Adaptation of National Regulations on the Use of Fall Protection Equipment for Firefighters to European Standards

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Abstract: Work at height during firefighting represents a distinct category of operational activity requiring specialized safety equipment and professional training. This task remains one of the most hazardous for firefighters, particularly under the current conditions and challenges in Ukraine. This study analyzes both domestic and international literature on personal protective equipment (PPE) used by firefighters for fall protection. A comprehensive review of the regulatory and legal framework highlights certain inconsistencies that require resolution and delineates the strengths and limitations of both national and European standards concerning firefighter safety belts. The national definition of the term "fire rescue belt" is examined and compared with interpretations in the normative documents of leading countries. Based on an analysis of academic and official sources, an authorial definition of the term "fire rescue belt" is proposed. This device is defined as a protective tool intended for securing fire and rescue personnel during firefighting operations and for self-rescue in situations that pose threats to health and safety, with consideration given to individual risk assessments. Unified quality indicators for firefighter belts have been identified, which are crucial for ensuring product reliability and suitability, directly influencing user safety. The findings of this research lay the groundwork for substantiating quality indicators and testing methodologies for firefighter belts and for revising national regulatory documents to align them with contemporary safety standards.

Keywords: fire rescue belt, firefighting, work at height, standards, quality indicators, testing methods.

1. Introduction

New challenges faced by Ukraine necessitate the revision of operational algorithms and logistical solutions to ensure the effective performance of fire and rescue units under exceptionally difficult conditions. In addition to typical fires, a significant threat is posed by fires caused by hostile shelling from the Russian Federation. Under such circumstances, firefighters are required to operate in high-risk zones, often without prior access to objective information regarding the situation at the site. The provision of modern personal protective equipment (PPE) plays a critical role in significantly enhancing the ability to safely execute assigned tasks.

At present, all height-related operations conducted by firefighters in Ukraine—particularly those related to mitigating the consequences of missile strikes—should be considered a distinct category of work with an elevated level of occupational risk, necessitating enhanced safety measures. To ensure the highest level of safety for firefighters working in hazardous environments, the fire rescue belt, as a personal

protective device, must adhere to specific requirements outlined in relevant normative documents and technical regulations. A modern fire rescue belt must comply with standards that not only ensure user safety—minimizing risks to life and health—but also contribute to the effectiveness of operational task execution.

One of the most pressing issues in equipment and product safety in Ukraine is the need to align national legislation with the existing European legal framework. Given Ukraine's ongoing efforts to harmonize its regulatory base with European Union standards—particularly through the implementation of the Association Agreement with the European Union—there is an urgent need to update normative documents concerning personal protective equipment, including fire rescue belts [1, 2]. Such harmonization is expected to facilitate Ukraine's integration into the European fire safety equipment market and ensure a high level of protection for firefighting personnel.

2. Methods

The aim of this study is to analyze national and international regulatory documents and literature sources that govern the use of fire rescue belts as personal protective equipment.

To achieve this goal, the following objectives must be addressed:

- To analyze literature sources, domestic regulatory frameworks, and the requirements of standards from leading countries concerning fire rescue belts for fall protection;
- To propose an original definition of the term "fire rescue belt";
- To conduct a comparative analysis of the quality indicators and testing methods for fire rescue belts as defined in national standards and those of leading countries, identifying the main differences;
- To identify unified quality indicators for fire rescue belts for fall protection in both Ukrainian regulatory documents and international standards, which are critically important for ensuring user safety.

The object of the study is the regulatory and legal framework governing the use of fire rescue belts as personal protective equipment against falls.

The subject of the study is the adaptation of national regulatory documents governing the use of fire rescue belts as fall protection equipment to the requirements of European standards.

The research hypothesis assumes the existence of a discrepancy between current national regulatory documents and European standards regarding fire rescue belts. It is proposed that eliminating this discrepancy through adaptation to European requirements will contribute to an increased level of user safety.

The following methods were applied in the course of the study: the analytical method was employed to examine the current regulatory framework of Ukraine and the standards of leading countries; the general theoretical method was used to develop and apply the conceptual apparatus of the research; the comparative method was utilized to identify differences and commonalities between Ukrainian requirements and those of leading countries concerning fire rescue belts; the expert ranking method was applied to define a unified nomenclature of quality indicators for fire rescue belts, the characteristics of which play a key role in ensuring users' individual fall protection.

3. Literature Review

The fire rescue belt is a type of equipment used by firefighters during every intervention involving fire suppression by emergency response units [3]. According to national regulatory documents, fire belts must be provided to personnel of fire and rescue units, individuals authorized to independently perform the duties of fire suppression commanders, as well as other individuals directly coordinating firefighting operations [4].

The issue of equipping users with fire belts and improving their operational application at fire scenes has been the subject of investigation by both domestic and international researchers. Key research directions include examining the multifunctionality and adaptability of fire belts to various operational scenarios.

Researchers Yu. Mykhailovskyi and O. Skorodumova have emphasized that the operational characteristics of fire belts largely depend on the materials used in their production, rather than solely on structural design. Consequently, the enhancement of belt performance is primarily achieved through the introduction of advanced materials and fabrics that ensure strength, resistance to high temperatures, and user comfort during prolonged use [5].

An alternative approach to the structural features and application methods of fire belts is presented in the studies by R. Ponomarenko and D. Stadnyk. Their research focuses on improving the fire belt design to enhance functionality, as well as identifying optimal usage methods aimed at maximizing user safety [6].

P. Antoniak, in the context of hybrid threats that may lead to increased morbidity among firefighters, emphasizes the importance of adhering to legal and organizational protective measures during firefighting operations. He identifies the mandatory use of a fire belt, in combination with a carabiner and axe, as personal protective equipment as a key factor in mitigating health risks for users operating in complex and unpredictable fireground conditions [7]. F. Scandella, while also highlighting the importance of personal protective equipment for firefighters, warns of the potential danger that arises when associated risks are underestimated and preventive measures are neglected [8].

According to observations by J.-E. Hegemann [9], one common scenario in which firefighters often forgo the use of a fire belt is during wildland firefighting. Current models of fire belts are considered ineffective in such contexts, as well as during interior structural firefighting. The weight of the belt contributes to physical strain, and its interaction with the straps of self-contained breathing apparatus (SCBA) creates additional operational difficulties. Furthermore, it is noted that tightening the belt eliminates the insulating air layer between the body and the protective clothing, thereby reducing thermal protection. Based on these findings, a balanced approach to equipping firefighters is recommended, with careful consideration of the nature of tasks performed during fire suppression. Hegemann concludes that the fire belt should be used solely for support and stabilization purposes, and not for victim rescue. These insights underscore the urgent need to reconsider the traditional approach to firefighter equipment, particularly the application of the fire belt in the contemporary context of firefighting operations in Ukraine.

Practical experience with the fire belts currently in use by firefighters in Ukraine under real operational conditions reveals limited functionality, poor compatibility with modern gear, and inadequate ergonomics. These findings highlight the urgent need for the modernization or replacement of existing fire belts to better meet actual operational demands and improve both the efficiency and safety of end-users. This situation underscores the necessity to revise the current standards regulating the technical specifications of fire belts, as well as to update the approaches to their selection, testing, and certification in accordance with contemporary usage conditions and user requirements [2].

The harmonization of national regulatory documents concerning fire belts with European standards is expected to ensure a high level of firefighter safety, taking into account technological advancements and the evolving risks encountered during duty.

4. Results and Discussion

The requirements for the design and manufacture of fire belts in Ukraine are outlined in the Technical Regulation on Personal Protective Equipment, developed in alignment with European standards [10]. Market surveillance of personal protective equipment used by firefighters is conducted by the competent state authorities [11]. According to this regulation, personal protective equipment is defined as any equipment designed and manufactured to be worn or held by an individual to protect against one or more risks to their health or safety. Since the primary function of a fire belt is to protect the life and health of the user from the risk of falling from height [12, 13], it is fully subject to the provisions of this regulation. As such, fire belts must comply with safety requirements, conformity assessment procedures, and marking obligations, among other provisions. Within the scope of the Technical Regulation on Personal Protective Equipment, fire belts are classified under risk category III, which pertains to equipment providing a high level of protection for the user during firefighting operations.

At present, the Technical Regulation on Personal Protective Equipment and other relevant regulatory documents [10, 11] do not provide a distinct classification for fire belts used by firefighters and rescue personnel. As a result, fire belts are officially categorized as standard equipment for both groups of professionals, without accounting for the unique qualifications and responsibilities associated with each role. However, the Handbook of Occupational Qualification Characteristics of Civil Protection Workers in Ukraine [14] explicitly differentiates between the professions of "Firefighter-Rescuer" (code KP-5161) and "Rescuer" (code KP-5169), highlighting a significant disparity in their respective tasks and responsibilities. Specifically, firefighters are tasked with extinguishing fires, locating victims in emergency zones, evacuating individuals, and providing preliminary medical assistance. In contrast,

rescuers perform a broader range of duties related to the mitigation of both man-made and natural emergencies, including rescuing individuals from hazardous situations. These distinct professional roles necessitate the use of specialized equipment to ensure the safe and effective performance of duties under high-risk conditions. Consequently, the difference in occupational responsibilities, coupled with the specific threats associated with each profession, demands a differentiated approach to the selection and utilization of personal protective equipment—particularly fire belts.

A key instrument that establishes the requirements for the design, materials, operational characteristics, testing methods, and nomenclature of quality indicators for fire rescue belts in Ukraine is the national standard DSTU 4262:2003 "Fire Rescue Belts. General Technical Requirements and Test Methods" [13]. Since the adoption of DSTU [Державні Стандарти України] 4262:2003, significant advancements in fire safety and occupational protection have occurred. These include the introduction of new manufacturing techniques, innovative materials, and improved technical solutions, all of which enhance the effectiveness and reliability of personal protective equipment (PPE). Given the specific nature of firefighters' tasks under current conditions, the use of differentiated fall protection equipment is essential. The fall arrest and restraint equipment specified in DSTU EN 1497:2017 [15], DSTU EN 361:2017 [16], DSTU EN 363:2017 [17], DSTU EN 364:2001 [18], and DSTU EN 358:2022 [19], developed in alignment with European standards, differs significantly in structural features and operational conditions from the fire rescue belts outlined in DSTU 4262:2003 [13].

At the same time, significant variability can be observed in the conceptual interpretation of the term "firefighter belt" across national regulatory documents and comparable fall protection equipment standards in leading countries. This divergence is primarily driven by differing approaches to the designated functional purpose of such equipment, which, in turn, are contingent upon the operational context in which firefighters perform their duties. Specifically, some national and international standards define the firefighter belt as a safety harness, while others categorize it as part of rescue equipment or as an evacuation tool (see Table 1).

An objective analysis of the current state of research on this issue is only possible with the establishment of a scientifically grounded definition of the term "firefighter belt." This definition should integrate structural, functional, and operational characteristics, while considering the specific nature of firefighting activities. Consequently, there is a clear need to formulate an updated concept based on the real-world conditions of belt use and the professional requirements of firefighters. This, in turn, implies the necessity of either adapting existing standards or developing a separate standard specifically for this type of equipment.

Table 1. Comparison of the Interpretation of the Firefighter Belt and Related Fall Protection Equipment in National and International Regulatory Documents

Regulatory Document	Definition Content	The main functions of the belt	Characterization of the concept definition	Level of concept detail
DSTU 4262:2003 [13]	The fire rescue belt is designed to protect and enable self-rescue for firefighters, as well as to facilitate the rescue of individuals during fire suppression and fire-rescue operations. Additionally, it serves to secure a fire axe and fire carabiner.	Protection, self-rescue, rescue, securing tools, an element of personal equipment during fire extinguishing	Generalized	Average
DSTU 2273:2006 [12]	The firefighter's belt is designed to secure and protect the firefighter during work at height, as well as to facilitate fire-rescue operations and self-rescue	Securing and protection at height, self-rescue, rescue, securing tools	Generalized	Average
DIN 14927:2018 [20]	The firefighter's belt enables fire protection personnel to mitigate the risk of falling by securing or restraining themselves using a lanyard (safety rope). In the context of risk assessment for life and health while working on upper floors, self-rescue using the firefighter's belt may be considered a last resort	Protection, self-rescue	Functional	High
NFPA 1983:2001 [21]	The firefighter's belt is a component of the system, designed as a fastener that secures around the waist and is categorized into two types: Rescue Belt: Intended for use solely as an emergency means for self-rescue by the wearer. Ladder Belt: Designed to secure a person while on a ladder.	Self-rescue, fixation, support during operations.	Differentiated	Very high

	The safety harness is also a system component; it consists of a collection of materials secured to the body, used to support a person during rescue operations in fire services			

The comparison presented reveals that, despite functional similarities, the interpretation of the concept of a firefighter's belt and related fall protection equipment varies across countries in terms of detail and terminological approach. In Ukrainian standards, different interpretations of the firefighter's belt are based on a combination of its characteristic features. In contrast, foreign regulatory documents—particularly the American standard NFPA 1983-2001 [21]—demonstrate a significantly higher level of specification and detailing of the requirements for such personal protective equipment, with a clear distinction between concepts based on the type of activity. This distinction is crucial for the differentiated use of firefighter belts during fire suppression operations.

A comparative analysis of the interpretation of the term "firefighter's belt" in Ukrainian standards, in relation to similar protective equipment definitions in German (DIN 14927:2018-11) and American (NFPA 1983-2001) regulatory documents, confirms that they share a common functional core: ensuring the user's safety from falling during the performance of professional tasks in fire-hazardous conditions. Special attention is given to the use of the firefighter's belt as a means for self-rescue. In foreign regulatory documents, it is explicitly stated that self-rescue is not the primary function of firefighters; rather, they may use it as a last resort, provided the individual risk assessment does not indicate a threat to life or health. Thus, the national interpretation tends toward a multifunctional approach, while German and American standards offer a more structured functional differentiation.

"Based on the analysis above, the following authorial definition is proposed: the 'firefighter's rescue belt' is an individual protective device designed to secure fire-rescue personnel during fire suppression operations and for self-rescue in the event of a threat to safety and health, considering the individual risk assessment. The proposed authorial definition of the firefighter's belt, as a means of individual protection, is grounded in a comprehensive approach to its functional purpose. This interpretation facilitates a new understanding of its structural features and regulatory requirements, as well as the processes required to ensure an adequate level of safety for fire-rescue personnel during fire suppression activities. In order to carry out rescues, firefighters should be provided with a specialized set of emergency-rescue tools and trained in their use during firefighting operations.

The study of current national and international standards that define the requirements for the firefighter's belt [13], rescue belt [15], fall protection equipment [18], restraint or limiting belt [19], and firefighter's belt [20]—in terms of their specific application—has enabled the formation of a basic nomenclature of quality indicators.

Using the expert ranking method, which involves arranging objects in ascending or descending order based on a specific characteristic [22], a unified nomenclature of quality indicators for the aforementioned belts will be established. These characteristics are crucial in ensuring effective personal fall protection. Consequently, the quality indicators outlined in the aforementioned standards will be selected. Each quality indicator will be assigned a weight coefficient, with a numerical value of 1, to reflect its relative importance. The total weighted sum of the quality indicators established in the regulatory documents is evaluated using the following formula: $S = \sum_{i=1}^{n} 1 = n$, where n is the number of quality indicators.

The indicators will be ranked, and a ranked list of the unified nomenclature of quality indicators for the belts will be compiled, with total scores arranged from highest to lowest. Higher total scores in this ranked list indicate that these indicators are critical safety factors, with their properties having a significant impact on the reliability and effectiveness of the user's personal protection.

By analyzing the selected unified quality indicators for the firefighter's belt, rescue belt, restraint and fall prevention belt, full-body harness, and other fall protection equipment, as defined in current regulatory documents [13, 15, 16, 18, 19, 20], it can be concluded that these indicators are essential for ensuring user safety (see Table 2).

Table 2. Unified Quality Indicators and Characteristics of the Firefighter's Belt, Rescue Belt, Restraint and Fall Prevention Belt, Full-Body Harness, and Other Fall Protection Equipment for Heights [13, 15, 16, 18, 19, 20]:

№	Quality indicators	Category	Impact on safety and reliability
1.	Examination of design, ergonomics, material, and construction	Functionality and comfort	Determines comfort, compatibility, and proper use during operations
2.	Static strength testing	Physical strength	Ensures load-bearing capacity without failure under static loads
3.	Dynamic strength testing	Physical strength	Ensures resistance to shock loads and maintains functionality under dynamic forces.
4.	Corrosion resistance testing	Material durability	Protects against degradation from environmental factors (e.g., humidity, salt, temperature fluctuations).

Thus, the quality indicator "Examination of Design, Ergonomics, Material, and Construction" highlights the importance of the firefighter's belt and its components, which directly influence user comfort and proper use of the equipment. This, in turn, helps prevent potential injuries and minimizes the risk of improper use. The second indicator, "Static Strength Testing," evaluates the ability of the firefighter's belt to withstand static loads without structural failure, a critical factor in preventing hazards. The subsequent indicator, "Dynamic Strength Testing," ensures that the firefighter's belt can endure dynamic loads, such as sudden movements or shocks, which is essential for maintaining safety in dynamic operational environments. Lastly, materials that pass the "Corrosion Resistance Testing" quality indicator exhibit adequate durability, ensuring their effectiveness and longevity in the complex and unpredictable working conditions faced by firefighters.

The unified nomenclature of quality indicators for the firefighter's belt, established through expert research, provides a conceptual foundation for formulating specific requirements for the firefighter's belt as an individual protective device. The direct requirements outlined in the Temporary Regulations [10] regarding personal protective equipment, including the firefighter's belt, are essential and indisputable, particularly in terms of ensuring the safety and health protection of users. This approach takes into account the real operational conditions and typical hazards that firefighters face on a daily basis.

The analyzed nomenclature of quality indicators for the firefighter's belt can be incorporated into the development of relevant standards. The adaptation of national regulatory documents concerning firefighter's belts to European standards will foster a qualitative advancement in the current state of fire-fighting technology, modernize personal protective equipment for firefighters, and improve fire suppression strategies.

5. Conclusion

The results of the conducted study highlight that the literature sources emphasize the need for improving the design of the firefighter's belt to enhance its functionality and determine optimal application methods for ensuring maximum user safety. Practical experience with the firefighter's belts currently used by firefighters in Ukraine confirms their limited functionality, poor compatibility with modern equipment, inadequate ergonomics, and other operational challenges.

It has been established that the Technical Regulation on personal protective equipment does not provide a distinct classification for belts used by firefighters and rescuers, despite the clear distinction between their tasks and functions. The difference in professional duties, considering the specific risks inherent to each of these professions, necessitates a differentiated approach to the selection and use of fall protection equipment. This calls for the introduction of appropriate amendments to the List of product types subject to state market surveillance, as well as to national standards that consider the specific applications of such equipment.

Variability in the interpretation of the concept of the firefighter's belt in national standards and related fall protection equipment for firefighters in foreign regulations has been observed. This discrepancy primarily arises from differing approaches to the conditions of use and the functional purpose of these devices. Based on the reviewed scientific and official literature, an authorial perspective on the term "firefighter's rescue belt" has been proposed. It is defined as a protective device designed to ensure the

safety of fire and rescue personnel during fire suppression operations, as well as for self-rescue in the event of a threat to safety and health, taking into account the individual assessment of risk levels.
The development of the basic nomenclature of quality indicators for the firefighter's belt has facilitated the identification of unified quality indicators, which are critical for ensuring the safety of users. The established unified nomenclature of quality indicators for the firefighter's belt can serve as a conceptual foundation for developing requirements for the personal protective equipment of Ukrainian firefighters, taking into consideration the specific risks and real operational conditions they face.

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