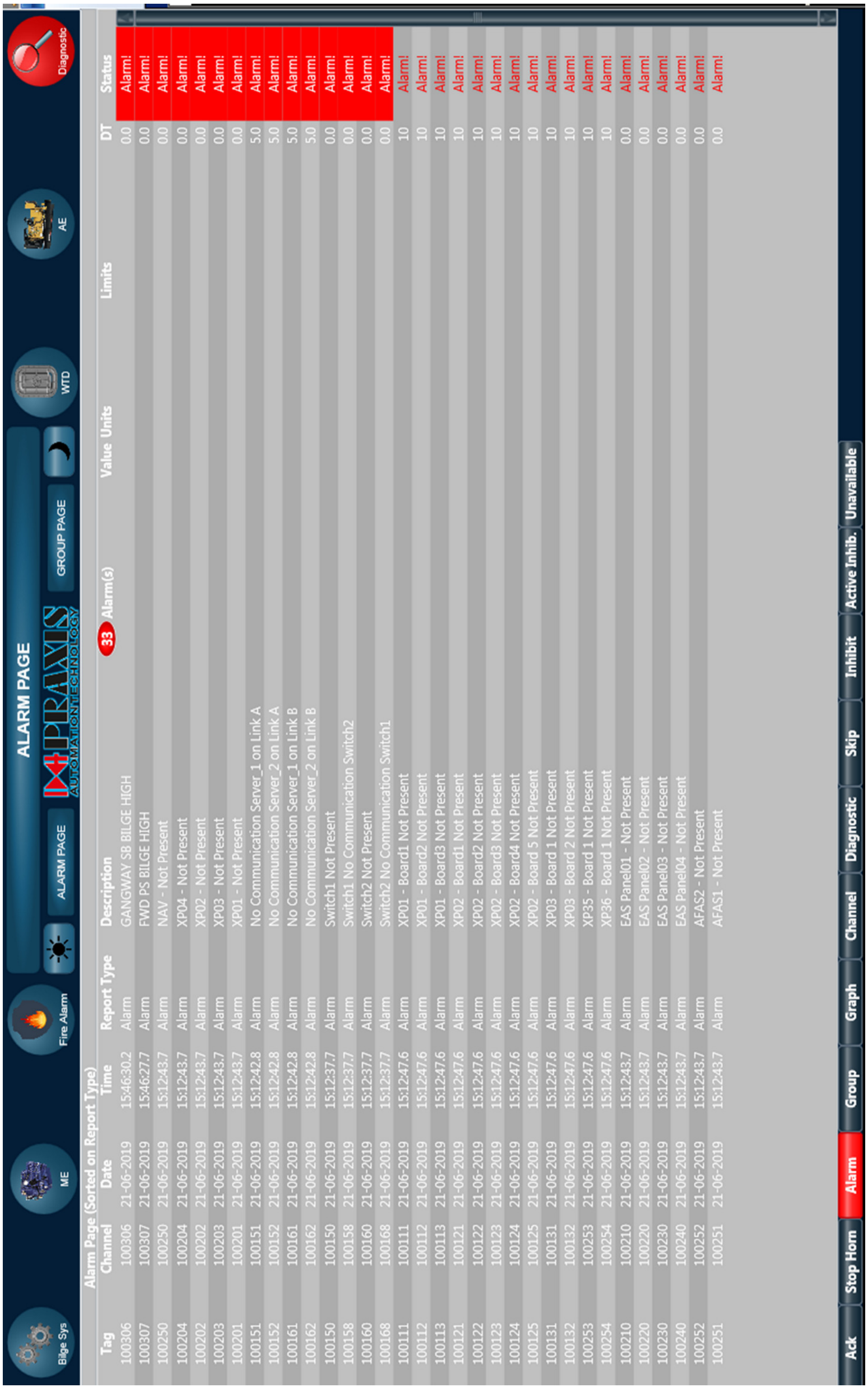


Fig. 4.19b. Diagnostic for alarm menu in MIMIC Display

Figure 4.19a. shows alarming menu that can be displayed in one window of the MIMIC display. Every single I/O data can be displayed and more detailed description can be simulated so the attended crew can easily access and have accurate verification before decide any acts following the alarm signal. This figure displayed in the normal condition without any emergency calls.

When one or more alarms coming the displayed MIMIC can be shown as Figure 4.19b for example. System give solution based on the diagnostic feature. This diagnostic feature is set depend on the requirements by authority Rules and Regulations and supported by well technical considerations from expertise.

Both condition occurred when any sensor detect signals then in the same time would rise up the alarm page windows within the specific address. The important is always honest to evaluate the detail information, put the name of components differently so they will not mess up and make confuse which part of bilge, Fire, and watertight-doors system.

The data from the diagnostics menu is integrated, recorded and documented within the specific numerical result. Low level system just shows the diagnostic data to the operator for further execution but more sophisticated system called as intelligence system which can do acts depend on the logical programme that established previously. Integration system just link and match among any system so can alert and affect in the similar route logical data. It is more practicable and effective to handle so many data in the ship operation. Bigger ship make more equipment and system must be installed on-board. Let computer help the operator to do their works without any interrupted with human situation and condition in change mentality and physically in daily time of ship's operation.

In order to further improve of the ships efficiency then many equipment manufacturers are looking into feeding the main control and monitoring system with opportunities for condition based monitoring. This would contribute further improvements in the possibilities of preventing any breakdowns and accident that may be occured on-board the ship.

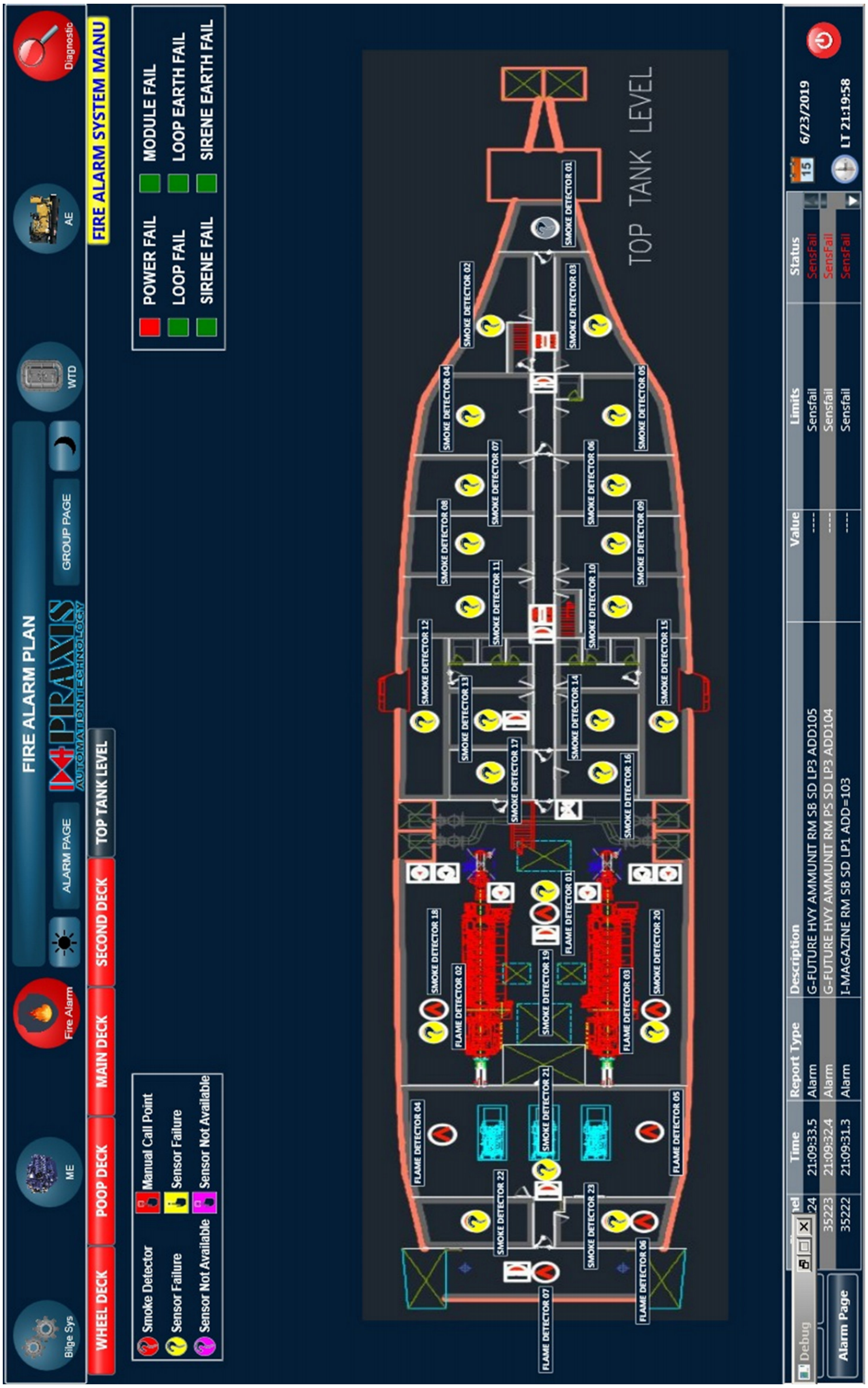


Fig. 4.20. Fire Alarm System integration in Top Tank Level

Figure 4.20. shows the integration of the fire alarm system for the compartment in the top tank level. Related to the topic of the study, therefore, only this deck level will be analysed. Because of potential damage of the hull may occur flooding mainly in this deck. Furthermore, in the real project design all decks level need to be investigated.

As the third part of menu in the inside of MIMIC display, the arrangement of fire alarm plan design and its system due to safety reason while flooding occurs are provided. The main investigation focused at top tank level only. Every single room are equipped by one audible alarm. It is a common sense that the sound can be heard from the outside of the wall. Everybody can hear from any position in the gangway so they can make detection to the fire sources and report to the navigation bridge where the officer or master in duty, and possible runaway.

Every icon has different interconnected line, for example in the specific compartment such as engine room and galley that possible common source of naked fire then they have two icons like smoke detector and flame detector, other else place has only one internal smoke detector. Each icon has meaning depends on its function. To fulfil safety matters on-board then it is a compulsory to fit sensors that capable of trigger the smoke detector, flame detector, fire plan, fire alarm bell, fire main valve, fire pump, and bilge pump on-board the ship. For smoke detector should be built in within two modes, there are automatic smoke detector and manual call point. Integrated all in one automation system such as VIAS will give progressive alert whenever initial small flames just coming, then quicker act to extinguishing them in very shorter time.

Figure 4.21. is experimental works when the new module of DCFS-VIAS is finished. Some analogue equipment installed as physical alarms system such as bell alarm, smoke detector, flame detector, etc. The DCFS-VIAS tested using dummy fire and smoke from fire-lighter and aerosol spray. All of the part as shown in Figure 4.20. and 4.21. tested one by one and finally conclude that all of the system are running well in term of detection, integration, and alarming report to the MIMIC display and cut off power sources from the power generation.

Fig. 4.21. Experimental tests for the Fire Alarm simulation

Gear to be prepared for simulating the fire alarm plan. Input the Fire Alarm Display that will receive all information later on. The system consists of marine optical smoke detector, marine manual call point, and bells.

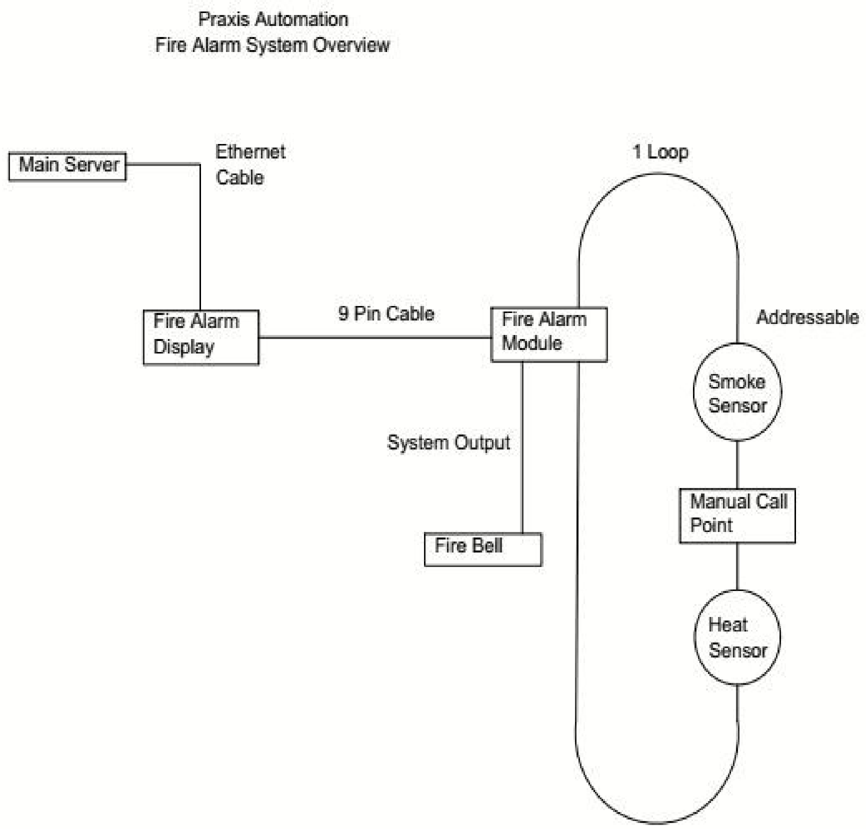


Fig. 4.22. Scheme of Fire Alarm System

Figure 4.22. shows the schematic diagram of the fire alarm system that has been generated as inclusion in the new module DCFS system. Important routine check to thing during simulation is how often to check the channels to always make sure their correct functionality. Daily documentation produces regularly under on-board activities can be used as recapitulation data whenever needs for someday when there is something missing.

Addressable devices such as smoke sensor, manual call point, heat sensor, etc., have loop to send information to the fire alarm module that it can start fire bell device. Fire alarm module send data via 9 pin cables to the fire alarm display in the navigation bridge then always notice by main server for further action.

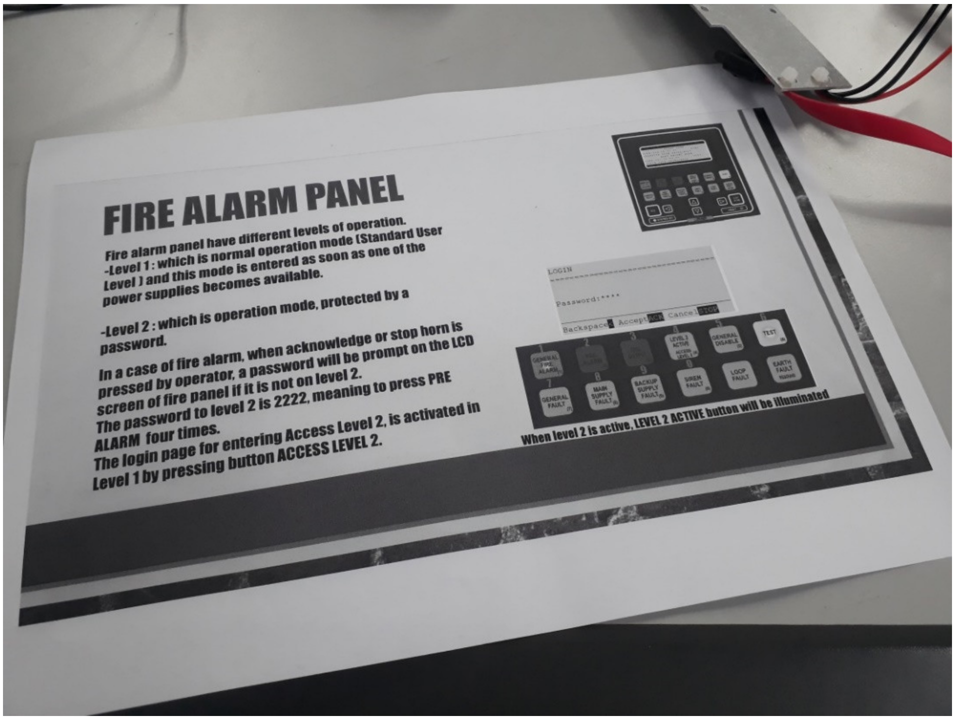


Fig 4.23. Fire Alarm Panel procedures

A Fire Alarm should be generated when one or more of the Fire Alarm System (FAS) detectors comes into alert conditions. The Fire Alarm System is able to distinguish all of the single detector alarm. The fire Alarm Procedure can be explained in this way as in following steps:

- Activation of fire alarm lamp, internal buzzer (2Hz), external siren (continuous) and identification of detector in alarm on the FAS Operational Panel

- When stop horn is pressed in level 2 the internal buzzer and external siren are silenced. This function is also available in level 1 when selected during installation

- When reset pressed in level 2 the system is reset. Fire alarm lamp will extinguish and detector alarm on touchscreen will be cleared when fire alarm condition has disappeared

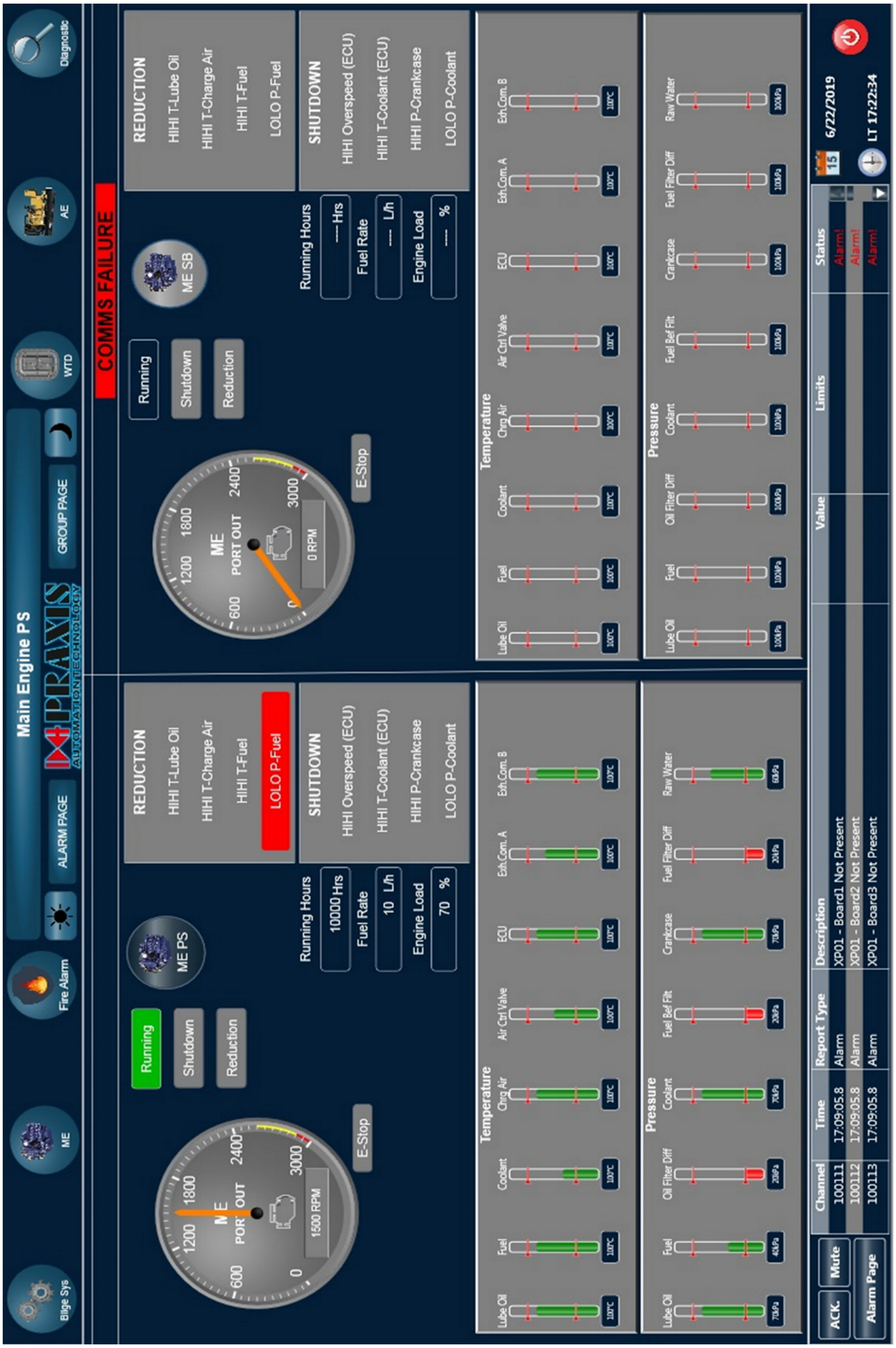


Fig. 4.24. Main Engine menu in MIMIC Display

Figure 4.24. shows MIMIC display of the main Engine menu in running condition and communications failure condition. Each part has three modes called as running, shutdown, and reduction. Many indicators devices are provided to show the condition of any 16 unit of temperature devices. As figure 4.24. shown that the ship is simulated in clear position at 1500 RPM.

Due to machineries condition assessment, then the system can individually improve corrective actions for the prevention of machinery failure. Instead of a condition based maintenance, then related model as systematic preventive maintenance should also be implemented. The system should be able to automatically activated while the detection of an emergency situation happens in purpose of recover a safe situation or at least to mitigate the damages for example automatic change-over mode.

4.4.2. Integrated System

There is no obvious and always possible when any single module work individually as a stand-alone system. But integrated them in one single mode result many benefits in term of technically aspect and sure there will be higher costs. Why assessment always done to certain time of ship life time. Integrated system offers efficient work then if accumulated possible to compensated the investment costs under shorter time of return of investment.

Integrated system performs higher level of the automation technology. Many advances feature offered by this sophisticated technology. The new module DCFS-VIAS can be integrated with all existing modules that was developed by Praxis Automation. The performances of the system can generate single multi-windows menu in one or several units MIMIC display. It is matter of the existence spaces in the ship dashboard on navigation bridge.

4.4.3. Test and Trial

Progressive test and trial has been done in the factory. The simulation and experimental test of this new module of DCFS has been proven reliable and working well in the integrated based system called as VIAS. Experimental works has been done in the Praxis workshop in Singapore by certain scenarios of the fire accident and damaged hull position.

4.4.4. Finalize Systems

Instrumentations used in here means that both the use of measuring instruments to monitor and control a process (sensors), and the equipment used to achieve control (actuators) for acting process. Focuses this study is on the whole layout of the equipment (sensors and actuators) that has been used to control entire process. Virtual sensors are connected to process vessels, equipment, and piping system to provide immediate continuous measurements of the process conditions which is used to control the process. Poor layout of the virtual instrumentations may be can influence serious consequences for process stability.

That explanation become baseline in the built of new module DCFS-VIAS here. Every single line is evaluated and validated in the experimental works. Finalize system has been carried out to make sure that every single line in perfect operation then they can give reliable system as its predecessor modules. Praxis has high standard to be followed.

4.5. SIMULATION DCFS

Due to the availability hardware and DAQ system then the experimental results can only be shown in the video medium. It will demonstrate in the final examination day. Simulation of the new module DCFS has been carried out in Praxis workshop and good results can be reported in the visualisation videos. As explained before, the simulation works is a part of numerical calculations to perform any phenomenon that modelled mathematically. It is slightly different with the new DCFS module and others module of VIAS. VIAS is a physical system that contains some virtual modes. VIAS and new DCFS module not simulated the works of system but by existence of DAQ (Data Acquisition) hardware it is a fully integrated system that capable of simulate the output data in a virtual display called as MIMIC.

4.5.1. Simulation Each System

The simulation will do in this final project only, due to the absence of DAQ board and complete lines that usually installed on-board a ship. Anyway, this limited simulation works studied for final project is properly become representative of the real duty. The new DCFS module is a typical DAQ board. It is working well as a software system that support the hardware module owned by Praxis.

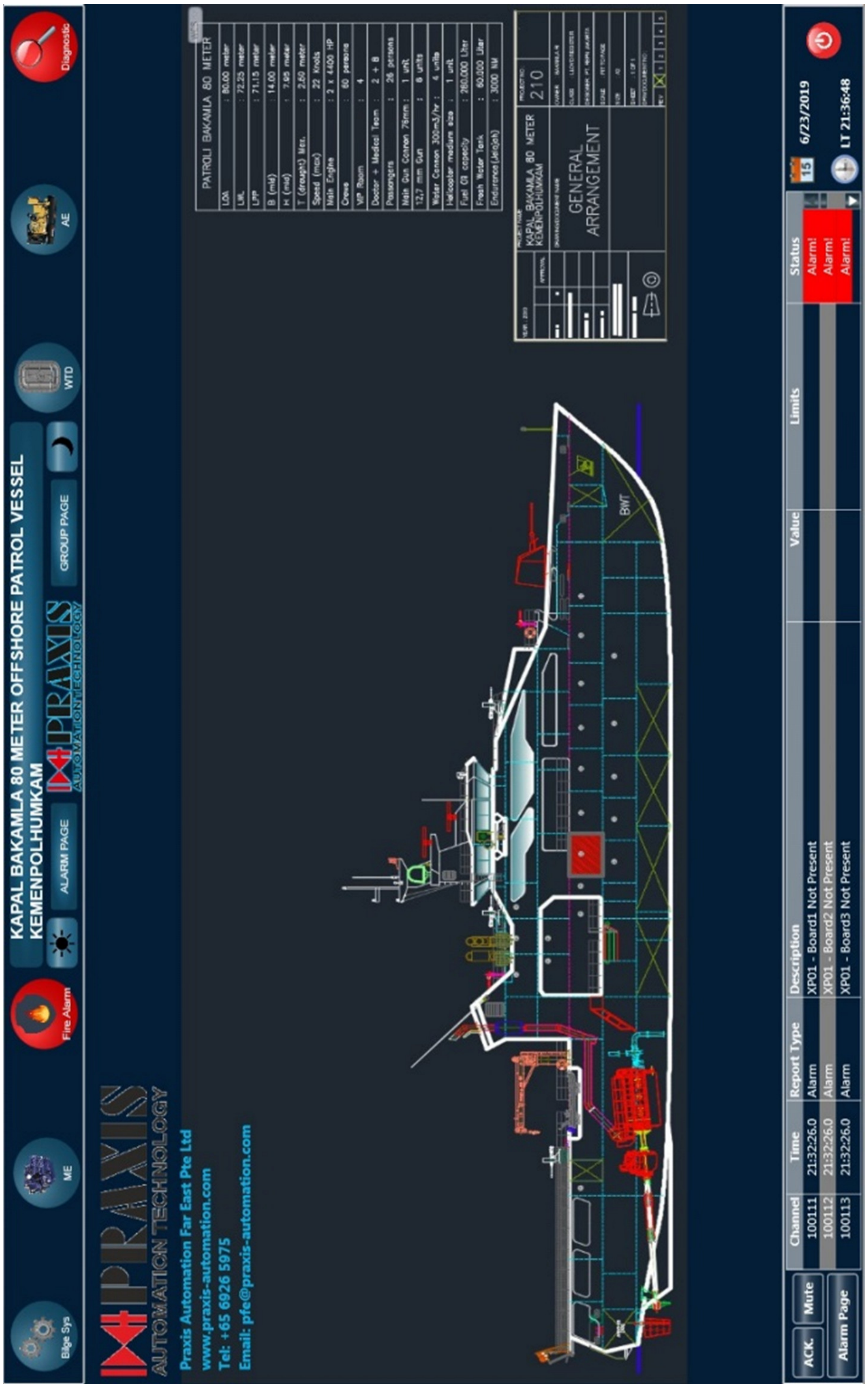


Fig. 4.25. Start Up Page in MIMIC Display

4.5.2. Integration Simulation for all Systems

Integration for all the DCFS systems has been carried out in the Praxis workshop. The results show good achievement when all systems can be operated properly. All sensors work well and they give alert excellently for any disturbances as typical of fire and flooding and any watertight doors also react and commanding the system to closed the certain door unit for insulate the existence of oxygen in air. The emergency safety device will also send signals to stop the operational of diesel generators and main engines inside the engine room compartments when the fire or flooding happen. By using some of the I/O channels in the DCFS module, then it is can be occupied to operate another alternative system called as Anti-Heeling System (AHS). All features in comprehensive new module of DCFS can handle one solution in term of any initial disaster at sea that always keep the ship in safe and secure.

To operate MIMIC Display look-likely similar with any common smartphone where several features within separate menu on each system can develop such as 6 (six) menu consist of start-up page, bilge system, main and auxiliary engines, fire alarm, watertight doors, and diagnostic menu window. Based on the trial during experimental works, the module capable of running and simulating the MIMIC Display in very responsive way. Demo tests under that experimental works are done by several scenarios of fire and flooding. Visualisation of the results during demo tests may be seen in the separate movie file and also direct use of the module in the on-board a ship or demo-case available.

4.6. PROVING UMS NOTATION

In the end of this study, as stated clearly in one of the research objectives, it is important to justify whether the built new module of DCFS is comply with UMS requirements or not. Evaluation based on the qualitative method by cross-check the availability feature of the new DCFS module on relation to the UMS capabilities.

4.6.1. Assessment of the Model DCFS

As the modern market, ship owners prefer to become more efficient with reduced staff on board when an automatic control and monitoring has been installed for the ship so that it will enabled to apply the unattended operation of machinery spaces. Vessels capable of safe operation at any period of time without any existence crews in the engine room and engine control room (ECR) when comply with the UMS (Unattended Machinery Space) Notation.

A modern automation and control system is a fully integrated systems covering many aspects of the ship operation that includes the propulsion plant operation, power management operation on the auxiliary engines, fluids machinery operation, cargo on-and-off-loading operation, navigation and administration of maintenance and purchasing of spares. Capability of automation system covers not only normal operation status but also under emergency and critical situations.

4.6.2. Decision Criteria for UMS Assessment

Based on the previous explanation called as UMS requirements then the features of this new DCFS module will be evaluated to investigate whether the system already comply with UMS Notation or not. In actually, official Class Society has authority to determine the acceptance of the UMS requirements. Table 4.1. resume all the requirements and the relation with new module of DCFS which is developed in this final project.

Table 4.1. New DCFS module for Propose the UMS Notation

	Technical Criteria	Comply UMS Reqs.
1	Fire Precautions	√
2	Protections against Flooding	√
3	Control of Propulsion Machinery from Bridge	√
4	Centralized Control and Instruments are Required in Machinery Space	√
5	Automatic Fire Detection	√
6	Fire Extinguishing System	√
7	Alarm System	√
8	Automatic Start of Emergency Generator	√

From the data shown in Table 4.1. and the audio/video demo list of new DCFS module then can be concluded that the ship “80 meter OPV” comply with UMS Notation. All features are available in this developed new DCFS module. Furthermore, all UMS requirement has been fulfilled with the latest advanced design as modern integrated automation technology. Technically speaking, it may contribute many benefits to the ship owner even economic assessment still in demand for realize the implementation of both the new DCFS module and UMS Notation. Economic analysis should be carried out based on long-term evaluation, such the long life of vessel about 25 years in advanced to knowing better acceptance of this investments.

CHAPTER V
CONCLUSION AND RECOMMENDATION

New module called as DCFS has been well generated under VIAS mode. There are some conclusions to be explained related to the purpose of this study. Mainly, can be stated that the new system already proven works on the VIAS system of the 80 meters OPV. It is become an encourages step in the development of the fully integrated automation in the national shipbuilding industry.

5.1. CONCLUSION

From all of the development works to build a new DCFS module under VIAS technology, then this final project concludes that the following goals of this research activities has been achieved. Prove of the goal of research are:

1. New DCFS module capable of using all of the existing fire and bilge system on-board the 80 Meter OPV. It is means there is no additional pumps and sensor & alarm system, even certain minor installation still in demands.
2. It has been proven that new DCFS module totally already comply with all of the requirements to establish the UMS Notation.
3. It shows the optimal integration automation design for new DCFS module and it comply with all of the requirements to get UMS Notation.
4. Complete system on the new DCFS module has been built effectively in the form of virtual MIMIC display.

5.2. RECOMMENDATION

The existing design of the 80 meters Offshore Patrol Vessel (OPV) use Active Fin Stabilizer for Anti Heeling System (AHS). For supporting the new DCFS module, it is recommended to use tank stabilizer system as AHS. Inserting a lot of water on-board a ship when fire extinguishing done, make the ship heeling may occur. Using tank stabilizer system can make easier in order to adjusting the angle of heeling.

The result of this study in the form of the DCFS MODULE will be proposed to be patented, for any enquiries and further information please contact the author.

“This page is intentionally left blank”

REFERENCE

[1] Bistrovic M., Tomas V, (2014), *Application of New Techniques and Information Technology for Early Fire Detection on ships*, Journal Nase Mone 61 (5-6), 2014, pp.87-95.

[2] Bulitko V.V., Wilkins D.C., (1999), *Automated Instructor Assistant for Ship Damage Control*, From: IAAI-99 Proceedings. Copyright © 1999, American Association for Artificial Intellegence. (www.aaai.org). USA

[3] Calabresse F., et all, (2012), *Damage Control System: an application for Ship Safety and Security*, 9th IFAC Conference on Manouvering and Control of Marine Craft, September 19-21, Arenzona, Italy

[4] Dey P., et all, (2013), *Design and Implementation of an Automatic Fire Extinguishing System Based on Fault Secure Multi-Detectors*, Proceedings of the International Conference in Mechanical Engineering and Renewable Energy 2013, ICMERE2013, 1-3 May 2013, Chittagong, Bangladesh

[5] Hiltz J.A., Daniels J., (2006), *Damage Control Technology – A Literature Review*, Technical Memorandum DRPC Atlantic TM 2006-045, March 2006, Canada

[6] Lin J., (2017), *PRAXIS Ship Automation*, Guest Lecturer slide presentation for Department of Marine Engineering ITS, 22 November 2017, Surabaya Indonesia

[7] Pitana T., Prastowo H., Zaman M.B., Nurwahyudi A., Gunawan R., *Flooding Causes Analysis in The Engine Room of KM. Nusantara Akbar*, International Journal of Marine Engineering Innovation and Research, Vol. 1(2), Mar. 2017. 88-97 (pISSN: 2541-5972, eISSN: 2548-1479), Surabaya, Indonesia

[8] Ruponen P., Larmela M., Pennanen P., (2012), *Flooding Prediction Onboard a Damaged Ship*, Presented by Napa Ltd, Proceedings of the 11th International Conference on the Stability of Ships and Ocean Vehicles 23-28 September 2012, Athens, Greece.

[9] Santoso A., Kusuma I.R., Lin J., (2018), *The Application of Vessel Integrated Automation Systems to Improve Ship Safety and Security*, Maritime Safety International Conference (MASTIC), 9-11 July 2018, Denpasar, Bali

[10] Santoso A., Lin J., Kusuma I.R., and Koenhardono E.S., (2017), *Penerapan Sistem Elektronik Terintegrasi Pada Rancang Bangun Kapal Patroli Buatan Dalam Negeri untuk Meningkatkan Kemandirian Bangsa didalam Menjaga Kedaulatan Maritim*, Seminar Nasional MASTER 2017, pp. 227-230, PPNS Surabaya, Indonesia

[11] Santoso A. Kusuma I.R. Saihilmi M.I., (2019), *Pengembangan Sistem Otomasi Terintegrasi Dengan Alat Safety Darurat Untuk Mengatur Start/Stop Mesin Diesel Di Kapal Yang Menggunakan Bahan Bakar Gas*, Seminar Nasional "Implementasi Hasil Riset Sumber Daya Laut dan Pesisir Dalam Peningkatan Daya Saing Indonesia", Fakultas Teknik dan Ilmu Kelautan Universitas Hang Tuah, Surabaya 11 Juli 2019

[12] Sen K., et all., (2015), *Automated Fire Detection and Controlling System*, International Advanced Research Journal in Science, Engineering and Technology Vol. 2, Issue 5, May 2015.

[13] Sheena P.A., Suneetha M.N., Prasanna K.H., (2016), PLC Based Control and Monitoring in Ship, International Journal of Electrical and Electronics Research ISSN 2348-6988 (online) Vol. 4, Issue 3, pp: (74-81), Month: July - September 2016, Available at: www.researchpublish.com

[14] Shtay A.D., Gharib W., (2009), *An Intelligent Control System for Ship Collision Avoidance*, International Journal of Engineering & Technology IJET-IJENS Vol:09 No:10, December 2009

[15] Varela J.M., Rodriques J.M., Soares C.G., (2014), *On-Board Decision Support System for Ship Flooding Emergency Response*, Procedia Computer Science, Volume 29, Pages 1688-1700, ICCS 2014, Elsevier

[16] Varela J.M., Soares C.G., (2007). *A virtual environment for decision support in ship damage control,* Journal of Computer Graphics and Applications, IEEE, 27(4): 58-69.

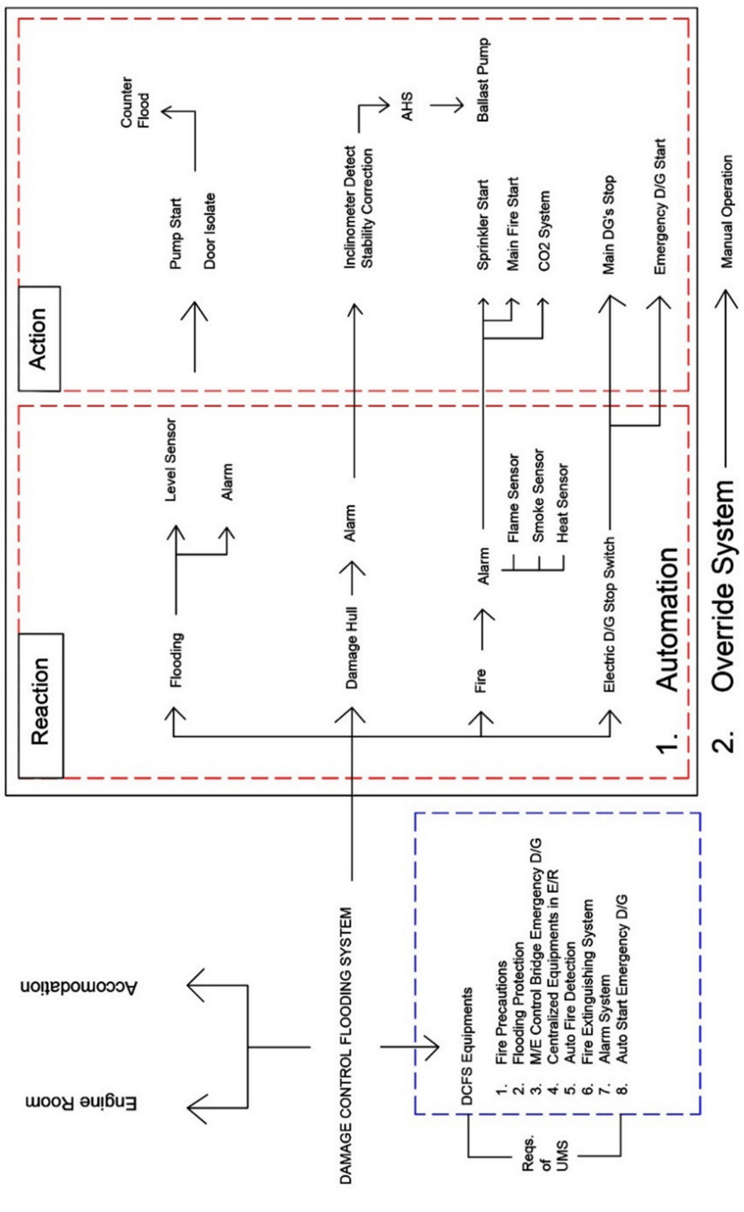
[17] Zaman M.B, Santoso A., Kobayashi E., Wakabayashi N., and Maimun A., (2015), *Formal Safety Assesment (FSA) for Analysis of Ship Collision Using AIS Data*, The International Journal on Marine Navigation and Safety on Sea Transportation, pp67-72., Vol.9., No.1., March 2015, Gydnia Poland

[18] Zaman M.B., Priyanta D., Afianza I., (2016), *Evacuation Analysis of 1200 GT Passenger Ship in Case of Fire using Agent-Based Modeling Approach*, Int. J. of Marine Engineering Innovation and Research, IJMEIR, Vol. 1(1), Dec. 2016. 9-11 (ISSN: 2541-5972), Surabaya, Indonesia

[19] Zhang L., Wang G., (2009), *Design and Implementation of Automatic Fire Alarm System based on Wireless Sensor Networks*, Proceedings of the 2009 Int. Symposium on Information Processing (ISIP'2009), August 21-23, pp. 410-413, Huangshan, China

"This page is intentionally left blank"

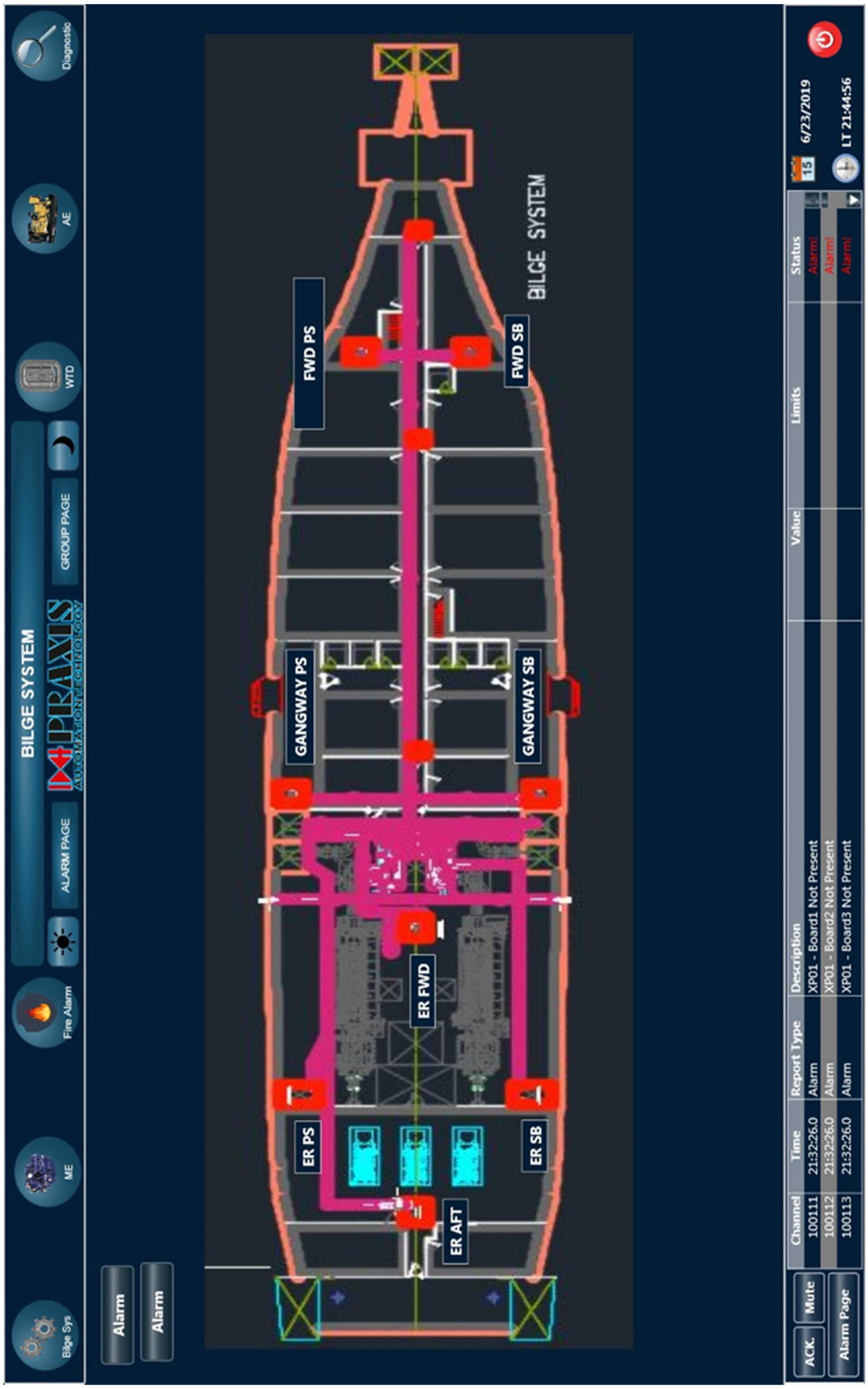
ATTACHMENT

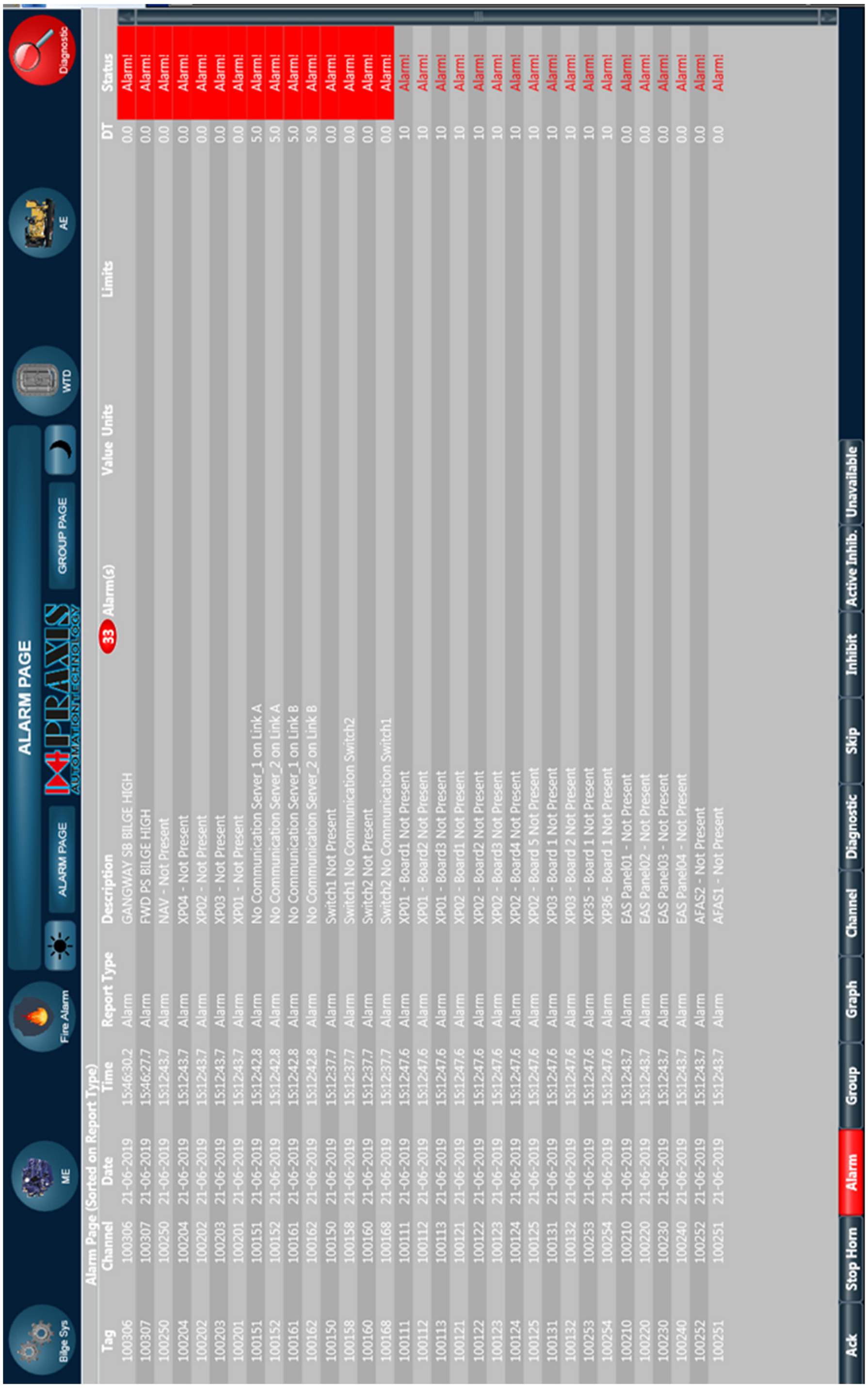


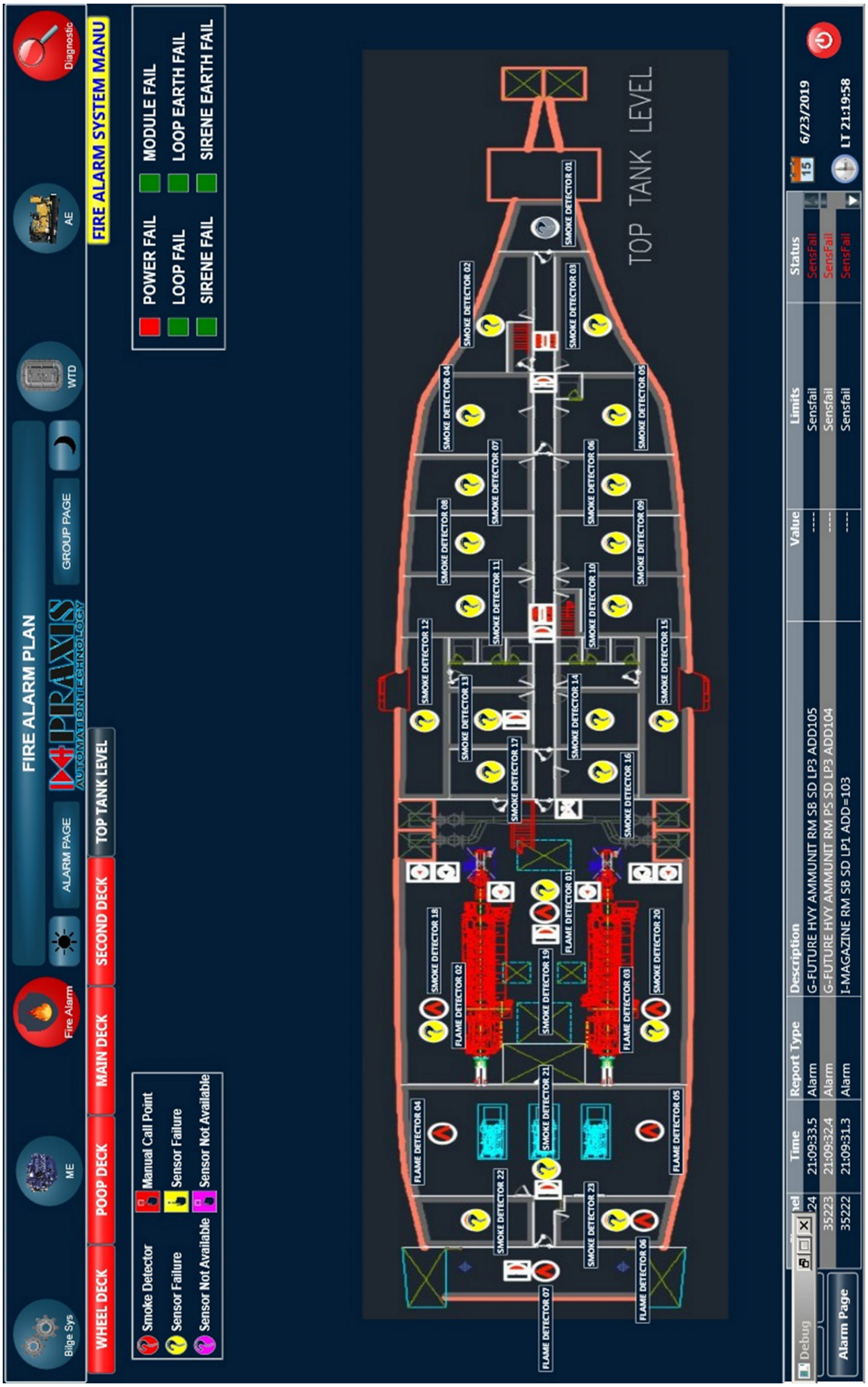
DAMAGE CONTROL FLOODING SYSTEM
Engine Room
Accomodation
DCFS Equipments
1. Fire Precautions
2. Flooding Protection
3. M/E Control Bridge Emergency D/G
4. Centralized Equipments in E/R
5. Auto Fire Detection
6. Fire Extinguishing System
7. Alarm System
8. Auto Start Emergency D/G
Reqs. of UMS
Reaction
Action
Flooding
Level Sensor
Alarm
Pump Start
Door Isolate
Counter Flood
Damage Hull
Alarm
Inclinometer Detect Stability Correction
AHS
Ballast Pump
Fire
Alarm
Flame Sensor
Smoke Sensor
Heat Sensor
Sprinkler Start
Main Fire Start
CO2 System
Electric D/G Stop Switch
Main DG's Stop
Emergency D/G Start
1. Automation
2. Override System
Manual Operation

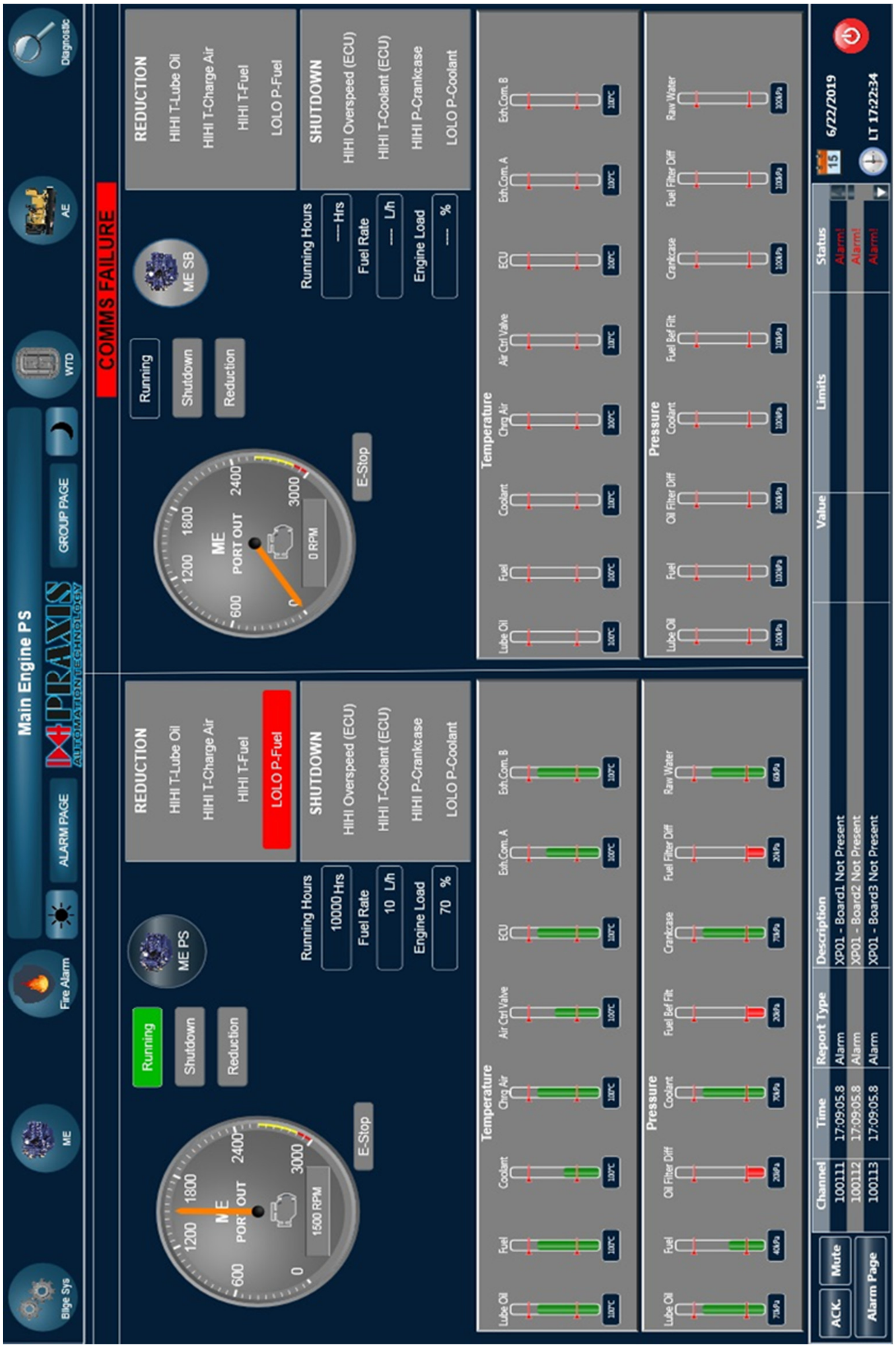

WATERTIGHT DOOR
FIRE SYSTEM
ALARM PAGE
GROUP PAGE
Fire Alarm
Pumps
Tanks
4/28/2019
XP35 - Board 1 Not Present
EAS Panel01 - Not Present
Alarm Page

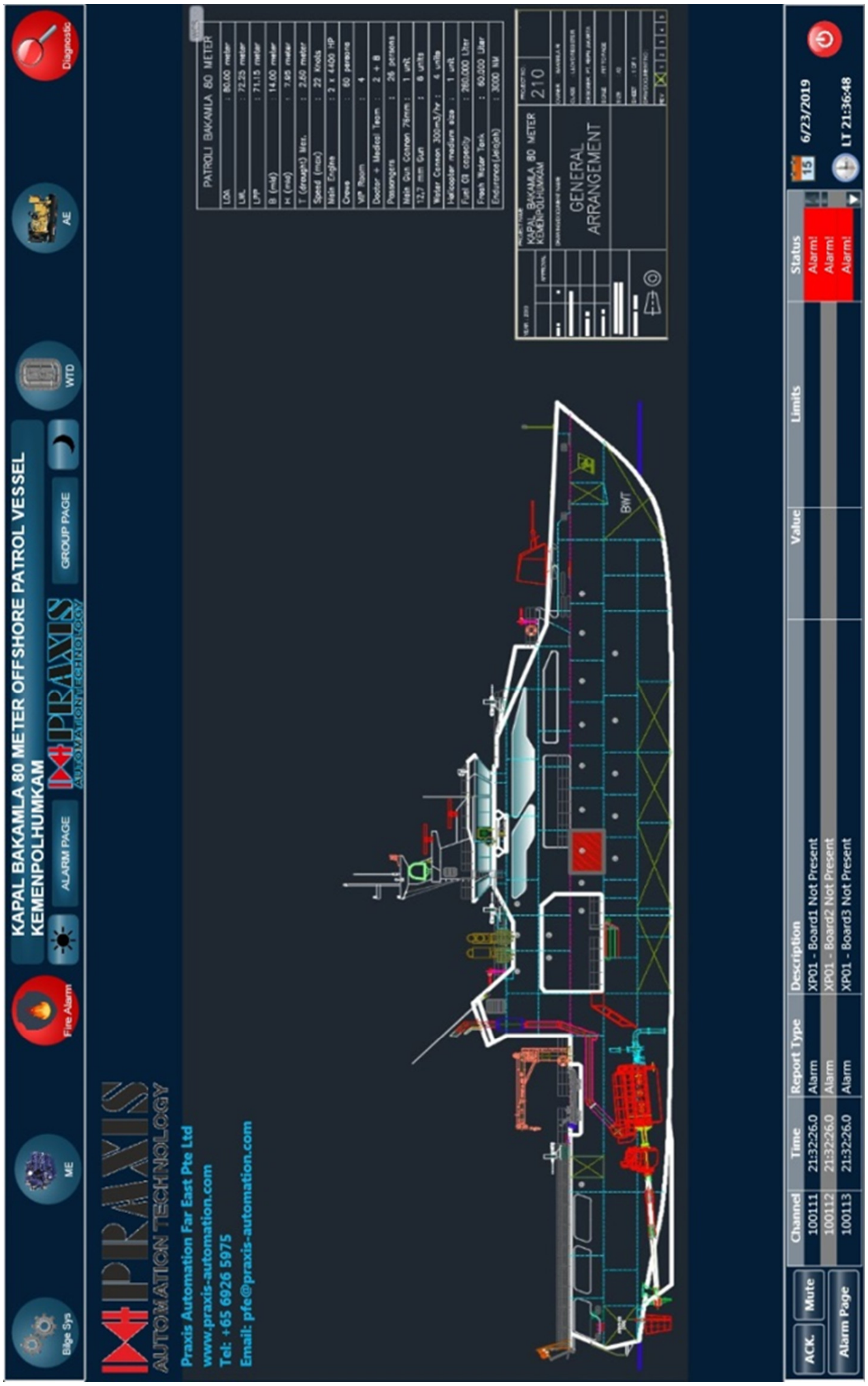

Bilge Sys
ME
Fire Alarm
ALARM PAGE
AUXILIARY ENGINE
PRAXIS
AUTOMATION TECHNOLOGY
GROUP PAGE
WTD
AE
Diagnostic
GE PS
GE SB
1600 RPM
0
400
800
1200
1600
2000
ENGINE
FUEL 50 KPA
Pressure
BATTERY 80 v
Voltage
COOLANT 73Celcius
Temperature
OIL 60 KPA
Pressure
Generator
50 Hz
440 V
HIGH AC FREQUENCY
LOW AC FREQUENCY
HIGH AC VOLTAGE
LOW AC VOLTAGE
ACK.
Mute
Alarm Page
Channel
Time
Report Type
Description
Value
Limits
Status
100111 21:32:26.0 Alarm XP01 - Board1 Not Present Alarm!
100112 21:32:26.0 Alarm XP01 - Board2 Not Present Alarm!
100113 21:32:26.0 Alarm XP01 - Board3 Not Present Alarm!
6/23/2019
LT 21:41:28

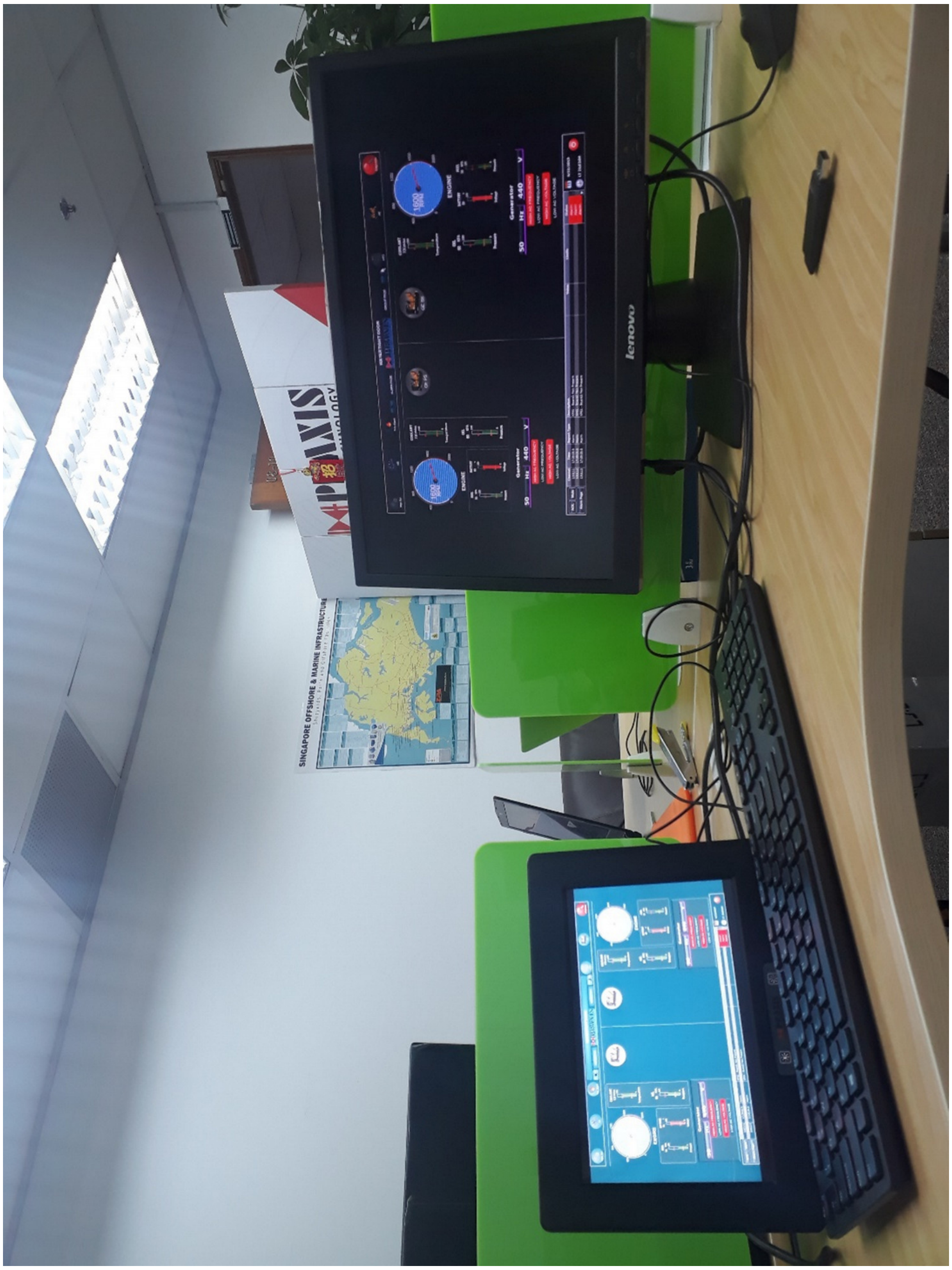

Diagnostic
AE
WTD
GROUP PAGE
BILGE SYSTEM
ALARM PAGE
Fire Alarm
ME
Bilge Sys
Alarm
Alarm
FWD PS
FWD SB
BILGE SYSTEM
GANGWAY PS
GANGWAY SB
ER FWD
ER PS
ER SB
ER AFT
ACK.
Mute
Alarm Page
Channel
Time
Report Type
Description
Value
Limits
Status
100111 21:32:26.0 Alarm XP01 - Board1 Not Present Alarm!
100112 21:32:26.0 Alarm XP01 - Board2 Not Present Alarm!
100113 21:32:26.0 Alarm XP01 - Board3 Not Present Alarm!
6/23/2019
LT 21:44:56


ALARM PAGE
Bilge Sys
ME
Fire Alarm
ALARM PAGE
PRAXIS
AUTOMATION TECHNOLOGY
GROUP PAGE
WTD
AE
Diagnostic
Alarm Page (Sorted on Report Type)
Tag Channel Date Time Report Type Description 33 Alarm(s) Value Units Limits DT Status
100306 100306 21-06-2019 15:46:30.2 Alarm GANGWAY SB BILGE HIGH 0.0 Alarm!
100307 100307 21-06-2019 15:46:27.7 Alarm FWD PS BILGE HIGH 0.0 Alarm!
100250 100250 21-06-2019 15:12:43.7 Alarm NAV - Not Present 0.0 Alarm!
100204 100204 21-06-2019 15:12:43.7 Alarm XP04 - Not Present 0.0 Alarm!
100202 100202 21-06-2019 15:12:43.7 Alarm XP02 - Not Present 0.0 Alarm!
100203 100203 21-06-2019 15:12:43.7 Alarm XP03 - Not Present 0.0 Alarm!
100201 100201 21-06-2019 15:12:43.7 Alarm XP01 - Not Present 0.0 Alarm!
100151 100151 21-06-2019 15:12:42.8 Alarm No Communication Server_1 on Link A 5.0 Alarm!
100152 100152 21-06-2019 15:12:42.8 Alarm No Communication Server_2 on Link A 5.0 Alarm!
100161 100161 21-06-2019 15:12:42.8 Alarm No Communication Server_1 on Link B 5.0 Alarm!
100162 100162 21-06-2019 15:12:42.8 Alarm No Communication Server_2 on Link B 5.0 Alarm!
100150 100150 21-06-2019 15:12:37.7 Alarm Switch1 Not Present 0.0 Alarm!
100158 100158 21-06-2019 15:12:37.7 Alarm Switch1 No Communication Switch2 0.0 Alarm!
100160 100160 21-06-2019 15:12:37.7 Alarm Switch2 Not Present 0.0 Alarm!
100168 100168 21-06-2019 15:12:37.7 Alarm Switch2 No Communication Switch1 0.0 Alarm!
100111 100111 21-06-2019 15:12:47.6 Alarm XP01 - Board1 Not Present 10 Alarm!
100112 100112 21-06-2019 15:12:47.6 Alarm XP01 - Board2 Not Present 10 Alarm!
100113 100113 21-06-2019 15:12:47.6 Alarm XP01 - Board3 Not Present 10 Alarm!
100121 100121 21-06-2019 15:12:47.6 Alarm XP02 - Board1 Not Present 10 Alarm!
100122 100122 21-06-2019 15:12:47.6 Alarm XP02 - Board2 Not Present 10 Alarm!
100123 100123 21-06-2019 15:12:47.6 Alarm XP02 - Board3 Not Present 10 Alarm!
100124 100124 21-06-2019 15:12:47.6 Alarm XP02 - Board4 Not Present 10 Alarm!
100125 100125 21-06-2019 15:12:47.6 Alarm XP02 - Board 5 Not Present 10 Alarm!
100131 100131 21-06-2019 15:12:47.6 Alarm XP03 - Board 1 Not Present 10 Alarm!
100132 100132 21-06-2019 15:12:47.6 Alarm XP03 - Board 2 Not Present 10 Alarm!
100253 100253 21-06-2019 15:12:47.6 Alarm XP35 - Board 1 Not Present 10 Alarm!
100254 100254 21-06-2019 15:12:47.6 Alarm XP36 - Board 1 Not Present 10 Alarm!
100210 100210 21-06-2019 15:12:43.7 Alarm EAS Panel01 - Not Present 0.0 Alarm!
100220 100220 21-06-2019 15:12:43.7 Alarm EAS Panel02 - Not Present 0.0 Alarm!
100230 100230 21-06-2019 15:12:43.7 Alarm EAS Panel03 - Not Present 0.0 Alarm!
100240 100240 21-06-2019 15:12:43.7 Alarm EAS Panel04 - Not Present 0.0 Alarm!
100252 100252 21-06-2019 15:12:43.7 Alarm AFAS2 - Not Present 0.0 Alarm!
100251 100251 21-06-2019 15:12:43.7 Alarm AFAS1 - Not Present 0.0 Alarm!
Ack
Stop Horn
Alarm
Group
Graph
Channel
Diagnostic
Skip
Inhibit
Active Inhib.
Unavailable


FIRE ALARM PLAN
PRAXIS AUTOMATION TECHNOLOGY
Bilge Sys
ME
Fire Alarm
ALARM PAGE
GROUP PAGE
WTD
AE
Diagnostic
WHEEL DECK
POOP DECK
MAIN DECK
SECOND DECK
TOP TANK LEVEL
FIRE ALARM SYSTEM MANU
Smoke Detector
Sensor Failure
Sensor Not Available
Manual Call Point
Sensor Failure
Sensor Not Available
POWER FAIL
LOOP FAIL
SIRENE FAIL
MODULE FAIL
LOOP EARTH FAIL
SIRENE EARTH FAIL
TOP TANK LEVEL
Time
Report Type
Description
Value
Limits
Status
21:09:33.5 Alarm G-FUTURE HVY AMMUNIT RM SB SD LP3 ADD105 ---- Sensfail SensFail
21:09:32.4 Alarm G-FUTURE HVY AMMUNIT RM PS SD LP3 ADD104 ---- Sensfail SensFail
21:09:31.3 Alarm I-MAGAZINE RM SB SD LP1 ADD=103 ---- Sensfail SensFail
Alarm Page
6/23/2019
LT 21:19:58


Main Engine PS
ALARM PAGE
GROUP PAGE
PRAXIS
AUTOMATION TECHNOLOGY
Bilge Sys
ME
Fire Alarm
WTD
AE
Diagnostic
COMMS FAILURE
Running
Shutdown
Reduction
ME PS
ME SB
1200 1800 2400 3000 600 0
ME
PORT OUT
1500 RPM
0 RPM
E-Stop
REDUCTION
HIHI T-Lube Oil
HIHI T-Charge Air
HIHI T-Fuel
LOLO P-Fuel
SHUTDOWN
HIHI Overspeed (ECU)
HIHI T-Coolant (ECU)
HIHI P-Crankcase
LOLO P-Coolant
Running Hours
10000 Hrs
---- Hrs
Fuel Rate
10 L/h
---- L/h
Engine Load
70 %
---- %
Temperature
Lube Oil
Fuel
Coolant
Chrg Air
Air Ctrl Valve
ECU
Exh.Com. A
Exh.Com. B
Pressure
Oil Filter Diff
Fuel Bef Filt
Crankcase
Fuel Filter Diff
Raw Water
ACK.
Mute
Alarm Page
Channel
Time
Report Type
Description
Value
Limits
Status
100111 17:09:05.8 Alarm XP01 - Board1 Not Present Alarm!
100112 17:09:05.8 Alarm XP01 - Board2 Not Present Alarm!
100113 17:09:05.8 Alarm XP01 - Board3 Not Present Alarm!
6/22/2019
LT 17:22:34


KAPAL BAKAMLA 80 METER OFFSHORE PATROL VESSEL
KEMENPOLHUMKAM
Bilge Sys
ME
Fire Alarm
ALARM PAGE
GROUP PAGE
WTD
AE
Diagnostic
PRAXIS AUTOMATION TECHNOLOGY
Praxis Automation Far East Pte Ltd
www.praxis-automation.com
Tel: +65 6926 5975
Email: pfe@praxis-automation.com
PATROLI BAKAMLA 80 METER
LOA : 80.00 meter
LWL : 72.25 meter
LPP : 71.15 meter
B (mld) : 14.00 meter
H (mld) : 7.95 meter
T (draught) Max. : 2.80 meter
Speed (max) : 22 Knots
Main Engine : 2 x 4400 HP
Crewe : 60 persons
VIP Room : 4
Doctor + Medical Team : 2 + 8
Passengers : 26 persons
Main Gun Cannon 76mm : 1 unit
12,7 mm Gun : 8 units
Water Cannon 300m3/hr : 4 units
Helicopter medium size : 1 unit
Fuel Oil capacity : 260.000 Liter
Fresh Water Tank : 60.000 Liter
Endurance (Jelajah) : 3000 NM
KAPAL BAKAMLA 80 METER
KEMENPOLHUMKAM
210
GENERAL ARRANGEMENT
BWT
ACK.
Mute
Alarm Page
Channel | Time | Report Type | Description | Value | Limits | Status
100111 | 21:32:26.0 | Alarm | XP01 - Board1 Not Present | | | Alarm!
100112 | 21:32:26.0 | Alarm | XP01 - Board2 Not Present | | | Alarm!
100113 | 21:32:26.0 | Alarm | XP01 - Board3 Not Present | | | Alarm!
6/23/2019
LT 21:36:48


SINGAPORE OFFSHORE & MARINE INFRASTRUCTURE
lenovo


NAV
ANCHOR
MAST
NAVIGATION
NAV. LIGHTS
ENTER

"This page is intentionally left blank"

BIOGRAPHY OF AUTHOR

Muhammad Irsyad Saihilmi was born on 31st May 1996 at Newcastle Upon Tyne, United Kingdom. The author is the first child of three brothers from Mr. Agoes Santoso and Mrs. Wahyu Iriani. The author graduated from elementary school at SDI Al-Azhar Kelapa Gading Surabaya on 2009. Graduated from junior high school at SMPI Al-Azhar Kelapa Gading Surabaya on 2012. Graduated from vocational high school at SMK Prapanca 2 Surabaya on 2015. Author is a student of Bachelor Degree Programme at the Double Degree Marine Engineering Department, Faculty of Marine Technology, Institut Teknologi Sepuluh Nopember (ITS) Surabaya Indonesia and Hochschule Wismar in Rostock Germany. The author is registered as member of the Laboratory of Marine Fluid Machinery and System (MMS) during works for Bachelor Thesis. On 2017, the author had a chance to join the Study Excursion Program to Hochschule Wismar in Rostock Germany. The author has been took 1st On the Job Training at PT. Dok dan Perkapalan Surabaya (Persero) in several Division and 2nd On the Job Training at IPC Marine PT. Jasa Armada Indonesia Tbk. in Procurement Unit. This research works mainly done in PRAXIS Automation Far East Pte. Ltd. in Singapore office. The author had achievement of Publish Paper that held by Seminar Nasional Kelautan XIV at Universitas Hang Tuah Surabaya as author and presenter. For furthermore information regarding to this bachelor thesis, with pleasure contact the author through email account saihilmid20@gmail.com.