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**ENSURING THE PROTECTION OF THE CIVILIAN POPULATION
AGAINST THE DANGEROUS FACTORS OF ARTILLERY AND ROCKET
FIRES DURING COMBAT ACTIONS**

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Introduction. Over the last century and in view of the current events taking place on the territory of Ukraine, armed conflicts are increasingly taking place in populated areas (cities, urban-type settlements, villages, villages), which leads to an increase in risks for civilians who are in the area of hostilities actions, namely: the risk of death, injury or the need to leave their homes. Warring parties often avoid open confrontations with the enemy and, at the same time, mix with the civilian population. The use of explosive weapons in populated areas also creates a danger of humanitarian problems, which include immediate and long-term consequences for the lives and health of civilians, the impact on civil infrastructure, and the work of life support services for the population: medical assistance services, water supply, energy supply and other services.



Fig. 1. Destroyed residential buildings in Kharkiv as a result of artillery shelling.

It is not always possible to carry out timely evacuation measures from the combat zone, therefore there is a need to protect the civilian population from the dangerous factors of artillery and rocket fire that arise during hostilities.



Fig. 2. Kharkiv railway station in the first days of full-scale military aggression against Ukraine.

Aim. Currently, the normative document DBN B 2.2.5-97 "Protective structures of civil defence" provides for protective structures of civil defence, which

are intended for the shelter in peacetime of personnel assigned to the appropriate categories, who are hiding from the consequences of accidents, disasters, natural disasters, and threaten mass damage to people, as well as in wartime – from modern weapons of mass destruction [1, 2]. At the same time, Chapter 7 of the Civil Code of Ukraine defines the main measures for sheltering the population in protective structures of civil defence and carrying out evacuation measures. The issue of the order and mechanism of sheltering the civilian population in the combat zone is not specifically defined by the current legislation and has not been fully investigated.



Fig. 3. People from Kharkiv, who are hiding in the basements of their residential buildings from shelling.

Analyzing the data on the availability of the fund of protective structures of the civil defence of Ukraine, including unready and limited ready-to-use storages, anti-radiation shelters, dual-purpose structures, the simplest shelters, their overall quantitative sheltering capacity, the requirements of regulatory documents for the construction of new ones, the question arose of insufficient provided in accordance with the requirements with protective structures of civil defence, namely: civilian population of cities, towns and villages. The issue of the needs of low-mobility

population groups, workers of life support services, is almost not considered in DBN B 2.2.5-97 "Protective structures of civil defence" [3].

Materials and methods. The development and modeling of protective structures of civil defence, which are part of a complex of residential buildings of different floors, buildings of institutions of life support services, is an urgent scientific and practical task. These structures must be designed for the shelter and protection of the civilian population, workers, as well as for their reasonable adaptation, taking into account the needs of less mobile population groups, for protection from the dangerous factors of artillery and rocket fire. Modeling of dangerous factors of fire and evacuation of people, necessary stability of building structures, is proposed to be carried out with the help of PATHFINDER software, LIRA-SAPR, as well as methods of state standards of Ukraine [4].

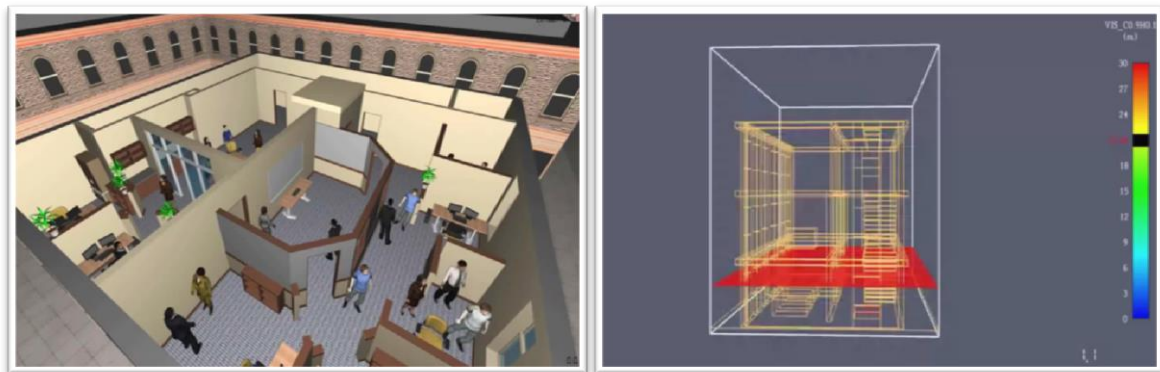


Fig. 4. Modeling the evacuation of people during a fire and the spread of dangerous fire factors in PATHFINDER and LIRA-SAPR.

The functionality of the PATHFINDER and LIRA-CAD software will allow you to solve the following issues at the design stage:

- optimal volumetric planning solutions;
- decoration, lighting conditions and the length of evacuation routes;
- requirements for mechanical resistance and stability, resistance to explosion and blast wave;
- sanitary, hygienic and ecological conditions;

- speed of human flow in the presence of furniture, equipment, means of life support; use of aids (sticks, prostheses, wheelchairs).

Conclusions. Using additional software PATHFINDER, LIRA-SAPR, we can solve the issue of designing modern safe storage facilities, which are part of a complex of buildings of various purposes, taking into account all the needs of the population.

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