

ГІГІЄНИЧНА ОЦІНКА ПЛАНУВАЛЬНИХ РІШЕНЬ МІСТ З РІЗНОЮ МІСТОУТВОРЮВАЛЬНОЮ БАЗОЮ ЗА СТАНОМ ЗАБРУДНЕННЯ ДОВКІЛЛЯ ТА РИЗИКОМ ДЛЯ ЗДОРОВ'Я НАСЕЛЕННЯ

Махнюк В.М., Гаркавий С.І., Назаренко В.І., Махнюк В.В.,
Шевченко О.А., Риженко Н.О.

HYGIENIC ASSESSMENT OF PLANNING DECISIONS FOR THE CITIES WITH DIFFERENT CITY-FORMING BASE BY THE STATE OF THE ENVIRONMENTAL POLLUTION AND RISK TO THE HEALTH OF THE POPULATION

F

ormation of Ukraine as a modern European state requires not only the preservation and development of national traditions and heritage, formation of new generation with a high potential of health, education, culture, national dignity, but also the attraction of innovative experience of other countries of the world in all spheres of public life development. Rather important economic indicator of any country in the world is a sphere of town-planning with its architectural, health preserving and price policy [1, 2].

In the last decade, the works on the development of the master plans for Ukrainian cities has been intensified. Nowadays, the master plans have been created for the majority of regional administrative centers and large industrial cities in the country.

At present, according to the hygienic analysis of master plans, the large industrial cities, especially of old industrial regions (Donbas, Prydniprovia, Kryvorizhzhia) with town-forming industries of metallurgy, coke chemistry, heavy machinery, mining industry, have significant problems with the violation of the territory functional zoning. Proximity of the residential buildings to the enterprises of the hazard class IV-V, living in the sanitary-protection zones (SPZ) of a considerable number of residents, location of public institutions

(preschools, secondary educational institutions, health care institutions), rapid growth of motorization and facilities for its maintenance (filling stations, gas filling stations, power stations for refueling of the electric cars), environmental pollution [3-4] lead to a significant harm to the health of the population.

This can be evidenced by the fact that there are unfavourable trends in the incidence of the population, especially children's one, with a significant excess of the indicators in ecologically dangerous areas against the backdrop of stable depopulation processes in the demographic situation of the country [2].

Under these conditions, the study of the dynamics of the environmental pollution (ambient air, reservoirs, drinking water, soil) and its impact on the health of the population (in terms of risk of the environmental pollution and the incidence of the population) in the large industrial cities with different city-forming base, and taking into account a degree of the implementation of the decisions of master plans, is an urgent problem.

Thus, the main idea of the work was to substantiate scientifically the sanitary-hygienic approaches to the assessment of planning decisions of the industrial cities with different city-forming base, to determine a tendency of environ-

¹MAKHNIUK V.M.,
²HARKAVYI S.I.,
³NAZARENKO V.I.,
⁴MAKHNIUK V.V.,
⁵SHEVCHENKO O.A.,
⁶RYZHENKO N.O.

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

²National O.O.Bohomolets Medical University, Kyiv

³State Institution «Yu.I. Kundiiiev Institute for Occupational Medicine, National Academy of Medical Sciences of Ukraine», Kyiv

⁴Ministry of Development of Communities and Territories of Ukraine, Kyiv

⁵State Institution «Dnipropetrovsk Medical Academy of the Ministry of Health of Ukraine», Dnipro

⁶Ministry of Health of Ukraine, Kyiv

HYGIENIC ASSESSMENT OF PLANNING DECISIONS FOR THE CITIES WITH DIFFERENT CITY-FORMING BASE BY THE STATE OF THE ENVIRONMENTAL POLLUTION AND RISK TO THE HEALTH OF THE POPULATION

¹Makhniuk V.M., ²Harkavyi S.I., ³Nazarenko V.I.,
⁴Makhniuk V.V., ⁵Shevchenko O.A.,
⁶Ryzenko N.O.

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

²National O.O. Bohomolets Medical University, Kyiv

³State Institution «Yu.I. Kundiiiev Institute for Occupational Medicine, National Academy of Medical Sciences of Ukraine», Kyiv

⁴Ministry of Development of Communities and Territories of Ukraine, Kyiv

⁵State Institution «Dnipropetrovsk Medical Academy, Ministry of Public Health of Ukraine», Dnipro

⁶Ministry of Public Health of Ukraine, Kyiv

Objective: We developed the hygienic approaches to the assessment of planning decisions of the cities with different city-forming systems in terms of environmental pollution and risk to the health of the population.

Methods: We used a set of general scientific and special research methods: bibliosemantic (for the analysis of regulatory and legal literature in the sphere of town-planning), theoretical (evaluation of the retrospective data of the research on the hygiene of planning of the settlements), analytical (**development of the method for hygienic evaluation** for various purposes), sanitary-epidemiologi-

© Makhniuk V.M., Harkavyi S.I., Nazarenko V.I., Makhniuk V.V.,
Shevchenko O.A., Ryzenko N.O. СТАТТЯ, 2020.

mental pollution, its probable risk for the health of the population.

The objective of the work was to develop the hygienic approaches to the assessment of planning decisions of the cities with different town-forming systems according to the state of the environmental pollution and risk to the health of the population.

Materials and methods. For hygienic assessment of the state of environmental pollution in the dynamics in the cities under investigation, a retrospective analysis of observations of ambient air pollution of the State Committee for Hydrometeorology of Ukraine over the 20-years period was carried out. The development and evaluation of the atmospheric pollution indicators was envisaged by 17 ingredients at maximum and average annual concentrations, both in the whole city and at separate stationary observation posts of the Central Geophysical Observatory of the MES of Ukraine, located in different planning zones of cities.

To assess the danger of the effects of chemical pollutants of the cities' ambient air on the population, we applied a risk assessment methodology [5-7].

To achieve the purpose and objectives, we used a set of general scientific and special research methods: bibliosemantic (for the analysis of legal-legislative regulation and scientific literature in the sphere of town-planning); theoretical (evaluation of the retrospective data of research on the hygiene of settlements); analytical (development of the methods for the hygienic evaluation of the construction designs of the objects of various purposes); sanitary-epidemiological examination of the master plans of the cities and the SPZ for the objects of different

hazard classes; epidemiological and medico-statistical ones.

Results. In the course of the work, we determined the cities for the study, taking into account the nature of main sectors of the economy that formed their city-forming base, as well as the features of planning structure of the cities which made it possible to identify the residential areas that were heavily influenced by industrial enterprises and beyond their influence, namely:

□ Cherkasy as an industrial city with the prior development of chemical industry and planning separation of the industrial area from the residential areas of the city;

□ Lviv as a large city of the western region with the development of machine building and light industries, tourism and high-density development of the central areas of the city;

□ Kyiv as a metropolitan city with a multi-sectoral economic complex with a predominant development of machine building, construction industry and transport infrastructure, a complex planning structure with the large areas of modern high-rise buildings.

It was established that mixed functional and planning structure of the territory (production and communal-warehouse facilities next to the residential and public ones), proposed by master plan of Kyiv, contradicted the requirements of both sanitary legislation and town-planning normatives.

The prospect of the development of industry, objects of sports, socio-cultural, sanitary and recreational services of the population was established not to be developed. The measures, foreseen by master plan for the implementation of the SPZ projects, may lead to a reduction of their area by 2496

hectares, which will lead to an unreasonable proximity of the residential development to the industrial territory.

In Kyiv, the density of residential buildings is twice as large and more (1000 people/ha at the rate of 450 people/ha) due to the reduction of the adjoining territories and recreational and green areas, which will lead to an increase in the socially-determined incidence: tuberculosis of pandemic character, in particular, and to an increase of psychogenic load in the residents of metropolis. The expansion of the city agglomeration (will include 6 districts of Kyiv oblast with an area of 1.2 millions hectares) is solving in a declarative manner without documentary confirmation and agreement with the local territorial communities.

The spectrum of harmful chemicals, emitted into the ambient air by the city's thermal power plants (TPP), is caused by the type of fuel (natural gas, coal, etc.) and the features of the auxiliary technological processes that can be changed depending on the economic situation in industry [8].

Cherkasy, a large industrial center with a major chemical complex, was chosen as another research object.

The industrial enterprises of the city are concentrated in two large industrial districts: the Southern which includes large enterprises of chemical industry (JSC «Azot» and «Khimvolokno»), TPP, light industry and construction industry; the Eastern which includes a plant of chemical reagents (re-oriented to the manufacture of the chemical products for plant protection), food processing and wood processing enterprises, construction one. The industrial areas are situated 5-8 km away from the city

cal examination of master plans of the cities and SPZ for the objects of different hazard class, epidemiological and medico-statistical ones. We applied a risk assessment methodology to evaluate the risk of exposure of chemical pollutants of ambient air of the cities to the population.

Results: *The cities were studied taking into account the nature of the main sectors of the economy which form their city-forming base, as well as the features of the planning structure of the cities, which made it possible to identify the residential areas that were heavily influenced by the industrial enterprises and beyond their influence.*

The obtained data make possible to develop measures for environmental adjustment and to resolve reasonably the issues of general plans for urban development of the cities, taking into account the specificity of the development of main industrial complexes, to make management decisions on the ground, their implementation to create safe conditions for human vital activity.

The processes of restructurization of the major branches of heavy industry, the consolidation and re-profiling of large industrial complexes and enterprises, and the intensive development of relatively small production facilities have become essential. In connection with the scarcity of land resources in the largest cities and megalopolises, the issues of the siting of existing filling stations and the design of prospective residential buildings near them, as well as the siting of designed filling stations under conditions of existing residential development, amid the rapid motorization of modern society are becoming increasingly important and require legislative regulation of the standardization of the SPZ for modern filling stations, taking into account not only hygienic requirements, but also the requirements of fire safety.

Keywords: *city master plan, state of environmental pollution, risk to public health, sanitary protection zone, filling station.*

ГІГІЄНИЧНА ОЦІНКА ПЛАНУВАЛЬНИХ РІШЕНЬ МІСТ З РІЗНОЮ МІСТОУТВОРЮВАЛЬНОЮ БАЗОЮ ЗА СТАНОМ ЗАБРУДНЕННЯ ДОВКІЛЛЯ ТА РИЗИКОМ ДЛЯ ЗДОРОВ'Я НАСЕЛЕННЯ

¹Махнюк В.М., ²Гаркавий С.І., ³Назаренко В.І., ⁴Махнюк В.В., ⁵Шевченко О.А., ⁶Риженко Н.О.

¹ДУ «Інститут громадського здоров'я ім. О.М. Марзєєва НАМН України», м. Київ

²Національний медичний університет ім. О.О. Богомольця, м. Київ, Україна

³ДУ «Інститут медицини праці ім. Ю.І. Кундієва НАМН України», м. Київ

⁴Міністерство розвитку громад та територій України, м. Київ

⁵ДУ «Дніпропетровська медична академія МОЗ України», м. Дніпро

⁶Міністерство охорони здоров'я України, м. Київ

Мета роботи – розробити гігієнічні підходи до оцінки планувальних рішень міст з різною містоутворювальною системою за станом забруднення довкілля та ризиком для здоров'я населення.

Методи досліджень. Використано комплекс загальнонаукових і спеціальних методів дослідження: бібліосемантичні (для аналізу нормативно-правового регулювання та наукової літератури у сфері містобудування), теоретичні (оцінка ретроспективних даних наукових досліджень щодо гігієни планування населених місць), аналітичні (розробка методики гігієнічної оцінки проектів будівництва об'єктів різного призначення); санітарно-епідеміологічної експертизи проектів генпланів міст та СЗЗ для об'єктів різного класу небезпеки; епідеміологічні та медико-статистичні методи дослідження; для оцінки небезпеки впливу хімічних забруднювачів атмосферного повітря міст на населення засто-

совували методологію оцінки ризику.

Результати. Досліджували міста з урахуванням характеру основних галузей господарства, які формують їхню містоутворювальну базу, а також особливостей планувальної структури міст, що дозволяють виокремити сельбищні території, які піддаються значному впливу промислових об'єктів та поза їхнім впливом.

Отримані дані дозволяють розробляти заходи з корегування стану довкілля та обґрунтовано вирішувати питання генеральних планів забудови території міст з урахуванням специфіки розбудови профілюючих промислових комплексів для прийняття управлінських рішень на місцях, їх впровадження для створення безпечних умов життєдіяльності людини. Суттєвого значення набули процеси реструктуризації основних галузей важкої індустрії, розукрупнення і перепрофілювання великих промислових комплексів і підприємств та інтенсивний розвиток відносно невеликих виробничих об'єктів.

У зв'язку з дефіцитом земельних ресурсів у найкрупніших містах і мегаполісах питання розташування існуючих АЗС і проектування перспективної житлової забудови, наближеної до них, а також розташування проєктованих АЗС в умовах сельбищної забудови, що вже склалася, на тлі стрімкої автомобілізації сучасного суспільства набуває все більшого значення і потребує законодавчого врегулювання унормування СЗЗ для сучасних АЗС з урахуванням не лише гігієнічних вимог, а ще й вимог пожежонебезпеки.

Ключові слова: генеральний план міста, стан забруднення довкілля, ризик для здоров'я населення, санітарно-захисна зона, автозаправна станція.

center. The normative SPZ for the enterprises of the above mentioned industrial areas are obeyed.

We determined that in the total emissions into the ambient air of the city (14,800.0 t), 87.4% of the pollutants came from chemical enterprises (Azot OJSC – 53.8% and Khimvolokno – 14.1%, plant of chemical reagents (0.13%) and thermal power plants (19.3%). Ammonia, nitrogen dioxide, carbon monoxide, dust are the limiting pollutants of ambient air in Cherkasy. According to the hygienic criteria for the impact of a complex of harmful substances, the atmospheric pollution in Cherkasy is estimated from weak (since 2002, when industrial enterprises were not operating at full capacity) to strong, extremely strong and even as environmental disaster zone (in 1990, when they operated with overload).

When restoring the functioning of industrial enterprises to full capacity, it is necessary to follow strictly the requirements of the functional zoning of the city territory, prevention of the proximity of the prospective residential development to the enterprises of the hazard classes I-III, implementation of their normative SPZ, implementa-

tion of modern technologies and effective nature protection measures at the industrial enterprises of the hazard classes I-III.

Lviv is a center of Western region of Ukraine, a part of the group of the 9 largest cities in the country. Light industry and tourism are the directions of the development.

Lviv is a large city with a high density of construction in its central districts where the industrial complex has not reached the predicted indicators over 15 years of the implementation of master plan and has been redeveloped into the tourist industry. Nowadays, the urgent problem of Lviv city is a development of noise protection measures because railway lines, highways, reloading railway stations make noise within its limits at the level of 72-77 dBA, and in some places 78-82 dBA. The location of the airport in close proximity to the city (6.5 km to the center) is an obstacle for the development of the territory in the south-west direction, although in the future, it is planned to build a new international airport outside it.

Thus, as a result of the scientific examination of master plans of three major cities of Ukraine (Kyiv,

Lviv, Cherkasy), the most acute sanitary-epidemiological problems in their planning and construction have been revealed: violation of the functional zoning of the territory; lack of modern production technologies and nature protection measures; ineffective management with industrial and household waste; mismatch of water supply and sewerage capacity to actual and prospective urban development needs.

According to the results of the analysis of ambient air pollution of studied cities, more than 61% of the pollutants entered into the ambient air of the cities from the stationary sources of emissions of the industrial enterprises (table 1).

Suspended matter (dust), sulfur dioxide, nitrogen dioxide, formaldehyde and BP were identified as the main pollutants with an excess of MACs in all cities: in Kyiv – 1.7, in Lviv – 1.4 and in Cherkasy – 1.9 times.

The changes of quantitative indicators of non-carcinogenic and carcinogenic effects over 25 years in mentioned cities are presented at figures 1, 2.

The assessment of the total carcinogenic risk to the health of the

population created by studied compounds in the air environment of the cities showed that its level was determined as a high in Cherkasy (1.5×10^{-3}), as warning – in Kyiv and Lviv (9.4×10^{-4} ; 6.2×10^{-4} , respectively).

The data obtained make it possible to develop measures for environmental adjustment and to resolve reasonably the issues of master plans for urban development of the cities, taking into account the specificity of the construction of dominant industrial complexes for local decisions, their implementation to create safe conditions for human vital activity.

Under conditions of a significant deficiency of the city land resources and the legally defined payment for land, the problem of the compliance with the normative SPZ, defined by the sanitary classification of the State Sanitary Rules for Planning and Construction of the Settlements, Particle Board № 173-96 (Annex № 4), is becoming increasingly acute for the industrial enterprises.

The processes of restructurization of the major industries of heavy industry, the consolidation and re-profiling of the large industrial complexes and enterprises, and the intensive development of relatively small production facilities have become essential.

In connection with a deficiency of land resources in the major cities and metropolises, the issue of the location of existing filling stations and the design of the prospective residential buildings close to them, as well as the location of the designed filling stations in the already existing residential development, against a background of the rapid motorization of modern society, is becoming increasingly important and requires a legislative regulation on the standardization of the SPZ for modern filling stations, taking into account not only hygienic requirements but also fire safety ones.

Conclusions

For the first time, on the basis of complex hygienic researches, the elements of integration and implementation of the international requirements to the national normative base on town-planning and ensuring of optimum conditions for human life in modern settlements with different city-forming structures have been substantiated scientifically.

1. On the basis of a systematic approach to the analysis of the national sanitary and town-planning legislation in the field of planning and construction of the settle-

ments, its inconsistency with modern international requirements has been established. The necessity of constant scientific and hygienic support of issues of planning and development of the territories (including objects of industrial and residential-and-public construction) based on the leading risk fac-

tors for the health of the population has been substantiated.

2. As a result of examination of master plans of three major cities of Ukraine (Kyiv, Lviv, Cherkasy) with a multi-sectoral and dominant industrial complex, the most acute sanitary-epidemiological issues in their planning and construction

Table 1
Comparative characteristic of air pollution of the cities under study

Pollutants	Pollution indicator C/MPC*k					
	1990	1995	2000	2005	2010	2015
Kyiv						
Suspended matters (dust)	0.67	0.67	0.7	0.46	0.82	0.87
Sulfur dioxide	0.40	0.61	0.31	0.28	0.27	0.21
Nitrogen dioxide	1.94	1.91	1.52	1.94	2.34	2.24
Formaldehyde	2.22	0.56	1.37	1.33	2.78	2.67
Benzopyrene	4.00	2.0	2.63	1.38	1.75	1.75
Pollution index	9.23	6.25	6.40	5.39	7.96	7.74
Excess of MAC	1.69	1.14	1.17	0.99	1.46	1.41
Lviv						
Suspended matters (dust)	1.22	1.25	1.08	1.13	1.18	1.17
Sulfur dioxide	0.97	0.84	0.77	0.67	0.60	0.62
Nitrogen dioxide	1.99	1.26	0.87	0.88	1.7	1.24
Formaldehyde	1.22	2.15	0.74	0.78	1.52	1.74
Benzopyrene	2.13	2.00	2.38	2.13	1.63	1.65
Pollution index I	7.53	7.50	5.84	5.59	6.10	6.42
Excess of MAC	1.38	1.37	1.07	1.02	1.12	1.17
Cherkasy						
Suspended matters (dust)	1.08	0.80	0.63	0.64	0.88	0.91
Sulfur dioxide	0.84	0.43	0.51	0.56	0.45	0.45
Nitrogen dioxide	1.63	0.80	0.79	0.66	0.92	0.97
Formaldehyde	4.85	3.37	4.41	3.93	2.30	2.37
Benzopyrene	2.25	2.13	1.50	2.00	1.38	1.50
Pollution index	10.65	7.53	7.84	7.79	5.93	6.20
Excess of MAC	1.95	1.38	1.43	1.42	1.08	1.13

Figure 1
Changes in the quantitative indices of the risk of non-carcinogenic effects (1990-2015)

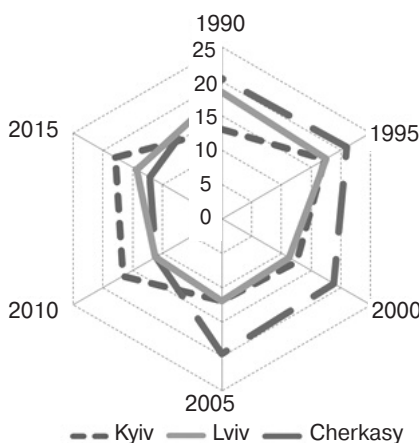
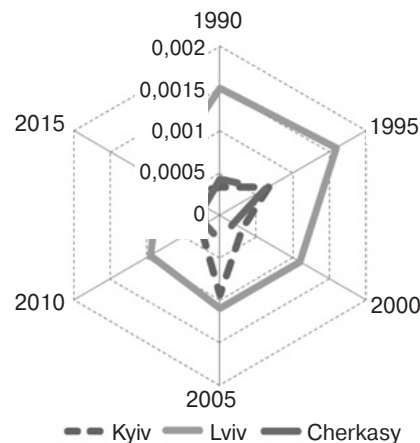


Figure 2
Changes in the quantitative indices of the carcinogenic risk (1990-2015)



have been detected, namely: violation of the functional zoning of the territory; lack of modern production technologies and environmental measures; inefficient management of industrial and household waste; mismatch of water supply and sewerage capacity to actual and prospective urban development needs; lack of planned development of the objects of socio-cultural, sports, sanitary and recreational services for the large masses of the population; inclusion of adjoining areas and settlements within the boundaries of the cities of Kyiv, Lviv without documentary confirmation and agreement with the local territorial communities.

3. The solutions of town-planning tasks of the city master plans affect directly the state of the environment and the health of the population. The analysis of ambient air pollution indicators of studied cities in the dynamics of the 20-years observation period shows that there is a tendency to reduce the emissions of harmful substances into the atmosphere and the levels of average annual concentrations of pollutants from strong, extremely strong, a zone of environmental disaster in 1990 (when industrial enterprises were overburdened) to weak (beginning from 2002, when they were not operating at full capacity) in the cities with different levels and nature of industrial development.

A the restoration of functioning of the industrial enterprises to full capacity, it is necessary, on the one hand, to adhere strictly to the requirements of functional zoning of the city territory, to prevent the proximity of the prospective housing development to the enterprises of hazard classes I-III, the implementation of their normative SPZ, on the other hand, to implement modern technologies and effective nature protection measures at the industrial enterprises of hazard classes I-III.

4. The need for the revision of the SPZ normatives for the enterprises of the hazard classes I-V taking into consideration different technologies, hazard class with a differentiation of their capacity, efficiency of the environmental protection measures and risk assessment for the health of the population has been proved.

ЛІТЕРАТУРА

1. Сердюк А.М., Полька Н.С., Махнюк В.М., Савіна Р.В., Могильний С.М. Гігієна планування та забудови населених місць на варті громадського здоров'я (до 85-річного ювілею ДУ «Інститут громадського здоров'я ім. О.М. Марзєєва НАМН

України»). К. : Дедінформ, 2017. 271 с.

2. Махнюк В.М. Наукове обґрунтування нових гігієнічних підходів до сучасного містобудування в Україні : автореф. дис. ... д-ра мед. наук : спец.

14.02.01 / ДУ «Інститут гігієни та медичної екології ім. О.М. Марзєєва НАМН України». К., 2015. 39 с.

3. Могильний С.М., Махнюк В.М., Зоріна О.В., Горваль А.К. До питання гігієнічної безпеки сучасних автомобільних заправних станцій за ступенем їхнього впливу на забруднення довкілля. *Довкілля та здоров'я*. 2018. № 3 (88). С. 40-44.

4. Makhniuk V., Mohylnyi S. Regulatory-legislative and ecological-hygienic issues on the location of modern motor filling stations. *Georgian Medical News*. 2019. № 7-8 (292-293). P. 96-103.

5. Оцінка ризику для здоров'я населення від забруднення атмосферного повітря: метод. рек. МР 2.2.12-142-2007. Затв. МОЗ України, наказ № 184. Офіц. вид. К. : МОЗ України, 2007. 28 с.

6. Гранично допустимі концентрації хімічних і біологічних чинників в атмосферному повітрі населених місць (затв. 03.03.2015 в.о. головного державного санітарного лікаря України). К., 2015. 12 с.

7. Державні санітарні правила планування та забудови населених пунктів : ДСП № 173-96. URL : <http://zakon.rada.gov.ua/laws/show/z0379-96>

8. Назаренко В.І. Комбінована дія магнітного поля промислової частоти, шуму, підвищеної температури повітря як проблема медицини праці : автореф. дис. ... д-ра. біол. наук : спец. 14.02.01 / ДУ «Інститут медицини праці ім. Ю.І. Кундієва НАМН України». К., 2010. 31 с.

REFERENCES

1. Serdiuk A.M., Polka N.S., Makhniuk V.M., Savina R.V. and Mohylnyi S.M. Hihiiena planuvannia ta zabudovy naselenykh mista na varti hromadskoho zdorovia (do 85-richnoho yuvileiu DU «Instytut hromadskoho zdorovia im. O.M. Marzieieva NAMN Ukrainian») [Hygiene of Planning and Building of the Settlements on the Watch of Public Health (in Commemoration of the 85th Anniversary of O.M. Marzieiev Institute for Public Health, NAMSU)]. Kyiv : Dedinform; 2017 : 271 p. (in Ukrainian).

2. Makhniuk V.M. Naukove obgruntuвання novykh hihiienich-

nykh pidkhodiv do suchasnoho mistobuduvannia v Ukraini : avtoref. dys. ... d-ra med. nauk : spets. 14.02.01 / DU «Instytut hihiieny ta medychnoi ekolohii im. O.M. Marzieieva NAMN Ukrainy» [Scientific Substantiation of the New Hygienic Approaches to Modern Town-Planning in Ukraine: Abs. Diss. Dr. Med. Sci. / SI «O.M. Marzieiev Institute for Public Health, NAMSU»]. Kyiv ; 2015: 39 p. (in Ukrainian).

3. Mohylnyi S.M., Makhniuk V.M., Zorina O.V. and Horval A.K. *Dovkillia ta zdorovia (Environment and Health)*. 2018 ; 3 (88) : 40-44 (in Ukrainian).

4. Makhniuk V. and Mohylnyi S. *Georgian Medical News*. 2019 ; 7-8 (292-293) : 96-103.

5. Otsinka ryzyku dlia zdorovia naselennia vid zabrudnennia atmosfernoho povitria: metodychni rekomendatsii MR 2.2.12-142-2007. Zatv. MOZ Ukrainy, nakaz № 184. Ofitsiine vydannia [Assessment of the Risk to the Health of the Population from Ambient Air Pollution: Guidelines MR 2.2.12-142-2007. Approved by the Ministry of Public Health of Ukraine, Order № 184. Official Publication]. Kyiv ; 2007 : 28 p. (in Ukrainian).

6. Hranychno dopustymy kontsentratsii khimichnykh i biologichnykh chynnykiv v atmosfernomu povitri naselenykh mista (zatv. 03.03.2015 v.o. holovnoho derzhavnoho sanitarneho likaria Ukrainy) [Maximum Permissible Concentrations of Chemical and Biological Factors in Ambient Air of Settlements (approved by the Acting State Head Sanitary Doctor of Ukraine, 03.03.2015)]. Kyiv ; 2015 : 12 p. (in Ukrainian).

7. Derzhavni sanitarni pravyla planuvannia ta zabudovy naselenykh punktiv : DSP № 173-96 [State Sanitary Regulations for Planning and Development of the Settlements: SSR № 173-96]. URL : <http://zakon.rada.gov.ua/laws/show/z0379-96> (in Ukrainian).

8. Nazarenko V.I. Kombinovana diia mahnitnoho polia promyslovoi chastoty, shumy, pidvyshchenoi temperatury povitria yak problema medytsyny pratsi : avtoref. dys. ... d-ra. biol. nauk : spets. 14.02.01 / DU «Instytut medytsyny pratsi im. Yu.I. Kundiiev NAMN Ukrainy» [Combined Effect of the Magnetic Field of Industrial Frequency, Noise, High Air Temperature as an Issue of Occupational Medicine: Abst. Dis. Dr. Biol. Sci. / SI «Yu.I. Kundiiev Institute for Occupational Medicine, NAMSU»]. Kyiv ; 2010 : 31 p. (in Ukrainian).

Надійшла до редакції 24.01.2020