Release Panel Feasibility Study

Concept design of release panel for fire protecting system in machinery spaces

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DEGREE THESIS	
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Abstract:
The intention of this degree thesis is to explore an alternative concept for the release panel used for water mist fire protection system HI-FOG in machinery spaces.
The current release panel is always designed separately for each project, and always built from scratch. This has been heavy throughout the organization, because it is time consuming for the electrical designer, production line and installation. The goal is to make the planning stage, production line and installation faster and more efficient with a more adaptive and modular panel.
With standardized panels the amount of alternatives increases, and the panel can be used for any project with as little modification as possible.
The new concept has to be more cost effective and faster to produce. Because the design of the release panel has always been the same, and not connected to component updates, there is a great opportunity to make it to the state-of art level.
The purpose with the new concept is to plan a release panel that the electrical designer can easily design, and it can be used for projects as projects with as little modification as possible.
The practical information I have received by making factory tests on the current release panel, and by interviewing personnel both from production line and electrical designers from R&D and project departments.
The concept that I choose will not be the final one and requires further development to be a final product.

Keywords:	Release panel, Release User Panel
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EXAMENSARBETE	
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Sammandrag:
Arbetets syfte var att undersöka alternativa koncept för att framställa en aktiveringspanel som används för brandskyddssystem med vattendimma HI-FOG i maskinutrymmen. Den nuvarande aktiveringspanelen är alltid planerad separat för varje projekt och byggs alltid från grund och botten. Detta har varit tidskrävande för hela organisationen, eftersom det är tidskrävande för el-planeringen, produktionen och installationen. Målet är att göra el-planeringen, produktionen och installationen mer snabbare och effektivare med en moduler aktiveringspanel. Med en standardiserad panel ökar alternativen för funktioner som medför att panelen kan användas projekt som projekt med så få ändringar som möjligt.
Det nya konceptet bör vara mer kostnadseffektivt samt snabbare att producera.
Eftersom den nuvarande panelen alltid har sätt likadan ut, bortsätt från komponent uppdateringar är det nu en bra möjlighet att uppdatera panelen till dagens teknik.
Målet med detta arbete är att komma upp med ett koncept som enkelt kan planeras, produceras och installeras.
Den praktiska informationen har fåtts genom fabrikstester på den nuvarande panelen, och genom att intervjua personal från både produktionslinjen och el-planerare från utvecklings och projekt avdelningar.
Det koncept som väljs kommer inte att bli det slutliga och kräver ytterligare utveckling för att bli en slutlig produkt.

Nyckelord:	Release panel, Release User Panel
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Språk:	Engelska
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ABBREVIATIONS

CAN	Controller Area Network
DI	Digital Input
DO	Digital Output
EMC	Electromagnetic Compatibility
FDS	Fire Detection System
I/O	Input/Output
PCB	Printed Circuit Board
PLC	Programmable Logical Controller
PU	Pump Unit
RUP	Release User Panel
SV-CARD	Section Valve-Card
VAC	Volts, Alternating Current
VDC	Volts, Direct Current
ABS	American Bureau of Shipping
BV	Bureau Veritas
DNV	Det Norske Veritas
GL	Germanischer Lloyd
KR	Korean Register of Shipping
LR	Lloyd’s Register
NKK	Nippon Kaiji Kyokai
RINA	Registro Italiano Navale
SOLAS	Safety of Life at Sea
FM	Factory Mutual
NFPA	National Fire Protection Association
UL	Underwriters Laboratories Inc.
VdS	Verband der Schadenversicherer

PREFACE

This degree thesis is done for Marioff Corporation Oy. Marioff is a global company, part of UTC Fire & Security, a division of United Technologies Corporation (UTC). Marioff is a leading provider of water mist fire protection on land and in marine applications.

The instructor of my thesis has been Mr. Pasi Pennanen, Senior Electrical Engineer, Marioff Corporation Oy. M.Sc Rene Herrman, Arcada is appointed as supervisor for my degree thesis. I want to thank all those who have helped and guided me in this degree thesis.

Vantaa 21.03.2011

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1 Introduction

The release panel is part of a HI-FOG® fire protecting water mist system that is used in vessels, buildings, oil plants and tunnels. The release panel is used to control the machinery valve that leads water into the HI-FOG nozzles in machinery spaces. This degree thesis mostly focuses on the release panel that is used in marine applications, but the plan is to expand it in the future for land applications. Marioff Corporation Oy was founded in 1985 by inventor Mr. Göran Sundholm and the first HI-FOG water mist system was launched in 1991. Marioff is today the leading water mist fire protecting company in the world. (www.marioff.fi)

1.1 Intention

The intention of this degree thesis is to explore an alternative concept for the release panel used for water mist fire protection system HI-FOG.

The current release panel is always designed separately for each project, and always built from scratch. This has been heavy throughout the organization, because it is time consuming for the electrical designer, production line and installation. The goal is to make the planning stage, production line and installation faster and more efficient with a more adaptive and modular panel. With standardized panels the amount of alternatives increases, and the panel can be used for any project with as little modification as possible. This will save costs in the future.

Because the design of the release panel has always been the same, and not connected to component updates, there is a great opportunity to make it to the state-of art level.
As in this degree thesis, the release panel is designed for marine application and has to meet the following system approvals: DNV, LR, GL, BV, RINA. To fill these requirements, the design must meet the SOLAS (Safety of Life at Sea) and the related rules from marine classification societies mentioned above. The future plan is to expand the release panel design to land applications and to meet rules and standards for land applications such as: VdS, FM, UL, NFPA.
The next release panel will include modular functions that fulfill:

A. Embedded system or PLC

B. Touch screen, commercial or custom made

C. Serial connection, Ethernet, Optical fiber

D. Line watch

E. History log

These modules can be combined independently, based on project needs.

1.2 Problem and objectives

In this thesis I have a few problems that I will try to solve and to propose a better solution for the release panel. I will put emphasis on how to improve the functionality of the release panel, and how to make the planning stage as fast as possible. My goal is to come up with a solution that not only satisfies the Marioff, but also makes it easier for the end user to use the release panel.

1.3 Method

In this degree thesis, an alternative concept is explored to find a solution for a new modular release panel. To get to the bottom of the how the new release panel should work and look like, each function in the current release panel is studied and just the necessary functions are chosen for the new concept. The focus is primarily on how the new release panel could look when ready, and what kind of features compared to the old one.

The practical information I have received by making factory tests on the current release panel, and by interviewing personnel both from production line and electrical designers from R&D and project departments. As I am a current Marioff Corporation Oy employee, it helped me to understand the whole concept and whom to ask for information. This thesis is done in a process, started from the old panel and ending up with a new concept. Two different options for a new release panel are combined and one is chosen in the end. To find the solution on who will design the release panel, four companies are interviewed and one is chosen to do the design.

1.4 Limitation of scope

Because the process of building a totally new product is very long, have I decided to limit this thesis into the planning stage. How to actually build the release panel is not part of this thesis. The component choice is done based on which components are used in other projects, and which components Marioff Corporation prefer. Finding the most profitable components is not part of this thesis. The concept that I choose will not be the final one and requires further development to be a final product.

The information of other release panels is based on information taken from manufacturers Internet homepages. No other information is used in this degree thesis. The communication, warning colours and layout for the release panel is determined by Marioff Corporation.

2 Sprinkler system user interface

The HI-FOG system typically consists of three kinds of panels.

a) Release panel
b) Mimic panel
c) Repeater panel

Figure 1. Release Panel with 9 Machinery sections
Figure 2. Mimic Panel with 8 machinery and 3 accommodation spaces
Figure 3. Repeater panel with 9 machinery spaces

All three panels are used to release or monitor the HI-FOG system.
As seen in attachment 1, the release panel is connected to every device included in the HI-FOG water mist system.

Figure 1. Release Panel

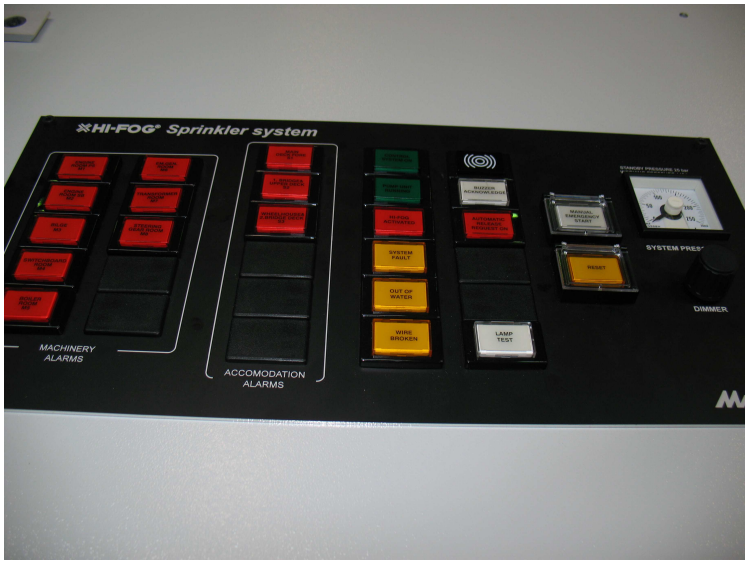

Figure 2. Mimic Panel

Figure 3. Repeater Panel

2.1 Machinery section

The Release panel controls the Machinery valves, and indicates release signals to Mimic and Repeater panels. The Release panel is typically located in the machinery control room. The machinery sections use dry pipes with solenoid operated section valves connected to open nozzles (spray heads). The solenoid operated section valve keeps water from going in to the Machinery section area in standby mode. When a fire is detected by personnel or by the ship's fire detection system (FDS), the machinery valve opens and the whole section will release. By releasing many nozzles at the same time, the fire is powerfully extinguished which suits exceptionally well machinery rooms where fire is critical. One section has usually 1–30 nozzles, depending on the size of the protected area. Figure 5 illustrates an open nozzle used in machinery spaces.

Figure 5. Spray Head 1000

2.2 Accommodation section

The accommodation system is typically used in cabins, offices and similar spaces. The accommodation system uses wet pipes, meaning that the water is pressurized until the nozzle. The system is released when high heat (normally 57° C) or fire breaks the glass bulb on the nozzle. Water then starts to flow through the system and when the flow switch detects the flow, it starts the pump unit (Flow start). Figure 6 illustrates a glass bulb nozzle used in accommodation areas.

Figure 5. Sprinkler 1000 Gold

3 Release Panel

The pump unit (PU) is supplying the release; mimic or repeater panel with 24VDC. The pump unit is secured with backup batteries if an electrical blackout would occur, it will keep the panels in standby so everything can be monitored as before. The release panel consists of different push buttons, light indicators and pressure meters that will tell the user what is happening in the system. Below is described how all functions work. When a fire is detected by the Fire Detection System (FDS) it sends a signal to the pump to start (Machinery start). When a release button is pressed, or FDS has detected a fire and the automatic release is chosen, it sends a signal to open the machinery section valve. In both cases the release button lights up. The Automatic release switch allows us to choose if the system starts automatically or not. When the switch is in ON mode the

machinery section valve will automatically open when the fire detecting system has got the indication, and the system will be released. The Automatic release request ON indicator tells us if the fire detection system gives release command or not. In both ON / OFF mode the manual release is always possible. To start the pump unit without any delays the Manual emergency start button has to be pressed. The pump unit will stop when the button is pressed again. After any activation of HI-FOG system it has to be reset to stabilize the pressure to standby pressure 25 bar and clear all alarms.

The lamps on the panel will show if there is something going on at the pump unit: out of water, pump unit fault, control system on, pump unit running, (buzzer and buzzer reset). Buzzer and buzzer reset exist on every panel. In case the system is out of water the pump unit will not start until it receive sufficient amount of water. As seen in the pictures, all three panels have similar appearances. This makes it faster and easier to manufacture the panel plate, also same components can be used on these three panels. Attachment 2 (Release Panel Section M1) illustrates how a release panel is built with relay technique. The release panel has been modified to have only one section.

Signals from pump unit starter cabinet to release panel

1. 24VDC (Power supply)
2. HI-FOG activated (Indicates when system is released)
3. Pump unit fault (Indicates if something is not right)
4. Reset indication (light when stabilization ON)
5. No fresh water (Out of water)
6. Control system on (Indicates that system is ON)
7. Pump unit running (Indicates that pump unit is running)
8. Reset (reset the release panel when pump unit is reset)

Released signals from ship’s fire detection system

1. Smoke & flame indication (One signal per section, M1-M5)

Signals from release panel to pump unit starter cabinet

1. System reset
2. Emergency start (Starts the pump unit immediately)

3. Machinery start (Starts the PU when smoke & flame detector gives alarm or a manual release button is pressed)

Signals from release panel to mimic

1. Automatic release indication
2. Flow indication (M1-M5)
3. Machinery system fault

Signals from release panel to repeater panel

1. HI-FOG activated (Indicates when system is released)
2. Pump unit fault (Indicates if something is not right)
3. Reset indication (Light when stabilization ON)
4. No fresh water (Out of water)
5. Control system on (Indicates that system is ON)
6. Pump unit running (Indicates that pump unit is running)
7. Reset (Reset the repeater panel when pump unit is reset)

3.1 Repeater panel & mimic panel

When only machinery protection is used, a repeater panel indicates all signals that the release panel indicates. The Repeater panel is usually located on the bridge, far from the control room where the Release panel is located. The repeater panel repeats the signals that come from the release panel, but there is no function to release anything. If the system includes an accommodation system the repeater panel will be replaced with a mimic panel that shows both accommodation and machinery system sections. The mimic panel is automated with a PLC (Programmable Logic Controller).

3.2 Machinery control cabinet (MCC)

When the release panel exceeds about 10 areas, it will not fit in the control room due to its size. Also the power consumption will be too big for the pump unit to supply. The release panel can be divided into release panel and machinery control cabinet (MCC). The release panel can now be installed inside the control room and the machinery control cabinet outside. Because the power consumption of the components exceeds, the

24 VDC supply from the pump unit will not be enough to provide for the machinery control cabinet. Dedicated 24 VDC supply could be enough, but 230 VAC is easier to get on a vessel. The machinery control cabinet uses 230 VAC and has its own main and emergency supply.

When a system uses 230 VDC directly from the ships own network, rules requires that it has its own backup battery supply for 12h. It also provides the release panel with 24 VDC.

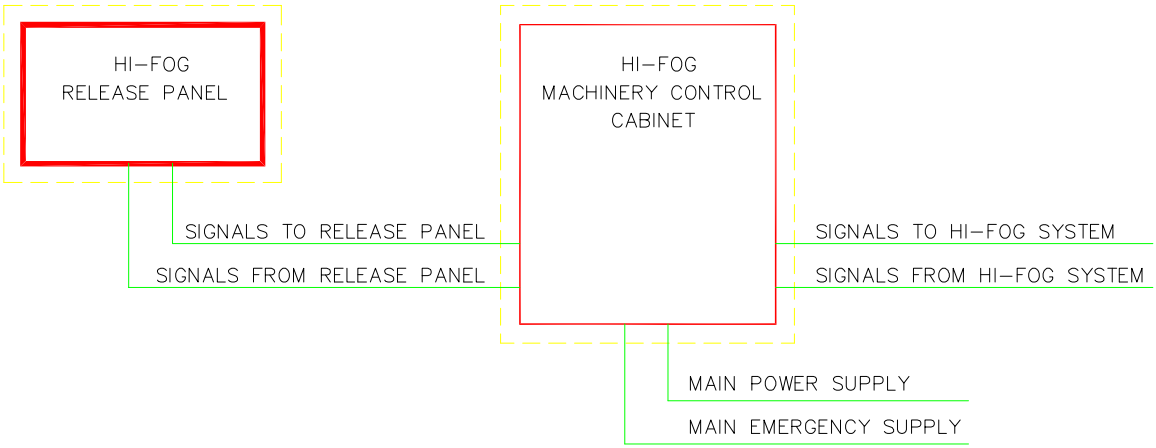

Figure 6. Machinery Control System

4 Similar water mist fire protection system

Marioff Corporation Oy is not the only high pressure water mist fire protection company on the market. Similar high-pressure water mist systems have been developed after Marioff started in 1991. Those companies that are mentioned below also have some kind of release panels that work with PLC or relay technology.

Table 1. Similar high-pressure water mist systems

	Marioff [1]	**Danfoss-Semco[2]**	**Ultrafog[3]**	**Fogtec[4]**	**Mini Max[5]**	**Novenco[6]**
Release Panel or similar	Yes	Yes	Yes	Yes	Yes	Yes
Standby pressure	25 bar	10-15 bar	-	-	-	-
Working pressure	140 bar	100-140 bar	100-150 bar	-	-	-
Accommodation, wet pipe	x	x	x	-	x	-
Machinery, dry pipe	x	x	x	-	x	-
Water amount, compared to conventional sprinkler	10-15 %	20 %	10-15 %		15%	-
Extinguishing fluet	water	water, dry powder	water	water	water	
Electrical motors	15-27 kW	10-33 kW	7,5-11 kW	-	-	-
Classification society approval	DNV	DNV	DNV	DNV	-	DNV

There are other fire protection companies that have alarm panels for detecting fires and releasing fire zones. These alarm panels are often designed for gas (CO2) systems, but with small modifications can be used for the same purpose as the Marioff Release Panel. One of them is Siemens XC-10, used for gas systems on land applications. The alarm panel, Siemens XC-10, has been used by Marioff in land applications, but experience has shown it being extremely time-consuming for the electrical design and the commission. The Siemens XC-10 is limited to just one section valve release, and it

becomes very expensive when several section valve releases are needed. The Siemens XC-10 is not used in marine applications, because it has no system approval for Marine. By comparing the functionality of the Siemens XC-10 with Marioff Release Panel, it gives ideas on what the new release panel could look like.
Other similar panels are:

1. AEGIS, manufactured by Kidde Fire Systems (www.kiddefiresystems.com)
2. Autoprime, manufactured by Autronica (www.autronicafire.com)

The user interface on the other panels is usually buttons and indicators. In this thesis a graphical panel will be used as the user interface.

5 Classification society

When a product is developed, there are specific standards that should be followed to obtain system approval for the product. These standards are made by classification societies, and one of them is DNV (Det Norske Veritas). In this project where the release panel is designed to be used on vessels, rules that are according to DNV Rules for Ships / High Speed, be followed. (Det Norske Veritas. 2008, Rules for Ships / High Speed, Light Craft and Naval Surface Craft)

5.1 Classification procedure

The release panels are installed in machinery spaces where high temperatures and vibrations are common environment factors. Therefore the design and test procedure of the embedded system shall be followed to the DNV Standards for Classification No 2.4 (Det Norske Veritas. 2006, standard for certification no. 2.4)

Table 2. Standards for Classification No 2.4

Parameters	**Class**	**Location**	**Minimum equipment specification**	**Minimun test level**
Temperature	B	Inside cubicles, desks, etc. With temperature rise of 5° C or more	Ambient temperatures: +5° C to +70° C	Test 3.7
Humidity	A	Location where special precautions are taken to avoid condensation	Relative humidity up to 96 % at all relevant temperatures.	Test 3.8.2
Vibration	B	On machinery such as internal combustion engines, compressors, pumps, including piping on such machinery	Frequency range: 3-25 Hz, Amplitude: 1.6 mm (peak value) Frequency range: 25-100 Hz, Acceleration amplitude: 4.0 g	Test 3.6.2
EMC	B	All location including Bridge and Open Deck	Conducted Low Frequency	Test 3.14.4
			Electrical Fast Transient/Burst	Test 3.14.5
			Electrical Slow Transient/Surge	Test 3.14.6
			Conducted Radio Frequency	Test 3.14.7
			Radiated Electromagnetic Field	Test 3.14.8
			Electrostatic Discharge	Test 3.14.9
Encloser	B	Engine rooms	IP 44	Test IEC Pub. No. 60529

Temperature:

Class B requires 16 hours in 55°C + 2 hours in 70°C

Humidity:

Class A requires 4 days in 40°C at humidity 93 %

Vibration:

Endurance test is to be carried out for at least 90 minutes at all actual frequencies. The product is attached to a bench that vibrates in a frequency range of 25-100 Hz.

EMC:

The test is to verify the robustness of the EUT to electromagnetic disturbance due to sources such as transmitters and other equipment.

Encloser:

IP44

In this thesis where both custom made and commercial products are being compared where some parts might already have DNV type approvals and therefore the test was not done.

5.1.1 Plan approval

Plan approval is a process that is part of the basis for the performance of a class certificate. Every drawing that is linked to the project has to be approved by the classification society in this case (DNV). That means that the design must be made according to international mandatory requirements, flag state requirements and classification rules (DNV).

In projects where software is used, a Software Quality Plan is needed. The Software Quality Plan shows that the product software is managed by the company and its personnel. The plan contains in which stage and how everything is done.

5.1.2 FMEA

As the release panel is part of an important safety system, shall all components and circuits be as robust as possible. FMEA (Failure Mode & Effect Analysis) is a procedure in product development for analysis of potential failure modes within a system for classification. The analysis contains every possible error that can appear in the product, the consequences of the error, and how to avoid or fix them. FMEA is not always a requirement by classification society but may help to prove the reliability of the device. Figure 8 gives an idea of the FMEA procedure.

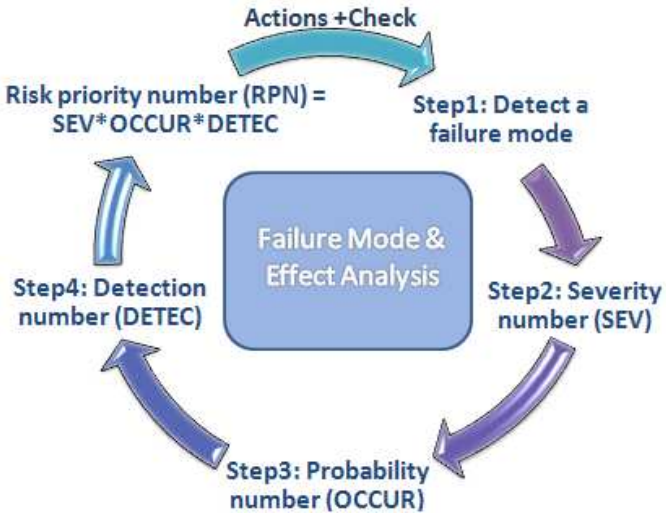

Figure 7. FMEA procedure
(http://en.wikipedia.org/wiki/Failure_mode_and_effects_analysis)

6 Various options for a new release panel

The current release panel is based on the principle where each machinery section is controlled by relays. The amount of relays and wiring will increases with increased number of areas, and in some stage the pump unit will no longer be able to supply the release panel with 24VDC. The release panel will then be divided into a Machinery Control Cabinet (MCC) that needs its own power supply which also means that battery backup has to be installed. To find a way to reduce the number of parts and make the release panel smaller, two different options will be compared. The first option is an embedded system where a printed circuit board is specially made for the release panel. The second option is based on PLC technology, where a commercial product is used. In both options software technology is used.
In both options the same touch screens are used to control the HI-FOG system.

6.1 Embedded system

For the first option the modular embedded system has been chosen. With this solution, every function can be specified separately and the release panel will be “tailor-made” for the HI-FOG system. The release panel will work with 24VDC supply that is taken directly from the pump unit, and the need of separate accumulators is excluded in smaller panels. When the amount of sections exceeds 10, a battery backup is brought into place. This is because the power consumption will be more than the pump unit can supply. The main layout for the new release panel stays as standard as possible. With a standard layout, the planning stage will be easy and not as time-consuming as before. The brain of the release panel will be the CPU. For every new project, the software has to be changed so it is suitable for the system. The control and indication of the release panel is done by the user panel. With the embedded system very little wiring has to be done, compared to the old system where the biggest job was to wire all components together.

The release panel is connected with an Ethernet cable to the pump unit. Attachment 3 (Release Panel Re-Design Signal Diagram) illustrates a signal diagram on every signal that goes between the pump unit and the
release panel.

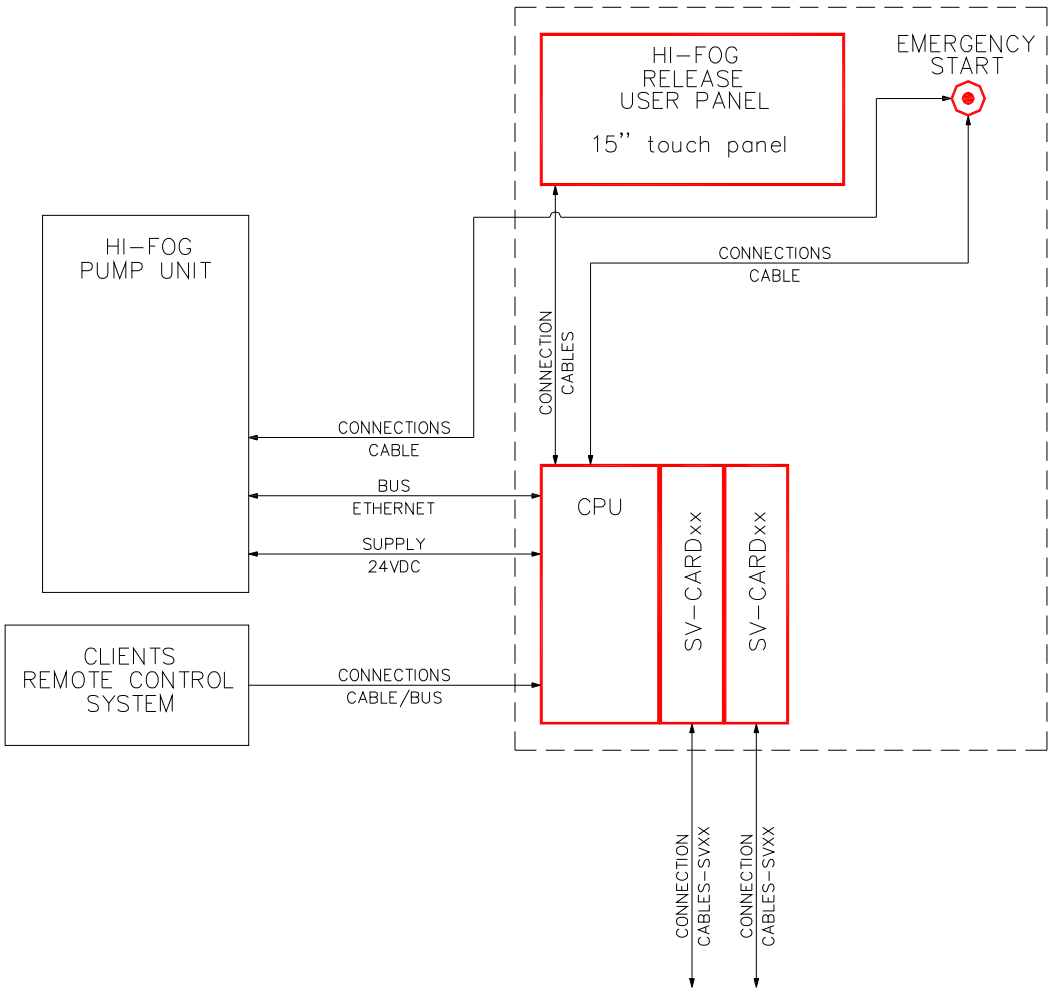

Figure 8. Embedded system

Printed Circuit Board, PCB

The embedded system is based on printed circuit boards (PCB) technology. PCB is used to mechanically support and electrically connect electronic components using conductive pathways. Once the PCB is designed and tested, the mass production is cheap. Because the PCB is manufactured by computers, there can be a large amount of functions fitted on a small board. In this thesis, SV-card got its name from section valve with the purpose of control section valves for machinery spaces. The SV-Card has 4 digital inputs for collecting, and 2 digital outputs for sending. The digital inputs (DI) are used for:

1. Position of the valve
2. Flow through the valve
3. Automatic or manual release
4. Local Switch

The digital outputs (DO) are used for:

1. Release signal to the valve
2. Audible & Visual signal

Also one DI and three DO are available for external field device. See attachment 4.

The main thing in the new release panel is to change the number of SV-Cards depending on how many areas the system has. All other hardware will stay same. One SV-Card will have three areas and can be added in a row, using CAN-bus.
If a system consists of, for example eight fire protection areas, three SV-Cards have to be installed. The total number of areas will then be nine, so one area has to be locked out in the software.

Central Processing Unit, CPU

The Central Processing Unit is the “brain” of the embedded system. The CPU is connected the every device in the release panel, SV-Cards, User panel, Clients control system, and the Pump Unit. Every signal that comes or goes to the field will pass through the CPU. In the planning stage when the software is made for the release panel, the number of SV-Cards has to be specified to the CPU.
In the software there has to be specified

- Which Pump Unit is in use
- How many protected areas are in the system
- Is there one or two release panels

The principle is to have one CPU that controls the modular section valve cards (SV-Card) and a user panel (Release User Panel, RUP).

Emergency Button

In case something happens to the user panel and it is not possible to release the HI-FOG system from the touch screen, there is an emergency start button that is directly

connected to the pump unit. By pushing the emergency button the pump unit will immediately start. The section valve of the fire area has to be opened manually.

6.2 User panel

In the current release panel, the push buttons and indicators are used for releasing and monitoring the status of the system. To reduce the time used for drilling and wiring the push buttons and indicators, a touch screen will replace those and also to fulfil the state-of-the-art level. As seen in attachment 3, the user panel is connected directly to the CPU with an Ethernet cable. The user panel is a graphical touch screen where push buttons and indicators are shown as symbols. The symbols and text status shall be modifiable in a later stage by configuration tool. The default panel language is English, but by customers request it can be changed.

The release user panel (RUP) makes it possible to have more functions than in the old non-graphical panel. This will help both Marioff personnel and customers. If needed, often in tight places in Yachts, the rest of the release panel can be mounted in different place than the RUP. The user panel is divided in to11 different windows, where one window can be opened at a time. See attachment 5
The following table 4 shows in detail which function is connected to which window.

Table 3. RUP signals

I/O	DESCRIPTION	FUNCTION	Control Process Unit, RUP=Release User Panel, SVC=Section Valve Card	PAGE
Section Signals				
DI	Test Valve Limit Switch	1=normal, 0=abnormal	SVC	3,4
DI	Flow Indication	1=flow, 0=normal	SVC	2
DI	Automatic Release (FDS)	1=open command, 0=normal	SVC	2,3,4
DI	Local Switch (LS)	1=open command, 0=normal	SVC	2,4
DO	Section Valve Solenoid	1=open, 0=closed	SVC	2
DO	Audible & Visual	1=on, 0=off	SVC	2

	Alarm			

Signals to Pump Unit				
DO	Emergency Start	1=start, 0=normal	PANEL	3,4
DO	Machinery Start	1=start, 0=normal	RCPU	3,4

Signals from Pump Unit				
DI	Pump Unit Running	1=running, 0=normal	RCPU	3,7
DI	HI-FOG Activated	1=activated, 0=normal	RCPU	1,7
DI	Stabilization in Progress	1=stabilization, 0=normal	RCPU	1
DI	Out of Water	1=fault, 0=normal	RCPU	3,4,7
DI	Pump Unit Fault	1=fault, 0=normal	RCPU	3,4,7
AI	System Pressure	System pressure 4-20mA / 0-250bar	RCPU	1,2

Common Signals				
DI	Buzzer Reset (mute)	1=reset, 0=normal	RCPU	2,3
DI	Reset Indication	1=indication, 0=normal	RCPU	
DI	Local Alarm Reset	1=reset, 0=normal	RCPU	
DI	Remote Alarm Reset	1=reset, 0=normal	RCPU	
DI	Total System Reset	1=reset, 0=normal	RCPU	
DI	Panel Fault	1=normal, 0=fault	RCPU	1,7
DI	Control System ON	1=ok, 0=fault	RCPU	1,7
DO	Dry Pipe System Released	1=released, 0=normal	RCPU	
BUS	Ethernet	1x Ethernet	RCPU	7
BUS	RS-485	1x RS-485	RCPU	
BUS	RUP BUS ??	RS-232 / RS-485 ??	RCPU	
PORT	USB	USB	RCPU	5,6,10
PORT	Programming Port		RCPU	

6.2.1 User panel functionality

Page 1, is the Main View window showing the current status of the system. This gives the user the most important information of the current status. The System Status can be in following mode: Standby, Activated or Stabilization. In case of fault, the Active Fault mode changes to YES. In Standby mode the pressure is 25 bar. In case of fire the user can easily switch to Section Release window, page 2 by pushing the Section Release button.

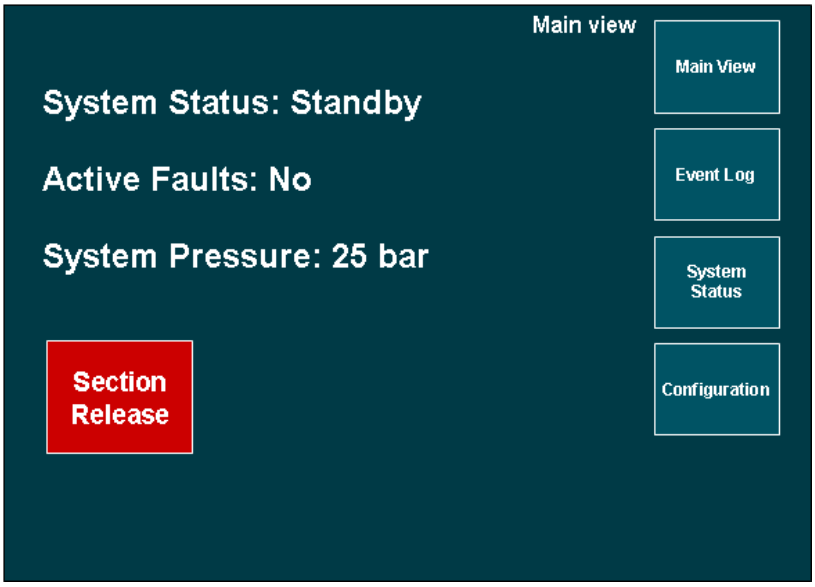

Figure 9. Main view

Page 2, Section Release window from where the machinery sections can be released. As seen in the picture, the active areas are brighter that the not active ones. This gives the user a quick look which section is released and which is not. The Automatic Release ON/OFF makes it possible for the user to choose if the HI-FOG system is automatically released. It is recommended that the ON mode is in use. The OFF mode can be in use during system maintenance. Manual release is always possible. In Automatic Release ON mode, the panel will automatically switch to release mode (2), and the section where the fire is located starts to flash. Also a yellow frame tells that the automatic release has detected the fire. If no action has been taken in 20 seconds after the fire detection system has given the release command, the HI-FOG system will release automatically.

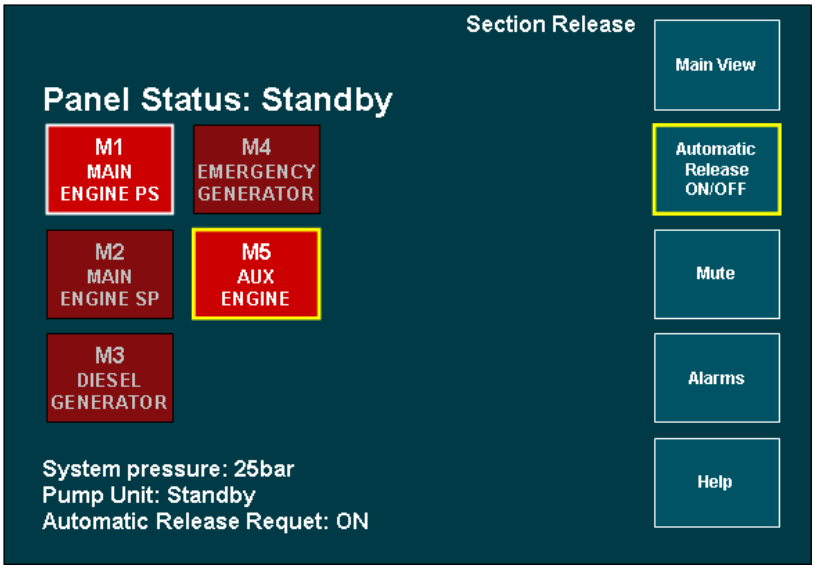

Figure 9+1. Section Release view

Page 3, Alarms that are active is shown. The colour Red and Yellow tells the user which kind of alarm is active. The Green colour means that HI-FOG is normal. The Red colour means that the alarm is critical, for example HI-FOG Activated. Yellow colour means that there is a fault in the system, for example Panel Fault, but it will not prevent the HI-FOG system for be released. By selecting the active alarm and pressing the Help button further instructions are given how has to fix the problem. Help view is on page 6.

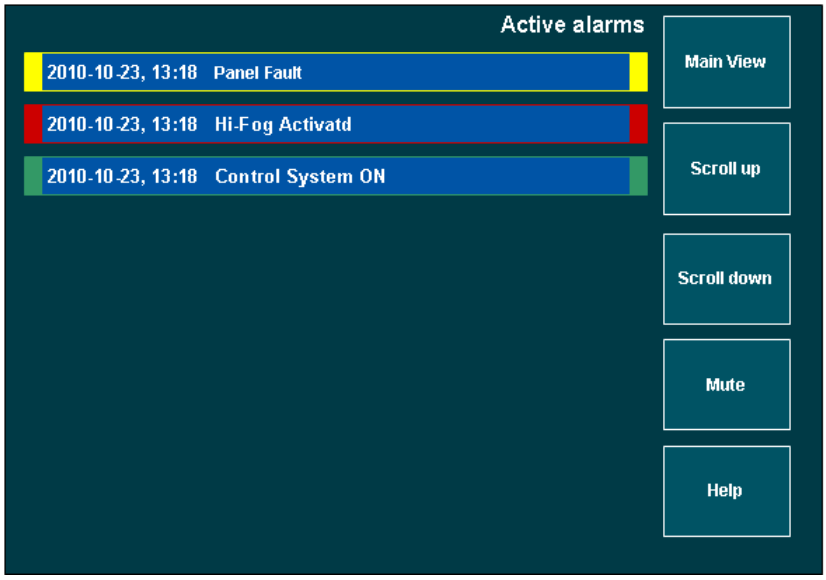

Figure 9+2. Alarm view

Page 4, Event log shows the old alarms that have been activated. In the current release no event log is available. The error log helps the user to locate the error and fix it. An explanation can be viewed on page 6, by selecting the error from the log and pushing Help. The log can be downloaded to a USB device and sent to Marioff service engineer for further action, see Figure 9+4.

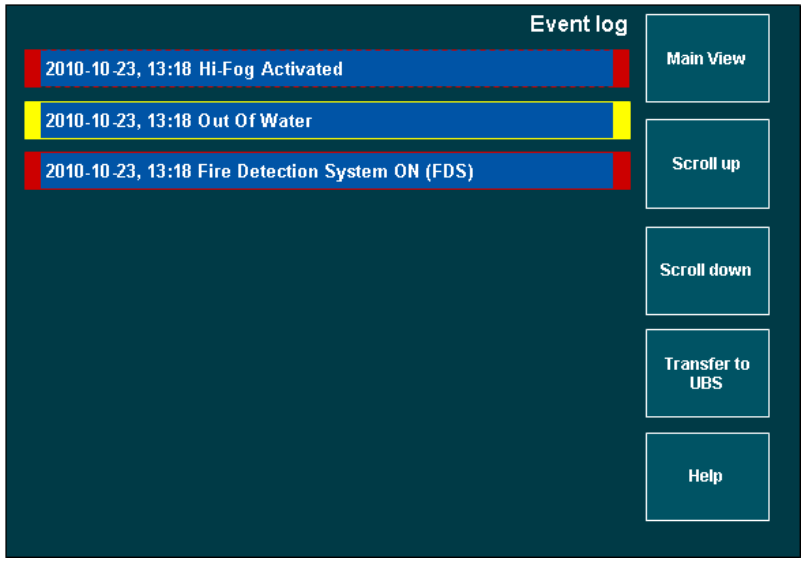

Figure 9+3. Event view

When the history log is transferring to USB, will it tell the user when it is ready and how much has been downloaded.

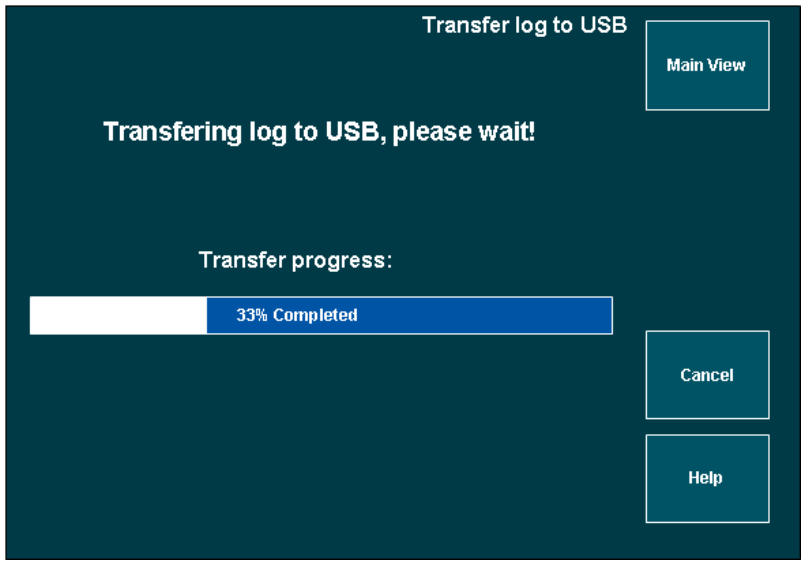

Figure 9+4. Transfer view

If the help button is pressed, the user panel displays the Help window. The help window is for the user to know what kind of actions can be done if something goes wrong or if the user is unsure of what to do.

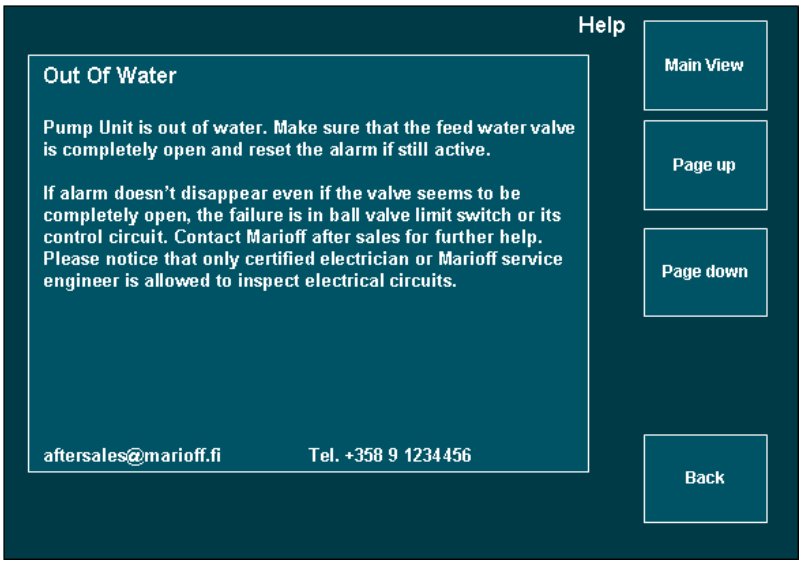

Figure 9+5. Help view

Page 7, system Status shows the whole HI-FOG system and what is connected to the ring network. If a serial connection between the devices has lost the connection or the connection has been damaged, the cable will start to blink yellow. This will not stop the system to communicate, thanks to the 2way communication. The device will stop responding if both cables to the device loose connection. Standby is always show as Green.

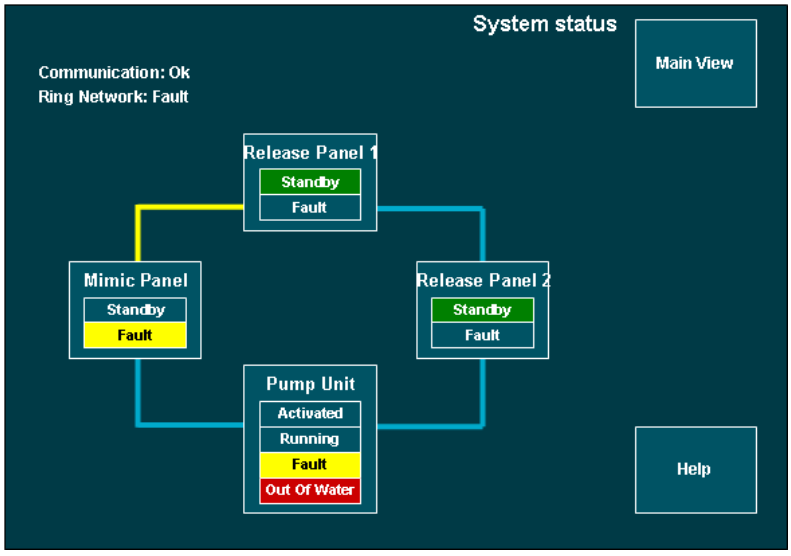

Figure 9+6. System view

The System configuration window shows the user which version of the software is running on the release panel. If there is a newer version available, it can be downloaded by pressing the RPC configuration button. Also the clock can be adjusted from here.

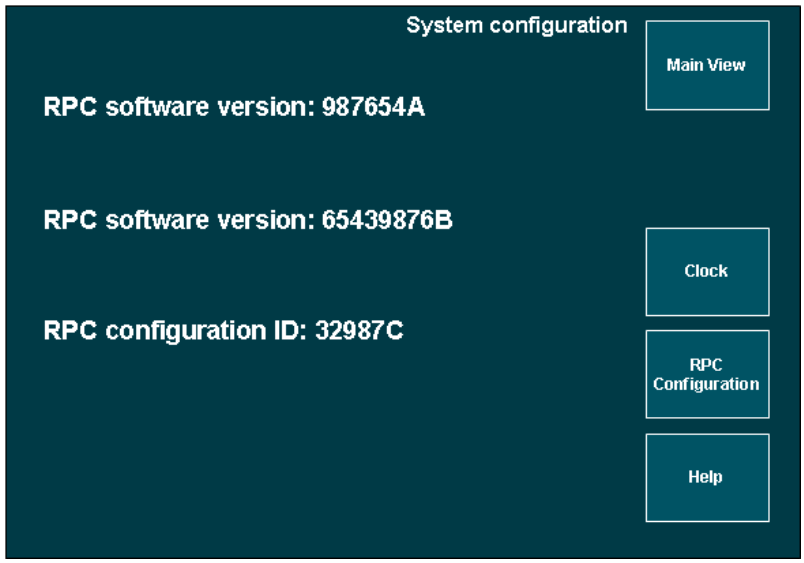

Figure 9+7. Configuration view

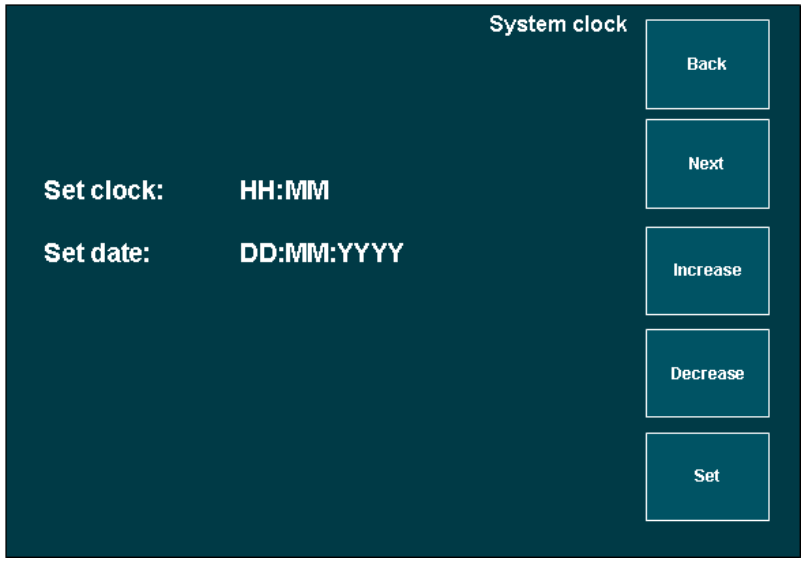

Figure 9+8. Clock view

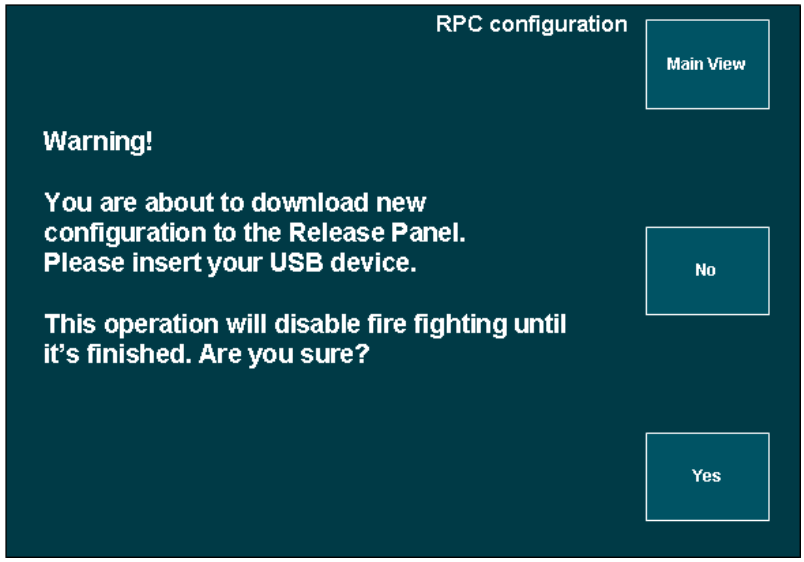

Figure 9+9. Release Panel Configuration view 1

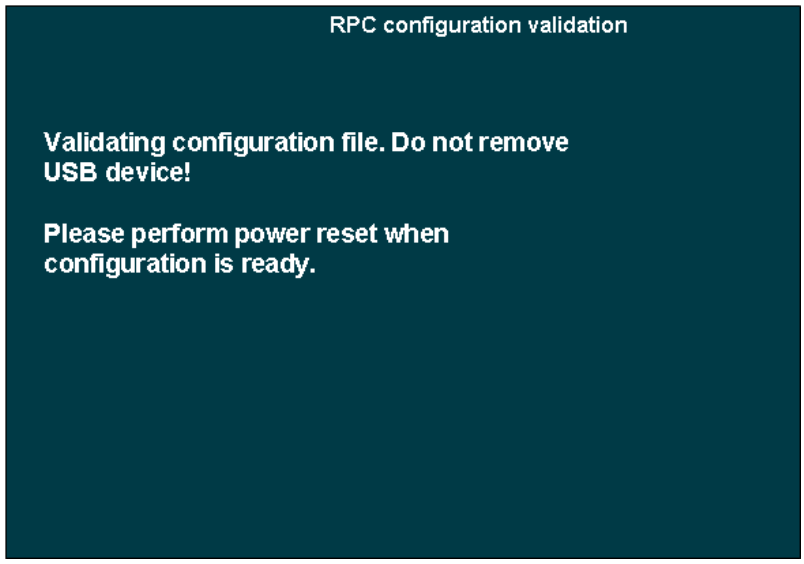

Figure 9+10. Release Panel Configuration view 2

6.3 PLC (Programmable Logic Controller)

For the second option I have chosen the PLC system. The PLC has almost the same features as the embedded system, but is a commercial product. The good thing is that the PLC already has most of the approvals that is needed in marine, so no separate test procedures are needed. When sections are less than 10, the PLC works also with the same 24VDC that is taken form the pump unit. When there are more than 10 sections a

battery backup is installed. The PLC system is mounted with the same principle as the embedded system.

For the SV-cards the PLC has its own expansion cards that increase the number of inputs and outputs. For this option Mitsubishi's MELSEC Q03-series and MELSEC FX3U-series are compared. The reason for choosing Mitsubishi Q-series is for the size and the multiple processor capacity. Mitsubishi FX3U-series is larger than the Q03 when the number of sections exceeds, and the goal is to find a solution for a smaller release panel. The FX3U has not as good processor capacity as the Q03-series, and could in some cases limit the expanding of the system. The Q03 & FX3U have the following certification for marine applications:

LR, GL, ABS, RINA, KR, NKK and DNV

In attachment 6 & 7 Q03 & FX3U-signals, the table shows which signal is connected to which module.

6.3.1 Mitsubishi Q03

Mitsubishi Q03 is a similar option compared to the embedded system. The Q03 consists of a Base Board, CPU and expansion cards, like the embedded system. As the embedded system the Q03 is small and possible to fit into small places. As described earlier in the text, the release panel signals are divided into:

1. Common signals
2. Signals from pump unit
3. Section signals

From 1-2 the Q03 is equipped with follow modules:

Table 4. Common signals (MELSEC Q Technical Catalogue)

Mitsubishi Q03-Series		
Amount	**Type**	
1	Q38DB	High speed base unit, with 8 I/O slots, supply slot, install up to 4 CPUs
1	Q63P	Power supply, in 24 VDC, out 5 VDC/6 A
1	Q03UDE-CPU	CPU module, 4096 I/O, 30 K program steps, USB/Ethernet port, max. 64 I/O modules
2	QX80	Input module, 24 V DC, 16 inputs
1	QY80	Output mod., 12/24 V DC, 16 transistor outputs, 0,5 A/output,

1	Q64AD	Analog input module, 4 channels, voltage/current

As in the embedded system, the Q03 series uses expansion cards to expand the number of sections.

Table 5. Section signals

Mitsubishi Q03-Series		
Amount	**Type**	
1	QY80	Output mod., 12/24 V DC, 16 transistor outputs, 0,5 A/output,
1	QX80	Input module, 24 V DC, 16 inputs

In case the number of section exceeds that much that the Base Unit runs out of I/O slots, the expansion bases can be installed easily.

Table 6. Expansion bases

Mitsubishi Q03-Series		
Amount	**Type**	
1	Q55B	Extension base unit with 5 I/O slots
1	QC05B	Connection cable for extension base unit

6.3.2 Mitsubishi FX3U

In FX3U PLC-system there is no separate Main Base, Power Unit or CPU. Everything is integrated in the FX3U-Base Unit.

Table 7. Common signals (FX Family Catalogue)

Mitsubishi FX3U-Series		
Amount	**Type**	
1	FX3U-48MR-DS	Base Unit, 24 VDC, 24inputs/24outputs, relay
1	FX3U-3A-ADP	Analog module, 2 inputs, 1 output, 0-10VDC, 4-20mA
1	FX3U-ENET	Ethernet module for FX3G/ U,TCP/IP,UDP,1xRJ45

As in the embedded system, the FX3U series uses expansion cards to expand the number of sections.

Table 8. Section signals

Mitsubishi FX3U-Series		
Amount	**Type**	
1	FX2N-16EX-ES/UL	Extension unit, 16 digital inputs, 24 VDC

1	FX2N-16EYR-ES/UL	Extension unit, 16 relay outputs, max. 2A

7 Cost estimation, old and new design

To be able to see the differences between the PLC, the Embedded and the Current Release Panel, a price graph, Figure 10, below shows estimated prices how much differences these options have. This price includes cabinet, external components, user panel and the actual product (Embedded, PLC). The cost estimation is done for one year and the cost calculation is done with the same volume for each product.

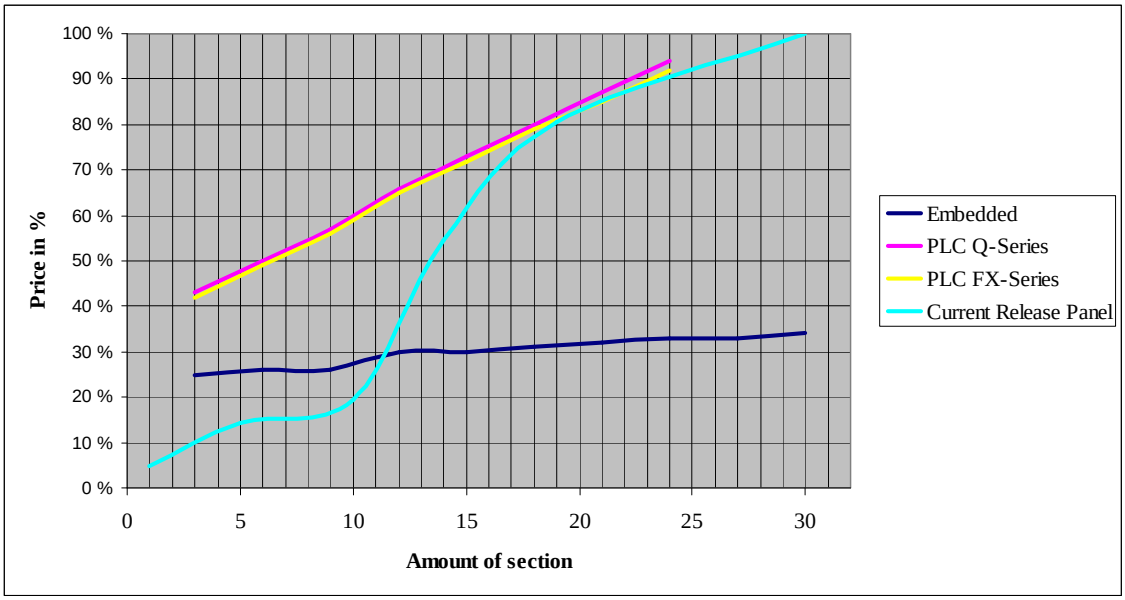

Figure 10. Additional cost per section

7.1 Current Release Panel vs. Embedded system

The first concept for the modular release panel is the embedded system. As seen in Figure 10, the current release panel (turquoise bar) is cheaper compared to the embedded system (blue bar) when the number of sections is around 10. When there are more than10 sections, the release panel is divided into release panel and machinery control cabinet (MCC) and a big difference can be seen at the price. The base cost of the embedded system with less than 10 sections is the CPU and User Panel. After 10 sections a battery backup is installed because the pump unit will no longer be able to provide enough power. This can be seen as a small increase in the price. All in all, the embedded price stays relatively the same all the way.

7.2 Current Release Panel vs. PLC system

The second concept for the modular release panel is the PLC system. As seen in Figure 10, the PLC system (purple and yellow bar) has a base cost that is much higher that the current Release Panel. When exceeding more sections the price is almost the same as the current release panel. The price stays relatively linearly the whole way.

7.3 Embedded system vs. PLC system

As seen in the Figure 10 the embedded system is much cheaper than the PLC-system, all way from the beginning to the end.

7.4 Selection of manufacturer for embedded system

In the option where embedded system is used to build the release panel, a specialized electronic planning company is needed to make the planning and the design. To find the designer, 4 specialized companies are interviewed. The choice of the designer is done on the base of:

- How much experience the company has
- What is the capacity (employees)
- In which schedule the company can proceed
- Which kind of tools they have
- The price, project & end product

The impression that the company gives is also one of the most important factors.
In case two companies are equal, two prototypes of the SV-card can be made and based on those, one designer, company chosen.

7.5 Product development process

When a new product developing process is started, it has to go in a certain order so nothing will be forgotten. This process is called Product Developing Process. The product developing process is a guideline to systematically go through every phase, and to know in which order it should be done. Marioff product developing process is divided in 6 different phases.

Phase 0: Program feasibility
Phase 1: Planning and requirements definition
Phase 2: Design & development
Phase 3: Release Preparation
Phase 4: Custom pilot
Phase 5: Full release of product
In this degree thesis, phase 0 is gone through.

8 Result

The result for the two options that I have been comparing was both expected and surprising. The expected part was that the embedded option would suit Marioff better than the PLC option, because the functions of the panel are specified only for Marioff purposes. The surprising part was that the cost for developing the embedded system is higher than I thought. Also the whole process that has to be gone through before a final product is ready was over my expectations.

The lifecycle management in the PLC is not as good as in the embedded system. If the manufacturing of the used PLC will stop or change, it can in worst case mean that the whole release panel has to be redesigned again. The cost for the PLC is much higher than expected. This is because of the high base price for the PLC, where many unnecessary functions are included. The PLC product development is not as time consuming and expensive as in the embedded system, because the part can be directly ordered and a smaller amount of software has to be developed. The production time for the PLC is estimated to be a little longer than for the embedded system, because the PLC-system includes more wiring. The reliability is estimated to be the same as for the embedded system. Because both PLC and embedded system works with a software program, service is not as easy as in the current release panel. Compared to the current release panel, the new design brings several new applications that could not be done with the current release panel, such as a history log.

The concept that has been chosen for further developing is the embedded system. The reason for choosing embedded system instead of the PLC system is the final price for

the product. If the developing part is ignored, the embedded system is already from the start much cheaper than the PLC-system, as seen in Figure 10. When the number of sections increases the more the price starts to rise for the PLC system, when the price for the embedded system stays quite the same.

The functions for the embedded system are specified for just Marioff's need. With a PLC, several extra functions are included that might not be used, and costs extra.

8.1 Savings with embedded system

To get a look on how much cheaper the embedded system is than the current release panel, cost estimation is done for one year and the volume is estimated to be the same as in Figure 10. As seen in Figure 11, the blue bar shows the price for current release panel in one year and the purple bar for the embedded system. When comparing the price to the embedded system it can be seen that the savings can be up to 40% in one year with the new modular embedded system.

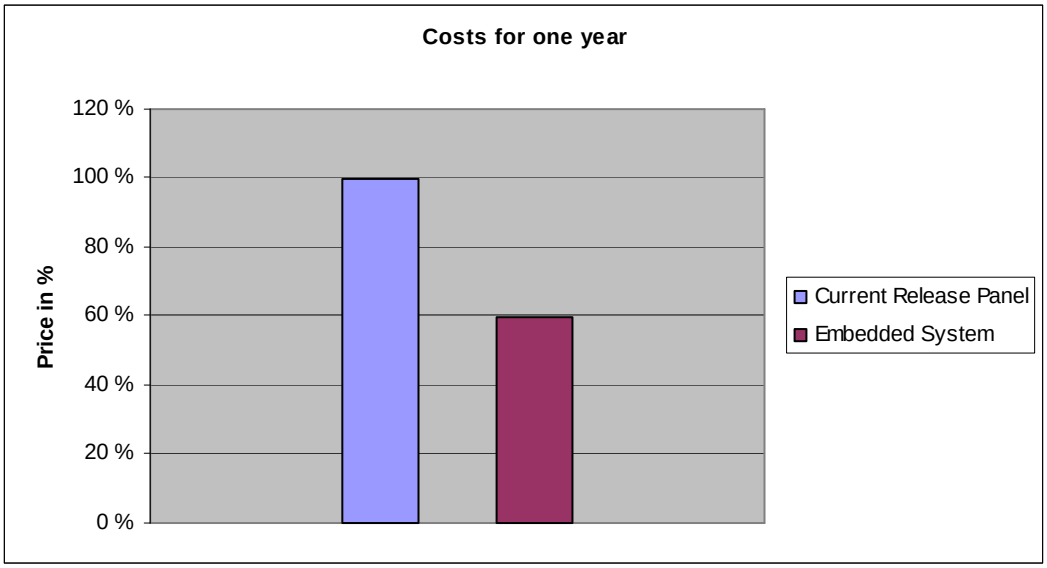

Figure 11. Cost differences in a year

The developing costs must also be taken into account, and calculate how long it will take to break even. The purple bar shows the same price as in Figure 11. As seen in Figure 12, the beige bar shows the costs for development for the embedded system in a year. The costs for the developing are estimated to be 67% of the cost price for the

embedded system in a year. This means that to break even it would take up to 8 months, and all after that is profit. The volumes are estimated to be the same as in Figure 11.

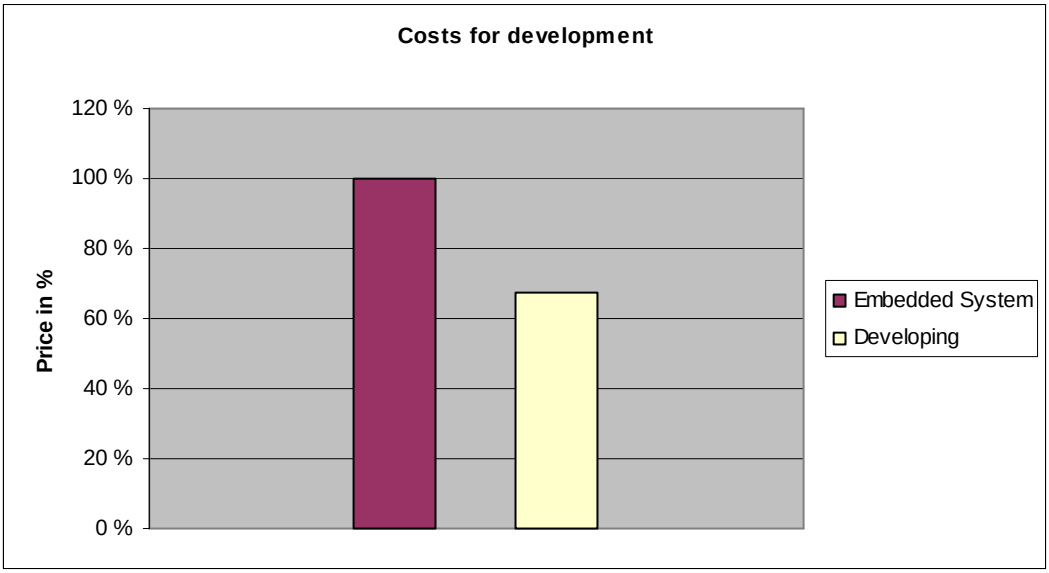

Figure 12. Development costs for a year

9 Discussion

The intention of this degree thesis was to explore an alternative concept for a release panel, how to make it more modular so it would suit better for Marioff needs. The criteria for the new concept were that it should be smaller and more modular than the old one and on the basis of this make the design, production line and installation faster. Because no actual product is built, the conclusion is based of theoretical calculation and from my own view they seem to be quite true.

Comparing to the old release panel, it seems theoretically possible that the new concept is going to be smaller. This is possible thanks to the modular SV-cards that will save a lot of space, especially in bigger panels with many sections to protect. Because the panel will be constructed by standardized parts, also the production line and installation is going to be faster than before.

In the future for Land applications, the new modular release panel seems to be a better choice that the currently used Siemens XC-10. Especially the possibility to connect several section valve releases than in the Siemens XC-10, where just one section valve can be used.

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