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Valentina MAKHNIUK¹, DSc (Medic.), Prof.
ORCID ID: 0000-0001-6196-4370
e-mail: valentyana2567@gmail.com

Oleksandr BONDAR², DSc (Biol.), Prof,
ORCID ID: 0000-0002-4488-2282
e-mail: dei2005@ukr.net

Serhii MOHYLNYI¹, PhD (Biol.)
ORCID ID: 0000-0002-6637-0413
e-mail: smogil@ukr.net

Volodymyr MAKHNIUK³, PhD Student
ORCID ID: 0000-0001-8757-9454
e-mail: zeron1995@gmail.com

Oleksandra VASYLIEVA³, DSc (Public Adm.)
ORCID ID: 0000-0003-1812-4557
e-mail: sandra_nadu@ukr.net

¹State Institution "O. M. Marzieiev Institute for Public Health of the
National Academy of Medical Sciences, Kyiv, Ukraine

²The State Ecological Academy of Postgraduate Education and Management, Kyiv, Ukraine

³State Tax University, Irpin, Kyiv region, Ukraine

URBAN PLANNING, ENVIRONMENTAL AND HYGIENIC STANDARDIZATION OF SANITARY PROTECTION ZONES FOR INFRASTRUCTURE OBJECTS – AUTOMOBILE REFUELING STATIONS AS A COMPONENT SUPPLY OF STATE ADMINISTRATION

Background. *In connection with the shortage of land resources in the largest cities and megalopolises, the issue of the location of existing automobile refueling stations (ARS) and the design of prospective residential buildings close to them, as well as the location of projected ARS in already established suburban areas, are becoming increasingly important. This is happening against the background of rapid motorization of modern society. This also necessitates the formation of new approaches to solving modern problems in the planning and development of the territories of settlements, namely state regulation on the standardization of sanitary protection zones (SPZ) for modern ARS. The purpose and task of the research is to carry out the ecological and hygienic substantiation of the regulation of SPZ for infrastructure objects – modern ARS, taking into account their differentiation in terms of capacity and degree of impact on the environment and the level of fire safety, as a component supply of public administration, to regulate the urban planning situation and make administrative and management decisions. The subject of the study is the achievement of safe conditions for the location of ARS on the territory of populated areas by means of ecological and hygienic standardization of the SPZ for them. The object of the study is the ecological, hygienic and fire safety of ARS for the population of residential and public buildings adjacent to the territory of the ARS as a component supply of public administration.*

Methods. *In the research process, abstract-logical, theoretical, modeling, instrumental and statistical and method of legal regulation – standardization of SPZ of infrastructure objects – modern ARS.*

Results. *The article presents the results of comprehensive studies on the justification of the standardization of new SPZ for modern ARS according to urban planning, ecological and hygienic criteria and the level of fire safety as a component supply of public administration.*

The establishment of SPZ for ARS is substantiated, taking into account their differentiation in terms of capacity, the state of implementation of environmentally friendly fuel handling technologies and the level of fire safety, which is important for making administrative and management decisions regarding the development of the territories of settlements adjacent to them.

The introduction of environmentally friendly equipment and modern technologies, the implementation of environmental protection measures during fuel storage at ARS are effective measures, both at the local self-government level and at the state level, which will slow down climate change on Earth. According to the research results, the classification of ARS according to the ecological and hygienic characteristics of gross emissions from sources of atmospheric air pollution is proposed: small, medium and large ARS, which is important from the point of view of urban planning.

Conclusions. *On the basis of a comprehensive approach, the adequacy of the standard SPZ of 50 m for small and medium-capacity ARS has been proven, and the creation of a new safe for the health and life of the population, from the point of view of urban planning, the size of the SPZ of 100 m for large-capacity ARS has been substantiated. It is proposed to approve the new standard of 100 m for high-capacity ARS at the state level by making changes to the existing regulatory framework of urban planning and sanitary legislation.*

It is substantiated as a component supply of public administration, the introduction of the range of changes in the sizes of SPZ for modern fire- and explosive-hazardous facilities in the legislation and practice of Ukrainian entrepreneurship on the basis of urban planning, ecological and hygienic justification and the level of fire safety.

The vector of further research should be aimed at the further implementation into the national urban planning, environmental and sanitary legislation of the requirements of the EU Directives, foreign experience in strengthening fuel quality control, ARS emission control and the introduction of advanced technologies and environmental protection measures at ARS, the use of modern transport to reduce negative impact on the environment and adjacent residential and public buildings, which will serve the formation of modern, environmentally conscious, independent domestic entrepreneurship.

Keywords: *state building norms, norming of sanitary protection zones, automobile refueling stations, ecological-hygienic substantiation, state regulation.*

Background

The implementation of urban planning activities in Ukraine is aimed at creating and maintaining a full-fledged environment for human activity, rational use of land and territories for urban planning needs, increasing the efficiency of land development and coordinating state, public and private interests during the planning and development of territories ("On the basics of urban planning", 1992). Due to the shortage of land resources in major cities and metropolises, the issues of locating existing ARS and planning prospective residential developments in close proximity to them, as well as the placement of planned ARS in already established suburban areas, have become increasingly important. This is happening against the backdrop of rapid motorization in modern society. This calls for the formation of new approaches to solving modern problems.

These issues require state regulation in terms of standardizing sanitary protection zones (SPZ) for modern ARS, taking into account the differentiation of their power, types of fuel used, types of vehicles (engine characteristics) that are refueled. It is also necessary to take environmental protection measures when storing fuel. The application of the latest approaches to the study of the mentioned issues and effective measures, both at the state and local government levels, would make it possible to slow down climate change and ensure the implementation of environmental protection measures during fuel storage (Makhniuk et al., 2020).

The huge losses of the domestic economy, the destruction and destruction of infrastructure objects, as a result of the full-scale invasion of the Russian Federation into Ukraine, determine the objective need for the adoption of operational and anti-crisis decisions by the state for their immediate restoration.

During the war in Ukraine, the number of ARS has decreased almost threefold, with an estimated current count of 2,5 thousand ARS compared to 7,5 thousand ARS before the war. The main reason for this decline is the shortage of fuel, coupled with the destruction of some ARS due to combat actions (In Ukraine, the number of gas stations..., 2022).

In order to restore their operation and construct new modern ARS, there is a pressing need to develop an ecological-hygienic component for norming the SPZ for them and incorporate it into Ukraine's normative urban planning framework.

Sources. With the rapid increase of the car fleet in Ukraine, the infrastructure of its service has developed, primarily this concerns ARS. The ecological and hygienic regulatory framework of Ukraine has not been revised in the last 25 years. The norms of SZZ for ARS were developed in Soviet times and have not been revised since then.

Current regulatory documents of sanitary legislation are "State Sanitary Rules for Planning and Development of Settlements. SSR № 173-96", approved by the order of the Ministry of Health No. 173 dated 19.06.1996 (with amendments) / hereinafter – SSP № 173-96/ and State

Building Regulations – SBN B.2.2-12:2019 "Territory Planning and Development", approved by the order of the Ministry of Regions of Ukraine dated April 26, 2019 № 104 /hereinafter – SBN B.2.2-12/.

The analysis of the latest research and publications (Lynnyk et al., 2021) indicates a great attention to the safety conditions of ARS operation and their impact on soil pollution and the geological environment at the location. Works (Lynnyk et al., 2021; Hsieh et al., 2021) are devoted to the study of ARS operating conditions related to atmospheric air pollution. In the works of I. V. Starodub the mechanism of regulation of SPZ as a whole in Ukraine and in comparison with foreign experience is disclosed (Starodub, 2022), Terrés I.M. issues of assessing the direct impact of ARS on the environment are highlighted (Makhniuk, Mohylny, 2019).

Many scientists, including abroad (Mathissen et al., 2012), cite the results of studies of emissions from light vehicles to the surface layer of the atmosphere. The works of W. Kam, J. W. Liacos, J. J. Schauer (Kam et al., 2012) are devoted to the study of air quality on highways and streets, in particular, a comparison of exhaust gas emissions on gasoline and liquefied natural gas. Noting the significant scientific developments in these areas, not all issues have found their conceptual and integral reflection in practical work. This requires updating the ways of state influence, which is actualized by those globalization challenges that are facing the state and communities regarding the safety and quality of life of the population in the surrounding environment.

The study of city-planning, ecological and hygienic regulations of SPZ for ARS of different capacities in the conditions of existing agricultural development, assessment of the risk of atmospheric air pollution by them for the health and living conditions of the population in Ukraine is extremely limited and fragmentary, which determined the relevance of the mentioned study.

Methods

The purpose of the study is to implement ecological and hygienic substantiation of the standardization of the SPZ of infrastructure objects – modern ARS, taking into account their differentiation by capacity and degree of impact on the environment and the level of fire safety, as a component supply of public administration, to regulate the urban planning situation and make administrative and management decisions. The subject of the study is the achievement of safe conditions for the location of ARS on the territory of populated areas by means of ecological and hygienic standardization of the SPZ for them. The object of the study is the ecological, hygienic and fire safety of ARS for the population of residential and public buildings adjacent to the territory of the ARS as a component supply of public administration.

To achieve the defined goal, a number of general scientific and special scientific methods were used in the research process, in particular: abstract-logical – for the analysis of literary sources and the formation of conclusions; theoretical (retrospective use of research data

on the hygiene of town-planning of the settlements at ARS' operation); modelling of the spread of chemical pollution in the atmosphere in the area affected by ARS; instrumental methods for the assessment of living conditions of the population and statistical ones; method of legal regulation – standardization of the SPZ of infrastructure objects – modern ARS.

Results

The results of the analysis of the compliance of national sanitary and town-planning legislation of Ukraine on the design and construction of ARS with modern requirements illuminated its shortcomings and contradictions.

By the current SBN B.2,2-12, the minimum standard (fire-prevention) distance from a low capacity ARS to the nearest residential building is 20 m, while according to the current SSR №173-96, industrial and administrative buildings of I, II, III fire resistance degrees, the SPZ makes up 50 m, which exceeds the fire-prevention one 2,5 times. For a large ARS, on the contrary, a minimum fire-protection distance is greater 1,6-2 times than the SPZ and is 80 m and 100 m, respectively, while the standard SPZ remains at the level of 50 m, which is dangerous for life and health of the residents of housing estate adjacent to the territory of ARS as a fire hazardous and explosive facility.

Taking into account that SPZ is a main hygienic and town-planning indicator in the planning and development of the residential areas and, when placing ARS, an underestimation of the SPZ standard brings fire-, explosive dangerous facility closer to the residential and public buildings, which makes the urban situation dangerous due to the contradictions of these standards in town-planning.

The current domestic sanitary classification of enterprises and industries (SSR № 173-96) for ARS is imperfect and requires a revision and standardization of the new differentiated SPZ for ARS of different capacities in compliance with the regulatory fire-protection distances and the introduction of a risk approach to their location that provide the right of the citizens to healthy living conditions and environment, defined by the Articles 3, 4 of the Constitution of Ukraine, the Article 114 of the Land Code of Ukraine, the Articles 15, 19 and 22 of the Law of Ukraine "On Atmospheric Air Protection", and the Articles 3 and 4 of the Law of Ukraine "On Environmental Impact Assessment", and the Articles 27 and 28 of the Law of Ukraine "On the Public Health System", and the Articles 31 and 33 of the Law of Ukraine "On Local Self-Government in Ukraine".

The European integration and implementation of the requirements of the EU directives into the national legal framework are relevant for Ukraine. The European environmental standards for internal combustion engines introduced in 1988 (Euro-0) and 1996 (Euro-1) in the European countries were improved into the direction of strengthening. Comparing the standards of 2018 (Euro-6) with the European standards of 1996, it was found that the standards of the content of harmful agents in the exhaust gases of vehicles with gasoline and diesel engines decreased: carbon monoxide – 2,2 and 5,4 times, nitrogen dioxide – 2,6 and 16 times. Only in 2006, Ukraine began to implement the European standards at the level of Euro-2 (1995). The law of Ukraine "On some issues of the importation at the customs territory of Ukraine and the first state registration of vehicles", 06.07.2005 № 2739-IV (as

amended), in particular, stipulates the gradual introduction of the international environmental requirements Euro-5 and Euro-6 for transport means stipulated by the Regulation (EU) №715/2007 on the emissions of harmful agents from cars. In 2016, the issue on the production of the vehicles in Ukraine and importing into Ukraine the cars with technical characteristics of their structures that meet environmental standards not lower than the Euro-5 level was regulated, which will reduce the content of harmful agents in exhaust gases: carbon monoxide – 2,2 times, hydrocarbons – 2,6 times, nitrogen dioxide – 2,5 times.

Only in 2025, the Euro-6 standards are expected to be implemented in the production of the domestic cars and to be distributed to cars that will be imported into the country.

The European Union Directives 2010/75/EU (on industrial emissions), 2008/50/EU (on ambient air quality and cleaner air), 2004/42/EU (on limitation of emissions of volatile organic compounds), 1999/32/EU (on reduction of sulfur content in some liquid fuels), 98/70/EU (on the quality of gasoline and diesel fuel), 94/63/EU (on the control of emissions of volatile organic compounds) established requirements for the quality of gasoline, diesel fuel and control of the emissions from ARS, which need to be implemented in the national sanitary legislation, in particular, the Laws of Ukraine "On Environmental Impact Assessment" (as amended), "On Local Self-Government in Ukraine" (as amended) to strengthen control over the implementation of environmental measures at ARS to reduce the negative impact on the environment and adjacent residential and public buildings.

An evaluation was carried out during the research, the estimation of air pollution in a zone of the impact of ARS of various categories (for small, medium and large ARS) at the distances of 25, 40, 50, 100 m from pollution sources.

The data on the expected calculated air pollution from modern ARS of low, medium and high capacity at different distances from emission sources of filling stations (25 m, 40 m, 50 m and 100 m) indicate that at the introduction of modern equipment at the designed studied ARS, emissions from their pollution sources will amount to 1,106 t/year (average value) – for small ARS, 2,590 t/year – for medium ARS and 3,733 t/year – for large ARS.

The low-capacity ARS (capacity of underground tanks for fuel storage up to 40 m³) – 55 % were found to be the most common in Ukraine, medium-capacity ARS (capacity of underground tanks – 40–100 m³) – 30 %, high-capacity ARS (capacity of underground tanks – more than 100 m³) – 15 %.

Maximum concentrations of the specific pollutants (gasoline, saturated C₁₂-C₁₉ hydrocarbons, nitrogen dioxide and carbon monoxide) in the ambient air at the area of small ARS at the standard SPZ 50 m and at 100 m distance did not exceed the hygienic standards of those agents and met the requirements of p. 5.4 SSR № 173-96.

In the work, modeling of the spread of chemical pollution in atmospheric air in the area of ARS of various types (with underground and above-ground fuel tanks) and of different capacities (small, medium and large) was carried out. Fig. 1 shows the simulation of the spread of chemical pollution in the atmospheric air in the area of a large ARS (with underground storage tanks) and a 3D linear model of the dependence of the gasoline concentration at different distances is built for it (Fig. 2).

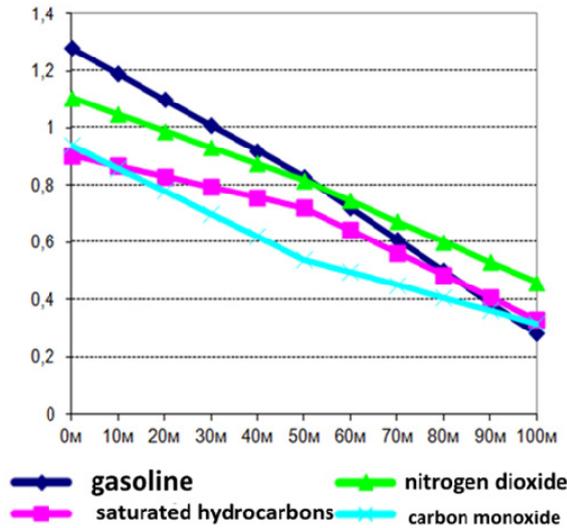


Fig. 1. Modelling of the dissemination of chemical pollution in the ambient air at the area of large filling station (with underground placement of tanks) (author's development)

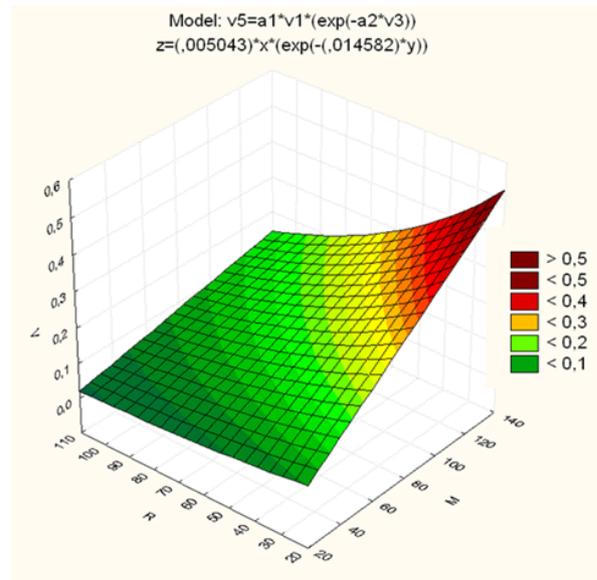


Fig. 2. 3D linear model of the dependence of the value of gasoline concentration on capacity and distance (author's development)

When modelling the distribution of the contamination agents (hereinafter – CA) in the ambient air from the ARS sources, it is shown that at a decrease of ARS capacity, the values of the specific CA concentrations, generated by them, proportionally decrease at different distances from

the emission sources not exceeding their standard MAC at the border of standard 50 m SPZ.

The modelling was also performed for the acoustic situation at the area of the impact of ARS of different capacity (low, medium and high) (Fig. 3).

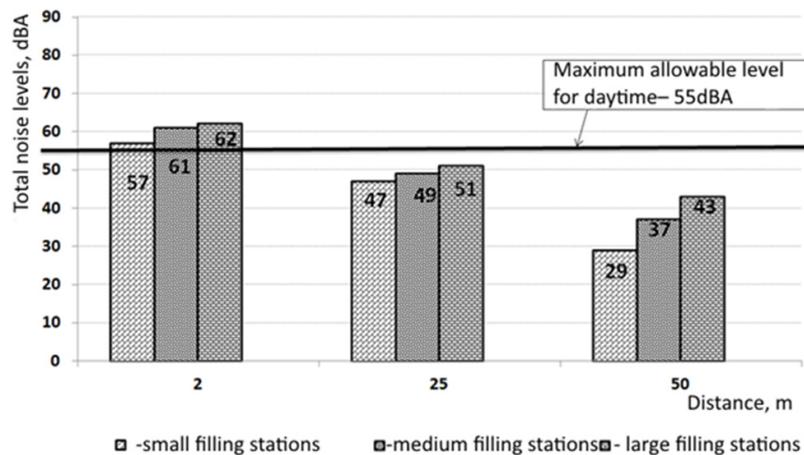


Fig. 3. Modelling of acoustic load dissemination at the area of filling stations of different capacity (low, medium and high) (author's development)

It was established that the operation of ARS can lead to acoustic pollution of the adjacent territory, and the production equipment with calculated total sound levels of 29-43 dBA was its source, that didn't exceed the permissible standards at a distance of 50 m (standard SPZ). According to the relevant research, the general sound levels did not exceed the permissible standards for both day and night, which ensured compliance with the acoustic regime of the adjacent territory.

According to the results of modelling of the dissemination of the acoustic pollution from ARS, the absence of the exceedings of the permissible noise levels was proved at the standard 50 m SPZ.

According to the results of field studies of the atmospheric air in the affected area of ARS of different strength (Table 1), carried out by the regional laboratory centers of the Ministry of Health of Ukraine, it was established that at the limit of the SZZ standard of 50 m in the affected area of small, medium and large ARS, atmospheric air pollution with nitrogen dioxide, oxide carbon and saturated hydrocarbons did not exceed their respective hygienic standards.

The level of the total ambient air pollution, calculated according to these data, was assessed as permissible for small and medium ARS and as slightly dangerous for large one.

Table 1

Ambient air pollution on the border of the standard SPZ (50 m from the main sources of emissions) of ARS of different capacities (according to the materials of field studies of regional laboratory centers of the Ministry of Health of Ukraine)

Categories of filling stations, capacity	Concentrations of the pollutants, in shares of MAC			ΣПЗ, ГДЗ MAC
	nitrogen dioxide	carbon monoxide	hydrocarbons	
Small filling stations (underground reservoirs up to 40m³)	0,09-0,13	0,33-0,73	0,30-0,60	0,80
Medium filling stations (underground reservoirs 40-100 m³)	0,14-0,24	0,36-0,80	0,43-0,88	0,84
Large filling stations (underground reservoirs more 100 m³)	0,38	1,00	1,00	1,09

Discussion and conclusions

Summarizing these data and on the basis of a comprehensive approach, the adequacy of the regulatory sanitary protection zone of 50 m for small and medium-capacity ARS was proved, and a new safe for the health and life of the population, in terms of urban planning, a 100-m safety zone for large-capacity ARS was substantiated.

The proposed 100 m size of the SPZ for large-capacity ARS before normalization requires approval at the state level in accordance with the law, namely by making changes to the existing regulatory framework of urban planning and sanitary legislation.

The new standard of 100 m SPZ for large-capacity ARS will contribute to safe urban planning and promote the realization of the right of citizens to healthy living conditions and the environment, defined by the Constitution of Ukraine, the Land Code of Ukraine, the Laws of Ukraine "On Atmospheric Air Protection", "On Environmental Impact Assessment", "On the public health system", "On local self-government in Ukraine" and others.

It is substantiated as a component supply of public administration, the introduction of the range of changes in the sizes of SPZ for modern fire- and explosive-hazardous facilities in the legislation and practice of Ukrainian entrepreneurship on the basis of urban planning, ecological and hygienic justification and the level of fire safety.

The vector of further research should be aimed at the further implementation into the national urban planning, environmental and sanitary legislation of the requirements of the EU Directives, foreign experience in strengthening fuel quality control, ARS emission control and the introduction of advanced technologies and environmental protection measures at ARS, the use of modern transport to reduce negative impact on the environment and adjacent residential and public buildings, which will serve the formation of modern, environmentally conscious, independent domestic entrepreneurship.

Внесок авторів: Валентина Махнюк (відповідальний автор) – формулювання цілей і завдань дослідження, курація даних, управління та координація планування та виконання дослідницької діяльності, нагляд, перегляд статті і її редагування; Олександр Бондар – концептуалізація, методологія, нагляд та керівництво плануванням та виконанням дослідницької діяль-

ності; Сергій Могильний – збір дослідницьких матеріалів та даних, програмне забезпечення, валідація даних, моделювання, візуалізація даних; Володимир Махнюк – формальний аналіз, аналіз результатів досліджень, формулювання висновків, написання чернетки статті і її редагування; Васильєва Олександра – керівництво плануванням та виконанням дослідницької діяльності, формулювання висновків, перегляд остаточної версії статті і її редагування.

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Валентина МАХНЮК¹, д-р мед. наук, проф.
ORCID ID: 0000-0001-6196-4370
e-mail: valentyana2567@gmail.com

Олександр БОНДАР², д-р біол. наук, проф., чл.-кор. НААН України
ORCID ID: 0000-0002-4488-2282
e-mail: dei2005@ukr.net

Сергій МОГИЛЬНИЙ¹, канд. біол. наук
ORCID ID: 0000-0002-6637-0413
e-mail: smogil@ukr.net

Володимир МАХНЮК³, асп.
ORCID ID: 0000-0001-8757-9454
e-mail: zeron1995@gmail.com

Олександра ВАСИЛЬЄВА³, д-р наук з держ упр.
ORCID ID: 0000-0003-1812-4557
e-mail: sandra_nadu@ukr.net

¹Державна установа "Інститут громадського здоров'я ім. О. М. Марзєєва НАМН України", Київ, Україна

²Державна екологічна академія післядипломної освіти та управління, Київ, Україна

³Державний податковий університет, Ірпінь, Київська область, Україна

МІСТОБУДІВНЕ, ЕКОЛОГО-ГІГІЄНИЧНЕ ОБҐРУНТУВАННЯ НОРМУВАННЯ САНІТАРНО-ЗАХИСНИХ ЗОН ДЛЯ ОБ'ЄКТІВ ІНФРАСТРУКТУРИ – АВТОМОБІЛЬНИХ ЗАПРАВНИХ СТАНЦІЙ ЯК СКЛАДОВИЙ ЕЛЕМЕНТ ЗАБЕЗПЕЧЕННЯ ДЕРЖАВНОГО УПРАВЛІННЯ

В с т у п . У зв'язку з дефіцитом земельних ресурсів у найбільших містах і мегаполісах дедалі більшого значення набувають питання розташування наявних автозаправних станцій (АЗС) і проєктування перспективної житлової забудови, наближеної до них, а також розміщення проєктованих АЗС на вже створених приміських територіях. Зазначене відбувається на тлі стрімкої автомобілізації сучасного суспільства. Це також викликає необхідність формування нових підходів до розв'язання сучасних проблем у плануванні та забудові територій населених пунктів, а саме державного регулювання щодо унормування санітарно-захисних зон (СЗЗ) для сучасних АЗС. Мета та завдання дослідження полягають у здійсненні еколого-гігієнічного обґрунтування нормування СЗЗ для об'єктів інфраструктури – сучасних АЗС з урахуванням їх диференціації за потужністю та ступенем впливу на навколишнє середовище і рівнем пожежної безпеки як складника забезпечення публічного управління для регулювання містобудівної ситуації та прийняття адміністративно-управлінських рішень. Предметом дослідження є досягнення безпечних умов розміщення АЗС на території населених пунктів шляхом еколого-гігієнічного нормування СЗЗ для них. Об'єктом дослідження є еколого-гігієнічна та пожежна безпека АЗС для населення житлової та громадської забудови, що прилягає до території АЗС, як складова частина забезпечення державного регулювання.

М е т о д и . Було використано абстрактно-логічний, теоретичний, моделювальний, інструментально-статистичний методи та метод правового регулювання – нормування СЗЗ об'єктів інфраструктури – сучасних АЗС.

Р е з у л ь т а т и . Наведено результати комплексних досліджень щодо обґрунтування нормування нових СЗЗ для сучасних АЗС за містобудівними, еколого-гігієнічними критеріями та рівнем пожежної безпеки. Обґрунтовано створення СЗЗ для АЗС з урахуванням їх диференціації за потужністю, станом запровадження екологічно чистих технологій поводження з паливом та рівнем пожежної безпеки, що важливо для прийняття адміністративно-управлінських рішень щодо розвитку територій, прилеглих до них населених пунктів. Виявлено, що запровадження екологічно зберігального обладнання та сучасних технологій, виконання природоохоронних заходів під час зберігання палива на АЗС є дієвими заходами як на рівні місцевого самоврядування, так і на державному рівні, що дасть змогу уповільнити зміни клімату на Землі. За результатами досліджень запропоновано класифікацію АЗС за еколого-гігієнічними характеристиками валових викидів від джерел забруднення атмосферного повітря: малі, середні та великі АЗС, що є важливим з погляду містобудування.

В и с н о в к и . На основі комплексного підходу доведено достатність нормативної санітарно-захисної зони 50 м для АЗС малої та середньої потужності і обґрунтовано створення нового безпечного для здоров'я та життя населення, з погляду містобудування, розміру СЗЗ у 100 м для АЗС великої потужності.

Новий норматив СЗЗ у 100 м для АЗС великої потужності пропонується затвердити на державному рівні шляхом внесення змін до чинної нормативної бази містобудівного та санітарного законодавства. Обґрунтовано як складовий елемент забезпечення державного управління запровадження діапазону зміни розмірів СЗЗ для сучасних пожежо-, вибухонебезпечних об'єктів господарювання у законодавстві та практиці українського підприємництва на підставі містобудівного, еколого-гігієнічного обґрунтування та рівня пожежної безпеки.

Вектор наступних досліджень має бути спрямований на подальшу імплементацію у національне містобудівне, екологічне та санітарне законодавство вимог Директив ЄС, закордонного досвіду щодо посилення контролю якості палива, контролю викидів АЗС та запровадження передових технологій і природоохоронних заходів на АЗС, використання сучасного транспорту для зменшення негативного впливу на навколишнє середовище та прилеглу житлову і громадську забудову, що слугуватиме формуванню сучасного, екологічно свідомого, незалежного вітчизняного підприємництва.

К л ю ч о в і с л о в а : державні будівельні норми, нормування санітарно-захисних зон, автомобільні заправні станції, еколого-гігієнічне обґрунтування, державне регулювання.

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