

## **AVALANCHE RESCUE OPERATION DEVICE IN AVALANCHE MOVING CONDITIONS**

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**Abstract:** *Encountering avalanche unprotected resulting in a high mortality rate - 60%. It was due to suffocation after being buried by snow mass. This mass shows complex mechanical properties. They make it too possible exits. If successful rescue operation took place about 10 minutes after encountering in the avalanche, the probability of survival was 97%. Using air bags provides rapid ascent to the surface of the avalanche and preserves the life and health of victims in 97% of cases of falling into an avalanche. This avalanche rescue device integrates four types of protection systems get stuck in the avalanche. If necessary, set enables long-term stay in the snow mass theoretically ensures survival at all probable situations.*

## **ЛАВИННО СПАСИТЕЛЕН КОМПЛЕКТ ПРИ ПОПАДАНЕ В ДВИЖЕЩА СЕ ЛАВИНА**

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**Ключови думи:** *Лавинно спасителен комплект, Попадане в движеща се лавина.*

**Резюме:** *Попадането в лавина без предпазни средства води до висока смъртност – 60%. Тя се дължи на задушаване след затрупване от снежна маса. Тази маса проявява сложни механични свойства. Те затрудняват изключително много евентуалното излизане на повърхността. Ако бъде проведена успешна спасителна операция до 10 минути след попадане в лавината, вероятността за оцеляване е 97%. Използването на въздушни раници осигурява бързо изплуване на повърхността на лавината и запазва живота и здравето на пострадалите в 97% от случаите на попадане в лавина. Настоящият лавинно спасителен комплект интегрира четири вида системи за защита при попадане в лавина. При необходимост комплектът позволява дълготрайно пребиваване в снежната маса, като теоретично осигурява оцеляване при всякакви възможни ситуации.*

## **Risk Management in Case of Natural Disasters, Transport Accidents and Industrial Crashes**

The modern practice develops risk management in case of natural disasters, transport accidents and industrial crashes [1, 2, 3, 4, 5, 6, 7].

**Avalanche Rescue Operation Device in Avalanche Moving Conditions.** In the high mountains often fall avalanches [1]. They pose a serious danger to skiers, snowboarders and sikers [1]. Fig. 1 shows the probability to be saved skier buried in an avalanche in function of time. On the Fig. 2 is shown the effect of Brazilian walnut - body with large volume and low weight when moving snow mass is pushed to the surface. Body small volume and the same size of the weight is buried snow mass. Fig. 3 shows stationary inflatable suit. In the Fig. 4 is shown skier equipped with avalanche rescue device to emerge surface movement of the avalanche and the skier without avalanche rescue kit remains buried under the snow (on figures from the Internet). Fig. 5 shows the principle scheme of avalanche rescue device. Avalanche rescue device presented in Fig. 5 and consists of:

- 1) A fixed aerodynamic part (Part 1) which is filled with air, oxygen-enriched. This part plays the role of stabilizer in skiing or snowboarding and provides additional confidence in the downhill at high speeds.
- 2) Detachable inflatable part that automatically fills with air from the bottle under pressure to reach avalanche.
- 3) Bag pack, in which folded type is mobile inflatable (Part 2) bottle with compressed air and has a camera storage of skier or snowboarder. The bottle is equipped with a fan, a battery and if necessary, can be used repeatedly.
- 4) System of straps through which the bag pack is attached firmly on the shoulders of the skier.
- 5) Helmet on which are mounted radio transmitting device and a breathing mask.
- 6) Transmitter device, equipped with an accelerometer antenna and GPS/GSM transceiver. The device carries out continuous radio contact with a mobile network operator in real time and at any given point in time GPS location on an electronic screen, hanging on the strap of the bag pack. In a predefined risk threshold acceleration of the movement of the skier or snowboarder, automatically launches mobile inflatable part of the system is filled with pressurized air from the bottle. Thus air bag pack acquire a total volume of over 250 liters (fixed and inflatable parts) and falling in avalanche provides retention on the surface of driving at a high speed snow mass. Even skier is not conscious, the transceiver includes a distress signal and immediately to the command center of rescue operations receive GPS location of the accident.
- 7) A flexible conduit connecting the mask 8) with a tank of oxygen-enriched air 1).
- 8) Mouthpiece breathing mask or air, stationary placed on the face of the skier. When you turn on the system through the pipeline automatically fed oxygen-enriched air, and if caught up in the avalanche skier has breathing for 30 minutes or more is made available oxygen, even in complete immobility of the body of the victim.
- 9) Trapezoidal spring handle for manual operation of the system.

**Avalanche rescue device** (air pack), consisting of stationary aerodynamic Part 1 (50 liters) filled with oxygen-enriched air; 3) bag packs containing a bottle of compressed air with automatic valve and balloons in skate type 2 (in exploded view with a volume of 200 liters) actuated automatically by the acceleration sensor (or manually by trapezoidal handle 9); regulator mouthpiece 8) (oxygen mask attached to the helmet 5) with line 7 connected with the stationary part 1 to provide breathing of the victim; harness 4 to carry a device; 5 helmets with built-in acceleration sensor, operable under certain conditions, the automatic valve and pumping balloons 2 and radio - transmitting device 6 - GSM/GPS (receiver-transmitter with antenna). In above paragraph the numbers with “) bracket” represent the different positions of the avalanche rescue device according to Fig. 5.

The proposed system provides the highest level of protection from getting an avalanche. Avalanche rescue device is able to preserve the life of the victim in the realization of high avalanche risk and long-term stay in the avalanche to the rescue.

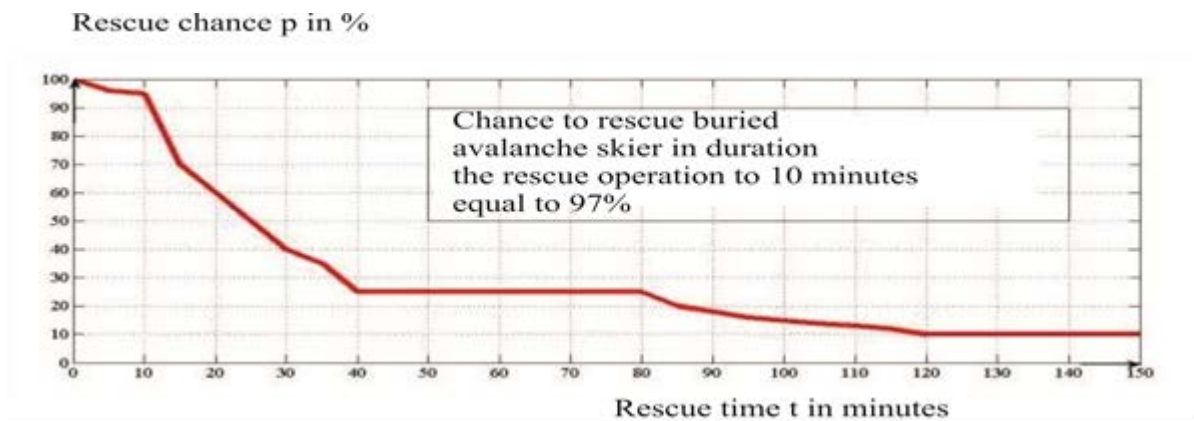


Fig. 1. Chance to rescue skier buried in an avalanche in function of time for rescue



Fig. 2. Effect of Brazilian walnut - body with large volume and low weight when moving snow mass is pushed to the surface - body with small volume and the same size of the weight is buried snow mass (in figures from the Internet).

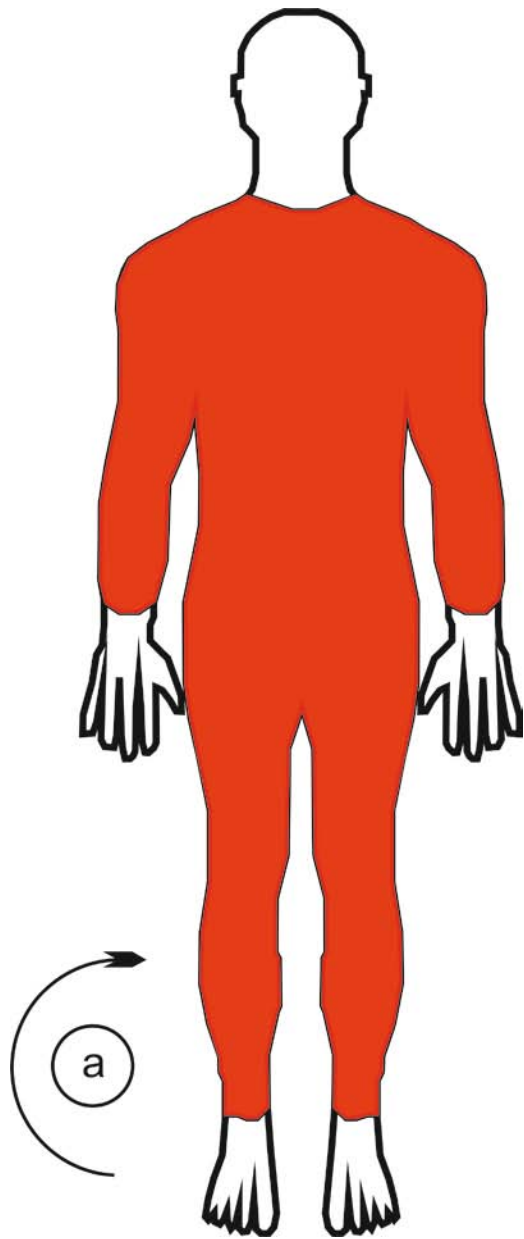


Fig. 3. Stationary inflatable suit – a).  
 Benefits: 1. Always in working condition  
 Disadvantages:  
 1. Material with a high density and elaborate workmanship,  
 2. Greater resistance,  
 3. Difficult movements,  
 4. Insufficient useful volume

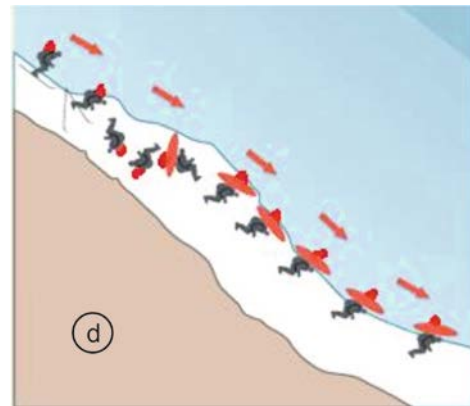
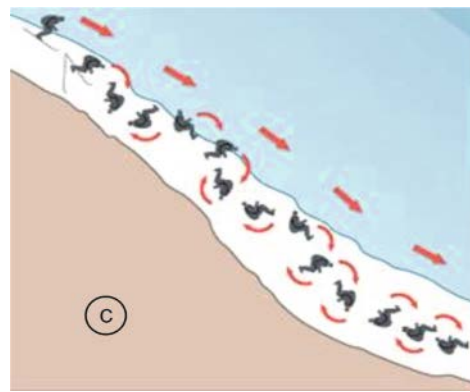


Fig. 4. Skier equipped with avalanche rescue device to emerge surface movement of the avalanche and the skier without avalanche rescue device remains buried under the snow:  
 a) swimming with avalanche rescue kit;  
 b) sinking without avalanche rescue kit;  
 c) sinking without avalanche rescue kit;  
 d) swimming with avalanche rescue kit.

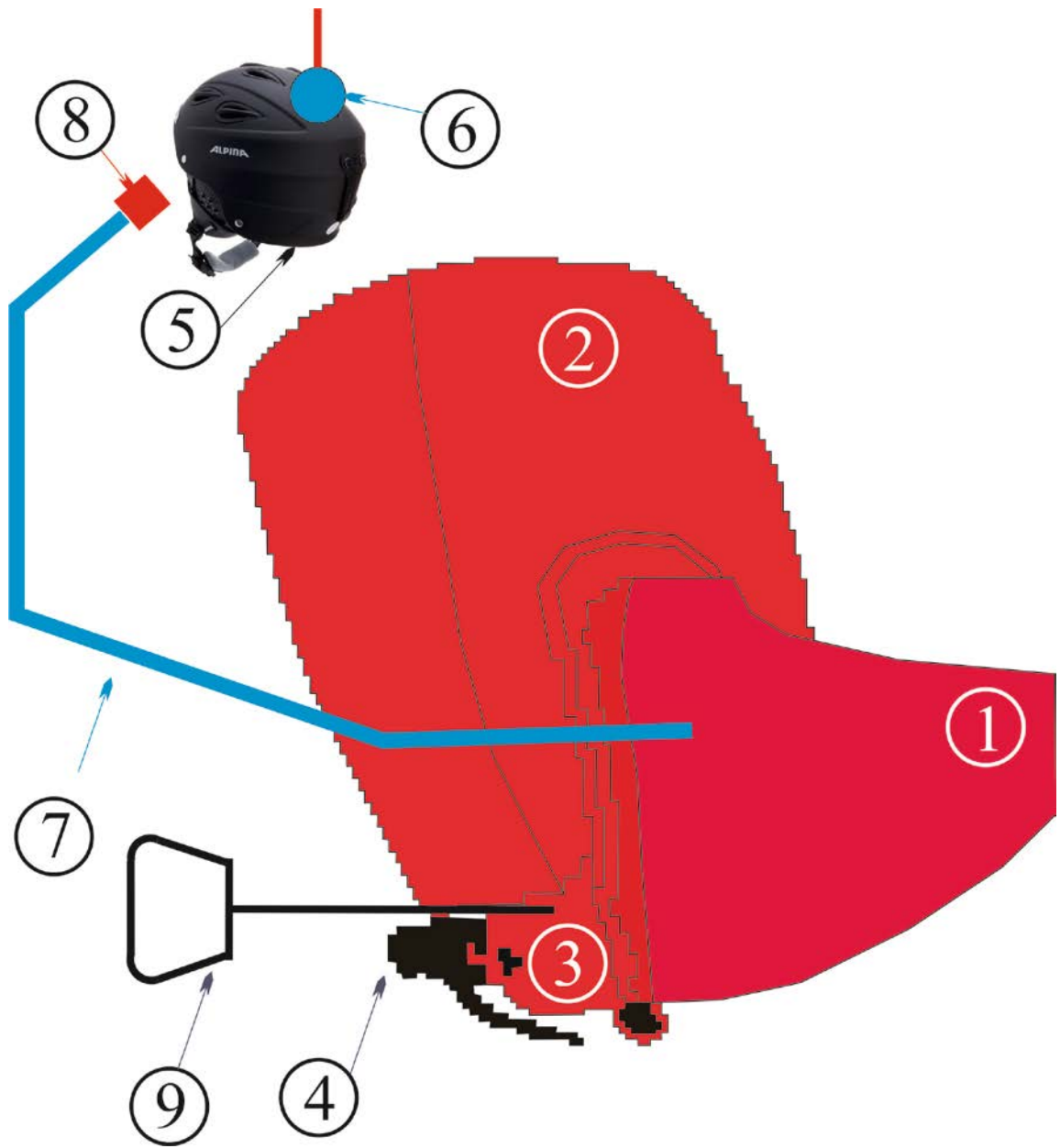


Fig. 5. Principle scheme of avalanche rescue device

**Conclusions.** The avalanche rescue device integrates four types of protection systems get stuck in the avalanche. If necessary, set enables long-term stay in the snow mass theoretically ensures survival at all probable situations.

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