

# Safety of polyspasts as rescue lifting devices

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**Abstract.** Construction accounts for 31.9% of economic activity in terms of the number of accidents as a result of falls from a height. PPE against falls from a height is one of the tools to ensure the safety of work at height. One of the important aspects of safety during a fall from a height is a well-designed rescue and evacuation plan, which involves safe and parametrically oriented components of the rescue system. The study examined the process of certification testing of polyspast. The analysis of the certification of the polyspast using the requirements and methods of EN 1496-2020 (standard of the Eurasian Economic Union) is carried out, the requirements for the polyspast are defined in accordance with its functional purpose, as one of the components of the life-saving system of personal protective equipment against falls from a height. As part of the study, a comprehensive analysis of the problem of product safety was carried out. To date, the certification of polyspasts does not ensure the safety and quality of products on the territory of the EEU Customs Union. The authors have proposed possible solutions to this problem.

**Key words:** labor protection, PPE against falls from a height, work at height, polyspasts

## 1. Introduction

According to the Ministry of Labor and Social Protection of the Russian Federation annually, for the period from 2018 to 2022, in organizations out of the total number of accidents with severe consequences, the share of accidents as a result of falls from a height [1]. The share of construction in the context of economic activity in terms of the number of accidents as a result of falls from a height is 31.9%.

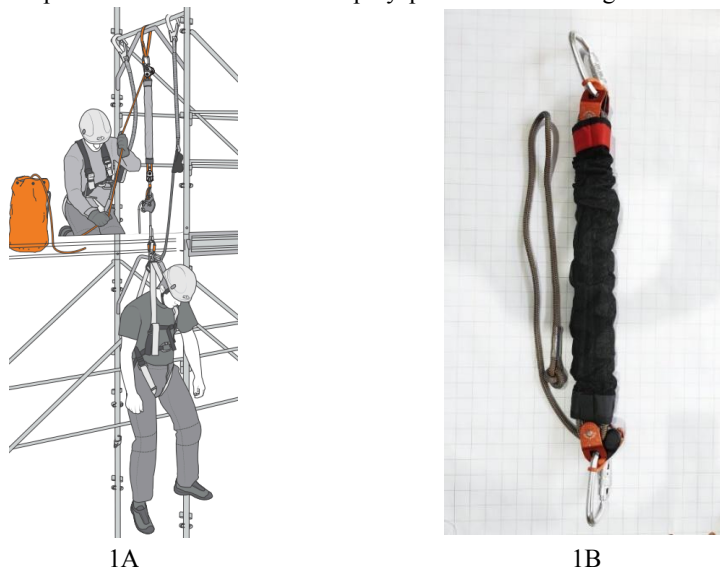
Certification of personal protective equipment (PPE) against falls from a height is the most important stage of product safety and quality control [2]. PPE against falls from a height, with proper operation, should work in 100% of cases and minimize injury to the user. However, even compliance with all operating rules, high qualification of the employee in this matter, periodic inspections of products cannot ensure the absence of injuries. It is always important to take into account the human factor, which can work completely unpredictable, and a person who has passed all the briefings may fall from a height. If a person falls, they may get bruises, fractures or even a concussion, while remaining alive. While in a suspended position, the user may experience various problematic conditions. The most dangerous for the victim is a violation of proper blood circulation, which leads to loss of consciousness, oxygen starvation of the brain, and in some cases even death [3-5].

In order to avoid injury to the suspended state, it is necessary to quickly remove the victim from this position. According to the regulations of regulatory documents, there are 10 minutes to rescue the victim [6]. Due to the above problems, the rescue system is distinguished

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in the classification of PPE against falls from a height [7]. One of the components of such a system is a polyspast [8]. An example of rescuing a victim using a polyspast is shown in Fig.1A. The product itself in the form of a polyspast is shown in Fig.1B



**Figure1.** 1A – An example of rescuing a victim using a system containing a polyspast. 1B – a component of the safety system - polyspast

The aim of this work is to increase safety during rescue and evacuation measures of the victim, who is in a suspended state after falling into a PPE against a falls from a height.

The tasks that were set within the framework of this work:

1. Consider the process of product certification for compliance with technical regulations Customs Union Technical Regulations 019/2011;
2. To analyze the correctness of the certification of the polyspast using EN 1496-2020 (the standard of the EEU);
3. Determine the necessary requirements for the polyspast;
4. To carry out a summary comprehensive analysis of the problem and make a final conclusion with recommendations for improving the certification process of polyspasts.

## 2. Analysis

In EU, a polyspast is considered as a set of products – a pulley, a climbing clamp, a low stretch kernmantel ropes or a dynamic rope, connecting elements, etc. In this case, a polyspast is considered as a system. Polyspast in the countries of the Customs Union of the EEU is considered as a means of personal protection against falling from a height and is certified as a rescue lifting device with an additional function of lowering a person manually.

When tested according to EN 1496-2020 (the standard of the EEU), problems are detected during the verification of the dynamic performance of the rescue lifting device [9 – 11]. During the preparation for the test, it is necessary to pull the rope by 4000 mm and attach a load with test weight A at the end of the rope including a measuring device for measuring the braking force. However, when conducting a polyspast test, the following contradictory aspects of the experiment arise:

- The polyspasts have different lengths and structures, in many cases it will not be possible to extend the polyspast by 4000 mm;

- There is no single solution how to achieve a length of 4000 mm: to pull out the free end of the rope or the entire length of the product should be 4000 mm, since structurally, when pulling a low stretch kernmantel ropes, the length of the product itself decreases.

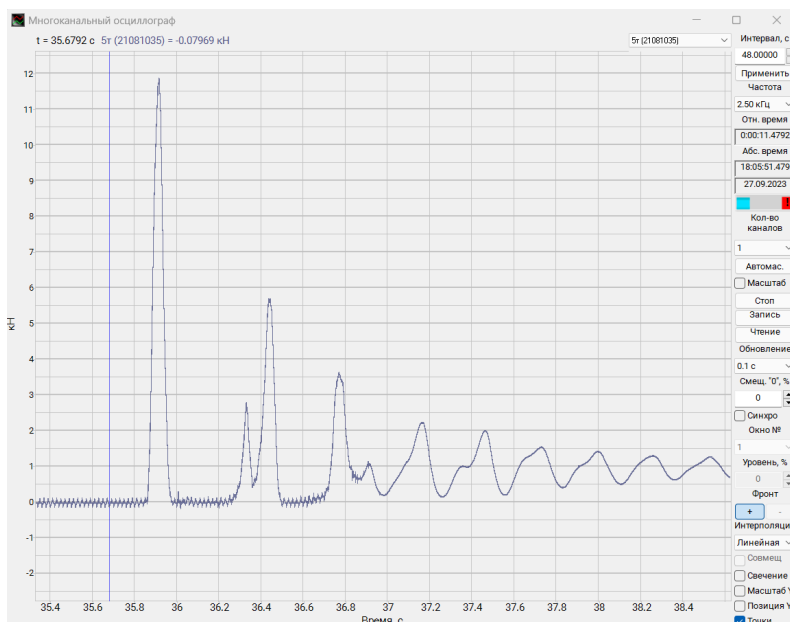
Thus, during the dynamic test, the fall factor increases, and, consequently, the load on the product, which can negatively affect the objectivity of the indicators.

Often, a polypast is a device with a manual lowering function, with the ability to control its speed, which defines a polypast as a rescue lifting device with an additional function of lowering a person by manual control of class B. This creates an additional requirement for the dynamic performance of  $F_{max}$  in the values of 6 kN when tested with a test mass equivalent to the maximum design load, but not less than 100 kg. To demonstrate this problem, static strength and dynamic performances were tested when a test load weighing 100 kg fell. To evaluate the results within the framework of the tests, the criterion of the value of the maximum braking force was used – checking the impact of the created loads on a person..

**Table 1.** Checking the static strength and dynamic performance of the polypast according to EN 1496-2020 (the standard of the EEU)

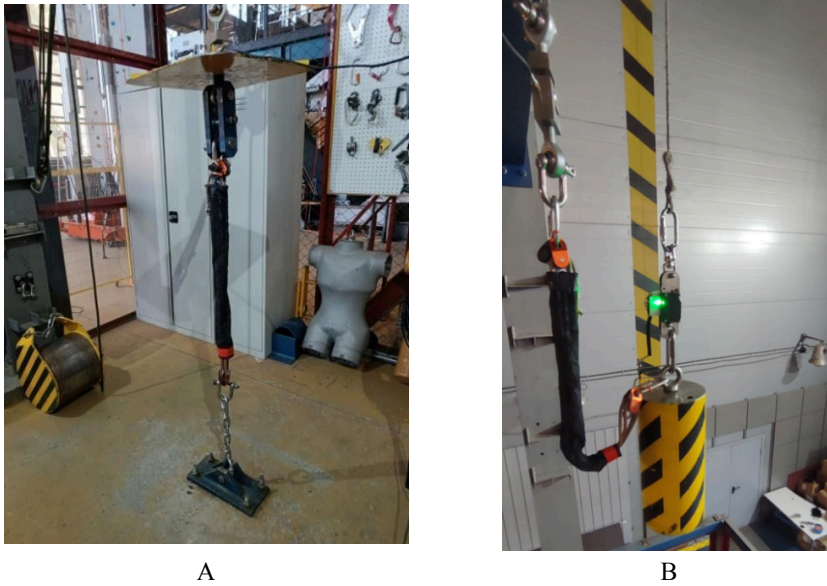
№	Point of technical requirements	Values of the load
1	4.6 Static load strength	$F = 12,3 \text{ кН}$ (for a 3 minutes)
2	4.5 Dynamic performance characteristics and purpose of a rescue lifting device (class B)	$F_{max} = 11,9 \text{ кН}$ – peak load

Thus, we see that the polypast does not meet the requirements of EN 1496-2020 (the standard of the EEU), during the certification process, an objectively high-quality device, with all its advantages for conducting rescue operations, will not be able to go through all the stages and enter the market, since the requirements of the standard are inappropriate for further application. Figure 2 shows a graph of the dynamic performance during testing in accordance with the requirements set out in Table 1..



**Figure2.** A graph of the change in braking force during the dynamic performance test

Polyspast is a tool for rescuing and evacuating the victim, who is always in a loaded state without sagging, which minimizes the risk of falling from a height. The dynamic characteristic in this case does not play an important role and creates additional difficulties during testing.



**Figure3.** The initial position of the product when tested according to the technical requirements set out in Table 1. A - The position of the polyspast during the static strength test; B - The position of the polyspast during the dynamic performance test

Since a polyspast is a device that reduces the effort expended, it is also necessary to take this characteristic into account for the predictability of efforts to work with it. It is desirable that the parameter of reducing the effort expended be taken into account in various states of the product, for example, at subzero temperatures, at high humidity or after exposure to a corrosive mist [12]. The theoretical effort always differs from the actual one, for example, for the tested polyspast, the multiplicity, according to data from the manufacturer, will be 4:1, this means that theoretically, in order to lift a load weighing 100 kg, it is necessary to apply an effort of 245.2 N, or to hang a load weighing 25 kg on the free end of the lanyard. However, in practice, due to friction, the actual effort may be 10-50% higher than the theoretical one.

### 3. Results and Discussion

Loads obtained during the dynamic performance test according to Class B EN 1496-2020 (the standard of the EEU) they are located beyond the zone of safe values for humans, on the other hand, with proper use and functional purpose in this type of product, the presence of good energy-absorbing properties that would extinguish the resulting kinetic energy of the fall is not required. The task of the device is to unload either the victim's trigger device or a lanyard with an energy absorber in order to either attach it to the lifeguard's trigger/lifting system, or to another one prepared for this. At the same time, it is important to add that dynamic strength tests are necessary because in the event of any incidents, the device may be subjected to dynamic influences. A separate characteristic that must be taken into account within the framework of this product is the reduction of effort expended under various climatic and

atmospheric factors. PPE related to rescue systems should not fail under any circumstances, the time of rescue operations and the life of the injured person depend on it.

#### 4. Conclusion

To date, the polyspast is certified as an anchor device or lanyard, which is completely inconsistent with its functional purpose and this does not allow you to check its safety and reliability during certification. Due to the fact that the device falls under class B EN 1496-2020 (standard of the EEU), it is subject to dynamic performance requirements. The first problem is that the design of the product does not allow the correct implementation of the test method, since it is based on working with devices such as winches. The second problem is that during testing, the peak force value is almost twice the maximum allowable 6.0 kN.

At the same time, the technical requirements do not take into account important parameters of the functional purpose of the polyspast. Such technical requirements should include reducing the effort when working in various climatic conditions, dynamic strength. At the same time, the dynamic characteristic is not necessary for products of this class, due to the fact that it is not designed to quench kinetic energy. If the manufacturer declares these functions for the product, as part of the parametric approach to standardization, it certainly needs to be checked for compliance with the requirements of dynamic characteristics. As a separate aspect, we would like to emphasize that all the elements of the policy must be checked in accordance with relevant regulatory documents: on low stretch kernmantel ropes, rollers, rope adjustment devices and connectors. It is necessary to allocate a third class of products within the framework of the EEU standard, which will relate to polyspast systems with the minimum set of functionally oriented technical requirements proposed in article.

The team of authors does not recommend prescribing the possibility of controlled descent in the operational documentation for the polyspast. The device objectively does not allow controlled descent. Additionally, it can be highlighted that the characteristic of reducing the effort expended is not included in the verification of technical requirements, the user does not know what force is necessary for controlled operation of the product on descent.

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