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Modern Equipment of the Polish SAR Service During a Real Rescue Operation in the Baltic Sea Taking Into Account the Recommendations of the 3-volume IAMSAR Manual

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ABSTRACT: The article presents the legal basis for action and decision support systems of the Polish Maritime Search and Rescue Service. Based on the course of a selected mission, the actual actions were compared with the IAMSAR recommendations, presenting the ways of communication and the latest training techniques for saving lives.
Conclusions from the conducted analysis indicate that because of the knowledge and experience of rescuers the requirements for conducting a search and rescue action according to IAMSAR differ from the actual actions of rescue services.

1 INTRODUCTION

The Baltic Sea area is divided into nine SAR areas of responsibility, belonging to eight EU Member States (Denmark, Germany, Poland, Lithuania, Latvia, Estonia) and Russia. The States subject to the SAR Convention base their activities on various forms of rescue work, in the case of Polish, Denmark, Germany they are full-time rescuers, in the case of Sweden the rescue is the responsibility of the military, while in the case of Latvia, Lithuania and Estonia, rescue operates on the basis of basic crew and volunteer rescuers. However, each country whose activities are coordinated by the Rescue Co-ordination Centers (RCCs) base their operations on the International Aeronautical and Maritime Search and Rescue Manual (IAMSAR) [2, 3]. This manual consists of three volumes:

- Volume I 'organization and management' which describes the importance of emergency services and how they work together. This volume is used by government agencies. On the basis of the guidelines of this volume, the "Search and Rescue Plan" was developed.
- Volume II "Coordination of rescue operations" containing guidelines for the planning and execution of rescue operations. This volume is used in coordination centers and on board rescue vessels.
- Volume III "Mobile equipment" describing means of communication, organization and means of search. This volume is required on board every floating and flying craft.

The Polish Maritime Search and Rescue Service bases its rescue planning activities on operational publications [4]:

- IAMSAR Volumes I, II and III, [2, 3]
- Search and Rescue Action Plan (SAR Plan), [7]
- National Plan for Combating Hazards and Pollution of the Marine Environment, [5]
- Air Search and Rescue Operational Plan (ASAR Plan), [7]
- Plan for sheltering vessels in need of assistance,

– Emergency Response Plan and many other regulations and instructions.

In addition to the publications, the decision-making process is supported by SARCAS (Search and Rescue Computer Aided System) software, designed to determine reference positions and create precise, most probable search areas, as well as broadly support the coordination and conduct of search and rescue operations. The designer and producer of this software is the Maritime Technology Centre in Gdynia. In addition to SARCAS, Polish RCC uses a number of systems such as:

– Shipping Safety Information Exchange System,
– EMSA - SEG (European Maritime Safety Agency) - a very powerful application to find information on vessels
– OpenEye - a system that receives all hazard information from the GMDSS (including AIS - SART).

The databases that are used for action planning are: an identification database of all vessels of Polish nationality (not only vessels subject to the STCW Convention), updated at least once a week. Further databases are: SARcontactinfo - Canadian database with contacts to all RCCs around the world, Database with MMSI numbers, as well as ELVYS communication consoles - VHF, MF, DSC, DGT network and telephone systems.

The Polish SAR service not only uses many modern software and databases, but also a modern communication system and high-end medical exercise equipment, which is described in the article.

2 IMPACT OF LOCAL HYDROMETEORLOGICAL CONDITIONS ON SAR PLANNING

In order to plan an effective rescue operation, it is essential to collect information about the object being rescued and complete data on the meteorological conditions at the scene. If the RCC is unable to obtain data from the victim and the actual conditions on site can be provided by the rescue team upon arrival on site, the RCC coordinators use the SatBaltic portal [6], which very precisely indicates the direction of the sea current, water temperature and other meteorological data.

The second portal used by the Polish coordinators is the Institute of Water Management and Meteorology (IMGW) [1] which provides all data on sea currents, water temperature, wind direction as well as wave forecasts.

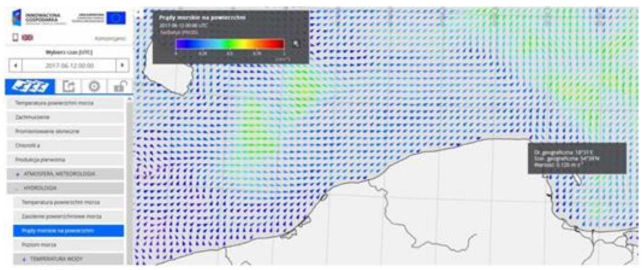

Figure 1. Image of sea currents according to SatBaltic service [1]

Coordinators shall use Volume II of IAMSAR to determine the reference position. The data that need to be collected to determine the reference position are entered in the summary form - Appendix K - datum worksheet [Fig.3] . The parameters to be calculated by means of the auxiliary forms are: average surface wind, total water current (calculated on the basis of tidal current, sea current, wind current and other observe current) , leeway.

The rescue units that arrive on the scene provide the current hydrometeorological conditions, which the RCC compares with the forecast ones. In the event of a significant change in the initial weather parameters, the RCC is required to recalculate the parameters.

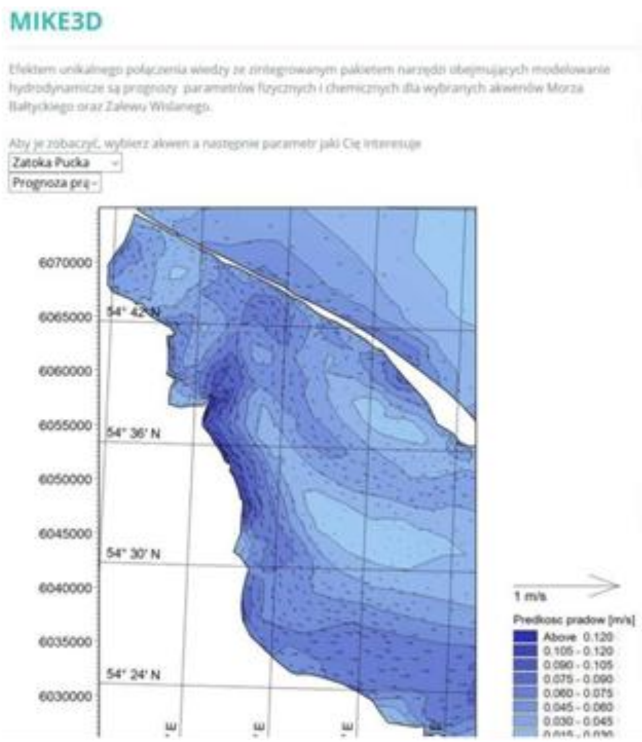

Figure 2. Image of sea currents according to IMGW Service [1]

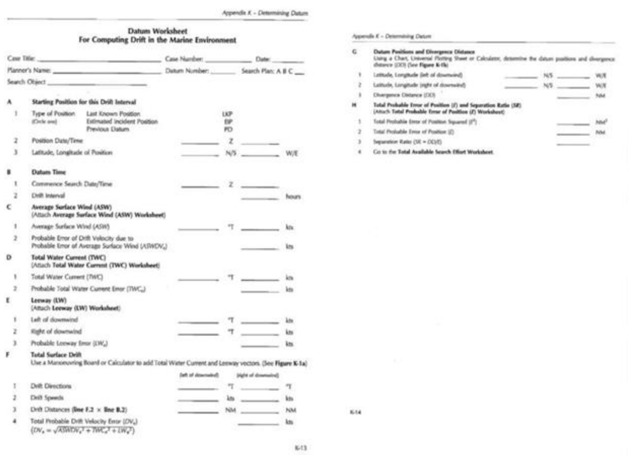
Datum Worksheet
For Computing Drift in the Marine Environment

Figure 3. Datum Worksheet [2]

3 DESCRIPTION OF THE RESCUE OPERATION

The analysis of the compliance of the actual rescue action is presented based on the selected rescue mission from 12.06.2017. At 21:49 from the emergency telephone 112 the Maritime Rescue Coordination Centre received a report of an overturned yacht in the area of Osłoniono - Rewa, one person on the shore, another in the water. The following units were dispatched to the scene: rescue boat R-20 from "Kapitan Poinc", rescue boat R-23 from BSR Władysławowo, a few minutes later the PSP Puck joined the search. At 23:07 an empty catamaran was located, the RCC gave orders for R-20 and R-23 to search in parallel lines in directions E - W [pic.4]. Officer R-20 via direct communication on VHF channel 11, not the SITREP form [pic.5] relays the current weather conditions at the scene – southerly wind 1-2°B; sea state 1-2; air temperature about +15°C; water temperature about +16°C; cloud cover 2; visibility 6 to 7. Before 01:00 a Navy helicopter joins the operation, weather conditions deteriorate. At 05:18, the MRCK decided to enlarge the search area and change the search direction to parallel lines with left tack, N - S directions, search speed ~ 4 / 5 knots. At 09:10 after the informant's jacket was found - the information was confirmed after a telephone contact, the direction of the search was changed - perpendicular to the current and the direction of wave propagation, parallel lines with right tack, from Rzucewo to the "Rybitwiej" sandbar, search speed ~ 5 knots. At 12:09 the coast guard boat joined the operation, the search direction was changed for the last time to parallel left tack (towards Rzucewo), NE - SW in the Kuźnica - Rewa line. At 19:00 the search was suspended and the survivor was not found. In total the search lasted 21 hours, 9 hours more than according to IAMSAR vol. II, where the assumed survival time for a person without special clothing in water with a temperature of 15 - 200C is less than 12 hours. These guidelines and the approaching dusk influenced the decision to suspend the search.

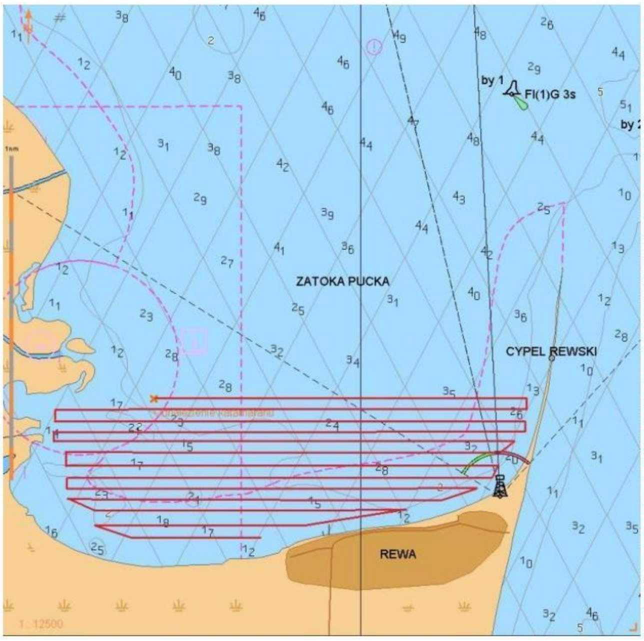

Figure 4 Searching Parallel track East – West [own materials]


Appendix D

Standard format for search and rescue situation report (SITREP)

Situation reports (SITREPs) should be compiled as follows:

Short form

To pass urgent essential details when requesting assistance, or to provide the earliest notice of a casualty.

Transmission priority (distress/urgency, etc.) ____

Date and time (UTC or local date time group) ____

From (originating RCC) ____

To ____

SAR SITREP (number) (to indicate nature of message and completeness of sequence of SITREPs concerning the casualty) ____

Identity of casualty (name, call sign, flag State) ____

Position (latitude/longitude) ____

Situation (type of message, distress or urgency; date/time; nature of distress/urgency, for example, fire, collision, medical) ____

Number of persons at risk ____

Assistance required ____

Coordinating RCC ____

IAMSAR MANUAL VOLUME III D-1

Figure 5. SITREP - Standard format for search and rescue situation rapport [3]

4 ADVANCED COMMUNICATION METHODS AND SYSTEMS ON BOARD A RESCUE VESSEL WITH REFERENCE TO IAMSAR VOL-2 COMMUNICATION RECOMMENDATIONS

Communications at the scene of the action, as well as between the rescue units and the RCC is very important and should be of the best possible quality. According to the requirements of IAMSARU vol. III, communication on the scene between vessels and the RCC should be conducted on VHF channel 16, and with the aircraft / helicopter on 121.5 MHz or 156.8 MHz (CH=16 VHF). These requirements are met by all countries around the world, as channel 16 and DSC Ch=70 are a channels for communication in distress, however, during the action a so-called working channel is established, so as not to block the frequency for emergency communication. In the case of the Polish SAR service in order not to block channel 16, which is used for communication in distress, for communication with the RCC and helicopter uses the frequency 156.550 - CH=11VHF.

4.1 *The David Clark wireless set*

Rescuers of western and northern Baltic states, as well as The English and Americans and Polish Maritime Search and Rescue Service on board of a rescue vessel, use the David Clark Wireless Communication System [8] to communicate with each other, ensuring uninterrupted communication on board rescue vessels and during rescue operations when there is a need to move to another vessel. The communication system ensures that crew members can move freely without being tethered by cables that restrict movement or snagged on board equipment. Communication is free from interference and noise. Reliable system components such as gateway base stations, personal stations and headsets are resistant to humidity and salinity.

4.1.1 *Components and technical specifications*

The communication system consists of mobile stations, the number of which corresponds to the number of crews sailing on each vessel. Usually one additional portable station is added as a backup. A pair of headphones is added to each portable station. Another component is the network base, which, via WiFi waves, connects the portable stations to each other (pairs) together with the VHF radio, which gives the possibility to initiate the outgoing wave from the VHF station. MSPiR vessels are also equipped with permanent intermediate stations, which offer the capabilities of mobile stations except for the freedom of movement, as they are stationary. The last item is a battery charger with two sets of batteries for the mobile stations, the number of batteries corresponding to the number of mobile stations supplied.

Figure 6 System elements of David Clark[8]

Table 1. Technical Specifications [8]

Frequency range	1.880 – 1900 MHz (Europe)
Average transmit power	10 MW, max. 20mW (Europe)
Range	in an unobstructed line of visibility
Baterry capacity	24 h work
Work temeperature	$-10^{o}C$ - $+45^{o}C$
Power	3,7V at consumption 100mA nominal
Battery type	3,7V 2000 mAh lithium – Polymer

4.1.2 *Operating principle*

The "Belt Station" personal station is a portable device connected to a network gateway. This creates a group of users communicating via an intercom. In a configuration with one network gateway, up to 4 persons can communicate. The crew has a simultaneous connection to the VHF radio. The VHF radios are configured and connected via a cable line to the network gateway. In this way, it is possible to listen continuously on the frequency selected on the VHF radio and to have an outgoing conversation with the Rescue Coordination Center or the unit in distress.

Transmitting is done using the PTT button located on the top of the mobile device. Thus, the system does not require lifting the handset and conducting communication in the standard way. According to the manufacturer, the range of the mobile station paired with the network gateway is up to 150 meters, and we are talking about uninterrupted, clean continuous communication. As the distance increases, the mobile station informs the crew member with a three-fold beep that the connection has been lost. Once back in range, the station automatically re-establishes the connection and further internal or external communication is possible.

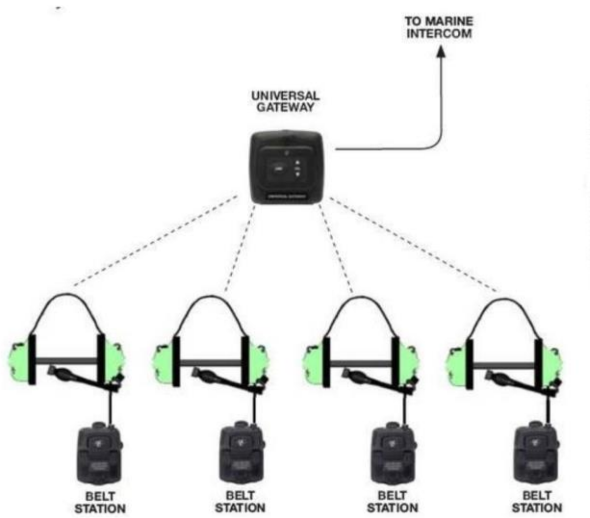

Figure 7. Principle of operation od David Clark [8]

This communication solution on rescue vessels undoubtedly gives work comfort. The crew can move around the rescue vessel and at the same time hold a conversation with each other, listen to information broadcast on the radio and conduct external communication. The same applies to rescue operations on a second vessel, where two rescuers assist the casualty. As long as the vessel is within range of the network station, part of the crew on the rescue vessel is in contact with the responders on scene. This significantly improves the rescue operation.

5 LIFE-SAVING TECHNIQUES IN TERMS OF MODERN TRAINING METHODS

Despite holding certificates required by the STCW Convention, Polish Maritime Search and Rescue Service crew members undergo additional rescue training and are equipped with top quality equipment to improve their skills. The latest purchase of the Polish Maritime Search and Rescue Service for all bases and vessels is a Phantom for learning / training BLS (Basic Life Support) / CPR / ALS (Advance Life Support) with integrated feedback and intubation capabilities for practicing first aid. [9] The aim of the investment is to consolidate and improve the ability of employees to carry out rescue operations with victims in various states of body capacity.

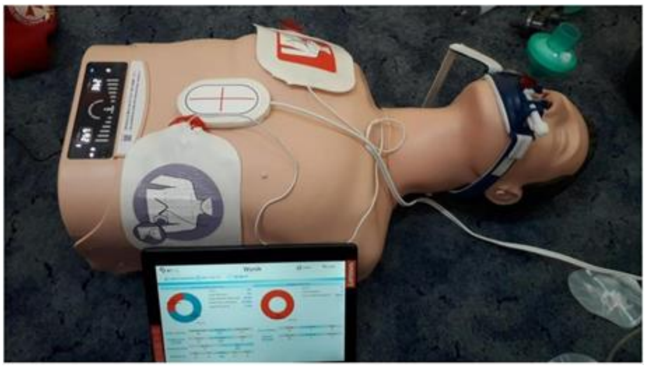

Figure 8. Phantom with equipment [own materials]

5.1 *Components*

The phantoms consists of a torso cut at waist height, a power supply unit with a 220 V plug, a lubricant for the phantom's mouth to facilitate implantation of laryngeal tubes, magnetic caps to detect defibrillator pads, an orthopedic collar, a display indicating the quality of the rescue operations carried out and a tablet with software for carrying out the exercises.

5.1.1 *Power modes*

For training purposes the phantom can operate in two power supply modes. The mode of work on cable power supply enables conducting exercises indoors, where it is possible to carry out exercises in conducting BLS CPR and ALS in the mode of self-realization of SAR personnel. In addition, it is possible to conduct training in the evacuation mode, i.e. to carry the casualty from point A to the Emergency Medical Team waiting in the port. In order to enable such a solution without access to a permanent power supply from a 220 V socket, there is a place for batteries in the phantom, which excludes the need for a conventional power supply.

5.1.2 *Ventilation of the phantom*

The phantom has the ability to conduct artificial ventilation of the victim not only at BLS level, but also ALS. In this regard, the phantom has replaceable lungs in the form of a sealed bag, which can be easily replaced. The artificial lungs enable ventilation of the victim, and therefore it is also possible to establish an airway and perform intubation.

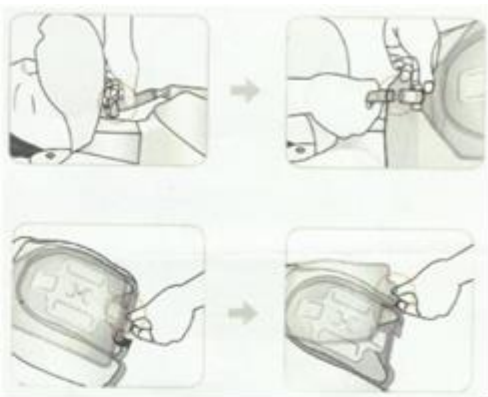

Figure 9. Phantom ventilation [9]

5.1.3 *Display*

The resuscitation training phantom is equipped with an LCD display that allows real-time monitoring of the correctness of CPR/BLS/ALS performance. The monitor indicates the total number of compressions performed (4) and how many of them were performed correctly (5). On the same display, there is a marker indicating whether the rescuer's hands are centrally placed on the chest during CPR or whether the hands are inappropriately moved away from central positioning.

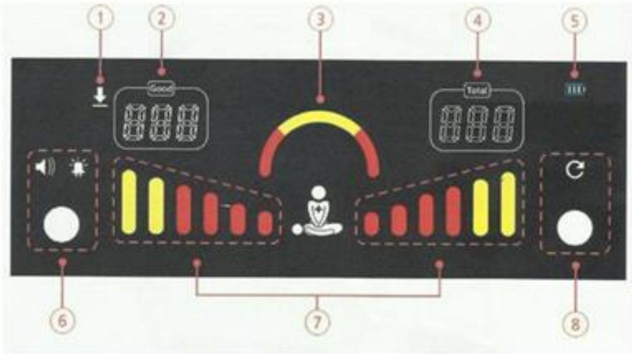

Figure 10. Phantom display [9]

Another element shown on the display is the rate of chest compressions, which also indicates whether the timing of one ventilation is correct (3) . These elements are important because they help the rescuer to remember not only how hard and how fast to perform chest compressions but also at what time to inject air or oxygen using the self-expanding bag commonly called the AMBU. The last indicator that is worth mentioning is the indication of the depth of chest compressions, its relaxation and the volume of ventilation carried out (7).

5.2 *Software*

A tablet with software, coupled with the phantom, was made available to the trainees. The software connects via bluetooth directly to the manikin and monitors the work on the phantom. The trainees have 3 modes of the programmer at their disposal. Game mode, which in a simply way shows whether resuscitation is successful or not. It contains only basic information about the number of compressions and inspirations. Second, the training mode with detailed data on the performed CPR. The last mode is the evacuation mode, which gives the possibility of conducting a test based on from rescuers previous training and simulating the evacuation of an injured person from a ship to a rescue unit. It is possible to connect up to six phantoms with the software at the same time. Thanks to such a solution, it is possible to conduct joint exercises of two particular units, based on the assumption that there are, for example, two or more casualties at the same time. The programmer monitors the work of two or more phantoms simultaneously. This solution significantly facilitates joint exercises between the crews of Marine Rescue Stations, Shore Rescue Stations and independent units.

5.2.1 *Training mode*

During training exercises, rescuers have a live view of the visualized effects of the BLS/RCPR/ALS performed. The training mode screen shows the time of on-going resuscitation from start to finish. When you tart chest compressions, the screen shows the forced heart rate as a curved line, similar to the rise curve on electrocardiography equipment. In addition, most of the information from the built-in display is repeated in the exercise program. The heart and lungs are shown from the time of compression/inspiration in two colors (1). Good compressions or sufficient ventilation volume are indicated in green, otherwise in red. The pie diagram (3) shows the rate of compressions (in this case 114 bpm), the chest relaxation and, again, the quality of the hand position on the chest. The vertical lines on the sides (4) of the display show the depth of chest compressions with numerical information (61 mm). The program also provides information on the number of compressions performed (5) and the amount and volume of ventilation (6). The entire training course is summarized with a summary displaying numerical information on the entire resuscitation cycle carried out.

Figure 11. Tablet display [9]

5.2.2 *Evacuation mode*

The evacuation mode involves simulating the transfer of the casualty, in the course of resuscitation efforts, from the place of danger to the rescue unit, within timescale. In this way, a group of rescuers can practice the process not only of resuscitation, but of moving with a victim in danger of cardiac and respiratory arrest from point A to point B. The programmer does not indicate clear data or illustrations during the rescue operation. After a set time (max. 10 minutes), the results of the group or groups are shown (if the actions are carried out simultaneously on two or more phantoms). This mode can contribute not only in a training way, but also in a self-realization way for the employees of the Maritime Search and Rescue Service.

6 CONCLUSIONS

The primary task of the Polish Maritime Search and Rescue Service is to ensure continuous and effective search and rescue operations throughout the Polish area of rescue responsibility. For this purpose, the rescue co-ordination center uses the knowledge contained in all volumes of IAMSAR and many additional regulations and plans. When comparing the actual SAR operation with the IAMSAR instructions, it can be seen that Polish SAR uses the IAMSAR recommendations, modifying them according to the situation. There is neither the time nor space on the rescue units to produce a written version of the SITREP, so information on the current meteorological situation and the stage of the search is transmitted by means of audio. It would be worthwhile in IAMSAR to draw up a version of the report transmitted by radio, which would be short and in kind, such as:

RCC RCC RCC this is...
meteorological conditions at the scene of the action:
Wind... current... temperature... visibility…
up-to-date search data if the situation has changed
Over

Changing the communication channel during an operation from 16 to 11 is a very prudent decision, as according to GMDSS guidelines this channel is used for distress calls and should not be blocked. The solution used could be introduced into IAMSARU vol. III, in order to improve the work of interoperable emergency services around the world. A pre-identified rescue channel would solve the problem of agreeing the working channel. In addition, the use of the same channel for communications by all units (sea and airborne) affects the efficiency of information transfer, as does the use of the David Clark wireless system throughout Polish SAR and other Baltic SAR services, which is an excellent solution for improving communications between multiple units.

When carrying out a lifesaving operation, communication with the crew is as important as the skills of the rescuers, who try to restore or maintain a person's vital functions until the casualty is handed over to medics on shore. When setting out on a search and rescue mission, rescuers do not know whether they are picking up a person alive or dead, which is why it is so important that they receive proper and regular medical and rescue training. SAR is always "Semper Paratus".

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