MOVEMENT OF RESCUERS IN SNOWY REGIONS

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Abstract. Rescue operations in snowy and icy environments require well-developed movement techniques, specialized equipment, and strict adherence to safety measures. Deep snow, icy surfaces, variable ice thickness, and low temperatures significantly complicate the movement of rescue personnel and increase physical load and operational risks. The effectiveness of search-and-rescue missions largely depends on the correct selection of movement methods, equipment, and transport means adapted to specific terrain and climatic conditions. This article analyzes the main methods of rescuers' movement in snowy areas, including walking, the use of snowshoes, skis, sleds, snowmobiles, and all-terrain vehicles. Particular attention is paid to safe movement on icy surfaces, assessment of ice strength and thickness, group movement rules, and the use of anti-slip equipment and alpine gear. The paper also examines hazards associated with snow-covered ice, ice hummocks, spring thaw conditions, wetlands, and moving sea ice.

The presented material emphasizes practical safety recommendations and technical solutions aimed at reducing physical fatigue, preventing accidents, and ensuring the safety and efficiency of rescuers during search-and-rescue operations in winter conditions.

Keywords: rescue operations, snowy terrain, ice safety, movement techniques, snowshoes, skis, ice thickness, winter rescue, all-terrain vehicles, search and rescue safety

Introduction. Rescue operations in snowy and icy environments present complex challenges that require specialized knowledge, equipment, and physical endurance. Deep snow, icy surfaces, low temperatures, and difficult terrain significantly affect the mobility, safety, and effectiveness of rescue personnel. In such conditions, the ability of rescuers to move efficiently across snow and ice while minimizing physical fatigue and operational risks is a critical factor in the success of search-and-rescue missions.

Snow cover depth, structure, and terrain characteristics directly influence movement speed and energy expenditure. Walking in deep or unstable snow requires considerable physical effort and often leads to rapid fatigue, necessitating frequent rotation of rescuers. To improve mobility and reduce energy loss, various means of transportation and movement techniques are employed, including snowshoes, skis, sleds, snowmobiles, and all-terrain vehicles. Each method has specific advantages depending on terrain conditions, slope gradients, and snow density.

Icy surfaces introduce additional hazards due to reduced friction and varying ice strength. The safety of movement on ice depends on factors such as ice thickness, water flow, temperature, and environmental conditions. Therefore, rescuers must strictly follow safety measures and use specialized equipment such as crampons, ice axes, anti-slip devices, and protective techniques to prevent falls and accidents.

This article examines the main methods and technical means used by rescuers for movement in snowy and icy environments, outlines the principles of safe navigation on snow and ice, and highlights the importance of selecting appropriate equipment and techniques to ensure operational efficiency and personnel safety during rescue and search operations.

Main Part. Rescuers can move across snow on foot using snowshoes, skis, sleds, snowmobiles, and all-terrain vehicles. One of the most common methods is movement on foot. Its speed depends on the depth and structure of the snow cover and the characteristics of the terrain. Snow cover with a depth of 0.3 m or more significantly complicates movement. This is due to the specific nature of walking in newly fallen or compacted snow, which requires selecting a particularly firm path. All these factors demand considerable physical effort and lead to rapid fatigue. Therefore, when moving through deep snow, it is often necessary to rotate the lead rescuer.

To prevent snow from entering footwear, trousers should be worn over boots and secured at the lower part. Special devices such as snowshoes help increase the speed of movement in snow and reduce energy consumption. Snowshoes consist of an oval frame made of 7 mm thick hardwood, with a length of 420 mm and a width of 200 mm. The frame has 8–9 holes with a diameter of 20–25 mm, through which it is laced with rawhide straps. A net formed in this way is fitted with a canvas or thick fabric measuring 80 × 270 mm and equipped with loops for fastening the snowshoe to the footwear.

In some cases, a snow–ice crust forms on the snow surface. It is characterized by high strength and a very low friction coefficient. Movement under such conditions requires strict adherence to safety measures and the use of special equipment such as crampons, tricones, and braking devices. In these conditions, the use of alpine gear, ice axes, and anti-slip footwear accessories is necessary. In dense snow, a path can be cut using the pick of an ice axe, the toe, or the heel.

When descending a snowy slope, the rescuer should turn onto their stomach, spread their legs, place the toes against the slope, and slow down the movement. In some cases, rescuers move through snow to search-and-rescue operation sites using skis. In difficult terrain, walking skis can be used, as they have a large supporting surface and slightly increase the width of the foot and heel. They allow easier movement through deep snow on flat terrain, are easy to control, and enable movement among numerous obstacles such as trees, shrubs, and rocks.

For movement on mountain terrain, cross-country skis are used, while mountain-type “skittles” skis are applied in alpine conditions. The length of cross-country skis is selected so that, when standing upright, the rescuer can reach the top of the ski with the fingers of an outstretched arm.

Weight distribution on skis should ensure smooth movement across the snow over the entire contact surface and along the full length of the ski. Rigid and semi-rigid bindings are used on skis. Ski poles should be 3–5 cm shorter than the rescuer’s shoulder joint height.

For long and steep ascents, it is recommended to use climbing skins made of animal hide to prevent skis from sliding backward on slopes, or to wrap skis with rope. On flat terrain, movement is performed using a two-step skiing technique. On gentle slopes, hard surfaces, and even ski tracks with good glide, step-less or one- or two-step techniques are applied.

Ascending slopes is performed using step-by-step, half-step, herringbone, or ladder techniques, while descending is carried out using basic or low stance methods. Braking is performed using stopping techniques, and in some cases, controlled falling is used to stop. For this purpose, the rescuer should crouch as low as possible and fall to the side.

Snowmobiles, all-terrain vehicles, ski tracks, and “Akya” type rescue sleds are used for reconnaissance, searching for casualties, transporting them, and delivering rescuers and equipment to the operation site.

At air temperatures of 0°C and below, water transitions from a liquid to a solid state (crystallizes), forming ice. The thickness and strength of ice on water bodies depend on water flow velocity, composition, and the presence of aquatic vegetation. Even ice forms on smooth, wind-protected water surfaces. When large ice masses collide, fragmented ice unsuitable for movement is formed between them.

Ice thickness varies significantly, especially in fast-flowing water, near shores, shallows, rapids, rocks, river confluences, river bends, and near frozen objects. Ice covered with snow or snowdrifts is considered particularly dangerous.

Movement of rescuers on ice requires enhanced safety measures. Ice thickness of 10 cm in freshwater and 15 cm in saltwater is considered safe for one person. Ice thickness must be determined by drilling or cutting.

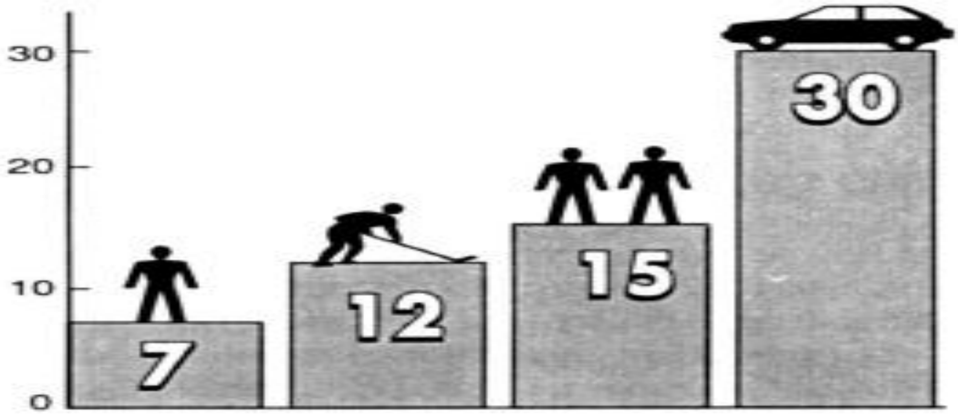

Figure 1. Minimum permissible ice thickness

The reliability of ice is checked by allowing a single rescuer to cross it; for safety reasons, the rescuer must be secured with a rope. If the ice produces characteristic cracking sounds while moving across it, walking on it is not permitted. If the ice breaks, heavy objects should be released, the rescuer should get onto the ice surface by lying on the stomach, use a pole, skis, or ski poles for support, and carefully crawl toward the shore.

Special caution is required when moving on ice covered with snow or water. When jumping from one ice layer to another, the support points should be no closer than 50 cm from the edge of the ice.

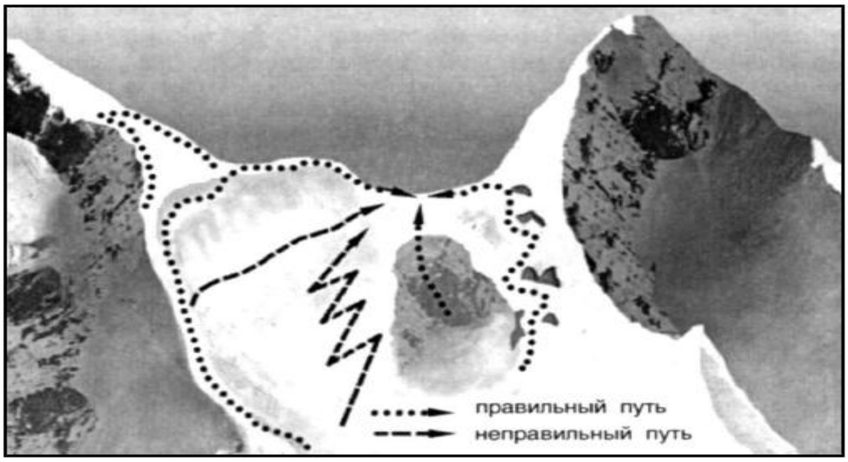

Figure 2. Safe movement methods in areas hazardous due to snow drifts

It is not recommended for several people to gather in one place on the ice or to store loads at a single point. The safe distance between rescuers moving on ice should be at least 5 m or more.

During winter, it is possible to move vehicles and transport loads across ice. The safe ice thickness required depends on the weight of the load and the vehicle and is presented in the table.

When moving across ice hummocks, steps should be taken only on solid ice blocks.

Safe Ice Thickness and Load Capacity

Ice thickness, cm	Vehicle / load weight, t	Safe distance from ice edge, m
	Sea water	Fresh water
15	0.1	5
25	0.8	10
30	3.0	20
45	6.5	23
50	10.0	26
70	20.0	30
100	40.0	40

Snow bridges formed between the peaks of ice hummocks are generally unsuitable for movement due to their fragility.

During the spring thaw, the ice surface becomes uneven and irregular. The ice turns porous and weak, often becomes covered with meltwater, and after the water drains, the ice surface dries, whitens, and softens. When temperatures drop, the meltwater may refreeze, forming a thin layer over the main, wet, and weakened ice. Movement on such ice is strictly prohibited.

Rescuers must consider that ice on seas, oceans, and lakes is constantly moving and shifting. This dynamic behavior should be taken into account when selecting routes and, in some cases, during area reconnaissance. Open water areas often form within ice fields and should be crossed using boats.

Rescuers should move on ice wearing footwear with anti-slip soles or using specialized anti-slip devices. If meltwater appears on the ice surface, insulated rubber-soled footwear is recommended.

Ice cover in wetlands is particularly hazardous. Thin ice “windows” often remain on the surface and can break under a person’s weight. Marshes covered with vegetation, trees, or shrubs freeze poorly. Snow-covered marshes freeze unevenly, with central areas generally freezing more reliably than the edges. Marshes with a thick snow layer are especially dangerous because the water beneath freezes slowly and unevenly.

Conclusion. Movement of rescuers in snowy and icy environments presents significant challenges due to deep snow, ice variability, unstable terrain, and extreme temperatures. The use of specialized equipment such as snowshoes, skis, sleds, ice axes, crampons, and all-terrain vehicles is essential to enhance mobility, reduce physical fatigue, and ensure operational safety.

Understanding the characteristics of snow cover, ice thickness, and underlying terrain is critical for selecting safe routes and appropriate techniques. Spring thaw, snow-covered wetlands, and ice hummocks introduce additional hazards that require careful assessment, adherence to safety protocols, and the use of anti-slip footwear or devices.

Safe operation in these environments depends on maintaining proper distances between rescuers, verifying ice reliability, and using protective measures when crossing fragile or partially melted ice. By combining technical knowledge, appropriate equipment, and systematic safety practices, rescuers can effectively conduct search-and-rescue operations in extreme winter conditions while minimizing risks to personnel and victims.

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