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Improvement of The Safety Systems for Working at Heights on Transmission Towers

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Abstract. The problem of workplace injuries connected with risk of falling from height is considered in this article. We have analyzed the variety of safety systems for working at heights on transmission towers, particularly the techniques of ascent, descent and horizontal movement on such constructions necessary for realization of operational tasks using flexible and rigid anchor lines, ladders and other support designs according rope access technologies. Variations of rescue and evacuation operations when working at height have been considered taking into account the above listed technologies. The analysis of various systems has revealed a number of functional disadvantages of such systems. On the basis of revealed defects of the functional features it have been offered the universal safe work procedures for work activity on transmission towers, and it have been considered the conceptual solutions of safety systems applicable for works at heights, and ways of its implementation. It is shown that introducing of anchorage and lifelines for construction and reconstruction works on transmission towers allows ensuring safety works at height in accordance with state standards and legal acts.

Key words: working at height, personal protective equipment, anchorage, flexible and rigid anchor lines, rope access, obligatory certification, inspection of PPE, labour protection.

Introduction

According to the Ministry of Labour and Social Protection of the Russian Federation, occupational injuries with lethal consequences during working at heightare top in the list [1-3].This is evidenced by the reports on the results of 2012, 2013 and 2014.These reports also show that 75% of all accidents occur due to organizational reasons and the “human factor”. These include the lack of timely or proper training of personnel, misuse of protective equipment, improper management of production tasks, excessiveworking hours, etc.Conditionally, all these reasons can be divided into two types:

- training and advanced training of personnel in the skills and techniques of safe work at height;
- improving technical equipment for protection against falling from height.

Safe working at height in the Russian Federation is regulated by the Rules of Labour Protection when working at height [4], which include the procedure for implementation of safety measures, types of works at height, technical equipment depending on the type of work, and levels of responsibility acc. to the documents.

Protective equipment is regulated in several normative documents, depending on the type of such equipment. There are two types of protection against falling from height:

- common protection equipment against falling from height (CPE FH);
- personal protection equipment against falling from height (PPE FH).

CPE is more preferable for a number of parameters, but it is more costly, and therefore not always suitable.CPE FHincludestemporary fences, protection-and-catching nets, signal fences, etc. Requirements for each group of such elements are written in the corresponding GOSTs, and their certification is not mandatory. This also complicates obtaining a safe product.

PPE isused more often and this is a more extensive class of elements, the requirements for which are mentioned in the Technical Regulations of the Customs Union 019/2011 (TR CU 019) [5].Unlike CPE, all PPE must undergo obligatory certification, after which the products are marked with EAC sign.

Maintenance of power linesincludes periodic working at height. Using CPE there is inadvisable due to low frequency of maintenance and complexity of providing this type of protection.Using PPE during operation is a priority and is justified, but requires certain skills and knowledge from employees.

Working on the power lines supports, regardless of their design, assumes being in a supportspace or in a partially support space. In such a case, safe staying on the support requires an additional unloaded safety line, which is used only in emergency. Therefore, there are three ways to arrange safe climbing and work on the support using PPE FH:

- remote safety line for the safety system [6] and subsequent climbinga structure or an open ladder with the upper safety equipment (Fig. 1, a);
- climbing a structure or an open ladder with the lower safety equipment for the safety system (Fig.1, b);
- climbing a structure or an open ladder with the alternatingsafety equipment with the help of a connecting-amortizing subsystem (Fig.1, c).

After climbing to the workplace by any of the methods, for convenient, comfortable and safe performance of yourtask, it is necessary to fix your position on the structure.For these, a special hugging slingis used with anti-abrasion protection and with a length regulator [7-9].

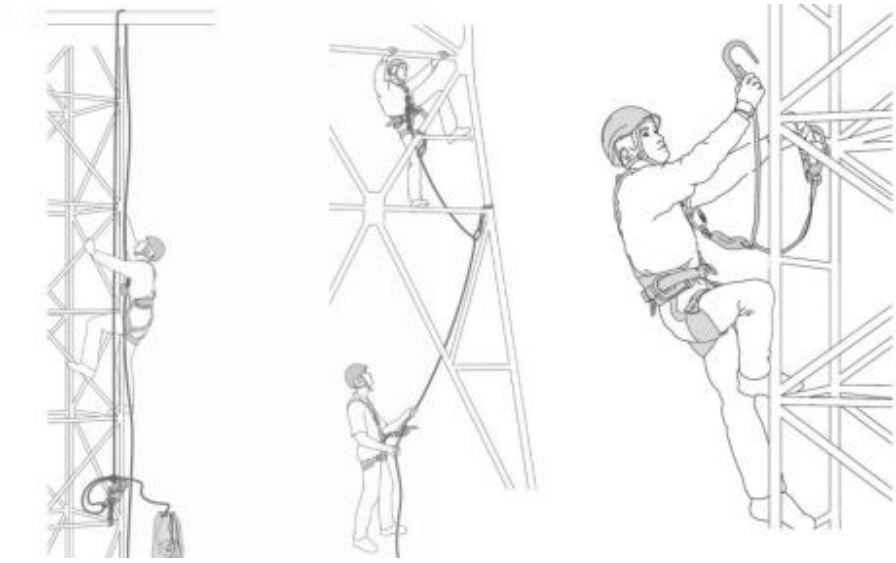
Each of the climbing methods has its advantages and disadvantages, and this should be taken into account when organizing work and drawing up Work Implementation Plans (WIP).

The purpose of this paper is to improve safety of working at height by using up-to-date systems and methods of accessing the workspace.

Methods. Analytical part

When analyzing these systems for ensuring safety of working at height on the power line supports, we will highlight their strengths and weaknesses in terms of an integrated approach.

Let’s consider the system of organization of work with the help of a remote safety system (Fig. 1, a). Such systems are the safest solution for providing work. In this case, rescue operations in the event of an emergency will be the quickest. This method is suitable for situations where the team of workers does not have strong qualified personnel in the field of contact rescue operations. It is also suitable in cases when accessing a victim may take a long time, and there is a risk of the suspended state injury [10-16]. The negative side of this method is resource intensity by the time of arrangement and by the quantity of equipment. When developing measures for arranging work, it is also necessary to take into account qualification of personnel and ability to implement such remote methods.



a. b. c.

Figure 1. Safe climbing a power line support using PPE FH.

Climbinga structure with lower safety equipment (Fig. 1, b) is climbing of a worker with a lower tether rope, which is fastened through temporary anchor points with a falling factor of maximum 1 [4, 17, 18], while the second worker provides safety.A positive aspect of this method of movement is relatively small amount of equipment involved, compared to the remote safety system.If this system is designed correctly, rescue work can be as fast as in case of the remote system, but an important issue is the fall and the correct location of the anchorage attachment points through which the safety rope passes.A negative aspect is complexity of arranging such climbing in terms of safety, because in reality, workers oftenneglect requirements of the falling factor to climb faster, which increases risk in case of an emergency. Also, everything is complicated by the need to find a suitable place for making temporary anchor points.Subsequent dismantling of such intermediate temporary anchor points is an integral part of this method.

Results and Discussion

When arranging safe operations by means of alternatingsafety equipment on power line supports (Fig. 1, c), it is necessary to take into account the possible danger of an emergency occurrence and a way out of this situation,since this climbing method requires much more time for rescue operations, than in cases mentioned above. Also, this method is dangerous when moving at low heights or over protruding structural elements due to peculiarities of operation of the safety equipment. Another negative aspect of this method is that, in reality, people neglect requirement of the falling factor to make the work on the support faster. Among positive aspects of this method are low cost of such a working kit, small dimensions of the kit and the possibility of independent movement of each worker.

There is a key problem in all three systems of safe work at height.With any method, you need to use an anchor point to fix the safety line. When working on power line supports, an anchor point is a structural anchor, with which the entire safety system then interacts.

Now anchor points that personnel have to work with, are not stipulated in the legislation. Meaning, now any structure element may be an anchor point.However, normative documents of the Russian Federation have strength requirements of 22 kN [4] for such points, and GOST [19] takes into account

also dynamic strength in technical requirements. But in spite of this, a worker chooses a fixing point on the structure to ensure his safety at height by himself.

Some designs of supports of high-voltage power lines provide for operational ladders (Fig. 2). They greatly simplify the process of climbing to the workplace, but not always this process can be considered safe. Such ladders are considered safe, if they have a continuous length of vertical climbing not exceeding 5 meters with the enclosing protection along the whole ladder [4].But since high-voltage power line supports have a height of several tens of meters, such ladders should be separated by rest platforms with barriers protecting from falling out (Fig.2, a).Only in this case, climbing a support on the ladder can be safe and does not require additional PPE during climbing.In reality, this solution is implemented on individual supports.

In Fig. 2,a, an operational ladder has fenced rest platforms, but does not have a guarding contour on the ladder itself. Climbing in this case can be safe only if there is a safety system.

One-pole open ladders are much more common (Fig.2, b).Such ladders are usually attached to one or two legs on lattice-type supports and do not have a guarding contour. Climbing on these ladders must involve using PPE FH.

As a rule, when climbing a ladder using PPE, a method of climbing with alternate support by each worker is used. At that, a step itself or a pole of the steps acts as an anchor point. After analyzing requirements of normative documents to vertical ladders and their elements [20-23], we can conclude that no element of a ladder can act as an anchor point able to withstand 22 kN. This means that climbing using alternatingsafety support against ladder elements is not safe and does not satisfy requirements of normative documents in the field of working at height [4].

a. b.

Figure 2. Some designs of operational ladders on power line supports.

The most optimal solution in terms of comfort, climbing speed and safety for a worker is installation of special ladders with a rail integrated into the rack, along which a safety clamp moves on (Fig. 3).This tool refers to PPE, but it is permanently mounted and can be used by several users, if it is stipulated by the manufacturer's instruction. But along with obvious advantages of this solution,there is an important disadvantage: rescue operations, if an emergency situation occurs with the upperworker and heis unconsciously hanging on the safety clamp. In this case, the time of rescue will be approximately between the rescue time with the remote method of providing safety and the rescue time when climbing with alternating safety support.This must be taken into account when planning work, and one should have a rescue kit for coming down.

Figure 3. An example of a rigid anchor line along climbingon unfenced ladder.

Conclusions

Based on the above, for improving safety of working at height during operations on power lines, it is necessary to solve the problem of arranging stationary marked and certified anchorage points of fastening. It can be done in several ways:

- color markers in special places on the structure of the support itself mentioning working and destructive loads in accordance with the permissible required norms and rules for using PPE products;
- fixing special certified anchor points on the structure along the entire path of the worker's movement to the working area and in the working area;

- on the ladder-type open structures, it is necessary to create a rigid anchor line for continuous safety support of a worker along the whole way up to the workplace (Fig.3);
- introducinga symbol for designation of an anchor point or a line for convenient planning of works at height.

All these measures will significantly improve safety of work at height and organization of these methods. Some of them have already been mentioned [24-28].But no technical measures will save a worker, if he cannot use them or does not know how to use them. Therefore, high-quality and timely training all your personnel as for the rules of working at height remains an integral part of safe work and generally improves the culture of production.

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