Suggestions for improving the organization of underwater search and rescue operations in hard-to-reach areas

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Abstract. The inability of vehicles in some cases to deliver lifeguards and equipment to hard-to-reach places has contributed to the development of the idea of using horses in such situations. It would not be difficult for horses to overcome places considered difficult to access, and this work would be done in a much shorter time. In this case, divers would not have to engage in heavy physical labor to carry weights. The developed methods of horse training and rescue training were tested, which confirmed the research of specialists

1. Introduction

As practice shows, very often when conducting diving search and rescue operations, violations of the labor protection requirements for divers are admitted, especially in relation to the recreational regime of diving personnel during diving descents.

In accordance with the Intersectoral rules on labor protection during diving operations (POT R M 030 2007), before diving, the diver must have a good rest [1–4]:
1. Medical support for divers during diving
2. In the pre-dive period, the person providing medical support for the diving descent must:
   make sure that the working and resting regime of divers before descent meets the established requirements;
   make sure that the diver, who worked at the depth, rests according to the regime provided for by the Rules.
3. After diving, divers should also be provided with rest.

However, in the daily activities of the search and rescue units of the EMERCOM of Russia, these requirements of the Rules are extremely rarely observed. Very often, the Ministry of Emergency Situations automobile transport cannot deliver a diving group directly to the site of search and rescue operations due to impassability and the diving team has to move on foot, carrying heavy diving equipment manually over long distances.
As a result of such trips, divers have to go under water in a state of severe overwork, which significantly affects the safety of diving (Tables 1 and 2).

Table 1. Duration of full rest of divers before descent, depending on the planned depths, duration and severity of ground work

| Descend depth [m] | Medium-severity ground work (work under ice) | Heavy ground work |
|-------------------|---------------------------------------------|-------------------|
| up to 12          | 30–45                                       | 45–60             |
| 13–40             | 60                                          | 90                |

Notes: 1. Full rest of divers is considered to be their release from all types of work. During this period, only a medical examination, preparation and operational verification of equipment are allowed. 2. In addition, 1 hour before the start of a full rest, divers should be freed from heavy physical work.

Table 2. Duration of full rest of divers after descent, depending on the depth and severity of ground work

| Descend depth [m] | Medium-severity ground work (work under ice) | Heavy ground work |
|-------------------|---------------------------------------------|-------------------|
| up to 12          | 30–45                                       | 45–60             |
| 13–40             | 120                                         | 180               |

Note: After full rest, divers should be freed from heavy physical work by the end of the working day.

After descents and work, the divers also do not rest, but are engaged in the transfer of heavy diving equipment to the transport left in the distance, which can lead to various diving diseases [5–8]. In many cases, even a cross-country vehicle does not help. There is a growing need to search for alternative vehicles that can overcome any obstacles that arise along the route of the search-and-rescue group to the place of work. As a means of optimizing the conduct of search and rescue operations (SAR), one can use equestrian and cynological services organized in recent years in rescue centers of the Russian Ministry of Emergencies.

2. Methods and materials
2.1. Possible tactics for using a mobile equestrian diving group

Option 1. The use of horses without additional technical means of delivery

If the place of the upcoming SAR is located near the SAR unit, the rescuers can get to the place of work on horses without using an automobile. A complete diving group mounts on horses, loads necessary equipment and diving station, and moves out towards the SAR site.

After completing the work, the diving group also returns to the unit ahorse not exhausted by heavy physical activities. But this option is possible only if the SAR site is no more than 25 km away from the unit, because according to regulatory documents, a horse can make only up to 50 km per day.

Option 2. The use of horses with pre-delivery vehicles

If the SAR site is located far from the SAR unit, then first of all horses, divers and diving equipment must be delivered as close as possible to the site using existing roads.

Then, from the closest and most convenient point, the diving group, in full or in part (depending on the number of horses), mounts on the horses, loads the necessary equipment and diving station, and sets off to the SAR site.
In case of insufficient number of horses, the priority for riding is the diver, which will dive first (a working diver). The second horse should be used to transport diving equipment in order to exclude the heavy physical work of divers before descents. The rest of the rescuers (providing and insuring divers) continue walking light on foot without any heavy load in their hands.

2.2. Structure and composition of the mobile equestrian diving group
The structure and composition of the mobile equestrian diving group depend on the number of horses available and on the materials and equipment of the search and rescue group. Depending on these factors, the following options for organizing a mobile group are possible:

Option 1. 3 horses + 3 divers.

Figure 1. Use of horses without additional delivery vehicles

Figure 2. Use of horses with pre-delivery vehicles

Figure 3. Mobile group organization: 3 horses + 3 divers.
Each lifeguard-diver moves ahorse. Diving equipment is put in special pack bags also mounted on horseback.

Option 2. More than 3 horses + 3 divers + supporting rescuers.

![Figure 4. Organization of a mobile group: more than 3 horses + 3 divers + supporting rescuers](image)

If it is necessary to attract more people to the SAR, additional horses are involved for their transportation, if available.

If there are not enough horses, supporting rescuers can move on foot, because unlike divers, they do not need to observe a resting time rules.

![Figure 5. Mobile group organization: 3 horses + 3 divers + supporting rescuers](image)

Option 3. 2 horses + 3 divers.

![Figure 6. Mobile group organization: 2 horses + 3 divers](image)

If only 2 horses are available, then a working diver must be riding, who will be the first to descend into the water. The second highest priority for riding is the standby diver. As for the supporting diver, in any case he moves on foot, because he will have enough time to rest. If he will need to descend, this will happen only after a considerable time.

In the event that a large amount of hardware and heavy equipment is required for the SAR, then two divers (supporting and standby) should go on foot, while one horse is used only for transportation of equipment.

![Figure 7. Organization of a mobile group with a large amount of hardware and heavy equipment](image)

It is option 3 that will be used more often than others when the SAR site is very far the SAR unit. The reason is the limited capacity of the horse trailer. The trailer of B-class vehicles can only accommodate two horses.
Figure 8. Organization of a mobile group when using cars with trailers

However, when using two cars with trailers, it is possible to transport four horses. In this case, various options are possible for the composition of the mobile equestrian diving group. But this is only possible in those SAR teams where there is a sufficient number of trailers and cars.

Materials and equipment of mobile equestrian diving team

For more effective work of the group and its normal functioning in SAR units, in addition to horses, there should be the following supplies:

Packing (baggage) bags for transportation of diving equipment and other hardware necessary for work. In this situation, combined luggage saddles can be used.

Currently, there are many different modifications of packing bags and saddles (Figure 9). All of them are suitable for transporting heavy diving equipment.

Figure 9. Packing (baggage) bags for transportation of diving equipment and other hardware

In accordance with regulatory documents, a horse can carry up to 170 kg. One set of packs for one horse is enough to transport a diving station.

If a lifeguard is riding a horse, then the weight of equipment in the bags should be minimal so as not to overload the horse, especially when riding off-road and in dirt.

If the horse goes riderless and is used only for transporting hardware, then full load is allowed. However, the quality of the road should be taken into account.

The diving station consisting of three sets of diving equipment weighs about 140 kg, which is quite manageable for one horse, provided that the cargo is compact in the packing bags (Figure 10).

Figure 10. Horse transporting diving station

Special horse trailers.

Currently, there are many different trailers for transporting horses (Figure 11). As a rule, they are designed for towing by a car and can accommodate two horses.
3. Results
The first experiment to create a mobile equestrian diving group was carried out in the Vytegra Training and Rescue Center of the ENERCOM of Russia in August 2013.

Practice has shown that for the full and well-coordinated work of lifeguard divers with horses, it is necessary to carry out preliminary educational work on the preparation of divers and horses.

When practicing various exercises with divers and horses, the following problems were identified:

- horses are frightened of strangers and work only with familiar employees of the Center. The reason is the lack of preparedness of horses;
- horses are frightened by rescuers dressed in diving or other rescue equipment. The reason is the lack of preparedness of horses that are not accustomed to an unusual type of equipment;
- horses are afraid of water and do not want to swim. The reason is the lack of preparedness of horses that must be trained in water;
- horses allow to ride them only within the stable and arena; in other places it is very difficult to ride on them. The reason is the lack of preparedness of horses;
- the horses are scared of the noise of working equipment. The reason is the lack of preparedness of horses;
- rescuers do not know how to ride. The reason is the lack of preparedness of the rescuers;
- mounting on a horse in full diving equipment is difficult. The reason is the insufficient preparedness of rescue divers, however, after training this is not difficult.

In this regard, it is possible to determine the range of tasks that need to be addressed during the preparation of the mobile equestrian-diving group.

The main exercises for the preparation of a mobile equestrian-diving group:
1. Training horses to work with strangers (Figure 6). It is necessary to train horses' contact with different rescuers as often as possible.
2. Getting the horses used to various equipment, especially to people dressed in such unusual equipment. Horses should not be afraid of lifeguards in diving equipment.
3. Training horses for water. Training horses swimming with lifeguards. The horse must calmly overcome water, ground and relief obstacles.
4. Training rescuers to work with horses. Training rescuers to interact with the horse.

Such preparation is a whole range of activities:

a) horse care;

Before starting work with a horse, rescuers must learn to care for it. They get acquainted with animals, master the methods of handling horses and caring for them. At the end of the training, the rescuer must be able to quickly clean and prepare the horse for a saddle.

b) horse riding equipment;

Rescue divers familiarize themselves with horse equipment and the rules for its use. At the end of the training, the rescuer must be able to quickly and correctly saddle the horse. Including fastening the packing bags on it.
c) mounting on a horse and dismounting, the basics of proper riding;

Initial training is carried out on a wooden model of a horse. Divers learn to sit properly in the saddle and dismount from the horse. Also, the correct sitting in the saddle and the basics of managing the horse are being worked out.

The peculiarity is that the diver performs these actions fully equipped.

d) the basics of riding, principles and techniques of horse control;

Riding in the open riding arena, a specially prepared, enclosed rectangular area with soft ground, is used to teach how to ride in the saddle and how to correctly control a horse. After successful training in the arena, horseback riding is also possible in the field, where riders can learn to overcome slopes, climbs, force shallow rivers and other simple natural obstacles.

If in the search and rescue group there are inexperienced riders, then the movement at the rear is possible when the experienced rider rides first and leads the column. The remaining rescuers, inexperienced riders, follow him in the column. Horses usually follow the front horse. In this way, inexperienced lifeguards can be transported on horseback.

e) training of rescuers to work with horses in diving equipment.

Mounting on a horse in full diving equipment is very difficult without help. But for training, a lightweight and compact diving balloon with a capacity of 6-7 liters is used. Such a mounting is advisable if the diver intends to ride on a horse into the water and dive directly from the horse’s back.

The following exercises serve to train such actions.

f) working out entry into the water on horseback;

d) working out the diver’s entry into the water in equipment from the horse’s back.

In the course of practicing all of the above exercises, such elements as practicing mounting on a horse in various places, and not just in the riding arena, training horses to work in noisy conditions near working equipment, are worked out in parallel.

During the experiment in the Vytregra Training and Rescue Center of EMERCOM of Russia, all exercises and training for divers were conducted by Nadezhda Nikolaeva, master of physical education, trainer of horses and riders from St. Petersburg. She is one of the leading experts in this field in the Russian Federation.

She also identified the principles for selecting horses that are more suitable for these purposes:

The choice of horses suitable for search and rescue is determined by the following factors:

- work in hard-to-reach areas with changing terrain;
- climatic conditions;
- strangers, sounds;
- exercise stress;
- emotional stress.

The horse used for search and rescue must be friendly, oriented to the person, get along well with other animals. The predominant type of temperament is sanguine. Native breeds, such as the Mezen breed, were recognized as the most suitable breeds.

4. Conclusion

As a result of the research with the aim of using horses for diving search and rescue operations, the following main conclusions were drawn:

- the ability of the equestrian diving group to reach inaccessible SAR sites, due to the higher cross-country ability of horses compared vehicles;
- the ability to exclude violations of the Intersectoral rules on labor protection when conducting diving operations regarding the working regime and rest time rules for divers;
- the ability to move hardware and equipment over rough terrain;
- the ability to transport horses in special vehicles with divers over long distances in the presence of roads;
- increased efficiency of diving operations, the ability of a diver to enter water directly from the horse.
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