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IDENTIFYING THE NEED FOR CIVIL PROTECTION SHELTERS IN EXISTING RESIDENTIAL AREAS

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To protect people from certain hazard factors arising from emergency situations in peacetime and the effects of weapons of mass destruction during special periods, civil defense and dual-purpose structures and the simplest shelters are used. The paper develops proposals for the planning of territories for civil defence shelters in existing residential areas. To achieve this goal, the authors analyse the basic requirements of the legislation on the creation of a fund of civil protection structures, provides recommendations for determining the construction objects suitable for inclusion in the fund of civil protection structures as the simplest shelters, as well as for their preparation, formulates the principles of spatial location of shelters for civil protection of the population and an algorithm for determining the need for such shelters. Among the main recommendations for determining construction sites suitable for inclusion in the fund of civil defense protective structures as the simplest shelters, it should be noted the analysis of the protective properties of enclosing structures from external ionizing radiation or the effects of air shock waves; the capacity of civil defense structures; the location of civil defense structures in relation to places of work or residence of the population; the availability of communications, etc. Local governments must periodically conduct an inventory of the existing fund of protective structures; determine the need for the fund of protective structures of civil defense, taking into account their actual condition; satisfy the needs of the fund of protective structures of civil defense; distribute the population among the existing structures of the fund of protective structures of civil defense, taking into account their capacity, state of readiness and location on the ground (taking into account the regulatory collection radii around such structures) and provide the population with information about the locations of protective structures of civil defense.

Key words: *civil defence, shelters, refuges, residential area.*

Гасенко А. В., Гасенко Л. В., Слонь В. В., Дарієнко В. В. До визначення потреби у сховищах цивільного захисту в існуючих житлових масивах

Для захисту людей від деяких факторів небезпеки, що виникають внаслідок надзвичайних ситуацій у мирний час, та дії засобів ураження в особливий період використовуються

захисні споруди цивільного захисту та споруди подвійного призначення і найпростіші укриття. У роботі розроблено пропозиції із планування територій для укриттів цивільного захисту в існуючих житлових масивах. Для досягнення поставленої мети виконано аналіз основних вимог законодавства щодо створення фонду захисних споруд цивільного захисту, наведено рекомендації щодо визначення будівельних об'єктів, придатних до включення до фонду захисних споруд цивільного захисту як найпростіших укриттів, а також щодо їхньої підготовки, сформульовано принципи просторового розташування укриттів для цивільного захисту населення і алгоритм визначення потреби в таких укриттях. Серед основних рекомендацій із визначення будівельних об'єктів, придатних для включення до фонду захисних споруд цивільного захисту у якості найпростіших укриттів, слід зазначити аналіз захисних властивостей огороджувальних конструкцій від зовнішнього іонізуючого випромінювання чи дії повітряної ударної хвилі; місткості (геометричних габаритів) споруд цивільного захисту; місць розташування споруд цивільного захисту по відношенню до місць праці чи проживання населення; наявності комунікацій (водопостачання, водовідведення, електропостачання, природної чи примусової вентиляції) тощо. Місцеве самоврядування повинно періодично проводити інвентаризацію наявного фонду захисних споруд; визначають потребу фонду захисних споруд цивільного захисту із урахуванням фактичного їх стану; здійснюють задоволення потреб фонду захисних споруд цивільного захисту; виконують розподіл населення по наявним спорудам фонду захисних споруд цивільного захисту із урахуванням їх місткості, стану готовності і розташування на місцевості (з урахуванням нормативних радіусів збору навколо таких споруд) і доводять до населення інформацію про місця розташування захисних споруд цивільного захисту.

Ключові слова: *цивільна оборона, укриття, сховища, житловий район.*

Introduction. To protect people from certain hazards arising from emergencies in peacetime and the effects of weapons of mass destruction in a special period, civil protection and dual-purpose structures and simple shelters are used. Under martial law in Ukraine, the issue of providing the population with temporary shelters (civil defence structures) is acute, requiring designers to come up with individual, non-standard solutions. In such cases, there are often no technical specifications and technological maps for the construction of civil protection shelters. Studying the principles of urban territory planning in order to allocate places for civil protection shelters is definitely an urgent issue. This is the reason for the expediency of the research.

Hnat, G.O. [6], Hnes, I.P. [7], Popovichenko, I.V. et al. [11], Adegov, O. et al. [1], Kuráň, J. [8] and Majorošová, M. [10] have dealt with the actual problems and tasks of housing policy in settlements. The design of civil defence shelters is discussed in Semyroz, N. [12], Celik, E. [4], Ghanbarzadeh G. et al. [5]. The choice of shelter location allows emergency services to immediately focus on assisting victims and survivors in the disaster area. Therefore, decisions about the location of shelters are crucial (Ma, Y. et al. [9]) and have a significant impact on how well relief efforts function. Researchers propose different models of shelter location: single-purpose, multi-purpose and hierarchical (Balcik, Burcu et al. [2]). Celik E. [3] proposed the DEMATEL approach as a causal model for the siting of temporary civil protection shelters. Song et al. [13] apply QUALFLEX as a multi-criteria decision-making method for selecting a site for a sustainable shelter. Yılmaz and Kabak [14] presented an AHP and TOPSIS approach using interval fuzzy sets to prioritize distribution centres in humanitarian logistics.

The purpose of this work is to analyse the general provisions of the organization of sheltering the population in civil protection facilities and formulates the principles for determining the need for civil protection shelters in existing residential areas.

Analyses of the general provisions for organizing the sheltering of the population in civil defense facilities. *Analysis of the main legislative requirements for the creation of a fund of civil defence protective structures for the organization of temporary*

shelter for the population. In accordance with Article 32 of the Civil Protection Code of Ukraine, the following buildings and structures or parts thereof are considered to be civil protection facilities: shelters; anti-radiation shelters; dual-purpose structures; simple shelters. The following requirements are imposed on protective structures for civil protection of the population:

1) protective structures must have structural strength in accordance with their class (class of protection against the impact of a shock wave) and be airtight;

2) protective structures must ensure continuous stay of people in them for at least 2 days;

3) protective structures must be located at a distance from the places of location of people they are intended to protect: no further than 500 m (for storage facilities) and no further than 1000 m (for radiation protection shelters);

4) protective structures should be used for a dual purpose: in emergency situations – to protect personnel, and in peacetime – for economic needs (as storage facilities, dressing rooms, emergency services, etc.);

5) no objects (warehouses, reservoirs) with hazardous substances and materials, main engineering networks, including heat and water supply, sewage, should be located near the protective structures, an accident on which may lead to injury and death;

6) free access to protective structures must be ensured, including for persons with disabilities and other groups with limited mobility.

The maintenance of civil protection structures in readiness for their intended use is carried out by their balance holders (business entities) at their own expense.

Recommendations for determining the construction objects suitable for inclusion in the fund of civil defence protective structures as the simplest shelters. The principles of the spatial location of civilian protective shelters include consideration of the geographical location of settlements, transportation routes, terrain and natural risks. Shelters should be located in such a way as to ensure maximum protection of the population in case of emergencies.

In order to protect the population from hazards and organize its life support, shelters must meet the following basic requirements:

1) to be located in the basement (underground), ground or first floor;

2) to be located close to the places of stay (work or residence) of the population to be sheltered, namely at distances that ensure the arrival of the population to the protective structure within 1 to 3 minutes from the receipt of a hazard notification;

3) not to be located near objects whose destruction may result in injury or death of the population to be sheltered;

4) not to be adversely affected by ground, surface, process or waste water;

5) to be provided with power supply, artificial lighting, water supply and sewage systems (if water supply or sewage facilities are not available, they must have separate rooms for installing remote sewage tanks);

6) do not have large openings in the external enclosing structures, the existing openings (except for doorways) provide for the possibility of sealing them;

7) to have at least two entrances (exits), one of which may be an emergency entrance (in case of planning a shelter with a capacity of up to 20 people, one entrance is allowed);

8) no water supply and sewerage lines, other main engineering communications (except for in-building engineering networks) pass through the premises intended for the stay of the population to be sheltered, the premises have a flat floor suitable for installing benches, other places for sitting or lying down;

9) no flammable, chemically and radiation hazardous substances are stored;

10) the height of the premises and parts of the facilities, such as doorways, is at least 1.7 m, and the distance to protruding parts of individual building structures and utilities is at least 1.4 m. The width of doorways shall be at least 0.8 m;

11) openings at entrances/exits shall be closed with reinforced doors made of non-combustible materials (metal or wooden, upholstered with iron) or protective screens (stone, brick or reinforced concrete) to a height of at least 1.7 m;

12) the premises must have forced or natural ventilation;

13) free access of persons with disabilities and other low-mobility groups is ensured or there is a possibility of retrofitting to ensure access within 12 hours;

14) the facility is in satisfactory sanitary and fire safety condition;

15) external enclosing building structures provide the normative coefficient of protection against gamma radiation in accordance with the requirements of DBN B 2.2.5-97 "Buildings and Structures. Protective structures of civil protection".

As a rule, the required protective properties are provided by facilities with walls 2 to 2.5 bricks thick or made of solid reinforced concrete structures (blocks, panels) at least 56 cm thick. A 67 – 78 cm thick soil layer also provides appropriate protective properties. For objects made of reinforced concrete or brick, the enclosing structures of which do not meet the above recommendations, it is possible to increase the protective properties by covering them with bags of soil (sand), filling the earthen bund when bringing the simplest shelters located in these objects into readiness for their intended use.

Recommendations for preparing the simplest shelters. In case of insufficiency of civil defence facilities, the majority of the population during a special period should be sheltered in the simplest shelters located in basements and ground floors of buildings and structures for various purposes: apartment and private residential buildings, administrative, industrial and commercial buildings or structures, and other underground premises.

Principles for determining the need for civil protection shelters in existing residential areas. *Principles of spatial arrangement of shelters for civil protection of the population.* The types of classification of territories based on the availability of civil defence shelters are shown in Figure 1.

The principles of the spatial location of civilian protective shelters include consideration of the geographical location of settlements, transportation routes, terrain and natural risks. Shelters should be located in such a way as to ensure maximum protection of the population in case of emergencies. Some of the principles of spatial arrangement of shelters include: location of shelters in the most populated areas; consideration of possible evacuation routes and transportation routes; ensuring accessibility of shelters for people with disabilities; avoiding the location of shelters in the area of possible natural disasters.

Algorithm for determining the need for shelters for civilian protection The general algorithm for calculating the shelter for the population and determining the need for the fund of protective structures, considering Resolution of the Cabinet of Ministers of Ukraine No. 138 (2017) is shown in the form of a flowchart in Fig. 2.

Planning of the territory for civil protection shelters in educational institutions on the example of a secondary school in Poltava. To assess the safety of schools, analyzed data on:

- geolocation of educational institutions;
- number of students and staff; the format of education;
- geolocation of explosions; proximity to infrastructure and military facilities;
- distance to the frontline;
- status of the community (occupied, active hostilities, possible hostilities).

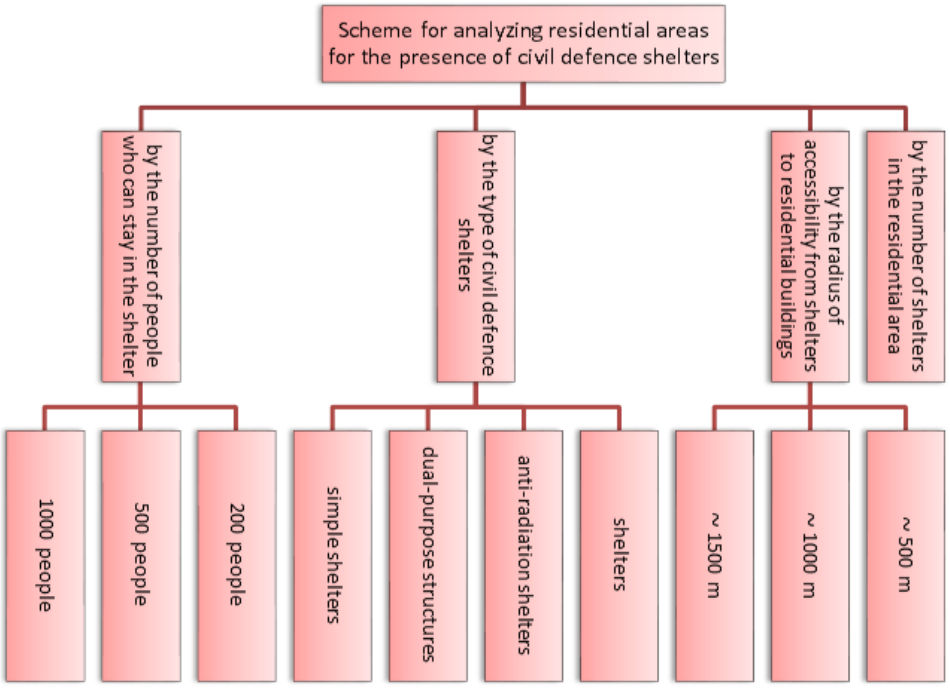

Fig. 1. Classification of residential areas according to the characteristics of shelters for civil protection

Source: compiled by the authors

In Ukraine, there are five levels of risk that determine the possibility of conducting offline learning:

1) incredible: areas with active hostilities or temporarily occupied;

2) very high: possible hostilities, schools are located up to 45 km from the frontline or the borders with Russia, Belarus or Moldova;

3) high: schools outside the area of artillery fire (up to 60 km from the front), but with a high risk of air strikes and proximity to infrastructure;

4) moderate: schools within 90 km of possible hostilities or up to 270 km from the borders with Russia, Belarus or Moldova;

5) satisfactory: schools in relatively safe environments where full-time education is possible.

The building of Poltava Secondary School No. 11 was constructed in the 60s of the twentieth century. Thus, the estimated age of the building is more than 50 years. Today, more than 830 students study there. The school building has three floors with an unused attic and is U-shaped. The overall dimensions of the building in the extreme axes are 66.8×38.8 m. The roof level at the highest point (above the assembly hall) is +14.150. The security risk level is satisfactory.

The Aviamistechko residential area with an estimated population of about 30 thousand people is located around the school. On the territory of the said residential area there is also a children's clinic with up to 300 staff and visitors, a children's art school with up to 150 staff and visitors, a sports complex with a swimming pool with up to 600 staff and visitors, and other social and amenity facilities (shopping pavilions, open areas for training and recreation, etc.).

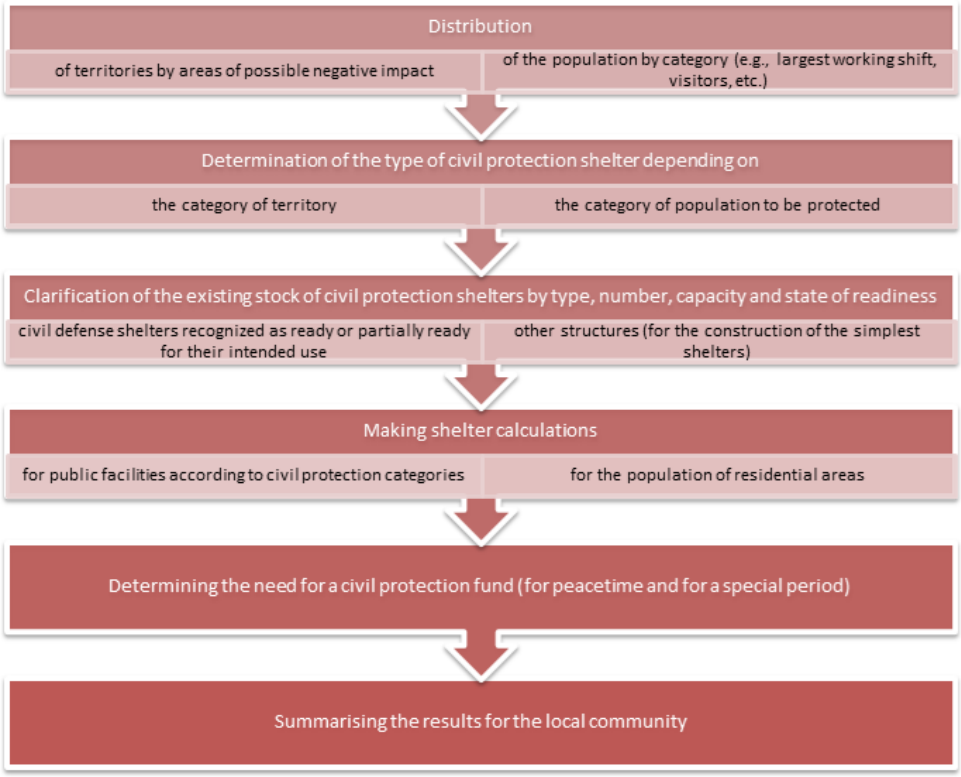

Fig. 2. The general algorithm for calculating the sheltering of the population and determining the need for a fund of protective structures

Source: compiled by the authors

In general, there are several shelters and anti-radiation shelters, as well as simple shelters and dual-purpose structures located directly on the territory of the Aviamistechko residential area and adjacent territories (see Fig. 3). Figure 4 shows the location and capacity of shelters near the secondary school.

According to the principles of spatial arrangement of civil protection shelters on the territory of existing residential areas, described in Section 3, the maximum accessibility (service radius) to public service facilities should not exceed 500 m. The total capacity of the simplest shelters within the specified radius to the school (see Fig. 4) is 1175 people, which is insufficient to shelter in the fund of protective structures the population of the neighbourhood that lives or may temporarily stay within a radius of 500 m. Therefore, the construction of a civil protection shelter on the school premises is reasonably necessary.

Conclusions. To protect the population from hazards arising from emergencies in peacetime and the action of munitions during a special period of martial law, civil protection facilities are used, including shelters, radiation shelters, dual-purpose facilities and simple shelters.

Fig. 3. Scheme of civil protection shelters on the territory of residential areas near the territory of a secondary school: red – shelters and radiation protection shelters; orange – simple shelters and dual-purpose structures

Source: compiled by official website of the Main Directorate of the State Emergency Service of Ukraine in Poltava region

Fig. 4. Location and capacity of storage facilities near a secondary school

Source: compiled by official website of the Main Directorate of the State Emergency Service of Ukraine in Poltava region

The main recommendations for determining the construction objects suitable for inclusion in the fund of civil protection structures as simple shelters include the analysis of: protective properties of the enclosing structures against external ionising radiation or airborne shock wave; capacity (geometrical dimensions) of civil protection structures; location of civil protection structures in relation to places of work or residence; availability of communications (water supply, sewage, electricity, natural or forced ventilation), etc.

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