http://dx.doi.org/10.18623/rvd.v23.n4.4931

MULTI-CRITERION ANALYSIS OF SAFETY PRINCIPLES FOR OPERATING HYDRAULIC PLATFORMS IN THE FIRE DEPARTMENT

ANÁLISE MULTICRITÉRIO DOS PRINCÍPIOS DE SEGURANÇA PARA A OPERAÇÃO DE PLATAFORMAS HIDRÁULICAS NO CORPO DE BOMBEIROS

Article received on: 10/16/2025
Article accepted on: 1/16/2026

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The authors declare that there is no conflict of interest

Abstract
Hydraulic lifting platforms enable firefighters and rescue workers to respond effectively and safely in difficult conditions. Machinery must comply with safety requirements, and protective measures must be designed in accordance with the principles of EN ISO 12100 for hazards and risks. Operators of this equipment must undergo training to be able to use this type of firefighting equipment correctly and effectively, with regard to their own safety and the safety of the people being rescued.

Keywords: Risk. Personal Protective Equipment. Mechanical Equipment.

Resumo
As plataformas hidráulicas elevatórias permitem que os bombeiros e equipes de resgate respondam de forma eficaz e segura em condições difíceis. As máquinas devem cumprir os requisitos de segurança e as medidas de proteção devem ser projetadas de acordo com os princípios da norma EN ISO 12100 para perigos e riscos. Os operadores deste equipamento devem receber treinamento para poderem usar este tipo de equipamento de combate a incêndios de forma correta e eficaz, tendo em vista a sua própria segurança e a segurança das pessoas que estão sendo resgatadas.

Palavras-chave: *Risco. Equipamento de Proteção Individual. Equipamento Mecânico.*

1 INTRODUCTION

One of the key areas of activity for fire and rescue services is responding to various types of incidents that threaten safety and property, such as fires, traffic accidents, technical interventions, and various accidents. Each type of intervention requires specific expertise, equipment, and approach in order to provide effective assistance and minimize damage. Within this complex issue, intervention at heights represents a special category. The rapid growth of high-rise buildings and technological facilities has led to an increase in emergencies in these areas. Interventions at heights are demanding and complex operations for firefighters, requiring special knowledge, skills, and equipment.

2 METHODOLOGY

The aim of this article is to analyze the areas of use of aerial access technology in firefighting and rescue operations, to characterize selected types of aerial lifting equipment, and to comprehensively assess the risks associated with their use MARKOVA;BERNATÍK (2023). The article includes a proposal for a training scenario for the safe deployment of hydraulic platforms and an analysis of stability loss in accordance with applicable technical standards.

3 METHODS AND PROCEDURES USED

3.1 Analysis of areas of application of height access equipment

The first part of the article uses an analytical method to identify and systematize the most common areas of use of height access equipment in firefighting and rescue operations.

The analysis is based on:

- professional literature,
- manufacturers' technical documentation,
- the practical experience of firefighting units.

3.2 Characteristics of aerial lifting equipment

A comparative method was used to describe the technical properties of hydraulic platforms, which made it possible to compare:

- load capacity,
- maximum working height,
- flexibility of movement,
- safety features.

The data sources were technical standards, product catalogs, and professional publications. F-HLA platforms designed for operations at heights above 100 m were analyzed separately.

3.3 Risk assessment of intervention activities

Two complementary risk assessment methods were applied to assess the risks associated with the use of aerial work platforms:

3.4 Point method and risk matrix (P × D) (STN EN ISO 12100,2011)

This method was used for a quick and clear assessment of risks during an intervention. The following were assessed:

- probability of an undesirable event occurring (P),
- severity of consequences (D).

The resulting risk (R) was classified into low, medium, and high risk categories. The output is a clear risk table with proposed preventive measures.

3.5 Extended point method (D × E × P)

The extended point method was used for a more detailed risk assessment, taking into account:

- the severity of consequences (D),
- the frequency of exposure (E),
- probability of occurrence (P).

This method allowed for a more accurate assessment of the risks associated with long-term or repeated activities at height and identified risks requiring systematic management.

3.6 Design of a training scenario

Based on the results of the risk assessment, a model and scenario method was used to design a training scenario for the safe use of hydraulic platforms. The scenario simulates real intervention situations and includes:

- technical risks,
- environmental impacts,
- human factors and psychological reactions of rescued persons.

The training methodology is focused on developing the decision-making skills of the intervention commander, team coordination and the ability to interrupt dangerous activities in a timely manner.

3.7 Analysis of the loss of stability of a hydraulic platform

In the last part of the article, a normative analytical method was used, based on the STN EN 1777 and ISO 4305 standards. The stability assessment is based on the calculation of:

- maximum overturning moments,
- combination of load, wind and manual forces,
- the most unfavorable overturning edges.

The calculations respect the standard safety coefficients and take into account the dynamic effects of the movement of the platform arm.

The methodology used combines:

- analytical and descriptive methods,
- quantitative risk assessment,
- scenario training approach,
- normative technical stability assessment.

The methodological framework chosen in this way enables a comprehensive assessment of the safety of using high-altitude access equipment in firefighting and rescue operations and provides practically usable outputs for professional practice.

4 INTERVENTION ACTIVITY

The activities of members of the Fire and Rescue Service include a wide range of activities aimed at providing assistance and rescuing people and property. High-altitude rescue vehicle technology, with sub-groups according to Decree 162/2006 Z. z., includes a fire engine equipped with a rotating ladder or a high-altitude work platform. The vehicle-mounted work platform has a more versatile design, greater mobility, and height reach, making it suitable for various rescue operations at heights. According to STN EN 1777, high-lift aerial equipment for fire and rescue services is a lifting platform consisting of a work platform and a hydraulic extension structure mounted on a base, which is a self-propelled chassis and is designed to transport people and their equipment, in some cases also fire monitors, to work sites used for firefighting, rescue operations, environmental protection, and various other activities. The intervention activities of firefighting units using aerial equipment play an important role in helping people in distress, Table 2. This equipment allows firefighters to reach hard-to-reach or extremely dangerous places, such as burning buildings, tall trees, or steep slopes, and to intervene effectively (MONOŠI,2023).

Table 1

Intervention activities with aerial equipment

General use of height Technology.	**Rescue and evacuation of people, animals, property, to safety from heights.**
Transport of firefighting equipment	Performing rescue and firefighting work from a controllable and functional cage Repairing roofs after strong winds.
Evacuation of persons from buildings and areas affected by fire.	Firefighting and transport of extinguishing agent to the site of the fire from above.
Conducting an investigation and inspection of the scene of the incident.	Transportation of personnel and materials needed to extinguish fires to elevated locations for quick and effective intervention. Lighting of the intervention site.

Source: Hasičská technika, 2021.

4.1 Areas of application for height access technology

Aerial equipment is used in fires in various locations that are difficult to access. Some of the most common areas of use for aerial equipment in fires are:

- High-rise buildings,
- Industrial facilities,
- Airports,
- Bridges and tunnels.

Features of aerial lifting equipment:

Load capacity: Platforms can carry considerable weight, allowing firefighters and rescue workers to transport the necessary equipment and personnel to the scene of an incident. Working height: Platforms can reach extremely high working heights, with some models reaching up to 112 meters, (SLOBODA,2021). This exceeds the capabilities of conventional fire ladders and allows intervention in situations such as extinguishing fires in high-rise buildings or rescuing people trapped in high places. Flexibility: Hydraulic arms allow the platform to move in different directions and reach even places with limited access. Safety: The platforms are equipped with safety features such as fall protection and stabilization systems to ensure the safety of workers at heights (STN EN 14044).

4.2 Types of lifting platforms

Ladder platform for firefighting and rescue in cities, Figure 1. Due to their compact design and short transport length, the platforms are designed to be fast in narrow city streets and in complex fire scenarios. They are available in various weight classes with optimal reach, with or without a rescue ladder (STN EN 14043).

Figure 1

Ladder platform for firefighting and rescue in cities (www.minv.sk, 2026)

Source: www.pozary.cz, 2026.

4.3 Aerial lifting platforms

The F-HLA aerial platforms enable efficient and safe operation in extremely demanding high-altitude rescue and firefighting missions up to 112 meters. These platforms are specially designed for urban areas with tall buildings and industrial firefighting applications, where distances of more than 100 meters need to be reached when spraying water, or when access to high structures is required. They are designed to provide reliable support when dealing with significant situations at great heights, (STN EN 14044).

Figure 2

High-altitude lifting platforms (STN EN 14044)

Source: www.pozary.cz, 2026.

4.4 Risk assessment of selected intervention activities involving aerial work platforms

The point method and extended point method according to STN EN ISO 12100 and STN EN 1777 were chosen to assess the risks of intervention activities using aerial equipment. The analysis took into account the risks for both firefighters directly involved in the intervention and for persons in the area affected by the intervention [9,10].

When firefighters use a hydraulic platform, there are several risks that can endanger the operator, the firefighters involved, and people in the vicinity. The overview of risks is as follows:

4.4.1 Technical risks

- Hydraulic system failure (oil leak, pressure loss, sudden arm movement)
- Stabilizer support failure (incorrect distribution, soft ground)
- Overloading (exceeding load capacity, uneven load)
- Control failure (electronics, emergency controls not working)
- Wear or damage to the structure (corrosion, cracks)

4.4.2 Risks arising from the environment

- Unstable or slippery surfaces (ice, mud, snow, debris)
- Strong winds – arm swaying, loss of stability
- Reduced visibility (smoke, darkness, fog)
- Extreme temperatures – impact on hydraulics and operators
- Radiant heat during a fire – damage to equipment or burns

4.4.3 Electrical hazards

- Contact with overhead power lines
- Electric arc flash
- Failure to maintain safe distances from high-voltage/low-voltage power lines

4.4.4 Operational hazards

- Collision with objects (facades, roofs, windows, structures)
- Falling material or persons from a height
- Arm getting stuck in a narrow space
- Incorrect positioning of the vehicle in relation to the object
- Simultaneous operation of several units in the vicinity of the hydraulic platform

4.4.5 Risks for operators and firefighters

- Falling from the basket (not using safety equipment)
- Loss of balance during sudden movements
- Fatigue, stress, operator overload
- Insufficient communication between operators and firefighters in the basket
- Insufficient training or practice

4.4.6 Risks during rescue operations

- Panic among rescued persons
- Sudden movements of persons in the basket
- Exceeding the load capacity during evacuation
- Clothing or limbs getting caught on the structure

4.4.7 Organizational and safety risks

- Failure to comply with occupational health and safety and tactical procedures
- Lack of or incorrect coordination of the intervention
- Underestimation of risks by the commander of the intervention
- Insufficient inspection of the technical condition before use

4.5 Risk assessment using a risk matrix and an extended point method

This chapter presents a risk assessment using a risk matrix and an extended point method. Individual risks were consulted with members of the fire department.

- P – probability of a negative event occurring (1–5)
- D – consequence/severity (1–5)
- R – risk

Table 3

Risk assessment using a risk matrix (authors)

No.	Risk	Cause	People at risk	P	D	R	Preventive measures
1.	Overturning of the hydraulic platform	Soft or uneven terrain	Operators, firefighters in the platform basket	3	5	15	Checking the load-bearing capacity of the terrain, using supports, prohibiting work on unstable surfaces
2.	Hydraulic failure	System malfunction, oil leak	Firefighters in the basket	2	4	8	Pre-intervention checks, regular servicing
3.	Firefighter falling from the basket	Failure to use safety devices, sudden movement	Firefighters in the basket	2	5	10	Using harnesses, prohibiting leaning out

4.	Contact with power lines	Failure to maintain a safe distance	Entire firefighting unit	1	5	5	Maintaining distances, supervision by the commander
5.	Overloading of the basket	Too many people/too much material	Firefighters in the platform basket	2	4	8	Checking load capacity, recording loads
6.	Falling objects from a height	Loose material in the basket	People under the platform	3	4	12	Dedicated work area, securing tools
7	Boom swaying in the wind	Strong wind	Firefighters in the basket	3	4	12	Interruption of work in strong winds
8	Collision with an object	Incorrect operation of the platform	Firefighters, people in the building	2	3	6	Experienced operators, slow movements
9	Loss of communication	Noise, smoke	Operators, firefighters in the basket	3	3	9	Use of radio stations, agreed signals
10	Panic among rescued persons	Stress, fear of heights	People being rescued	3	3	9	Calming down, max. 1 person at a time

Source: authors, 2026.

- High risks (R ≥ 11) – require immediate organizational and technical measures
- Medium risks (R 6–10) – require control and compliance with procedures
- Low risks (R ≤ 5) – acceptable if OSH is complied with

By complying with the specified measures, regular training, and thorough inspection of the technical condition of the hydraulic platform, it is possible to significantly reduce the risks of intervention activities to an acceptable level.

Hydraulic platform – extended point method D × E × P

Explanation of the method

- D – consequence (severity of injury)

1 = minor injury,2 = injury resulting in incapacity for work,3 = serious injury,4 = fatal injury

- E – exposure (frequency of exposure)

1 = rarely,2 = occasionally,3 = often,4 = continuously

P – probability of occurrence

1 = unlikely,2 = unlikely

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- E – exposure (frequency of exposure)

1 = rarely,2 = occasionally,3 = often,4 = continuously

- P – probability of occurrence

1 = unlikely,2 = unlikely,3 = likely,4 = very likely

Resulting risk R = D × E × P

Table 4

Risk assessment using the extended point method (authors)

No.	Risk	D	E	P	R	Risk level Measures	Risk level Measures
1	Overturning of the hydraulic platform	4	2	2	16	medium	Check the terrain, supports, no work on soft surfaces
2	Hydraulic failure	3	2	2	12	medium	Regular checks, servicing
3	Firefighter falling from the basket	4	2	2	16	medium	Harness, no leaning out
4	Contact with power lines	4	1	1	4	low	Keep safe distances
5	Overloading of the basket	3	2	2	12	medium	Check load capacity
6	Falling objects from height	3	3	3	12	medium	Dedicated space, secure tools
7	Wind impact	3	3	2	18	medium	Stop work in windy conditions
8	Collision with an object	2	2	2	8	low	Experienced operators
9	Loss of communication	2	3	2	12	medium	Radio stations
10	Panic among rescued persons	2	2	3	12	stredné	Upokojovanie, obmedzenie počtu osôb

Source: authors, 2026.

Evaluation according to the D×E×P method

- 1 high risk → requires immediate action
- 6 medium risks → requires management and control
- 3 low risks → acceptable if OHS is observed

The use of a hydraulic platform in firefighting operations is possible if:

- technical and organizational measures are implemented,
- regular training of operators is provided,
- regular risk assessments are carried out by the incident commander.

4.6 Conclusion of risk assessment

Based on the risk assessment carried out for the use of hydraulic platforms during firefighting operations, two complementary risk assessment methods were applied, namely:

- P × D risk matrix (probability × consequence)
- Extended point method D × E × P (consequence × exposure × probability)

The use of both methods enabled a comprehensive and multi-level risk assessment, taking into account not only the possible consequences of extraordinary events, but also the frequency of exposure to risk and the actual operating conditions of emergency response activities.

5 TRAINING SCENARIO FOR THE SAFE USE OF HYDRAULIC PLATFORMS

This chapter presents a training scenario for the safe use of hydraulic platforms in rescue operations by firefighters.

1. Training objectives

- Proper decision-making by the incident commander
- Coordination between the fire platform operator and firefighters in the basket
- Recognizing when it is necessary to interrupt or change activities.

2. Training participants

- Incident commander (IC) – manages activities, decides on the use of the HP
- Hydraulic platform operator (HPO) – controls the equipment
- Firefighters in the basket (HK) – perform rescue operations
- Observer/instructor – evaluates procedures and decisions

3. Initial situation (basic scenario)

Type of intervention: simulated rescue of a person from a higher floor of a building

Environment: training ground / training building

Conditions: light wind, good visibility

Equipment: hydraulic platform in fully functional condition

Participants have PPE at their disposal.

4.1 Course of training – model situations

4.1.1 Model Situation 1

Unstable terrain under the hydraulic platform

Description of the situation: The operator points out that the ground under one of the supports is soft.

Tasks of participants:

- The operator of the hydraulic platform reports the risk to the incident commander
- The incident commander performs an operational risk assessment
- Decides whether to reinforce the ground or move the hydraulic platform

Correct procedure:

- Stop unfolding the supports
- Eliminate the risk before continuing

Instructor's assessment:

Emphasis on early risk recognition.

4.1.2 Model Situation 2

Change in weather conditions during work

Description of the situation: The wind picks up while working at height.

Participants' tasks:

- Information about the deterioration of stability
- The platform operator monitors the reaction of the arm
- The incident commander decides whether to:
- continue with restrictions,
- or interrupt the activity

Correct procedure:

- Slow down movements,
- if necessary, lower the basket to a safe position.

4.1.3 Model Situation 3

Risk of objects falling from the basket

Description of the situation: Tools are loosely stored in the basket.

Participants' tasks:

- Identify the risk
- Secure the tools
- The incident commander assesses the work area under the platform

Correct procedure:

- Secure the tools
- Mark out the danger zone.

4.1.4 Model Situation 4

Loss of communication

Description of the situation: Voice communication is unclear due to noise.

Participants' tasks:

- Switch to radio communication.
- Use agreed signals.

Correct procedure:

- Confirm each instruction.
- Stop moving if anything is unclear.

4.4.5 Model Situation 5

Psychological reaction of the rescued person (simulation)

Description of the situation: The simulated person shows uncertainty and hesitation when entering the basket.

Participants' tasks:

- Firefighters communicate calmly and clearly.
- The incident commander decides to limit the number of people in the basket.Correct procedure:

- Remain calm.
- Proceed slowly and safely.
- Training evaluation criteria:
- Timely identification of risk.
- Correctness of measures taken.
- Communication and cooperation.
- Compliance with occupational health and safety regulations.
- Ability to interrupt the activity.
- After training, the following is carried out:
- analysis of individual situations,
- discussion of alternative solutions,
- connection with real interventions,
- recording of findings.

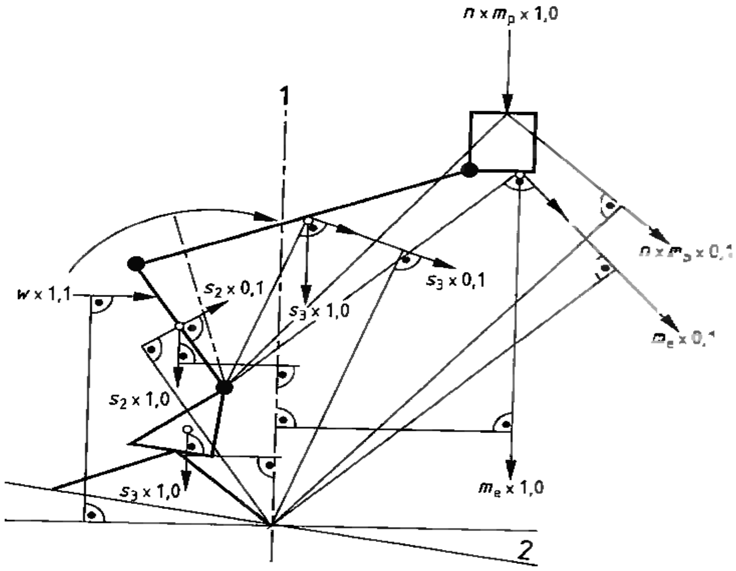
The training scenario develops the ability to think dynamically, make decisions, and act safely, which is key when working with a hydraulic platform in real-life emergency conditions. (www.minv.sk, 2026)

6 LOSS OF STABILITY – RISK WHEN HANDLING A HYDRAULIC PLATFORM

Based on standard EN 1777, forces acting perpendicularly downward, which are formed by the dead load and the nominal load and create a moment of overturning or loss of stability, must be multiplied by a factor of 1.0 in calculations. If movement is expected, they must be multiplied by a factor of 0.1, assuming in calculations that they act in the direction of movement and create the greatest overturning moment. Manufacturers may also use factors lower than 0.1, provided that they are determined by measuring the effects of acceleration and deceleration under the most unfavorable conditions. Wind forces shall be multiplied by a factor of 1.1, assuming that they act horizontally in the direction that produces the greatest overturning moment. Manual forces exerted by persons on the work platform must be multiplied by a factor of 1.1, provided that they act in a direction that produces the greatest overturning moment. Figure. 3, 4, 5.

Figure 3

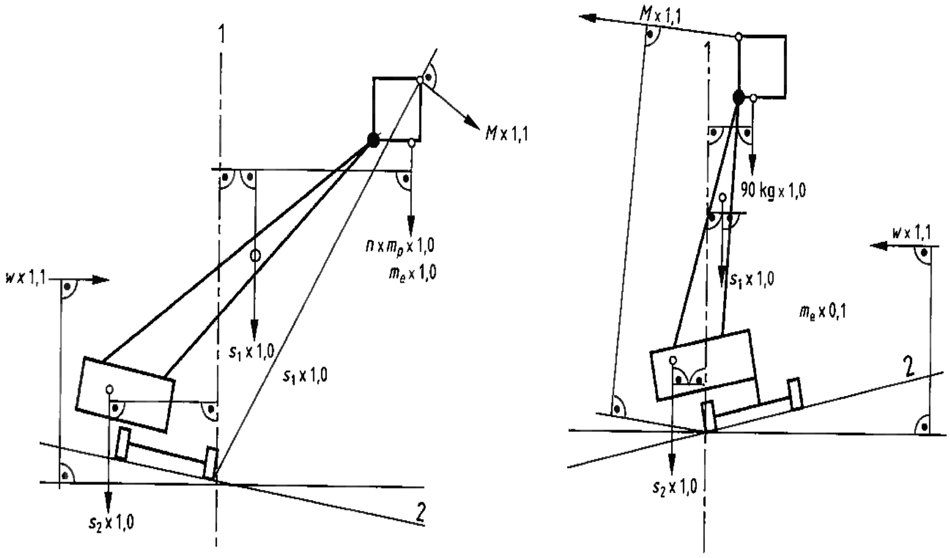
Combination of maximum overturning moment due to load and force



1-fold edge
2-maximum slope +0.5°
n-number of persons
mp -weight of each person
me- hmotnosť prídavného zariadenia
S1,S2,S3- dead weight
w- wind load

Figure 4

Examples a) and b) for combinations of maximum overturning moment by load and force

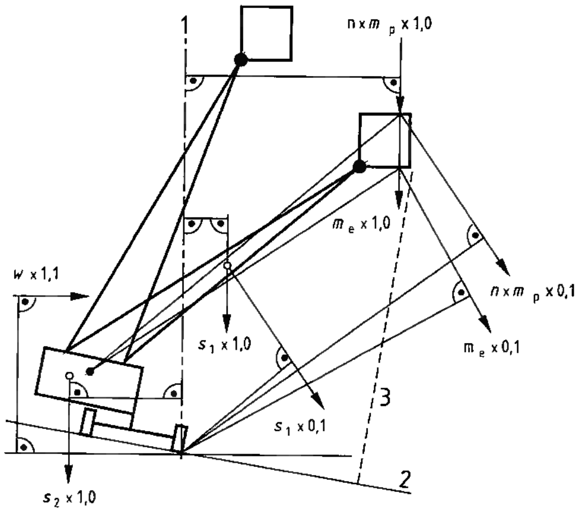


1-fold edge
2-maximum slope +0.5°

n-number of persons
mp -weight of each person
me- weight of additional equipment
S1,S2,S3- dead weight
w- wind load

Figure 5

Example for the combination of maximum overturning moment by load and force

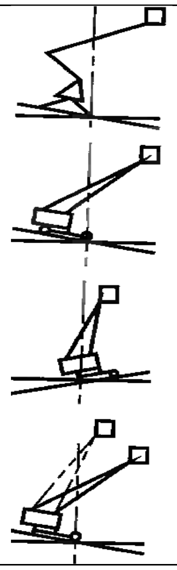


1-fold edge
2-maximum slope
3-limited range
n-number of persons
mp - weight of each person
me - weight of additional equipment
S1, S2 - dead load
w - wind load

The maximum moments of overturning for the relevant loss of stability must be calculated taking into account the most unfavorable flapping edges, whereby, in the case of a hydraulic platform designed to operate on pneumatic tires, any tire may fail. The tipping edges are determined in accordance with ISO 4305. All loads and forces that may act simultaneously must be taken into account in their most unfavorable combinations.

Table 5

Example of load directions and forces, as well as their combinations for stability calculations

Example	Operating conditions and movement	Nominal load		Own load		Manual force		Wind power		Additional forces		Pictogram
		x1,0	x0,1	x1,0	x0,1	x1,0	x0,1	x1,0	x0,1	x1,0	x0,1	
1.	Lifting, lowering	V	A	V	A	-	-	H	H	a)	a)	
2.	Forward stability, standing on a slope	V	-	V	-	A	A	H	H	a)	a)	
3.	Rearward stability, standing on a slope	90 kg V	-	V	-	A	A	H	H	a)	a)	
4.	With limited reach, forward stability, standing on a slope, lowering	V	A	V	A	-	-	H	H	a)	a)	

Source: STN EN 1777: 2010 (92 0607)
V-vertical, H-horizontal, A-angle, a)- determined by the manufacturer, The calculated moment of stability must be greater than the calculated moment of overturning.

7 RESULTS AND DISCUSSIONS

Preparation and planning are important before performing work with aerial equipment, and it is essential to have a precise plan and preparation. It is essential to include in the plan the identification of risks and possible hazards associated with the use of aerial equipment. Another important factor is professional training and preparation. Ensure that all team members who will be working with aerial work platforms undergo professional training and have the necessary skills and knowledge to use this equipment safely. Regular maintenance and inspection minimize the risks associated with equipment failure or malfunction. The introduction of strict safety procedures and the requirement to use personal protective equipment such as safety belts, helmets, and other protective equipment. Monitoring and communication are related to ensuring constant monitoring of the situation during the intervention and effective communication between team members working with height access equipment.

Linking the STN EN 1777 standard with the risk table according to the D × E × P method.

The STN EN 1777 standard defines the technical boundary conditions for the safe operation of a hydraulic platform (stability, load, wind effects, dynamic forces). However, these parameters according to the standard do not evaluate the frequency or operational circumstances of the intervention. Therefore, the standard influences are transformed into risk factors in this work, which are subsequently evaluated using the extended point method D × E × P.

Conversion of EN 1777 standard factors to D, E, P parameters

Linking EN 1777 standard to risk parameters D × E × P

Table 6

The relationship of EN 1777 to the risk parameters D × E × P

Factors according to EN 1777	Impact on the intervention	Parameter D × E × P	Explanation of the connection
Nominal load and dead weight	Knock moment	D	Exceeding the limits leads to loss of stability with possible fatal consequences
Dynamic effects of movement (0.1)	Swinging arm	E	Arm movement occurs repeatedly during the intervention
Wind (factor 1.1)	Side load	P	Increases the probability of a dangerous condition
Manual forces of persons (1.1)	Unintentional deflection	E / P	Frequent and difficult to predict human behavior
Action of forces in the direction of movement	Increase in moment	D	Increases the severity of the consequences in the event of failure

Source:authors, 2026.

Direct link between EN 1777 and Table 4

Link between EN 1777 and assessed risks (D × E × P)

Table 7

Linking EN 1777 to assessed risks (D × E × P)

Risk (Table 4)	Article of EN 1777	Link to standard	Rationale for D × E × P rating
Overturning of the hydraulic platform	Stability, overturning moments	Load, wind, movement	High D, medium E, P influenced by terrain
Wind impact	Calculation of wind forces (1.1)	Side load	Increased P, medium E
Overloading of the basket	Nominal load	Limit load	High D, P dependent on discipline
Firefighter falling from the basket	Manual forces of persons	Change of center of gravity	Combination of high D and E
Swinging of the boom	Dynamic effects (0.1)	Moving forces	Increased E
Collision with an object	Platform movement	Arm dynamics	Medium D and P
Falling objects	Manual forces	Secondary load	Medium D, higher E

Source: authors, 2026.

7.1 Explanation of a specific example

For example, the risk of wind impact (R = 18, medium risk), the EN 1777 standard requires the consideration of wind loads with a factor of 1.1, which ensures the static stability of the structure, Table 5,6,7. However, in real intervention conditions, the wind:

- acts irregularly,
- changes over time,
- interacts with the movement of the boom and the behavior of people in the basket.

For this reason, the following values were chosen in the D × E × P table:

- E = 3 (frequent occurrence),
- P = 2 (probable occurrence),

which justifies the classification of the risk as a medium risk level, despite the standard compliance with the EN 1777 requirements. The STN EN 1777 standard determines the technical limits of safe operation of hydraulic platforms, however, only their transformation into the parameters of the D × E × P method allows an objective assessment of the risks resulting from real intervention conditions, activity dynamics and the human factor.

ACKNOWLEDGEMENTS

KEGA 037TUKE-4/2024 Creation of interactive tool for increasing of students' skills and competences in teaching of study subjects relating to elaboration of drawing documentation.

REFERENCES

Portál Minv.sk. Hasičský a záchranný zbor. (2026) [online] https://www.minv.sk

Markova, I., Bernatík, A. (2023) *Special Issue: "The Design and Optimization of Fire Protection Processes",* Processes 2023, 11(12), 3338; https://doi.org/10.3390/pr11123338

MinKyung, Ch.MoonSoo, S.HongSik, Y. JungGyu, K. JooIee,Y. (2026) *Risk Analysis of Firefighting and Rescue Operations in High-Rise Buildings: An Exploratory Study Utilising a System Dynamics Approach,* Fire, 9(1), 25; https://doi.org/10.3390/fire9010025

Raková, J. a kol. (2023) Hasiči - Spravodajca protipožiarnej ochrany a záchrannej služby. Bratislava: Ministerstvo vnútra SR-Prezídium Hasičského a záchranného zboru, ISSN 1335-9975.

Sloboda, A. Palúch, B. Svetlík, J.Monoši, M. (2021) *Hasičská technika I.,* Košice: elfa, 2021, ISBN 978-80-8126-185-5.

Monoši,M.Sloboda,.Svetlík,J.Lendelová,J.Žitňák,M.Pačaiová,H.Balážiková,M.Uherek,J .Sloboda,O.(2023) *Hasičská technika 2.,* Košice : Vienala - 2023. - 480 s.. - ISBN 978-80-8126-213-5.

Portál pozary.cz ohnisko žhavých zpráv. [online] [cit. 26.1.2026]. dostupné na internete: https://www.pozary.cz [accessed: 11 Jun 2024].

Portál hzscr.cz Hasičský záchranný sbor České republiky. [online] [cit. 11.03.2024]. dostupné na internete: https://www.hzscr.cz, [accessed: 11 Jun 2024].

STN EN 1777: 2010 (92 0607) Vysokozdvíhacie hydraulické plošiny (HP) pre hasičské a záchranné služby. Bezpečnostné požiadavky a skúšky.

STN EN ISO 12100:2011 Bezpečnosť strojov. Všeobecné zásady konštruovania strojov. Posudzovanie a znižovanie rizika.

STN EN 14043 Vysokozdvižná automobilová technika pre hasičskú a záchrannú službu. Otočné rebríky s kombinovanými pohybmi. Bezpečnostné a prevádzkové požiadavky a skúšobné metódy. https://normy.normoff.gov.sk/norma/119012/

STN EN 14044 Vysokozdvíhacia automobilová technika pre hasičskú a záchrannú službu. Otočné rebríky so sekvenčnými pohybmi. Bezpečnostné a prevádzkové požiadavky a skúšobné metódy. https://normy.normoff.gov.sk/norma/119013/

STN EN 280-1 Pojazdné zdvíhacie pracovné plošiny. Časť 1: Konštrukčné výpočty. Kritériá stability. Konštrukcia. Bezpečnosť. Preskúšanie a skúšky https://normy.normoff.gov.sk/norma/134710/

STN EN 280-2 Pojazdné zdvíhacie pracovné plošiny. Časť 2: Dodatočné bezpečnostné požiadavky na zdvíhadlá nákladu umiestnené na výsuvnej zdvíhacej konštrukcii a pracovnej plošine. https://normy.normoff.gov.sk/norma/134711/

Smernica 2006/42/ES (smernica o strojových zariadeniach).https://eur-lex.europa.eu/eli/dir/2006/42/oj

Vyhláška Ministerstva vnútra Slovenskej republiky z 20. novembra 2006 o hasičských jednotkách.https://www.slov-lex.sk/ezbierky/pravne-redpisy/SK/ZZ/2006/611/20250301

Authors' Contribution

All authors contributed equally to the development of this article.

Data availability

All datasets relevant to this study's findings are fully available within the article.

How to cite this article (APA)

Tomašková, M., Balážiková, M., & Maláková, S. (2026). MULTI-CRITERION ANALYSIS OF SAFETY PRINCIPLES FOR OPERATING HYDRAULIC PLATFORMS IN THE FIRE DEPARTMENT. Veredas Do Direito, 23(4), e234931. https://doi.org/10.18623/rvd.v23.n4.4931