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РИЗИКОВИЙ ПІДХІД ДО САНІТАРНО-ЕПІДЕМІОЛОГІЧНОЇ ОЦІНКИ РОЗМІЩЕННЯ СУЧАСНИХ АВТОЗАПРАВНИХ СТАНЦІЙ

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RISK APPROACH TO SANITARY-AND-EPIDEMIOLOGICAL ASSESSMENT OF THE LOCATION OF MODERN FILLING STATIONS

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Keywords: filling station, sanitary-and-epidemiological assessment, risk assessment, environment contamination.

In connection with a shortage of land resources in the largest cities and megalopolises and against the impetuous automation of modern society, the issues of the location of existing filling stations (FS) and design of perspective residential construction, close to it, and location of designed FS at the territory of formed residential area are becoming increasingly important. They require a legislative regulation for the normalization of sanitary-and-protective zones (SPZ) for modern FS, taking into account a differentiation of their rating, a use of fuel types, types of refilling transport, an implementation of the environmental protective measures, etc. [1, 2].

An ubiquitous construction of the FS of different types and categories, extension of their functions, including the elements of the maintenance of the vehicles, drivers and passengers, use of modern filling technologies and fuel storage, and tendencies of the approaching of these objects to the residential districts of the city require a full substantiation of the hygienic requirements to their location from the point of view of the methodology of risk assessment for the health of the population for the prevention of their pos-

РИЗИКОВИЙ ПІДХІД ДО САНІТАРНО-ЕПІДЕМІОЛОГІЧНОЇ ОЦІНКИ РОЗМІЩЕННЯ СУЧАСНИХ АВТОЗАПРАВНИХ СТАНЦІЙ

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***Метою роботи** є визначення показників ризику для здоров'я населення від забруднення навколишнього середовища хімічними речовинами, створюваного викидами автозаправних станцій (АЗС) різної потужності, з урахуванням територіальних особливостей сельбищних територій.*

***Матеріали і методи.** У роботі використовувалися методи санітарно-гігієнічного обстеження діючих об'єктів, санітарно-епідеміологічної експертизи проектів санітарно-захисних зон АЗС різної потужності, оцінок ризику.*

***Висновки**. Отримані результати свідчать, що санітарна класифікація підприємств та виробництв потребує перегляду та унормування диференційованих санітарно-захисних зон (мінімальна і максимальна) для АЗС з урахуванням потужності, впровадження ефективних повітроохоронних заходів та запровадження ризикового підходу до санітарно-епідеміологічної оцінки розташування АЗС. Доведено необхідність впровадження на існуючих та проектованих АЗС обладнання для утримання канцерогенних випаровувань при заправках транспортних засобів, що забезпечить зменшення забруднення прошарку повітря робочої зони працівників АЗС та довкілля прилеглої житлової забудови.*

Ключові слова: автозаправна станція, санітарно-епідеміологічна оцінка, ризиковий підхід, забруднення атмосферного повітря.

sible unfavorable effect on the conditions of its vital functions.

Objective of the work is a detection of risk indices for the health of the population from the environmental contamination with the chemicals created by the emissions of the FS of various ratings, taking into account territorial features of the residential areas.

Materials and methods. The methods of sanitary-and-hygienic examination of operating objects; sanitary-and-epidemiological examination of the SPZ designs for the FS of different ratings, risk assessment were applied in the work. Risk conception is considered as a main mechanism for development and management decisions directed on the reduction of the environmental contamination and prevention of its unfavorable effect on the health of the population. We used the Methodical Recommendations "Assessment of the Risk for the Health of the Population from the Ambient Air Pollution. MR 2.2.12-142-2007" adopted by the Ministry of Public Health of Ukraine (Order N184, 13.04. 2007) [4]. Methodology of risk assessment was applied in the study for the assessment of calculation concentrations of the pollutants in ambient air of the filling stations being built or reconstructed.

Results and discussion. 50 designs of the construction /reconstruction of the FS of small, average, and large ratings were studied for the detection of sanitary-and-hygienic problems of modern planning organization of the construction of the residential areas of Ukraine on the location of new and reconstruction of existing FS by means of sanitary-and-epidemiological examination, using risk assessment methodology.

Specific pollutants from the operation of the FS are saturated hydrocarbons, gasoline, and kerosene, unspecific – nitrogen dioxide, hydrocarbon oxide from the operation of motor engines, and also black, sulfur dioxide, methane from the operation of boilers and diesel generators of the FS; contribution of the last ones is mostly minimum in total emissions of designed FS.

Calculated maximum concentrations of the specific pollutants in the ambient air in the area of the location of the FS of small rating and risk indices of the development of negative effects in the health of the population depending on the distance of their location are demonstrated in table 1.

Maximum concentrations of the specific pollutants (gasoline, saturated hydrocarbons, kerosene, nitrogen dioxide, and carbon monoxide) in the ambient air in the areas of the small FS at the distance of 25 m from the sources of emissions (i.e. on the industrial site of the FSs), at the standard SPZ of 50 m, and at a distance of 100 m didn't exceed the hygienic standards according to the Sanitary Rules and Norms 4946-89 "Sanitary Rules on the Protection of Ambient Air of the Residential Areas" and met the requirements of the " State Sanitary Rules for Planning and Constructions of the Residential Areas. State Sanitary Rules N173-96" [5].

By the total indices of the atmospheric pollution, calculated by the maximum concentrations of the specific pollutants at all distances (25, 40, 50, and 100 m), a level of pollution was assessed as an allowable one.

According to the international methodology for the assessment of the risk for human health, if calculated risk ratio of chemicals doesn't exceed a unity, a probability of the development of the hazardous effects under daily exposure of this compound during the whole life is insignificant, and such an effect is characterized as an allowable one; in case of the exceeding of the unity, the probability of the beginning of hazardous effects grows in proportion to the HQ quantity [4, 6].

Classification of the levels of non-carcinogenic risk is shown in table 2.

On the basis of obtained quantities of risk ratios of the chemicals (Table 2), a number of compounds can be identified as the most negatively affecting as the toxicants the health of the population, living in the residential construction close to the territory of the FS. A qualitative index of risk ratio by maximum gasoline concentration is rather high (>3) at all studied distances with a tendency to a sharp decrease : at 25 m – 45.8, at 40 m – 36.6, at 50 m – 19.0, and at 100 m – 10.9. The highest risk ratio is detected at the industrial site (25 m) – 45.8, 2.5 times less at the standard SPZ (50m) – 19.0, and 4.2 times less at the distance of 100 m in comparison with the industrial site.

Calculated maximum concentrations of specific pollutants in the ambient air in the area of the location of average rating FS and the risk indices of the development of negative effects in the health of the population, depending on the remoteness of their location, are shown in table 3.

By all specific substances, expected ambient air pollution in the zone of location of average rating FS on the verge of the normative SPZ of 50 m was not observed. Even at the industrial site (at the distance of 25 m from the sources of the FS emissions) the concentrations of gasoline, saturated hydrocarbons, nitrogen dioxide, and carbon monoxide in the ambient air made up from 0.045 up to 0.8 MAC and didn't exceed the

Table 1

Expected ambient air pollution in a zone of the impact of the FS of small rating (by the materials of the calculation of the FS construction/reconstruction and risk ratios of the development of negative effects in the health of the population)

Pollutants	Concentrations of the pollutants at different distances from the sources of emissions, m							
	25		40		50		100	
	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC
Gasoline	0.295-3.25	0.059-0.65	0.3-2.6	0.026-0.52	0.125-1.35	0.025-0.27	0.075-0.775	0.015-0.155
HQ	4.2-45.8		1.8-36.6		1.8-19.0		1.1-10.9	
Hydrocarbons C12-C19	0.032-0.554	0.032-0.554	0.005-0.430	0.005-0.430	0.002-0.30	0.002-0.30	0.0001-0.06	0.0001-0.06
HQ	0.45-7.8		0.007-6.1		0.03-4.2		0.001-0.85	
Kerosene	0.312-0.948	0.26-0.79	0.264-0.792	0.22-0.66	0.19-0.540	0.158-0.45	0.0036-0.46	0.003-0.383
HQ	31.2-94.8		26.4-79.2		1.90-54.0		0.36-46.0	
Nitrogen dioxide	0.004-0.069	0.02-0.345	0.002-0.067	0.01-0.33	0.001-0.039	0.005-0.195	0.0008-0.0158	0.004-0.079
HQ	0.10-1.73		0.05-1.68		0.03-0.98		0.02-0.4	
Carbon oxide	0.525-2.20	0.105-0.44	0.05-2.15	0.01-0.43	0.05-2.0	0.01-0.4	0.02-0.585	0.004-0.117
HQ	0.18-0.73		0.02-0.72		0.02-0.67		0.01-0.2	

РИСКОВЫЙ ПОДХОД К САНИТАРНО-ЭПИДЕМИОЛОГИЧЕСКОЙ ОЦЕНКИ РАЗМЕЩЕНИЯ СОВРЕМЕННЫХ АВТОЗАПРАВОЧНЫХ СТАНЦИЙ

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***Целью работы** является определение показателей риска для здоровья населения от загрязнения окружающей среды химическими веществами, создаваемого выбросами автозаправочных станций (АЗС) различной мощности, с учетом территориальных особенностей селитебных территорий.*

***Материалы и методы.** В работе использовались методы санитарно-гигиенического обследования действующих объектов, санитарно-эпидемиологической экспертизы проектов санитарно-защитных зон АЗС различной мощности, оценок риска.*

***Выводы**. Полученные результаты свидетельствуют, что санитарная классификация предприятий и производств требует пересмотра и нормирования дифференцированных санитарно-защитных зон (минимальная и максимальная) для АЗС с учетом мощности, внедрения эффективных природоохранных мероприятий и применения рискового подхода к санитарно-эпидемиологической оценке размещения АЗС.*

Доказана необходимость внедрения на существующих и проектируемых АЗС оборудования для сдерживания канцерогенных испарений при заправках транспортных средств, что обеспечит уменьшение загрязнения прослойки воздуха рабочей зоны работников АЗС и окружающей среды прилегающей жилой застройки.

Ключевые слова: автозаправочная станция, санитарно-эпидемиологическая оценка, рисковый подход, загрязнение атмосферного воздуха.

hygienic standards by the Sanitary Rules and Norms 4946-89.

Analysis of the obtained risk ratio quantities of the chemicals, represented in Table 3, indicates a high risk ratio by a maximum gasoline concentration both on the verge of standard SPA of 50 m – 29.6 and at the distance twice more than the standard SPZ – 100 m (5.6). Risk ratio by the maximum concentration of hydrocarbons is also high (>3) on the verge of standard SPZ – 6.3, and alarming (1.1-3.3) at the distance of 100 m (2.8).

Analogous situation on the expected ambient air pollution is observed in a zone of the location of high rating FS (table 4).

On the verge of normative SPZ of 50 m, the large rating FS doesn't create the levels of ambient air pollution (by all pollutants) that exceed the hygienic standards by the Sanitary Rules and Norms 4946-89.Maximum concentrations of gasoline, saturated hydrocarbons, nitrogen dioxide, and carbon monoxide in the ambient air made up from 0.041 up to 0.59 MAC.

The quantities of the risk ratios of the chemicals, presented in Table 4, indicate a high risk ratio by maximum gasoline concentration both on the verge of standard SPZ of 50 m — 20.4 and at a distance twice as large the standard SPZ of 100 m – 13.4.Risk ratio by the maximum hydrocarbon concentration is also high on the verge of the standard SPZ – 8.3 and at a distance of 100 m (7.5), for nitrogen dioxide on the verge of SPZ – alarming (1.8), for carbon monoxide — allowable (0.24). Mentioned indices of risk ratios of the effect of gasoline and hydrocarbons of high rating FS are higher than 1.9 and 2.3 times the analogous indices of small FS.

From the above materials it can be stated that the risk ratios of the development of non-carcinogenic effects are more informative for the assessment of the impact of air environment on the population in the zone of FS location than the pollution indices. By the quantities of non-carcinogenic risk, the pollutants from the sources of emissions of all types of FS (small, average, large), especially kerosene, were dangerous for human health, though the maximum concentrations didn't exceed their MAC and pollution index was less than a unity.

The respiratory system, cardiovascular system, liver, kidneys, central nervous system and the blood are man's critical organs and systems because the pollutants from the FS emission sources (gasoline, kerosene, carbon monoxide, and nitrogen dioxide) affect them firstly.

Table 2

Classification of the levels of non-carcinogenic risk

Level of risk	Risk ratio of the development of non-carcinogenic effects (HQ) for separate compounds
High	>3
Alarming	1.1–3
Allowable	0.11–1.0
Minimum (desirable)	0.1 and less

Table 3

Expected ambient air pollution in a zone of average rating FS (by the materials of the calculations of construction/ reconstruction of the FS and risk ratios of the development of negative effects in the health of the population)

Pollutants	Concentrations of the pollutants at different distances from the sources of emissions, m							
	25		40		50		100	
	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC
Gasoline	1.1-3.99	0.22-0.80	0.5-2.25	0.1-0.45	0.295-2.1	0.06-0.42	0.13-0.395	0.026-0.079
HQ	15.4-56.2		7.0-31.7		4.2-29.6		1.8-5.6	
Hydrocarbons C12-C19	0.33-0.51	0.33-0.51	0.105-0.45	0.105-0.45	0.1-0.43	0.1-0.43	0.0002-0.2	0.0002-0.2
HQ	4.6-7.2		1.5-6.3		1.4-6.1		0.003-2.8	
Nitrogen dioxide	0.009-0.013	0.045-0.067	0.007-0.0104	0.035-0.052	0.006-0.01	0.03-0.05	0.0028-0.01	0.014-0.05
HQ	0.23-0.34		0.18-0.26		0.20-0.25		0.07-0.25	
Carbon monoxide	0.525-0.55	0.105-0.11	0.5-0.55	0.1-0.11	0.4-0.5	0.08-0.1	0.3-0.45	0.06-0.09
HQ	0.18-0.18		0.17-0.18		0.13-0.17		0.10-0.15	

Requirements to the quality of gasoline, diesel fuel and control of the emissions from the FS were established by the Directives of the European Union 2008/50/EU of 21.05.2008, 2004/42/EU of 21.04.2004, 1999/32/EU of 26.04.1999, 98/70/EU of 21.05.1998 and 94/63/EU of 20.12.1994. They should be implemented into the national sanitary legislation.

Conclusions

1. Sanitary classification of enterprises and productions was proved to require the review and the normalization of differentiated sanitary-and-protective zones (minimum and maximum SPZ) for the FS, taking into account a quantity, introduction of the effective air protective measures and risk approach to sanitary-and-epidemiological assessment of the FS location.

2. It is necessary to implement the equipment for getting of the carcinogenic evaporations at the filling of vehicles at the existing and designed FS to decrease a pollution of air layer of working zone of operating FS and environment of the adjacent residential construction and to meet the EU requirements (2008/50/EU of 21.05.2008, 2004/42/EU of 21.04.2004, 1999/32/EU of 26.04.1999, 98/70/EU of 21.05.1998, 94/63/EU of 20.12.1994) to the quality of gasoline, diesel fuel and control of the FS emissions, and the national legislation of Ukraine (State Sanitary Rules №173-96, Sanitary Rules and Norms 4946-89).

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Table 4

Expected ambient air pollution in a zone of the effect of large FS (by the materials of the calculations of construction/ reconstruction of FS and risk ratios of the development of negative effects in the health of the population)

Pollutants	Concentrations of the pollutants at different distances from the sources of emissions, m					
	40		50		100	
	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC	mg/m^3	Proportions of MAC
Gasoline	1.00-2.95	0.20-0.59	0.925-1.45	0.185-0.29	0.1-0.95	0.2-
HQ	14.1-41.5		13.0-20.4		0.85-13.4	
Hydrocarbons C12-C19	0.14-1.00	0.14-1.00	0.032-0.59	0.032-0.59	0.001-0.53	0.001-0.53
HQ	2.0-14.1		0.45-8.3		0.01-7.5	
Nitrogen dioxide	0.026-0.087	0.13-0.435	0.02-0.071	0.1-0.355	0.0034-0.031	0.017-0.155
HQ	0.65-2.18		0.5-1.8		0.09-0.78	
Carbon monoxide	0.585-1.6	0.117-0.32	0.2-0.705	0.04-0.141	0.045-0.6	0.009-0.12
HQ	0.2-0.53		0.06-0.24		0.02-0.2	

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