

PERSONAL PROTECTIVE EQUIPMENT AND ITS IMPORTANCE

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Abstrakt:

Príspevok poukazuje na osobné a ochranné pracovné prostriedky a ich vplyv na bezpečnosť a ochranu zdravia pri práci hasičov, ako súčasť najdôležitejšieho elementu pri záchrane osôb a majetku v akýchkoľvek podmienkach. V závere príspevku je analýza rizík pomocou zvolenej metódy podľa normy ISO TR 14121-2.

Abstract:

The contribution refers to personal and protective work equipment and their impact on fire safety and health at work as part of the most important element in rescuing persons and property under any circumstances. The conclusion of the contribution is the risk analysis using the selected ISO TR 14121-2 method.

The purpose of personal protective equipment is to protect employees from exposure to hazards without interfering with their health or hindering their work, being in conformity with relevant legislation in order to meet the requirements of the valid provisions hereof [1].

Employers provide personal protective equipment to employees when hazards cannot be eliminated or reduced by other technical means, collective protective measures or methods and forms of organization of work. If several hazards require the simultaneous wearing of more than one piece of personal protective equipment, the employer is obliged to provide employees with personal protective devices which can be combined with one another and assure effective protection against these hazards.

This paper describes personal protective equipment and its importance for firefighters in their work as part of rescuing persons and salvaging property in various conditions. The analysis of hazards is presented in the conclusion of the paper.

1 LAUNCH OF PPE ON THE MARKET

The process of launching PPE on the market is governed by the provisions on technical requirements for products. Current provisions on protection of employees using personal protective equipment (hereafter only as PPE) can be divided into four main groups:

- I. Legal regulations (acts, government regulations, etc.) of the SR,
- II. EU legal regulations for PPE,
- III. Slovak technical standards (STN, STN EN ISO),
- IV. Employer's internal rules (e.g. guidelines on the use of PPE, operating instructions, a collective labour agreement, etc.) [1]

pursuant to the Regulation of the Government No 117/2018 Coll. which lays down the details on technical requirements and conformity assessment procedures for personal protective equipment.

Before launching personal protective equipment on the market, the manufacturer or its authorized representative compiles the technical documentation to be submitted to the supervisory body in accordance with [6] on technical requirements on the products and conformity assessment.

According to Act No 56/2018 Coll. of the National Council of SR, PPE must have:

1 level of quality, 2 utility properties, 3 safety, 4 sizes, 5 trade name, 6 brands, 7 testing of a product and testing methods, 8 packaging, 9 marking of a product or identification with a label, 10 procedures of assessment of conformity of products with legal regulations or technical standards. The documentation must contain all the important information on the resources used by the manufacturer to provide conformity of personal protective equipment with the main requirements placed on it.

Technical documentation of the manufacturer includes:

- General and detailed drawings of a personal protective device completed, where necessary, with calculations and the results of product testing to the extent necessary to verify the conformity to the relevant general requirements,
- A complete list of main requirements for safety and harmonized Slovak technical standards or other technical specifications taken into account when designing a personal protective device,
- Description of control devices and testing equipment used by the manufacturer to check the conformity of production of a personal protective device to the harmonized Slovak technical standards or other technical specifications and to maintain the level of quality.

Before starting mass production of personal protective equipment, the manufacturer or an authorized representative ensures the EC-type testing by a notified body in compliance with applicable legislation.

The type testing is not required for personal protective equipment of a simpler design where it is assumed that the user can himself assess the level of protection provided by the personal protective equipment against individual minimal risks, whose escalating effects can be identified early and safely by the user.

Personal protective equipment can be divided into three categories of hazards depending on the requirements placed on PPE: [1].

Category 1 – Low-risk

- PPE of a simpler design

- The user is able himself to assess the level of protection against hazards which can be identified early and safely,
- Must be certified with conformity sign CE
- Type testing of samples is not necessary, declaration of conformity is sufficient, e.g. PPE protecting against exterior mechanical impact at temperatures of 50 degrees C, climatic influences which are not extreme, minor impacts or solar radiation (sunglasses).

Category 2 – Medium risk

- Other PPE which, by its nature, doesn't satisfy the definitions given in category I or III, is classified as category II,
- Type sample tests are necessary, e.g. gloves EN 388, protection against danger of mechanical injury.

Category 3 – High risk

- PPE designed to protect against life-threatening hazards or dangers which can cause serious and permanent health damage,
- the user cannot identify immediate danger in time,
- apart from the type sample test, quality control is necessary as it is defined by ISO standards and involves inspecting all of the PPE, e.g. protective gloves for members of firefighting squads or work with chemicals that could be spilled or released and cause serious damage to user's health (lethal danger), PPE for respiratory protection, protection above the temperature of 100°C or lower than –50°C and all PPE to protect from falling from height and hazards caused by electrical voltage.

The Declaration of Conformity is created by the manufacturer that certifies the safety of the product. The CE marking indicates that the product is safe and meets the applicable requirements.

Pursuant to the Directive of the President of the Fire and Rescue Corps No 64/2002 Coll. paragraph 2, members and employees are provided with protective equipment according to their job position and a guide list for provision of protective equipment adopted based on the assessment of dangers associated with individual activities carried out by the Corps. “[8]

1.1 CLASSIFICATION OF PERSONAL PROTECTIVE EQUIPMENT

PPE must be designed and manufactured in such a way as to facilitate its correct positioning on the user and to remain in place for the foreseeable period of use, bearing in mind ambient factor, movements to be made and postures to be adopted.

PPE can be divided into the following groups OOPP:

- full-body protection,
- foot protection,
- hand protection,

- trunk and abdomen protection,
- head and face protection,
- respiratory protection,
- skin protection,
- protective accessories of certified PPE [1]

1.2 CRITERIA FOR SELECTION AND ASSESSMENT OF PERSONAL PROTECTIVE EQUIPMENT

PROTECTIVE HELMET

Tab.1 Hazards against which personal protective equipment has to protect: [5]

Hazards	Causes and types of hazards	Criteria and measures for safety and production of PPE
Mechanical	- falling objects , impacts - side clamping	- ability to absorb impacts - lateral strength and - resistance to punching
Electrical	- low voltage	- electrical insulation
Thermal	- cold or heat	- retaining protective properties at low and high temperatures
Unrecognizability	- insufficient recognisability	- warning or light reflecting colour

PROTECTIVE GOGGLES AND FACE SHIELDS

Tab.2 Hazards against which personal protective equipment has to protect:

Hazards	Causes and types of hazards	Criteria and measures for safety and production of PPE
Non-specific	- penetration of small foreign objects with low energy	- lenses with sufficient mechanical strength and resistance to impact and smashing - tightness and resistance
Mechanical	- particles with high energy, e.g. shatters, chips, spattered fluid	- mechanical ruggedness
Cold	- impact of the cold on eyes and neighbouring parts of the body	- personal protective equipment fitting tightly against the face
Chemical	- irritation caused by gases, fumes, vapours, solid and liquid substances	- tightness, side protection and chemical resistance

HEARING PROTECTION

Tab.3 Hazards against which personal protective equipment has to protect:

Hazards	Causes and types of hazards	Criteria and measures for safety and production of PPE
Noise	- permanent noise - impulsive noise	- sufficient reduction of noise for the relevant type and frequency of noise

RESPIRATORY PROTECTION

Tab.4 Hazards against which personal protective equipment has to protect:

Hazards	Causes and types of hazards	Criteria and measures for safety and production of PPE
Effect of dangerous substances in inhaled air	- solid and liquid substances (particles) polluting air (dust, smoke, vapour), gas, fumes	- filter for collecting particles with required effectiveness (level of filtration) corresponding to concentration, toxicity, hazard and size of particles - special attention should be paid to liquid particles
	- gasses and fume polluting air	- choice of a suitable type of anti-gas filter and level of filtration that correspond to the concentration, toxicity, hazard, the required time of use and the nature of work
Lack of oxygen in inhaled air	- oxygen fixation - oxygen extrusion	- provide supply of oxygen by personal protective equipment - take oxygen capacity in the personal protective equipment into account with respect to the time of its use.

PROTECTIVE GLOVES

Tab.5 Hazards against which personal protective equipment has to protect:

Hazards	Causes and types of hazards	Criteria and measures for safety and production of PPE
General	- by contact - stress state during use	- covering the skin - resistance against tear, elongation and wear
Mechanical	- rough, pointy and sharp objects - impact, hit	-resistance against penetration, puncture and cutting – damping properties
Thermal	- hot or cold materials, temperature of the environment, - contact with naked flame	- insulation against heat and cold - non-flammability, fire-resistance
Electrical	- electrical voltage	- electrical insulation
Chemical	- effects of chemicals	- impermeability , resistance
Vibrations	- mechanical vibration	- absorption of vibration
Contamination	- contact with radioactive materials	- impermeability easy decontamination, resistance

PROTECTIVE FOOTWEAR

Tab. 6 Hazards against which personal protective equipment has to protect:

Hazards	Causes and types of hazards	Criteria and measures for safety and production of PPE

Mechanical	- objects falling on the front part of the leg which can injure it - fall and impacts on the heel - fall as a result of slipping - stepping on sharp or pointy objects - effects on individual parts of the leg: • shin bone • ankle • instep • foot	- solid front part (shoe's toe) of the footwear - ability of the heel to absorb energy - strengthening of the instep - anti-slip properties - puncture resistant sole , - effective protection of individual parts of the leg
Electrical	- low and medium voltage - static electricity	- electrical insulation - static charge lead
Thermal	- cold or heat	- thermal insulation against cold or extreme heat
Chemical	- harmful or dangerous fluids or dust	- impermeability, resistance
Excessive wear and tear	- excessive standing or walking	- shaping the insole of the footwear

PROTECTIVE CLOTHING

Tab.7 Hazards against which personal protective equipment has to protect:

Hazards	Causes and types of hazards	Criteria and measures for safety and production of PPE
General	- contact - tear and wear	- covering of the body - resistance against wear and tear, tear propagation, stability in size
Mechanical	- tough, pointy and sharp objects	- resistance against penetration
Thermal	- hot or cold materials , temperature of the environment - contact with naked flame – effects of welding work	- Insulation against heat and cold - inflammability, fire-resistance - protection and resistance against radiation and splattering molten metal
Electrical	- electric voltage	- electrical insulation
Chemical and biological	- chemical and biological effects	- impermeability, resistance against chemical and biological influences
Humidity	- permeability of water	- waterproof
Indistinguishability	- insufficient distinguishability of clothing	- bright or light reflecting colours
Contamination	- contact with radioactive material	- impermeability, easily decontaminated, resistant

2 EFFECT OF PPE ON MINIMIZATION OF HAZARDS

Personal protective equipment provided to employees by the employer must ensure effective protection against existing and also foreseeable danger and must not increase the risk. The following tables provide an assessment of the risks of a rescue firefighter, pointing out the importance of using personal protective equipment. At the end of the article, it is stated that when choosing personal protective equipment it is necessary to place particular emphasis on the safety and health of firefighters, who are an essential component in saving people.

Tab.8 Point-to-point safety margin assessment

Category of hazard	HAZARD	Point range	Safety assessment (criteria)
1	Moderate	1 - 4	Acceptable safety
2	Serious	5 - 10	Acceptable risk paying increased attention
3	Unacceptable	11 - 50	Risk cannot be accepted without protective measures

Tab. 9 Assessment of hazards for a firefighter - rescuer using risk matrix [9]





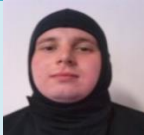


Hazard	Description of danger	P	D	R	Importance of PPE in terms of hazard	
					Yes	No
Mental burden: Physical and mental stress, neurosis, depression, cardiovascular diseases	Repetitive stress increases physical and mental resistance, but up to a certain extent. Physical performance declines with age along with the amount of mental stress that can be handled. The amount of accumulated experiences grows with the increasing number of stressful experiences.	4	2	8		✓
Cardiac arrest, heart muscle paralysis and interruption of blood circulation, damage of tissue	As electrical network is, as a rule, earthed, touching a conductor with high voltage causes a current flow through the body.	2	4	8	✓	
Direct contact with flame, or exposure to extreme thermal	Skin temperature rises in extreme thermal conditions, heat activity and perspiration increase	2	5	10	✓	




conditions						
Death caused by suffocation due to lack of air – spasms of vocal cords, hypothermia, infection	Suffocation in the environment with content of dust particles, aerosols, in premises with gas fire extinguishing systems, in inadequately ventilated premises	2	5	10	✓	
Burns : severe pain in the injured area and around it, erythema and possible swelling in the affected area, blisters, signs of shock	When fire is extinguished by spraying water or mists, there is a lot of water vapour in the air under pressure and because of that hot gasses can penetrate through all layers of protective clothing including underwear and hood.	2	5	10	✓	
Overheating : exceeding the maximum body temperature, increase in pulse frequency	Acute risk of overheating during firefighting or rescue operations depends on the type of clothing, time and intensity of the electrical load, the temperature of the surrounding environment is influenced by radiant heat and direct solar radiation.	3	4	12	✓	
Mechanical injury of lower limbs : from sharp edges	During rescue operation there is a risk of injuries from sharp edges, broken windows, protruding structures	2	4	8	✓	
Landslide and Collapsing	Landslide can occur during the operation on flooded slopes, in excavation or building pits where walls are not reinforced or tightened, in old shafts, in bulk material containers, etc.	3	4	12		✓
Collapse of a structure	Injury and burying of people and firefighters in the debris of falling structures, suffocation of people, drowning of people trapped in the debris of buildings.	3	4	12	✓	
Hazards from road accidents	Might occur when dealing with the consequences of fire accidents of transport vehicles, in buildings next to busy roads with heavy traffic flows, road incidents, leakage of dangerous substances from vehicles, natural calamities	2	3	6	✓	

	and impacts of natural environment				
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It is important to be aware that personal protective equipment itself can increase risks. [4,8]

Tab.10 Possible risks from protective equipment

Name of PPE	Main parts of PPE	Safety requirement	Hazards
Helmet 	Shell	Protects a firefighter against direct injury of head by shards, water, heat, electric current, chemical substances	Reduced audibility, reduced feeling of temperature
	Head-gear system 	Protects the head from contact with the head-gear system, absorbs the effects of dynamic stress caused by particles falling on the firefighter's head.	Loose fitting of the helmet, when bending forward moves or even falls off the head
	Neck shield 	Provides protection of the back part of the neck against penetration of particles under the clothes.	Insufficient protection of the back part of the neck, penetration of water, ashes or other particles under clothes
Helmet accessories (shield, goggles)		Eyes and full face protection	Injuries of the cheek bone, only partial covering of the face and eyes
Hood		Protection against thermal effects and burns of firefighter's skin.	Injury of skin on the unprotected part
Firefighter's clothing		Protection against external influences (mechanical, chemical, against thermal radiation)	Hazards to the body include: Flame, spattering of liquid metal, risk of being hit by solid particles, cut by a chain saw, cold, etc. Worn-out braces that don't hold up trousers, the possibility of falling, the possibility of flammable parts falling into pockets.
Firefighter's pants		Protection in terms of ergonomics includes material, comfortable wear, surface quality, design, weight, the lowest possible while maintaining the strength.	
Firefighter's coat			

Firefighter's gloves		Protective gloves must be designed and manufactured taking into account foreseeable conditions of their use for the purpose for which they are intended to enable the user to carry out the required activity .	Hazards which could expose hands to danger are the following: Mechanical danger, heat, fire, cold, ionising radiation, electricity
Firefighter's footwear		Based on the requirements of safety and health protection at work as well as mechanical properties and hygienic factors.	Untied laces may get caught on something and cause falling, not fully buttoned zipper can cause penetration of water or other particles into the footwear, wrong size can cause blisters and pain.
Breathing apparatus		As work activities pose various hazards, the choice of this personal protective equipment requires expertise. When protective equipment is used for protection of respiratory tract against hazardous substances that may damage health, it is essential to consider its efficiency, capacity, time spent in the polluted environment.	Free holding of the device can cause loss of the firefighter's stability, obstruction of movement (get hit when leaning forward)

Tab.11 Lack of personal protective equipment resulting from the experience of HAZZ personnel at a particular fire station

Firefighter's personal protective gear /HAZZ –particular fire brigade /[9]	What hazards do they protect against?	Drawbacks of PPE based on firefighters' experience
Protective helmet Mask Dräger with a quick-fastening to the helmet	<ul style="list-style-type: none"> ✓ impact, ✓ puncture, ✓ deformation, ✓ protection of head against contact with electrical conductive parts , ✓ against injuries caused by chemical 	<ul style="list-style-type: none"> ✓ Type-Dräger, changes colour depending on the temperature, ✓ Articulated joints on fastening clamps break, ✓ Springs in the

	<p>substances, ✓ against temperatures ,</p>	<p>expiratory valve often snap</p>
<p>Mask OM - 4, Mask OM - 5,</p>	<p>✓ Protect respiratory tract against the risk of inhaling dangerous substances in the air</p>	<p>✓ Plastic eye protection lens is scratched during a firefighting operation and the visibility is bad , ✓ Midpoint is not suitable in terms of visibility, ✓ Distorted peripheral vision It is advisable to replace plastic lens with a glass one.</p>
<p>Protective clothing FIRE man 4 FIRE man 5 Type: Diamond</p>	<p>✓ Protects the whole body against the risks posed by high temperatures or exposure to chemical substances</p>	<p>✓ Heat removal is difficult, ✓ At high temperatures the lining cannot be removed The drawback was resolved in the newer type Problem with impregnation Without lining, without layer protection</p>
<p>Protective footwear Type: KRAL Type: HAIX Type: ZEMAN</p>	<p>✓ Provide protection to lower limbs against hazards to firefighters from moving around in the dangerous environment, against puncture, high temperatures, when entering spilled solutions of chemically aggressive substances</p>	<p>✓ Water permeability No drawbacks No drawbacks</p>

Gloves	Protects against contact heat, Against exposure to open flame, Radiant heat, Against penetration of water, Against mechanical hazards , etc.	✓ Water permeability of gloves
Self-contained breathing apparatus	Provides clean air for breathing in harmful environment	The valve freezes

Conclusion:

At present, members of fire squads and departments, besides the vital work of firefighting, also work in a diverse range of other rescue services including road traffic incidents, major accidents, natural disasters, leakage of dangerous and radioactive substances, many other technical actions and rescue operations. Crucially, firefighters help prevent fire with comprehensive public information and play an important role in enhancing the safety of buildings against fire outbreaks. They often cooperate with police, rescue squads, medical ambulances and military forces in dealing with an emergency situation, which is why it is important to give proper consideration to the hazards imposed by this work and provide firefighters with appropriate PPE to provide safe working conditions and protect their health.

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