

Utilizing Protective Clothing for Construction Workers: Safeguarding Against Hazards on the Construction Site

Jerzy OBOLEWICZ^{*1}, Adam BARYŁKA²

¹Institut Naukowy Inżynierii Bezpieczeństwa Obiektów Antropogenicznych, Poland;
International Academy of Applied Sciences in Lomza, Poland

²Military University of Technology, Warsaw, Poland

Abstract

Performing construction works requires from the employee not only appropriate knowledge and practical skills related to a given profession, but also basic knowledge about safety and health protection. The article characterizes protective clothing as the basic type of personal protective equipment and proposes a procedure for its correct selection.

Key words: construction, construction site, dangerous and harmful factors, protective clothing

1. Introduction

Performing construction works requires from the employee not only appropriate knowledge and practical skills related to a given profession, but also basic knowledge about safety [1,4,10,14] and about the functioning of one's own body, about all processes taking place in the human body and about the conditions for maintaining health [3,6,7]. According to a generally accepted definition, health means a state of complete physical, mental and physical well-being. This definition defines health as a positive value that includes many different elements.

The built environment (popular construction site), understood as the place where construction works are carried out, is a specific environment. Specific conditions for the implementation of construction structures make the construction process significantly different from processes in other industries [10].

The significant dispersion of construction works in the field significantly distinguishes construction from industrial production. In industrial production plants, workstations are concentrated close to each other, usually in closed rooms, which allows for stable production organization. In construction, however, the workstations of individual teams are distant from each other and located in different places or on different facilities. This makes it difficult to organize work and use permanent organizational structures.

The individual nature of each construction site is another specific feature of this sector. Practically, it can be said that each construction object (e.g. building, viaduct, bridge, excavation, embankment, road) is built according to a different individual design, technology and organization - it has an individual character. Facilities constructed according to the same technical and organizational design have different locations, different soil and water conditions of foundation, weather conditions accompanying the execution of works, different conditions of material supply and usually a different team of employees carrying out the execution tasks. All this means that each construction site must be planned individually, adapting to environmental conditions. Different construction sites influence the use of different methods of organizing deliveries and storing materials and equipment. They may result in failure to maintain safe and hygienic working conditions.

* **Corresponding author:** E-mail address: (obolewiczjerzy@gmail.com) Jerzy OBOLEWICZ

Constant changes in the location and size of construction sites make it difficult to maintain the required level of labor protection there.

The individual nature of each construction makes the use of industrial production methods much more difficult. In the history of Polish construction, attempts have been made to use industrial organization systems characterized by repeatability and mechanized production. In this way, a large part of the construction process was transferred to the so-called house factories. It was a repeatable assembly line production, at fixed workstations, with previously prepared tools and equipment. However, it required expensive transport of prefabricated elements from the factory to the construction site. Although prefabrication is currently used less frequently, its advantages resulting from the possibility of using industrial production methods remain valid.

The durability of construction site processes is another important specificity of construction. The effects of construction works are usually visible after they are completely completed and the facility is put into use. This requires the investor and the contractor to have the necessary financial resources for the entire construction period and to freeze the funds for a longer period (including the winter period) and recover them after the works are completed.

The long period of operation of buildings process that construction entrepreneurs should not only implement new technologies, but also maintain the ability to use old ones. The use of construction techniques and technologies that are no longer used today may prove indispensable, for example, during renovations of old buildings.

Each building object is permanently (less permanently in the case of temporary structures) connected to the ground. The property of construction products must be taken into account in the organization of works. The building is permanent, but the workplaces are constantly changing. Such organization does not allow for permanent instrumentation of the workstation, equipment, tools, measuring instruments, etc., or for adapting the workstation to health and safety requirements and the ergonomic needs of the employee. Construction workers are constantly moving from one job to the next. This requires the organization of these positions each time, which depends mainly on the skills of him and his direct superior (foreman or foreman). The immobility of construction products means that each construction facility requires appropriate development of the construction site: warehouses, administrative and social rooms, water and electricity supply, fire protection, etc. Such development is organized at each construction site and is liquidated after the works are completed. In industry - in permanent factory buildings - there are also permanent facilities: warehouses, cloakrooms, washrooms, water installations, electricity networks, etc.

Another specific feature of construction is *the large dimensions and considerable mass of construction's objects*. Moreover, relatively long construction cycles require the involvement of a significant amount of materials and the work of people and equipment, and masses of materials, semi-finished products and semi-finished products must be delivered and installed safely to the construction site. Such activities require the involvement of appropriate means of horizontal and vertical transport and a diverse team of employees.

The specific nature of construction means that the environment in which a construction worker works affects his body. The human body receives stimuli through the nervous system and responds to them with various adaptive reactions. External conditions affecting a construction worker may be natural or artificial. An example of natural conditions is the influence of climate, understood as a system of temperature, wind and air pressure. Artificial conditions, on the other hand, are conditions that the employee creates for himself in order to perform work or to make it easier or more enjoyable. Taking into account the specificity of construction, the health of a construction worker can be defined as the state of relative balance of his body to variable stimuli of the external environment.

The main goal of safety and health protection on construction sites is to create conditions for each employee that would completely exclude or limit as much as possible the possibility of any threat to health or life [5]. Everyone working on a construction site must be provided with such working conditions that their performance does not expose them to danger or disease and does not excessively burden their body.

2. Employee's personal protective equipment – PPE

One of the ways to ensure proper working conditions is employees' *personal protective equipment (PPE)*, including protective clothing and work clothes [8,9,11,12]. *PPE* is used in working conditions where it is not possible to eliminate threats to the life and health of workers by introducing organizational and technical measures. The purpose of *PPE* is to protect the employee against mechanical injuries (impacts, cuts), harmful effects of poisonous, corrosive and scalding substances, electric shock, open flame, thermal radiation and splatters of hot or liquid metal, against the effects of noise, vibrations and shocks, and getting wet. and low

temperatures, falling from a height and slipping, etc. Using *PPE* on construction sites is burdensome. They restrict freedom of movement (protective and work clothes), make vision difficult (glasses), sometimes make communication impossible (ear protection), etc. However, there are certain construction works that cannot be performed without PPE. These works include sewer works, gas tank repairs, work at heights, etc.

In terms of design and general purpose, PPE is divided into nine groups, i.e.:

- protective clothing, including: abdominal, chest and shoulder protectors;
- lower limb protection measures, including: foot protectors, safety shoes, knee protectors;
- upper limb protection measures, including: elbow and hand protectors;
- head protection measures, including: helmets;
- face and eye protection measures, including: goggles;
- hearing protection equipment, including: earmuffs, anti-noise earplugs;
- respiratory protection measures, including: dust masks;
- measures that isolate the entire body, including: gas-tight suits;
- measures to protect against falls from height, including: helmet, harness, ropes [8,9,11,15].

PPE also includes:

- assemblies consisting of several devices or types of equipment that have been connected together to protect humans against one or more simultaneous threats;
- protective devices or equipment, combined with non-protective personal equipment worn or held by a person in order to perform specific activities;
- interchangeable components of personal protective equipment that are essential for their proper functioning, used only for such equipment.

However, PPE does not include:

- uniforms that are not specifically designed to ensure the safety and health of the employee;
- personal protective equipment used by the army, police and other public order services;
- equipment used by rescue services;
- personal protective equipment used pursuant to the provisions of the Road Traffic Law;
- sports equipment;
- measures for self-defense or deterrence;
- portable devices for detecting and signaling threats and violations of public order.

2.1. Protective clothing

An employee starting work should be equipped with protective clothing and/or work clothes [9,14,15]. Protective clothing protects the employee against the effects of dangerous and health-damaging factors occurring in the work environment or reduces their effects. However, work clothes are intended for work that may involve contamination with substances that are not harmful to health, factors that may accelerate the destruction of clothing, or special conditions for the protection of the manufactured product, e.g. hygienic or antistatic, may be required. However, work clothing (unlike protective clothing) does not protect the employee against threats and is not marked with the CE marking.

In the construction work environment, there are factors that are dangerous or harmful to health, so the construction worker must wear protective clothing. Protective clothing protects him against the influences of the construction environment, i.e. mechanical, chemical and thermal. Protective clothing includes: coats, capes, jackets, overalls, front aprons, sweatshirts, clothes, trousers, vests, chest protectors, abdominal and torso protectors, hoods, hats, caps, berets, cones, scarves, hat covers and others [14,15].

Protective clothing is available to employees working in conditions in which they are exposed to: atmospheric factors harmful to health, water and rain, low temperatures; chemical factors, dust, hot factors (thermal radiation, flames, sparks, molten metal splashes), mechanical factors (splatters of metal, wood and plastics), electromagnetic radiation (including microwaves), ionizing radiation (X-ray, nuclear), accumulating electrostatic charges or the possibility of electric shock.

Protective clothing is marked according to its intended use. These are graphic symbols placed on labels permanently attached to clothes. Marking of protective clothing should include the following information: type of product; name, manufacturer's mark; clothing size; number of the standard whose requirements the clothing meets; graphic symbol and protection class; maintenance method.

In accordance with the requirements of the Labor Code [13], the employer is obliged to provide employees with free protective clothing protecting against the effects of dangerous and harmful factors occurring in the work environment and to inform them about how to use these means.

The most typical construction works during which protective clothing should be used include work performed under exposure to weather conditions, water, high and low temperatures; chemical and dust factors; mechanical and biological, including in particular:

- outdoor work – exposed to rain and cold;
- work in low temperature conditions;
- carrying or being near high-temperature loads and working at high temperatures;
- work in channels, trenches, ditches, underground crypts, wells, tanks and other similar places - with exposure to damp or wet horizontal or vertical partitions;
- welding, forging, demolition works, dismantling;
- work in contact with objects with rough surfaces, sharp edges and others posing a risk of injury;
- cleaning and sandblasting of building facades or construction products;
- work at risk of the body getting wet or clothing soaking through as a result of using water, liquid masses, oils, fats or liquid, moist, oily or greasy substances;
- work at risk of body contamination with rottable or infected substances or waste;
- work during which employees must be visible, including work performed in places with increased vehicle traffic, e.g. during road works [13,14,15].

Protective clothing should be issued to workers in kind. It is unacceptable to pay employees a cash equivalent, as labor law provisions do not provide for the possibility of such payment.

In the event of loss or destruction of protective clothing, the employer is obliged to immediately provide the employee with other clothing provided for by law. If the loss or destruction of clothing is due to the employee's fault, he or she is obliged to pay an amount equal to the unamortized part of the value of the lost or damaged clothing. The employer may reduce this amount if the circumstances of the destruction justify it.

Due to the specificity of construction, special attention should be paid to clothing protecting against bad weather and clothing protecting against cold.

Clothing that protects against bad weather is required when working outdoors.

The outer material determines whether thermal clothing is intended for work in closed or open spaces. Warm clothing for working in open spaces should also protect the employee against precipitation and wind [2,5]. It should be rainproof or waterproof and have low air permeability. Warm clothing intended for use in open spaces may be classified as class I or II due to the fabric properties related to water permeation. In class I (lower class) heat-insulating clothing, the outer fabric is only rain-resistant. Its water absorption after rain for 10 minutes should be no more than 30%. Waterproof fabrics are used for this type of clothing. Such clothing is intended for work during which the employee is not exposed to very intense rainfall and does not stay outdoors for too long. For work in difficult weather conditions, where the employee is exposed to intense precipitation, class II clothing should be selected, in which the outer fabric should be waterproof above 80 hPa. Materials coated with rubber, polyvinyl chloride or polyurethane are used for this type of clothing.

Clothing protecting against cold should be used for work performed at low temperatures. The purpose of clothing for work in a low-temperature environment is determined by the thermal insulation of the clothing [2, 5, 15]. Clothing protecting against cold should meet the requirements of European standards EN 342:2004:2004 (for clothing used at temperatures below -5oC) or EN 14058 (for clothing used at temperatures down to -5oC).

2.2. Rules for selecting protective clothing

Protective clothing should be used in situations where threats cannot be avoided or cannot be sufficiently limited by means of collective protection measures or appropriate organization of work on the construction site.

There is no perfect protective clothing that effectively protects against one or more types of hazards. You should look for solutions that provide effective protection and reduce the comfort of work as little as possible.

The sample procedure (Fig. 1) may be useful in selecting protective clothing for workers on a given construction site.

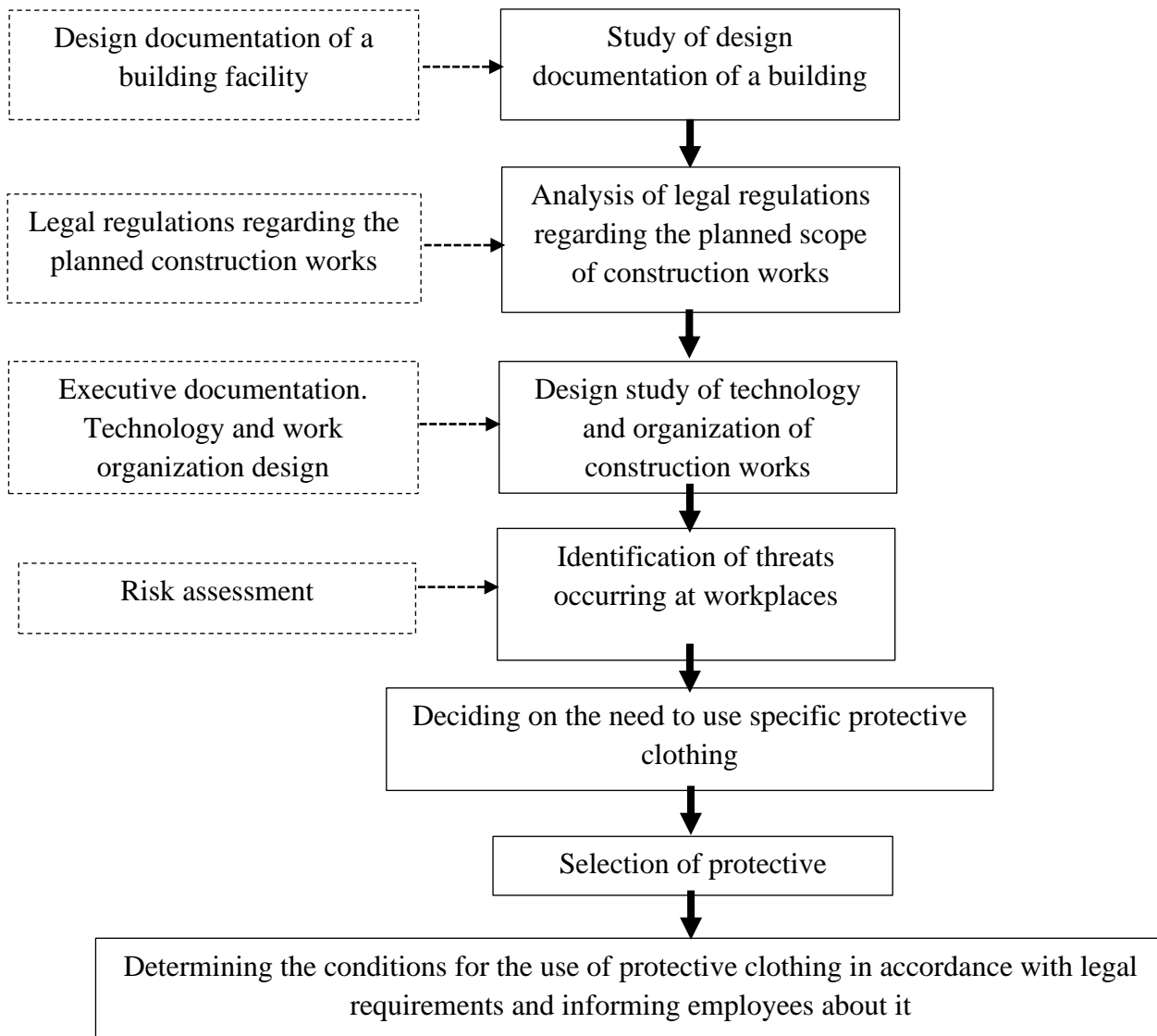


Fig. 1. An example procedure for selecting protective clothing for construction workers

When selecting protective clothing, it is very important to analyze the threats occurring at workplaces during the implementation of individual works in the construction process. Its results enable decisions to be made regarding the protective properties of the materials from which it is made and its effectiveness.

For this purpose, using design and executive documentation (technology and organization design), it is necessary to identify threats that may occur during the implementation of individual works in the construction process and to assess the occupational risk. Please remember that an occupational risk assessment is mandatory.

Occupational risk assessment is nothing more than: carefully looking at the work performed and the place where it is performed and determining what factors may have an adverse impact on the health of employees and determining whether the risk associated with the impact of these factors on the employee is:

- permissible - this is the case if sufficient measures have been taken to protect employees against the impact of these factors, e.g. collective protection measures or appropriate work organization,
- unacceptable - further action should be taken and additional protective measures should be applied, e.g. assigning employees appropriate protective clothing.

Important issues in the process of selecting protective clothing that should be taken into account are:

- intensity and form of occurrence and duration of action of a harmful or dangerous factor;
- frequency of exposure of employees (disposable or long-term clothing);
- parts of the employee's body exposed to harmful factors;

- climatic conditions of the working environment;
- type of activities performed.

When selecting clothing, you should also take into account its proper fit to the figure and the range of movements and positions that the user may assume during work or other activity. The design of protective clothing should ensure that no parts of the body are exposed during expected movements of the user [8,9,15].

3. Summary

There are many models of protective clothing available on the market. The correct choice should be preceded by an occupational risk assessment, in particular the identification of harmful factors, their impact on the human body, exposure time and the required area of protection.

When selecting clothing, ergonomic aspects should not be ignored, such as the ability to perform work and the thermal comfort of employees. You should also remember about legal requirements, in particular about the compliance of clothing provided to employees with the requirements for CE marking.

Literature

1. Ejdyś J., Lulewicz A., Obolewicz J., Zarządzanie bezpieczeństwem w przedsiębiorstwie, Wyd. Politechniki Białostockiej, Białystok 2008
2. Obolewicz J., Baryłka A., Szota M., Safe operation of buildings during the winter period, JAMME Volume 116, Issue 1, January 2023
3. Obolewicz J., Bezpieczeństwo i ochrona zdrowia jako element zarządzania organizacjami, [w:] Dylematy organizacji gospodarczych – Teoria i praktyka początku XXI wieku, Wyd. Difin, Warszawa 2011
4. Obolewicz J., Identyfikacja bezpieczeństwa i ochrony zdrowia w przedsiębiorstwach budowlanych, [w:] Warsztaty Inżynierów Budownictwa „Problemy przygotowania i realizacji inwestycji budowlanych, Puławy 2007
5. Obolewicz J., Ochrona pracy na budowie, Promotor 3/2022
6. Obolewicz J., Wymagania dotyczące bezpieczeństwa i ochrony zdrowia w budownictwie, [w:] Wiadomości Projektanta Budownictwa nr 9(176)2005, Warszawa 2005
7. Obolewicz J., Zagrożenia zdrowia i życia w środowisku pracy, Inżynieria Bezpieczeństwa Obiektów Antropogenicznych ISSN 2450-1859 e-ISSN 2450-8721 nr ¾ (2017) s.30-35
8. PN-EN 13402-1:2002 Oznaczenie wielkości odzieży – Część 1: Terminy, definicje i sposoby pomiaru ciała
9. Pościk A., Klasyfikacja oraz dobór odzieży ochronnej, Promotor 3/2022
10. Projekt MNiSW realizowany przez Politechnikę Białostocką nr G/WBiIS/S/2010 nt. Identyfikacja stanu bezpieczeństwa i ochrony zdrowia w polskich przedsiębiorstwach budowlanych po wejściu do UE i zaprojektowanie modelu zarządzania bioz spełniającego europejskie kryteria jakościowe, ochrony środowiska, ergonomii i ochrony pracy, kierownik projektu J. Obolewicz, Białystok 2012
11. Rozporządzenie MPiPS z dn. 26 września 1997r. w sprawie ogólnych przepisów bezpieczeństwa i higieny pracy, zał. nr 2 (stan 2021)
12. Rozporządzenie parlamentu Europejskiego i Rady (UE) 2016/425 z dnia 9 marca 2016r. w sprawie środków ochrony indywidualnej oraz uchylenia dyrektywy Rady 89/686/EWG
13. Ustawa z dnia 26 czerwca 1974 Kodeks pracy (stan 2023)
14. Ustawa z dnia 7 lipca 1994 r. Prawo budowlane (stan 2023)
15. Zarządzenie Ministra Zdrowia i Opieki Społecznej z dnia 29 marca 1994 r. w sprawie zasad przydzielania pracownikom środków ochrony indywidualnej oraz odzieży roboczej