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The HOMAR OPA simulator as a training tool for professional petty officers and seamen trainings in the subject of fire fighting and water defence

Symulator HOMAR OPA jako narzędzie służące do szkolenia załóg jednostek pływających Marynarki Wojennej

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Abstract

Safety of navigation is a complex problem which consists of many aspects. Seagoing and the level of training contribute to one making the right decisions in accordance with the principles of conduct. Crew training takes place at sea, as well as in maritime training centres.

The article describes the safety problems of a warship in the event of fires in various regions of the vessel, hull puncture and unsealing. The problems connected with the identification of damage, its types and methods and tools to repair it have been described. The simulator of damage control has been described and scenarios of events which can be simulated have been presented. One of the scenarios – fire in the engine room – has been chosen and the course of the training with the use of the HOMAR OPA (organization of operations against fire and water), simulator produced by The Autocomp company for the Navy Training Center in Ustka, has been described.

The main subjects of trainings are connected with fire safety, fire simulation, fire fighting, hull damages, water and fire defence, investigating damages, warship survivability, repair works etc. The trainings with the use of the simulator include preparation procedures for removing the hull damage and equipment failures as part of the process of securing the proper equipment to fight with water and fires, development of methods for detecting the inflow of water and fire, preparation of procedures to fight with water and fire, training of the crew to fight fires and water. The OPA simulator has been developed on the basis of the latest computer technology, with the use of large-size projection on the screen in the form of a cylinder's segment.

Słowa kluczowe:

Abstrakt

Bezpieczeństwo żeglugi jest złożonym problemem, na który składa się wiele aspektów. Na podejmowanie właściwych decyzji oraz zgodne z zasadami postępowanie wpływa praktyka morska i wyszkolenie. Szkolenie załóg odbywa się podczas rejsów morskich, jak również w ośrodkach szkolenia morskiego.

W artykule opisano problemy bezpieczeństwa okrętu wojennego w sytuacji wystąpienia pożarów w różnych rejonach jednostki, przebić kadłuba oraz rozszczelnień. Przedstawiono problemy identyfikacji uszkodzeń, ich rodzaje oraz metody i narzędzia do ich naprawy. Opisano symulator obrony przeciwawaryjnej i scenariusze zdarzeń, które mogą zostać zasymulowane. Wybrano scenariusz pożaru w siłowni oraz opisano przebieg szkolenia załogi na nowo powstałym symulatorze HOMAR OPA (Centrum Szkolenia MW w Ustce).

Szkolenie na symulatorze obejmuje procedury przygotowania do usunięcia awarii kadłuba i urządzeń w zakresie zabezpieczenia odpowiedniego sprzętu do walki z wodą i pożarami, opracowanie metod wykrywania napływu wody i wystąpienia pożarów, przygotowanie procedur przeciwdziałania do walki z wodą i pożarami,

przeszkolenie załogi w walce z wodą i pożarami. Symulator OPA zbudowany został na bazie najnowszej technologii komputerowej z użyciem wielkogabarytowej projekcji na ekranie będącym wycinkiem walca.

Introduction

Although the ages passed from first ships, fires are still one of main reasons of ship damages and loss. Safety of ship is a problem connected with navigation, fire safety, proper work of mechanisms, human behavior and many other factors. The ship is a very typical object and it may be hard to detect similarities with any land one. Multiple factors whose presence could result in a fire are easily found aboard ships, such as combustible materials: fuels, oils, combustible cargoes, paints, solvents etc. Sources of potential fires are hot surfaces, ignitions, sparks, static electricity, oxidisers (usually oxygen). Conditions of work on a ship are risky too. Indeed, people work in a very specific environment and when a fire (or another accident) occurs the crew usually has no chance to get help.

Fire spread on the ship is connected with the place of origin, quantity of combustible materials, possibilities of fire spread, but also active and passive methods of fire prevention and protection application. Passive methods are based on the construction of ship. They determine restricted use of combustible materials, separation of spaces with fire resisting bulkheads and decks; they are also connected with protection of evacuation roads and division of ship into main vertical zones. Active methods describe fire – fighting appliances and methods.

The third group of safety measures concerns the so-called safety management which is related to the conduct of the crew (Fig. 1).

Approved seagoing service and training are one of the factors contributing to one making right decisions. Crew training takes place at sea, as well as in maritime training centres.

The article describes the problems of ship's safety. It presents the simulator of damage control (the OPA simulator). Different scenarios of fire fighting which can be simulated have been presented. One of the scenarios – fire in the engine room – has been chosen and the training with the use of the HOMAR OPA simulator for this event has been described.

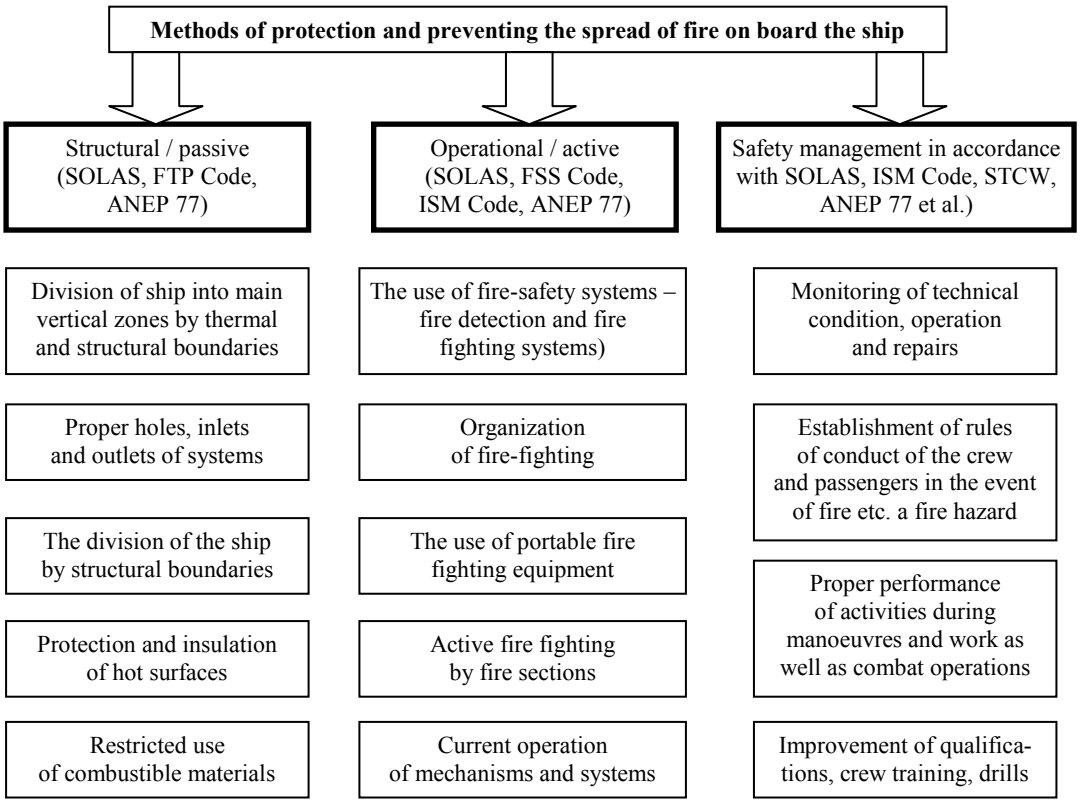

Fig. 1. Methods of protection and prevention of the spread of fire on board the vessel [1]
Rys. 1. Metody ochrony i zapobiegania wybuchowi ognia na pokładzie statku [1]

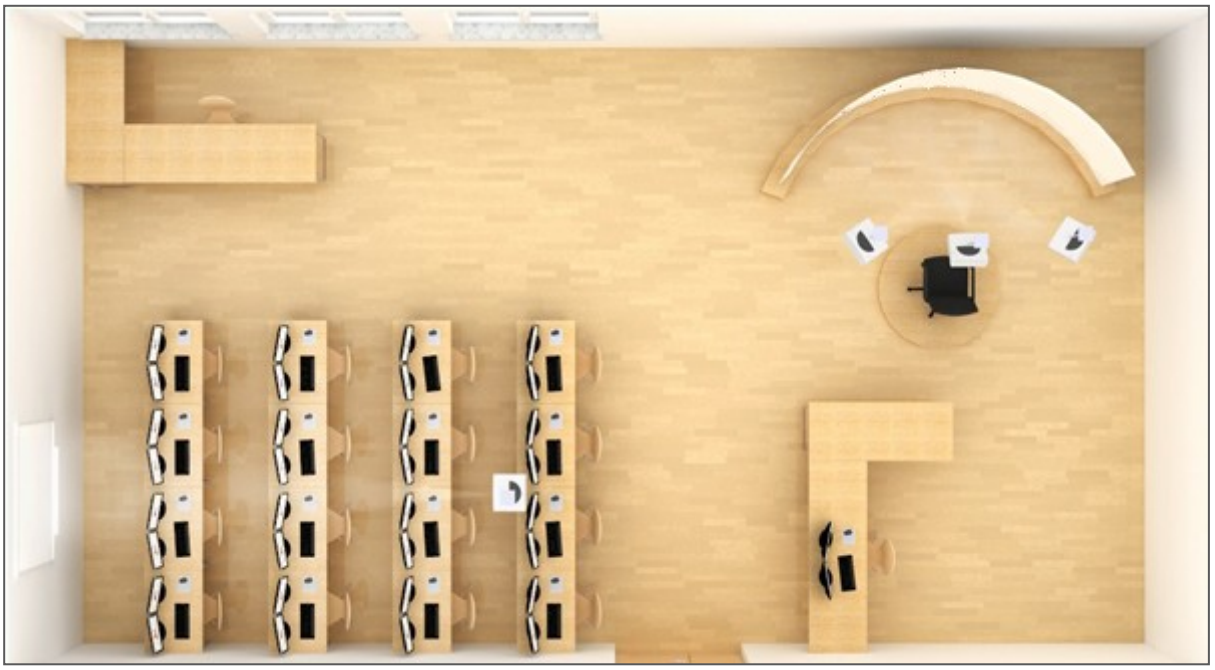

Fig. 2. Cabinet of the HOMAR OPA simulator [3]
Rys. 2. Pomieszczenie symulatora HOMAR OPA [3]

In the Naval Training Centre in Ustka, the HOMAR OPA fire-fighting simulator is being developed. It is intended for theoretical and practical preparation of students, as well as the crews of vessels of the Navy in the subject of fight with water and fire on the ship. The simulator includes preparation procedures for removing the hull damage and equipment failures as part of the process of securing the proper equipment to fight with water and fires, development of methods for detecting the inflow of water and fire, preparation of procedures to fight with water and fire, training of the crew to fight fires and water.

The simulator is based on the guidelines contained in the Defence Standardization Manual-PDNO-07-A094 Maritime procedures. Fire-fighting [2]. The simulator consists of the following components: OPA commanding position with large-size screen; 16 positions – OPA group members; – instructor position; didactic position with multimedia table (Figs 2–4).

The video subsystem allows for displaying the tactical situation on the ship. Rescue operation is managed from the control panel of the OPA commander.

The management of the simulator and control of the process of training take place at the instructor post. It allows for, among other things, selection and change of exercise parameters, preview of the current tactical situation on the plan of the vessel.

Fig. 3. Large-size screen of the HOMAR OPA simulator
Rys. 3. Wieloformatowy ekran symulatora HOMAR OPA

Fig. 4. Didactic room of the HOMAR OPA simulator
Rys. 4. Pomieszczenie dydaktyczne symulatora HOMAR OPA

The instructor position also allows for the modification of exercise conditions on the ship.

The OPA simulator has been developed on the basis of the latest computer technology, with the use of large-size projection on the screen in the form of a cylinder's segment.

Fight with fires and hull damages on vessels

Fires, explosions and damage to the hull are one of the most serious threats to warships. They can lead to the withdrawal of the vessel from the "line". Each of the above events involves large material losses counted in millions of PLN. In addition to the direct results of fires, such as, destruction of equipment, there is always a number of indirect effects. The ship must be rebuilt, which is connected not only with financial outlays but also the materials and equipment that must be produced for this purpose instead of for further development and expansion of the fleet of warships.

The most common cause of occurrence of fires on warships is warfare and damage resulting from the use of attack measures by the enemy.

Other causes of fires and explosions on ships engaged in military operations include self ignition, spontaneous combustion, explosion in hydraulic systems, mechanical damage, failure of power systems and electronic equipment, as well as staff misconduct.

A number of methods for the prevention of fires on ships is used. Ships are equipped with fire detection and fire fighting systems, as well as portable equipment.

Sample systems include water systems, foam extinguishing systems, gas systems (e.g., CO_2, INERGEN), steam systems, halon alternative systems ,(e.g., CEA 410), dry powder extinguishing systems, fire-fighting stations, et al. [1, 2, 4].

The main method of prevention of origin and spread of fires on warships, in addition to the above, is high-level fire prevention which is carried out through the control of factors that may cause the possible event.

The main methods of prevention include observance of the principles of safety, control of the behaviour of people and equipment. That is a complex organizational system involving influencing human consciousness through appropriate warningsand messages transmitted predominantly in the form of safety signs and informational boards, trainings, compliance with regulations, instructions, procedures and standards, monitoring compliance with safety rules specified in instructions, observance of standards of operation of equipment, appropriate technical equipment and appropriate actions during emergency situations (Fig. 5) [2].

Fig. 5. Extinguishing a fire on board the ship – the HOMAR OPA simulator
Rys. 5. Gaszenie ognia na pokładzie statku – symulator HOMAR OPA

The ship may, as a result of a collision with another ship or a fixed navigational obstacle, grounding, firing, mines etc., suffer damage to the hull, which is followed by the intrusion of water into the ship. Ships and vessels are designed in such a way as to be able to survive this kind of accidents involving the loss of shell plating.

The basic safety systems of the ship against undesirable effects of water intrusion include its components, shape and design of the hull, watertight bulkheads, watertight compartments as well as holes, inlets and outlets of systems properly constructed and operated in the watertight hull. What is also very important is the correct placement of the mechanisms and devices on the ship as well as deployment of supplies.

Inside tanks, chambers, double bottom and reinforcements are used for protection against torpedoes.

Fighting with water on the ship involves organized and quick actions which aim to protect against the intrusion of water into the hull, reduce its spread and move it overboard.

What is most important on the ship is its subdivision to fight for stability. It is implemented by raising an alarm indicating the size and location of the damage, sealing of manholes, bulkhead spools and other communication openings, switching on remaining drainage pumps, establishment of patches and sealing on the puncture and the removal of water and constant monitoring of bulkheads, hatches and glands in the damaged compartment.

All the above-mentioned activities should, if possible, be performed simultaneously [1, 2, 4].

Simulator of damage control

The HOMAR OPA simulator of damage control is intended for theoretical and practical preparation of students and the crew of the Navy units in the subject of fighting with water and fire on the ship.

The simulator covers preparation procedures to remove the damage of the hull and equipment failures concerning:

- securing the right equipment to fight with water and fire;
- methods for detecting the inflow of water and occurrence of fire;
- preparation procedures to fight with water and fire;
- crew training in the fight with water and fires.

The simulator is based on typical solutions found in the Polish Navy.

The simulator for fighting with water on the ship includes:

1. Detection of damage.
2. Prevention of damage connected with the intrusion of water into the hull and damage caused by the enemy.
3. Types of ship hull damage and their causes (in peacetimeand in combat operations).
4. The nature and appearance of damage (punctures, notches, protuberances, folds, outgrowths, damaged joints of the hull).
5. Types of equipment to fight water used in the Polish Navy and NATO.
6. Rules of the use of equipment to fight with water (methods, safety conditions, requirements of sealing).

Simulator for fire fighting on the ship includes the following topics:

1. Fire hazard, causes of fires and prevention of fire on ships:
   - theory of fire (basic concepts, parameters and typical fire processes, descriptions of fires in various parts of ships, fire risk factors, groups of fires, fire statistics, modelling of fires etc);
   - fire hazard of vessels (risk typical for different parts of the ship, combustible materials, ignition sources, human error, origin, development and spread of fire in a given region and between given regions, ways of fire spread;
   - causes and prevention of fires on the ship;
   - fire-hazardous loads;
   - selected topics in chemistry and physics of fire.
2. Measures, systems and equipment for fire fighting on the ship:
   - extinguishing agents (review of measures and their characteristics);
   - fire-fighting and alarm systems (regulatory requirements);
   - fire-fighting equipment;
   - technical support and use of equipment, fire detection and alarm systems;
   - maintenance and operation of fixed fire extinguishing systems;
   - control of the spread of fire on the ship (construction / passive methods).
3. Preparation of the crew to fight fire on the ship:
   - organization of fire protection on the ship;
   - firefighting tactics on the ship;
   - principles of cooperation with the fire brigade.

The video subsystem of the simulator allows for displaying the tactical situation on the ship. Management of rescue operation takes place from the position of the OPA commander.

Management of the operation of the simulator, i.e. change of parameters and conditions of exercise and supervision of the training process, is carried out at the instructor position.

The configuration of the bridge along with the deployment of its essential elements is presented by the diagrams and photos attached to the simulator.

For the purpose of the training, the scenarios of events are developed. For each scenario, detailed instructions of conduct for members of the crew and the course of action in individual time steps are described. Among other things, the following scenarios have been developed: fire in the engine room, cabin, kitchen, on the bridge and warehouse of ammunition, radio booth; leaking of pipeline and hull; controlled flooding; uncontrolled flooding, et al.

In the simulator, a 3D model of a warship has been created and the crew and their conduct have been modelled. Teaching materials have been placed and teaching boards have been created [3].

Example of application of the simulator

For the purposes of the article, a sample scenario of events has been selected – a fire in the engine room (fire fighting system has been damaged). It was assumed that there was damage to the fuel system and the ignition of the fuel occurred as a result of the contact of fuel with the hot surface of the engine housing.

It was assumed that temperature detectors and automatic detection system worked.

It was assumed that, simultaneously, the fire was noticed by the watch officer stationed in the engine room. The officer alerted the crew about the incident and turned on the fire alarm button in the engine room. The commanding position was notified. An immediate attempt to extinguish a fire with extinguishing handy equipment was made – all means available to extinguish the fire in the bud, such as, a CO_2 fire extinguisher, water fire protection system and fire blanket etc. were used.

At the command post, after receiving the relevant reports, the fire alarm on the ship was announced. The required actions were taken. Students take exercise positions according to the OPA organization.

In accordance with the procedures, in various parts of the ship other activities provided for in the OPA procedures are simultaneously carried out.

Due to a wide range of activities carried out at various points of action of the OPA group, only the scenario of activities in the area of fire – "extinguishing" will be described.

Activities in the area of the fire – extinguishing

Attack I

Immediately after the announcement of the fire alarm:

- persons designated to act as attack I (two persons from the group of the service on duty or the marine watch on duty) put on individual clothing [anti-flash] and go to the area of fire (the time for attack I to reach the place of fire is 60 s). Upon arrival, they receive the report from the person who first noticed the fire;
- having familiarized themselves with the situation, one person from the group attack I starts to extinguish the fire with the person who was first on the scene, the second person from the group delivers other handy extinguishing measures.

Attack II

While attack I is extinguishing fire, attack II is getting prepared for fire fighting. Next, they go to the place of fire (the time for attack II to reach the place of fire is 3 minutes).

Attack II is equipped with a breathing apparatus, after the receipt of the situational report they proceed to extinguish the fire. At the same time, the person who first noticed the fire and attack I withdraw from the place of fire. One person from attack I leaves to help attack II (help with the equipment etc.).

The fire-fighting operation conducted by attack II should put out the fire within 6 minutes. If the actions of II attack do not help, the emergency group enters. In this situation, the withdrawal of attack II from fire-fighting follows and the report by attack II is submitted to the emergency group.

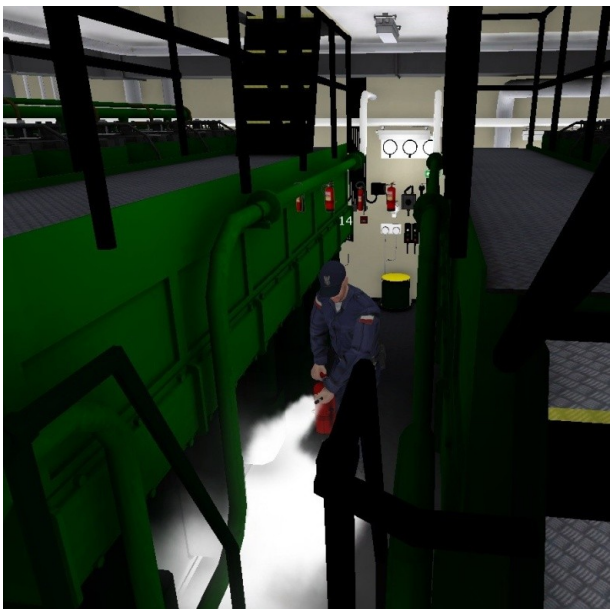

Fig. 6. Fire fighting in the engine room: the first reaction, the use of handheld equipment – event simulation with the use of the HOMAR OPA simulator
Rys. 6. Gaszenie pożaru w siłowni: pierwsza reakcja, użycie sprzętu – symulacja zdarzenia przy użyciu symulatora HOMAR OPA

Fig. 7. Fire fighting in the engine room: attack II event simulation with the use of the HOMAR OPA simulator
Rys. 7. Gaszenie pożaru w siłowni: atak drugi, symulacja zdarzenia przy użyciu symulatora HOMAR OPA

The use of simulators

The development of computer technology and its possibilities resulted in simulators being applied in almost every field. The ease of operation allows

for their use by all users. Popularity of various types of computer simulators led to their wide use also in education.

The spectrum of possible applications of computer visualization technology in education is now very broad, from simple educational programs to complex ones from various fields of science.

Simulators, thanks to their characteristics, allow for getting to know and understand complex phenomena. Virtual images in three dimensions allow for presenting the computer model of a real image.

Practical application of the OPA simulator in the Training Centre in Ustka will not only help verify and use theoretical knowledge gained in lectures, but it will also help verify practical skills acquired during work with the simulation program.

The acquisition of practical skills through performing a certain activity with the use of the simulator allows the trainee to develop habits that in real conditions will allow them to make correct decisions in the event of a fire or water hazard.

The skilful conduct of the final part of the classes where the last stage is its summary is very important. The errors discussed by the instructor, as well as exchange of experiences (among students) acquired during the simulation and observation of other students allow for comparison and analysis of what happened.

Effectively conducted classes on the simulator should result in students gaining the experience similar to the one gained in a real situation, such as, fire on the ship or real equipment to fight fire or water.

The use of simulation during classes allows for deepening and broadening topics covered during lectures. Students can learn more about the equipment, installations, systems, devices and situations, sometimes known only from a theoretical description. By influencing (through their decisions and actions) the functioning of facilities and development of the situation, they observe the effects of their decisions and are able to validate the procedure.

Extensive simulation models allow one to gain experience very similar to the one gained over the years in real conditions.

Simulators are an interactive tool to support training and give the opportunity to present simulated objects, transfer theoretical and practical knowledge, motivate and mobilize for reflection and discovery. They allow for direct transfer of knowledge and acquired skills to be used in daily work. Thanks to simulators, "new operators" are able to, in a shorter period of time, reach the level of training comparable to that achieved in a longer period of time in real conditions.

Simulators allow the use of the entire model of the facility on which they are trained. Learning the correct facility operational procedures is the basis for training. In addition, education along with the possibility of introducing various types of failure scenarios allows the operators to develop the ability to make a rapid decision for the simulated situations and, at the same time, see, without any financial consequences, the effects of those decisions.

To conclude, it can say that simulators help one achieve the appropriate level of training. They reduce training costs while increasing the safety level of the facilities.

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