Zeszyty Naukowe SGSP 2017, Nr 63/3/2017

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Analysis of the Usefulness of the Mobile Evacuation Floating Platform in Rescue Operations

Abstract

Flat-bottomed propeller boats are vessels which have been well-known for more than a hundred years. However, in Poland they are less popular and are used only for recreational purposes. The project implemented by a consortium of Polish research centers and companies within the limits of the competition for the Applied Research Program (financed by The National Centre for Research and Development, NCBR) led to the creation of the first dedicated rescue unit in Poland. The Main School of Fire Service (SGSP) together with the Automotive Industry Institute (PIMOT) carried out practical tests on both: flowing water (the Narew river) and standing water (the Zegrze Lake).

Keywords: flooding, water rescue, airboat

Analiza przydatności Mobilnej Ewakuacyjnej Platformy Pływającej w działaniach ratowniczych

Abstrakt

Płaskodenne łodzie z napędem śmigłowym są jednostkami pływającymi znanymi od ponad stu lat. W Polsce jednak są mało popularne i jeżeli są wykorzystywane, to jedynie w celach rekreacyjnych. Projekt zrealizowany przez konsorcjum polskich ośrodków naukowo-badawczych oraz firm w ramach konkursu Programu Badań Stosowanych doprowadził do powstania pierwszej w Polsce tego typu jednostki dedykowanej dla służb ratowniczych. Szkoła Główna Służby Pożarniczej (SGSP) wraz z Przemysłowym Insytutem Motoryzacji (PIMOT) przeprowadziła testy praktyczne zarówno na wodach płynących (rzeka Narew), jak i stojących (Zalew Zegrzyński).

Słowa kluczowe: powódź, ratownictwo wodne, airboat

1. Introduction

This article outlines the history, construction and the operation of the propeller-driven flat-bottomed boats. This construction has been known for over a hundred years, but on the Polish market the advantages of this style solution practically haven't been perceived. These include, a slight immersion and a high speed of movement. It is also possible to move across the land at short distances. During the natural disasters such as floods, it is hard to overestimate the vessel from the rescue service perspective.

The first airboat, called Ugly Duckling, was built in 1905 in Nova Scotia (Canada, USA) by a team headed by dr Alexander Graham Bell. It was used to test different engines. Figure 1 shows the original version of the airboat.

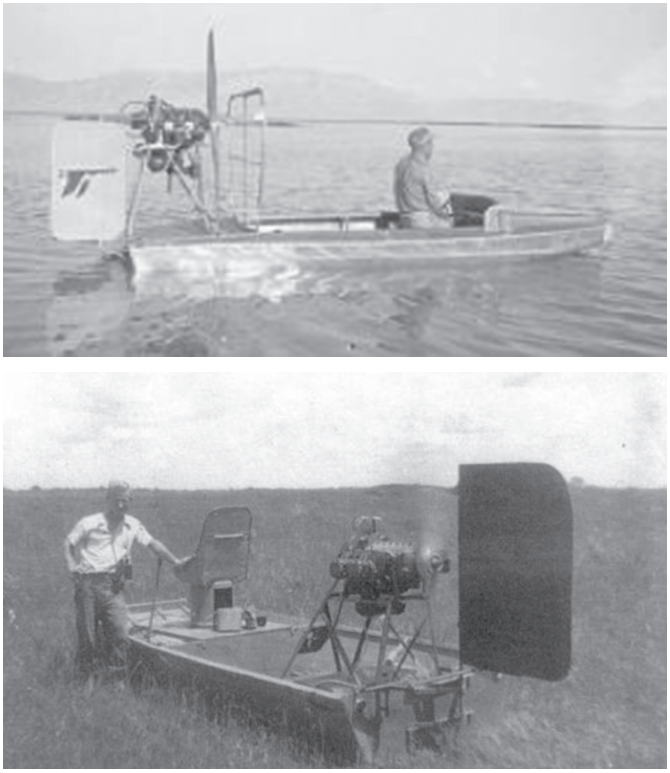

Fig. 1. An early form of the airboat

Source: A. Kidawski, A. Wlodarczyk and others, Analysis of existing solutions; compilation of existing systems in terms of individual exploitation and technical properties. Scientific description of the PIMOT No. BLH.021.13B, Lodz 2013

The airboat is a flat bottom boat driven by a propeller located at the rear and a motor. Airboats are very popular means of transportation in Florida (USA). They are mainly used for fishing and tourism, rather in swampy and shallow areas, where using a standard propeller or outboard would be impractical. The engine and propellers are enclosed in a protective metal cage, which prevents objects such as tree branches from entering. The propeller forms an air column that propels the airboat.

The airboat is powered by the propeller, which produces a rearward column of air behind it. The resulting prop wash averages 241 km/h.

Control is effected by the forced air passage through the vertical rudder fins. Modern airboats are made of aluminum or fiberglass. The choice of material depends on the area in which the boat will be used. Figure 2 shows modern airboat designs.

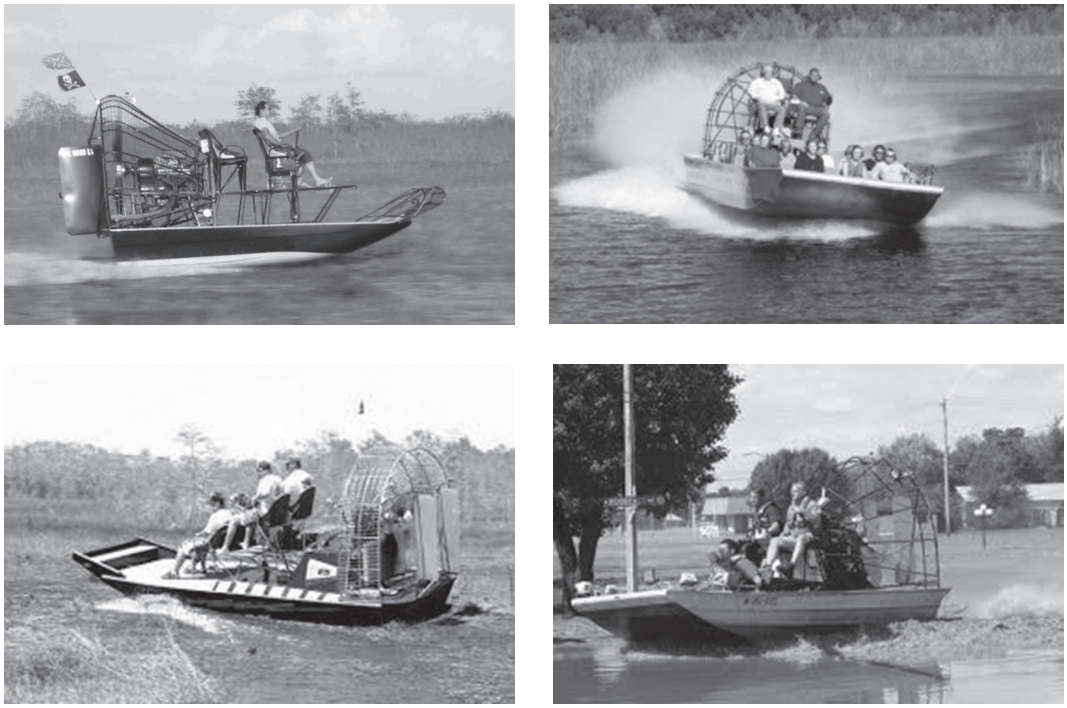

Fig. 2. Examples of airboats designs and their use

Source: A. Kidawski, A. Wlodarczyk and others, Analysis of existing solutions; compilation of existing systems in terms of individual exploitation and technical properties. Scientific description of the PIMOT No. BLH.021.13B, Lodz 2013

In order to approximate the operational possibilities of this type of boat, the project entitled "Mobile Evacuation Floating Platform with Research Position Functions" has been developed.

Acronym: MEPPZFSB
Contract number: PBS1/B6/15/2013
Implementation period: April 3, 2013 – December 31, 2014

The project implemented by the consortium consists of: The AMZ-KUTNO Ltd., Motor Transport Institute, The Jankowski Golinski Research and Design Center, The Warsaw University of Technology, The ROMA Ltd. and The Military University of Technology and The Automotive Industry Institute as a leader. The purpose of the project was to create a floating platform which enabled the evacuation of people from the flooded areas.

Project manager: Andrzej Wlodarczyk
Deputy project manager: Antoni Kidawski

The technical specifications of the drive unit TURNKEY COMPLETE 550 HP GM "LSA" 6.2 Ltr. V8 MARINE ENGINE are as follows:
Maximum power: 550 hp
Power supply type: fuel injection
Engine speed: maximum torque with 4000 rpm (5600 rpm – fuel cut off)
Total weight of the boat: 1800 kg
Materials used for its construction: aluminum (body), polyurethane PE1000
Figure 3 shows the prototype of The Mobile Evacuation Floating Platform (MEFP) during the field tests conducted at SGSP in cooperation with the PIMOT.

The prototype of the floating platform is built on the backwaters and shallow beards and allows effective identification and coordination of rescue operations in the field.

The proposed floating vehicle (sliding on the water surface) belongs to unconventional units. It is designed for tasks carried out by the Police, the Rescue Services, the Fire Brigades, the Border Guard, the Crisis Management Centers and the Army [1].

Fig. 3. Mobile Evacuation Floating Platform during maneuvers on the Narew (Training Center of SGSP in Nowy Dwor Mazowiecki)
Source: photo P. Wolny

2. Use of the platform in emergency situations

Due to its unique construction, a floating platform equipped with a push propeller can be used in emergencies where traditional rescue boats cannot go. The airboat floats above the waterline, which means it can move freely in shallow waters and among water items that could damage the traditional rescue boat control system.

The airboat's parameters meet 2 requirements:

a) the dimensions of the boat enabling the transport on a specially prepared trailer with an overrun brake without exceeding the permissible dimensions highlighted in traffic regulations and the possibility of its rapid introduction into the action,
b) simplicity and reliability of the structure, availability of the service and the possibility of selection of the propulsion unit and number of propeller blades.

Spatial structure and propulsion system must provide rapid access to places affected by natural disasters, help injured or evacuate people and their property.

The unit, due to its intended use, will be capable of carrying two crewmembers having their seats behind the steering wheel and for transport in a specially adapted space of up to 8 persons. Moreover, the deck of the unit is equipped with the special cleats to transport the load during the evacuation. Preparation at the design stage of a dedicated cargo space will allow the enhancement of tasks within transport time. It was initially assumed that it would be possible to transport 2 Europallets [2].

3. Use of the platform for rescue purposes

The initial purpose of the project was to create a floating unit that would enable the effective evacuation of people from the areas affected by floods. This is not the only rescue function that this unit can successfully implement. The other possibilities for using the platform will be presented in the following.

Evacuation involves a number of organized actions involving the rescue and displacement of people, animals and property from the threatened areas. Evacuation can be carried out on a small scale, such as rescuing people from ships subjected to fire, or it may be an extended logistic operation utilizing operational voids of the provincial or even national level. An airboat unit should be effective in both situations.

Functional use of the platform for rescue purposes is possible upon fulfillment of the following assumptions:

- selecting the necessary equipment, which will be the equipment of the platform,
- analysis of the positioning methods of the unit in the field,
- defining the field conditions, ways of units communication with the commanding center,
- planning the deployment of rescue units in the country, the location of a stationary command center.

Depending on demand, a propeller platform can be used to:

a) evacuate people and animals from the flooded areas,
b) conduct the search and rescue operations in deep water bodies, shallow plains, swamps and frozen water bodies,
c) participate in search and rescue operations in high currents,
d) support the search and rescue of people and animals from ships or yachts that enter the shallow,

e) support the fire brigade,
f) support for oil spill clean-up operations.

Flat boat construction allows:

a) safe navigation on water, ice, swamps and among the remains of objects, on flat ground,
b) operating in extreme weather conditions with a wind speed of up to 50 km/h and a wave not exceeding 0.5 m high.

The boat is destined for a maximum of 8 people (excluding boat crew).

Life-saving equipment provides the following:

- first aid kit in a waterproof container,
- resuscitation kit,
- lifebuoy,
- lifejackets,
- defibrillator,
- heat protection (foil of life),
- thermal insulation suits for the crew (winter conditions).

Table 1 shows the minimum crew capacity that can perform an effective rescue operation depending on the risk involved.

Table 1. Recommended minimum number of crews depending on the threat [3]

Type of threat	Number of people (min.)	Boat crew
Flood	3	1 helmsman 2 lifeguards
Fire	5	1 helmsman 2 lifeguards 2 firefighters
Oil spill	3	1 helmsman 2 operators of anti-fouling equipment
Search and rescue operation on ice	4	1 helmsman 3 people – rescuers with ice-breaking equipment

4. Proposed equipment of a lifeboat for the State Fire Service

For effective rescue operations, the different types of equipment and tools are necessary. Based on rescuers' experience, the equipment list must be implemented to expedite the rescue operations. Some of the equipment is due to the requirements that are imposed on the vessels. Table 2 contains proposals for basic airboat equipment, which, in the opinion of the prototype developers, should be on board.

Table 2. Boat life equipment (proposed) for the State Fire Service [3]

Ordinal	Equipment name	Unit of measure	Number
1	Lifebuoy	pcs.	4
2	Water rescue throw bags	pcs.	4
3	Personal flood defense package (mounted on the rescuers' hips)	pcs.	4
4	Life jacket (50 N displacement) for the crew	pcs.	4
5	Lifejacket (150 N displacement) for victims	pcs.	12
6	Pants type „Waders"	pcs.	6
7	Paddles	pcs.	4
8	Danforth anchor – folding with 20 m rope	pcs.	2
9	Boat hook	pcs.	2
10	Water bucket	pcs.	2
11	Shovel	pcs.	2
12	Crowbar	pcs.	2
13	Lumber type „Hooligan"	pcs.	1
14	Dielectric axle	pcs.	2
15	Hammer (10 kg)	pcs.	1
16	Pike pole (5 m)	pcs.	1
17	Extension ladder	pcs.	1
18	Blanket (water proof)	pcs.	16
19	Floating buoys with 10 m rope	pcs.	4

Table 2

Ordinal	Equipment name	Unit of measure	Number
20	Searchlight mounted on a stand or side of a boat – powered by a boat generator, min. 1000 W	pcs.	1
21	Medical bag type PSP-R1	pcs.	1
22	Backboard with 4 belts	pcs.	1
23	Sam Splint kit	pcs.	1
24	Mobile radiotelephone, f.e. MOTOROLA GM360 VHF	pcs.	1
25	Handheld radio, f.e. MOTOROLA GP360 with charger kit	pcs.	4
26	Marine GPS, f.e. GPSMap 720	pcs.	1
27	Maps set for the selected region	set	1
28	Powder extinguisher (6 kg)	pcs.	2

Table 3 presents the airboat equipment options for optional equipment based on the specifics of the stock and weather conditions.

Table 3. Optional equipment – mounted when needed [3]

Ordinal	Equipment name	Unit of measure	Number
1	Pneumatic rack tent NPA 37, powered by 6 liters air cylinder (min. 2 bottles included)	pcs.	1
2	Heating device for a tent (heating power up to 32 kW) Device example: heater IDE 30 Power supply type: oil Mass: 34.2 kg Dimensions L x W x H: 1107 x 498 x 766 mm	pcs.	1
3	Tent lighting	pcs.	2
4	Safety harness	pcs.	4
5	Dynamic rope for assurance (50 m)	pcs.	2

Table 3

Ordinal	Equipment name	Unit of measure	Number
6	Generator set min. 3 kVA (degree of protection IP 54)	pcs.	1
7	Extension cord on the drum 20 m (minimum degree of protection IP 67) with a 4-junction splitter	pcs.	2
8	Rinses 550 W (minimum degree of protection IP 55) with tripods	pcs.	2
9	Unmanned aerial system for observation activities	pcs.	1

5. Training and courses for the crew of the airboat

The control of the floating platform equipped with propeller propulsion requires special skills. It is important to remember that this unit is controlled quite differently than a conventional rescue boat and that it does not have the ability to apply reverse thrust to speed and precision. Before launching a new rescue platform, the special training and courses should be developed and implemented for the airboat crew operator .

Not only the operator should be trained but also should the crew . These are people who directly take part in rescue activities.

The only documents that authorize the rescue boats of all types during exercise and rescue operations in fast-flowing and flood waters are the Rescue Boat Helmsmen Patent holders (issued by the Chief Inspectorate of Maritime and Inland Navigation).

Both patents of the Motorboat and the Senior Motorboat Helmsman do not authorize the boat navigation during exercises and rescue operations in fast-flowing and flood waters. They allow the use of boats and motorized water equipment only for self-recreation.

The basic courses and trainings that must be completed by each firefighter to allow the use of the rescue equipment are as follows:

- completed the training on sawmill,
- completed the Pre-Medical Assistance course,

- completed the practical training in life,
- completed the lifeguard course (in Poland Water Volunteer Rescue Service) – optional,
- completed the High Altitude Course – optional,
- the Rescue Boat Helmsmen Patent.

6. Training ground scenario

As part of the exercise titled "Search and Rescue Maneuvers with Ground and Water Terrestrial Platforms" held on 18th May, 2017 at the SGSP Rescue Training Center in Nowy Dwor Mazowiecki, under the guidance of experienced instructors, the capabilities and usefulness of the Mobile Evacuation Floating Platform was tested. The elaborated practices in the field (with the help of a fake) were carried out on 10th June, 2017 as a part of the "Safe Holidays" exercises conducted in cooperation with the Water Volunteer Rescue Service (WOPR), the Helicopter Emergency Medical Service (LPR) and the Police on the Zegrze Lake. The scenario involved taking the victim with a suspected spinal injury out of water.

On the airboat's boat there are always 2 people (the operator and the rescuer). This is so-called –the patrol set. In this scenario, a LPR doctor and 2 extra rescuers have additionally participated.

After locating the injured by the WOPR rescuer in the water, the person was fastened to the orthopedic board and the doctor performed a preliminary examination of the patient on board (Figure 4).

According to the construction of the platform, it was possible to reach land where the rescue helicopter was located (Figure 5). The cervical vertebra was protected by an orthopedic collar and the victim was prepared for immediate transport by rescue helicopter (Figure 6). This greatly speeds up the rescue operation and prevents secondary injuries during cartage.

What's more, there could be two separated rescue stands set up and two individual rescue missions might be conducted at the same time due to the bulk of space on the deck.

However, this requires confirmation at a later stage of the tests. The element which was missed during the exercise and might improve the rescue action is to install the actuators to lower and raise the bow ramp.

Fig. 4. Taking the victim out of water

Source: photos P. Wolny

Fig. 5. Transfer the protected victim to services on land

Source: photos P. Wolny

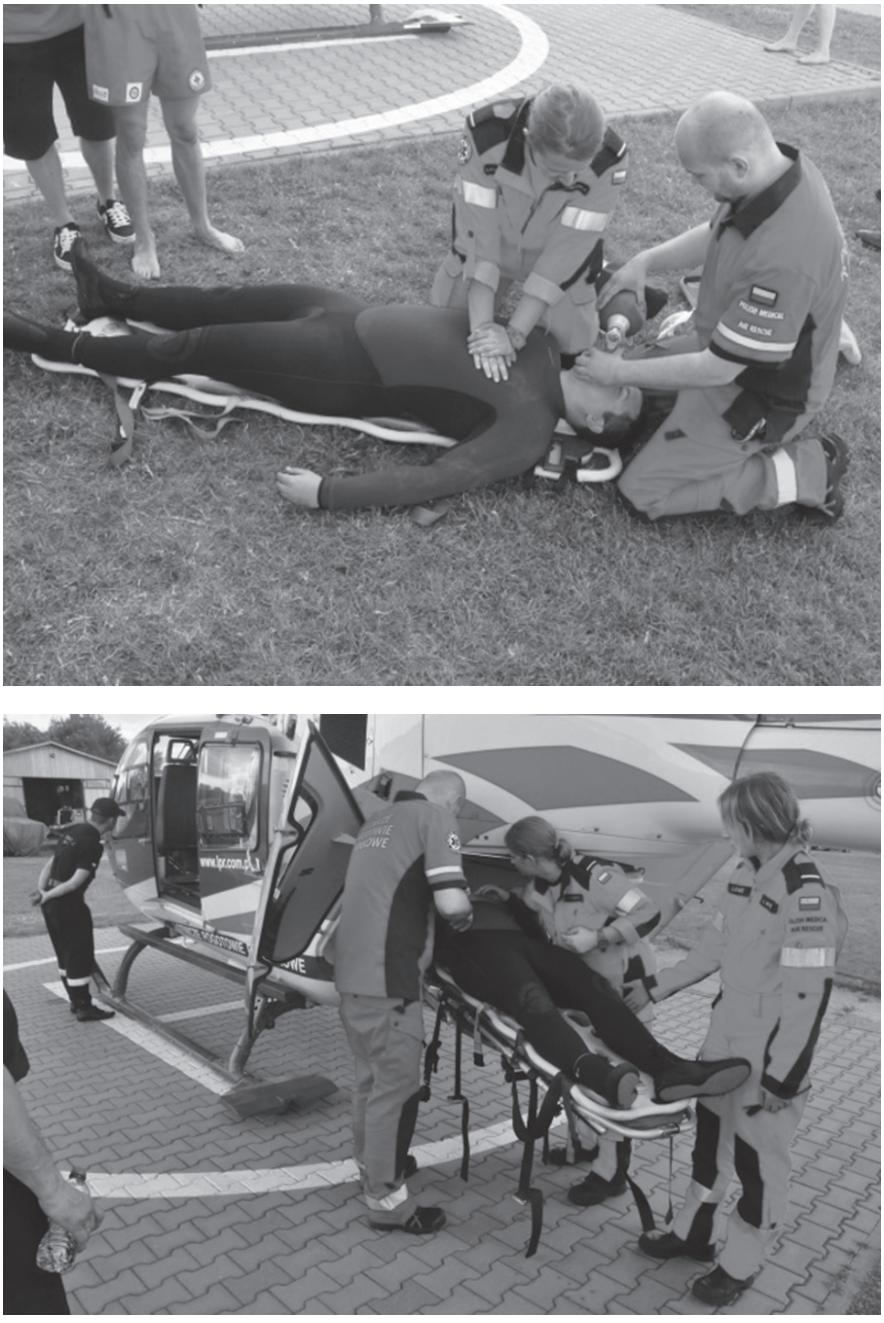

Fig. 6. Granting qualified medical care by LPR personnel and boarding on helicopter

Source: photos P. Wolny

7. Development version

To fully exploit all the capabilities of the airboat platform, you should consider building up the boat's upper deck. In addition to the natural shield from wind, waves and fire, this unit can also be used during winter rescue operations in frozen water bodies. Rescuing people from ice-covered waters is one of the most difficult and dangerous tasks for rescuers. The airboat unit would provide them with safety and significantly spurt reaching people in need of immediate help.

Summary and Conclusions

The performance analysis carried out at the Scientific and Research Centre for Fire Protection – National Research Institute (CNBOP-PIB) [4] have assessed both the advantages and disadvantages of the Mobile Evacuation Floating Platform prototype. The advantages of airboat include:

- boat transport on a dedicated trailer to a water tank,
- self-access to land and off-shore water,
- stabilization / balance on surface of water during maneuvers,
- predictable behavior, including waves formed on large water bodies,
- the ability to take and transport victims from water, ice and land,
- speed up to 80 km/h on water surface, the ability to reach and transport during rescue operations,
- the MEFP is suitable for use in the case of floods or other incidents where rapid evacuation of people and equipment is required.

The CNBOP-PIB comments on platform construction include [4]:

- big mass,
- useful on large backwaters only,
- generated propeller blast makes it impossible to use it in urban conditions,
- vague control,
- loud,
- slow "drive" on land requiring high power,
- insufficient loading area,
- no possibility to install floating pumps,
- small area of cargo and transport part,

- recommended installation of mechanical dray (the manual one requires 2 people to serve it),
- recommended loading platform modification for transport of flood protection equipment.

Platform builders refer to these comments as follows [5]:

1. The mass is due to the size and the way the platform is built. The size seems optimal in relation to the requirements of its transport. The length and width do not exceed the values required for admission to road traffic. The ease of transport of rescue equipment is very important. As for development, it will be adapted to the requirements and expectations of the ordering party. The current configuration of the platform is only a proposal for the hull. Multifunctionality of buildings (transport of goods, people and additional lockers) makes the construction of quite complicated, so the mass is quite significant.

   Various materials for platform hull construction were considered during the designing process in the project. Comparison of mechanical properties of two materials, i.e. carbon fiber composite and aluminum, was performed. Using the same thickness,the element made of carbon fiber showed 30% better stiffness, 50% less mass and 60% better resistant to mechanical damage than the element made of aluminum. One should keep in mind that the carbon fiber composite is having two times lesser density than the aluminum, and because of that, it is possible to reduce the weight of the construction just by changing one material into the other maintaining the same dimensions. The carbon fiber due to its lower density can be machined easily, but in case of hull of slider few issues were raised. It is difficult to use such materials due to complicated process of permanent elements joining with meeting water-proof requirement (element tightness). The standard epoxy composites are able to withstand the temperatures up to 70–100 °C. If temperature resistance should be higher than 100 °C, it is the common procedure to use the temperature hardened composites (based on carbon fibers), which allows to increase temperature resistance to 200 °C. For example, the Prepreg Gurit EP127 can withstand temperatures to 230 °C. Obtaining such high temperature resistance for various composites is possible, but one should remember that those are the expensive materials, that requires hardening in high

temperature furnace, as well as vast knowledge from vendors. There is clear correlation oft he thermal resistance and prices of discussed above composites. It makes them useless in hot areas of sliders. The biggest disadvantage of the carbon fiber – the epoxy composite is low resistance for the UV radiation, which creates a need for covering it with the additional reflecting lacquer but it can increase the costs of production.

2. The platform is dedicated to use in large areas because of its high velocity, but it can be moved at low speed and fairly precise control. This requires only operator training. The main advantage of the platform is the ease of transition from one environment to another (from water to ground, ice, swamp) and vice versa, which is difficult or even impossible for the amphibians. The ease of movement of the platform in the field is not dependent on the size of the water area.
3. Generated blast propeller does not prevent the use in the urban conditions. In the rescue mode this is the most possible and it only requires caution and skill.
4. Precise control is possible, it only requires skill acquired during the practice, as with any vehicle.
5. Large work noise results from the propeller features. When transporting the injured or evacuated during the flood, due to the short exposure time, the noise is not too burdensome. On the other hand, operators and crew for long periods of time recommend the use of hearing protectors.
6. Slow travel on land requires a lot of power, but land travel takes place only where is necessary, such as shortening of obstacles between flooded areas etc. This is usually done at higher speeds.
7. The size of the entire platform depends on the traffic rules. Relatively small loading surface is compensated by the mobility and speed.
8. There are no technical restrictions that prevent the installation of floating pumps. They were not provided for in a particular copy, but if you need it, it will be installed as you expect.
9. Mounting above the traps to pull out the platform and modifying the load platform to transport the flood control equipment are possible according to the expectations of the user.

The structure of the hull with its perpendicular to water surface transom, as well as propulsion system, prevents platform from moving backwards. Flat-bottomed boat with propeller propulsion system has to be equipped

with a motor of a great power, due to the character of its movement. It is a well-suited solution when the precision and swiftness of the decision making is required. However, there are situations in which the usage of primary propulsion is unneeded, e.g. case of patrolling shores of standing water tanks. Therefore, it is assumed that the auxiliary engine of a small power can be installed at the stern of a unit to take over propulsion system's functions. For such low speed, it is possible for the unit to move backwards. Using the main propulsion system for backwards movement seems unjustified and would be costly in the structural engineering means. Experienced and seasoned helmsman should be able to handle every encountered situation with such propulsion systems installed at the platform.

According to the authors of the study, the Mobile Evacuation Floating Platform has many advantages in terms of conducting rescue operations. In order to fully recognize the opportunities offered by airboat rescuers, further exercises (including night time) are planned in cooperation with the WOPR and the SGSP Medical Section. At this moment, there is a need to develop procedures for using an external automatic defibrillator on board. It is also necessary to verify the possibility of simultaneous operation of two medical units on a vessel.

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