

# PREVENTIVE HEALTHCARE: TOPICAL ISSUES OF HEALTH RISK ANALYSIS

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Research article

## AMBIENT AIR QUALITY AND HEALTH RISKS AS OBJECTIVE INDICATORS TO ESTIMATE EFFECTIVENESS OF AIR PROTECTION IN CITIES INCLUDED INTO THE 'CLEAN AIR' FEDERAL PROJECT

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*It is important to estimate effectiveness and results achieved by measures implemented within the 'Clean Air' Federal project as regards public health in cities included into it.*

*The aim of this study was to analyze changes in levels of ambient air pollution and airborne health risks in cities included into the 'Clean Air' Federal project in dynamics over 2020–2022 and to estimate whether the measures aimed at reduction of emissions were adequate to risk rates and factors.*

*The study relied on analyzing the results of field observations over ambient air quality within social and hygienic monitoring. Monitoring covered priority chemicals that made 95 % contributions to impermissible health risks according to dispersion calculations. Risk assessment was performed as per standard algorithms and indicators. Adequacy of air protection and correctness of its orientation were estimated in Norilsk as an example city.*

*The study established that levels of harmful chemicals in ambient were higher than hygienic standards over the analyzed period in all the cities participating in the project. We did not detect any significant reduction in ambient air pollution; there were no positive trends in health risks rates either. In 2022, a risk of respiratory diseases under chronic exposure was ranked as high (hazard index or HI 10.5÷43) in Chelyabinsk, Mednogorsk, Norilsk, Krasnoyarsk, Lipetsk, and Chita; it was ranked as 'alerting' in Bratsk, Chita, Novokuznetsk, Magnitogorsk, and Omsk (HI 4.0÷5.8). A permissible risk was identified over the analyzed period only in Cherepovets (HI<3).*

*So far, reductions in emissions of pollutants declared by economic entities have not ensured absence of impermissible health risks in 11 out of 12 cities. Ungrounded orientation to a 20 % reduction in emissions of all the economic entities included in the experiment and failure to consider risk indicators when setting quotas for emissions can lead to absence of any substantial effects for public health in the analyzed cities. In some cases, this may even result in excessive spending on activities that do not have any significant influence on a sanitary-hygienic situation.*

**Keywords:** Federal project, ambient air quality, health risk, air protection, setting quotas for emissions.

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The Federal Project 'Clean Air' was developed specifically to improve quality of the environment in several cities with high levels of ambient air pollution [1, 2]. These targets hardly seem arbitrary since negative effects of ambient air on medical and demographic indicators (population incidence and mortality) have been proven by multiple Russian and foreign researchers in their studies [3–9].

Initially, 12 cities were included into the project and the experiment on managing ambient air quality through a system of setting emission quotas. They were Bratsk, Krasnoyarsk, Lipetsk, Magnitogorsk, Mednogorsk, Nizhniy Tagil, Novokuznetsk, Norilsk, Omsk, Chelyabinsk, Cherepovets, and Chita. Twenty-nine new cities are going to be included in the experiment on September 01, 2023; they are

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mostly located in Siberia and the Far East. Most programs and action plans are developed within the 'Clean Air' Project in a maximum integrated way. They cover all the possible activities aimed at reducing emissions such as industrial modernization, replacement of old boiler-houses, making private households switch from coal to environmentally friendly heating sources, development of transport infrastructure and introduction of public transport powered by liquefied natural gas.

However, the ultimate result of the project is substantial improvement of quality of life in cities included in the experiment [10, 11]. This target is not set directly within the project profile; however, it is public health protection and a growth in the human potential in the country that is in line with all the strategic directions in the country development [12–14].

The Federal Project envisages considerable financial investments; therefore, it is interesting to estimate productivity and effectiveness of all the funds spent by the federal budget on implementing the project activities. Optimization of such investments also seems quite relevant.

The RF Government Order<sup>1</sup> (Item 12 in the Rules...) stipulates that allocation of the budget transfers should yield the following results:

- reduction in ambient air pollution;
- reduction in aggregated emissions of pollutants into ambient air against the levels established in 2017;
- a growth in consumption of liquefied natural gas as a motor fuel.

Reduction in emissions and implementation of relevant technical, technological and organizational activities aimed at reducing aggregated emissions of pollutants are certainly

the most important ultimate results of the project. However, the top priority is given to 'reduction in ambient air pollution' as its primary target. At the same time, this result has been transformed into 'Reduction in emissions of hazardous pollutants that produce the greatest negative effects on the environment and human health' in the Profile of the Federal Project. Accordingly, changes in levels of ambient air pollution are suggested to be described through emission volumes. Undoubtedly, levels of pollution in the lower atmosphere depend directly on masses of emitted chemicals. However, any relationships within the 'emission – ambient air pollution – public health' system are much more complex and require mandatory consideration since it is people who are to be provided with better environmental conditions on urbanized territories. Any activity implemented within the Federal Project is to be directed at satisfying people's need in a safe and healthy environment.

Obviously, several objective indicators can be applied to estimate effectiveness and productivity of air protection on a given territory including:

- concentrations of pollutants in ambient air identified by direct instrumental measurements at ecological and / or social-hygienic monitoring (SHM) posts, frequency and intensity of violations of hygienic standards;
- health risks assessed not only by dispersion calculations but also relying on field observation data;
- actual numbers of people asking for medical aid can be and should be considered when estimating effectiveness of implemented activities and financial investments [15–17].

<sup>1</sup> Ob utverzhdenii Pravil predostavleniya i raspredeleniya inykh mezhyudzhethnykh transfertov iz federal'nogo byudzheta byudzheta sub"ektov Rossiiskoi Federatsii na realizatsiyu meropriyatii po snizheniyu sovokupnogo ob"ema vybrosov zagryaznyayushchikh veshchestv v atmosferyi vozdukh, snizheniyu urovnya zagryazneniya atmosfernogo vozdukh v krupnykh promyshlennykh tseentrakh, obespechivayushchikh dostizhenie tselei, pokazatelei i rezul'tatov federal'nogo proekta «Chistyiy vozdukh» natsional'nogo proekta «Ekologiya»: Postanovlenie Pravitel'stva Rossiiskoi Federatsii ot 05.12.2019 g. № 1600 [On Approval of the Rules for granting and distributing other inter-budgetary transfers from the federal budget to the budgets of the RF regions to be spent on implementation on activities aimed at reducing the total emissions of pollutants into ambient air, decreasing ambient air pollution in large industrial centers thereby providing achievement of goals, targets and results within the 'Clean Air' Federal Project of the 'Ecology' National Project: the RF Government Order issued on December 05, 2019 No. 1600]. Available at: <http://static.government.ru/media/files/bgdJwTAcotUFNWAeh3nCNb7oUgh7f608.pdf> (January 21, 2023) (in Russian).

**The aim of this study** was to analyze changes in levels of ambient air pollution and airborne health risks in cities included into the Federal Project ‘Clean Air’ in dynamics over 2020–2022 and to estimate whether the measures aimed at reduction of emissions were adequate to risk rates and factors.

**Materials and methods.** Ambient air quality in the analyzed cities was estimated over the period 2020–2022 relying on social-hygienic monitoring data. It is noteworthy that, opposed to Rosgidromet posts, social-hygienic monitoring posts are usually located in zones with the highest health risks thereby providing systemic observations of the greatest hazards and threats [18–20].

Instrumental research was accomplished in the selected cities by experts from the regional centers for hygiene and epidemiology. All the laboratory centers were certified to estimate ambient air quality. Air samples were taken as per comprehensive and / or non-comprehensive programs. Hygienic assessments and health risks assessment relied on data being adequate and sufficient for calculating average annual concentrations (not less than 300 single measurements or not less than 75 daily ones as per each chemical at each sampling point). The monitoring programs included all the chemicals making contributions to 95 % of unacceptable health risks; these chemicals were identified as priority ones and fixed as such by letters of the RF Chief Sanitary Inspector<sup>2</sup>. An average annual concentra-

tion in health risk assessment was taken at the top 95 % confidence limit. If a chemical concentration was identified below the limit of detection in more than 95 % of samples, it was excluded from health risk assessment.

Health risks were assessed in full conformity with algorithms and indicators stipulated in the Guide R 2.1.10.1920-04 Human Health Risk Assessment from Environmental Chemicals<sup>3</sup>. Health risks were classified in accordance with the Methodical Guidelines MR 2.1.10.0156-19 ‘Assessment of ambient air quality and public health risk analysis ...’<sup>4</sup>.

Air protection was analyzed by using calculated estimations of contributions made by specific chemicals and by economic entities as a whole to unacceptable health risks (the estimation relied on an aggregated database that contained parameters of emission sources in a given city).

A contribution made by a specific object (a facility, motor transport, or autonomous heat sources) to a risk rate was identified as weighted average of contributions made by a facility at specific points as per the formula:

$$\delta_j^k = \frac{\sum_i HQ_i^k \cdot \delta_{i,j}^k}{\sum_i HQ_i^k},$$

where  $\delta_j^k$  is a contribution of the  $j$ -th facility to a hazard index at the  $k$ -th point;

$HQ_i^k$  is a hazard quotient identified for the  $i$ -th chemical at the  $k$ -th point;

<sup>2</sup> Pis'mo Rospotrebnadzora ot 23.11.2020 № 02/23971-2020-23. Perechni prioritnykh zagryaznyayushchikh veshchestv dlya territorii g. Bratsk, g. Nizhnii Tagil, g. Cherepovets [The Letter by Rospotrebnadzor dated November 23, 2020 No. 02/23971-2020-23. The lists of priority pollutants in Bratsk, Nizhniy Tagil, and Cherepovets] (in Russian); Pis'mo Rospotrebnadzora ot 11.12.2020 № 02/25401-2020-23. Perechni prioritnykh zagryaznyayushchikh veshchestv dlya territorii eksperimenta (g. Noril'sk g. Lipetsk, g. Chelyabinsk, g. Krasnoyarsk) [The Letter by Rospotrebnadzor dated November 11, 2020 No. 02/25401-2020-23. The lists of priority pollutants on the experiment territories (Noril'sk, Lipetsk, Chelyabinsk, and Krasnoyarsk)] (in Russian); Pis'mo Rospotrebnadzora ot 21.12.2020 № 02/26092-2020-23. Perechni prioritnykh zagryaznyayushchikh veshchestv dlya territorii eksperimenta (g. Magnitogorsk, g. Omsk, g. Chita, g. Mednogorsk, g. Novokuznetsk) [The Letter by Rospotrebnadzor dated December 21, 2020 No. 02/26092-2020-23. The lists of priority pollutants on the experiment territories (Magnitogorsk, Omsk, Chita, Mednogorsk, and Novokuznetsk)] (in Russian).

<sup>3</sup> Guide R 2.1.10.1920-04. Human Health Risk Assessment from Environmental Chemicals. *KODEKS: electronic fund for legal and reference documentation*. Available at: <https://docs.cntd.ru/document/1200037399> (January 21, 2023) (in Russian).

<sup>4</sup> MR 2.1.10.0156-19. 2.1.10. Otsenka kachestva atmosfornogo vozdukha i analiz riska zdorov'yu naseleniya v tselyakh prinatyia obosnovannykh upravlencheskikh reshenii v sfere obespecheniya kachestva atmosfornogo vozdukha i sanitarno-epidemiologicheskogo blagopoluchiya naseleniya: Metodicheskie rekomendatsii [Methodical Guidelines MR 2.1.10.0156-19. 2.1.10. Assessment of ambient air quality and public health risk analysis in order to make well-grounded managerial decisions concerning provision of ambient air quality and sanitary-epidemiological wellbeing of the population: Methodical guidelines]. *KonsultantPlus*. Available at: [http://www.consultant.ru/document/cons\\_doc\\_LAW\\_415503/](http://www.consultant.ru/document/cons_doc_LAW_415503/) (January 01, 2023) (in Russian).

$\delta_{i,j}^k$  is a contribution made by the  $j$ -th facility to ambient air pollution at the  $k$ -th point as per the  $i$ -th chemical.

Contributions made by specific objects to hazard indexes were calculated only in zones where unacceptable health risks were identified and separately for each critical organ or system. Assessment of these contributions gave grounds for identifying priority objects responsible for unacceptable public health risks in a given city.

Relevance and adequacy of air protection was assessed on the example of Norilsk. Parameters of implemented activities were taken in accordance with the Complex regional plan on reduction in pollutant emissions and the documents issued by economic entities to set quotas for emissions.

We compared suggested quotas and reduction in emission levels and contributions made by an economic entity to unacceptable health risks, both in total and as per specific chemicals in emissions.

**Basic results.** Instrumental research was established to be accomplished in conformity with the existing programs and in required volumes in all 12 cities.

Hygienic standards were violated actually in all the project cities and these violations were detected over the whole observation period as per one or several priority chemicals.

Thus, for example, average annual concentrations of six chemicals were higher than average annual maximum permissible ones (MPC) in Krasnoyarsk in 2022. Out of 14 priority chemicals (some types of priority dusts are measured as ‘particulate matter’ at the monitoring posts), elevated levels were identified for nitrogen oxide (3.32 average annual MPC), nitrogen dioxide (4.60 average annual MPC), particulate matter (1.21 average annual MPC), and benz(a)pyrene (up to 2.07 average annual MPC). Particulate matter PM<sub>2.5</sub> and PM<sub>10</sub> were not included into the lists of priority chemicals<sup>5</sup> but they were still identified in high concentrations at monitoring posts, up to

1.47 average annual MPC and up to 2.11 average annual MPC accordingly. Benzene, a hazardous toxicant and carcinogen, was identified at monitoring posts in levels equal to 1 average annual MPC.

In Chelyabinsk, average annual concentrations of seven chemicals were higher than the existing hygienic standards over the same period: benzene (up to 4.81 average annual MPC), dimethyl benzene (up to 1.79 average annual MPC), prop-2-en-1-al (up to 5.61 average annual MPC), sulfuric acid (up to 26.4 average annual MPC), trichloroethylene (up to 1.43 average annual MPC), formaldehyde (up to 1.13 average annual MPC), and ethenylbenzene (up to 2.87 average annual MPC).

In Norilsk, nitrogen dioxide levels reached 1.5 average annual MPC; benzene, 5 average annual MPC; manganese, 5.6 average annual MPC; copper oxide, 15.4 average annual MPC.

In Omsk, average annual concentrations of two chemicals were higher than the hygienic standards in 2022, namely, benz(a)pyrene (1.8 average annual MPC) and benzene (3.3 average annual MPC).

The most favorable situation was in Cherepovets where the hygienic standards were violated only as per chromium compounds in 2022 according to social-hygienic monitoring data.

It is noteworthy that the sanitary-hygienic situation concerning ambient air quality did not change substantially over the analyzed period in the project cities. Any changes were either unstable or within statistical error. Table 1 provides average annual concentrations of priority chemicals in dynamics in Krasnoyarsk. There is a slight reduction in levels of some chemicals (manganese and formaldehyde). However, there is a growth in average annual levels of such chemicals as nitrogen oxide and dioxide, benz(a)pyrene, and fluorine compounds in ambient air in the city.

<sup>5</sup> Due to the fact that these pollutants are not considered in emissions from industrial sources and, consequently, in aggregated calculations for the city as a whole.

A similar situation is observed in Norilsk (Table 2). Ground-level concentrations of nitrogen dioxide, particulate matter, and copper oxide grew over the analyzed period. These

chemicals are known to make substantial contributions to negative effects on public health. There was no significant reduction in average annual concentrations of other chemicals.

Table 1

Average annual concentrations of priority pollutants in ambient air in Krasnoyarsk in 2020–2022 (according to SHM data), shares of *average annual MPC*

Chemical		av.an. MPC, mg/m <sup>3</sup>	2020	2021	2022**
Π*	Nitrogen (II) oxide	0.06	0.65	0.74	3.32 (2.62–4.36)
Π	Nitrogen dioxide	0.04	0.74	1.0	4.60 (4.13–4.99)
Π	Benz(a)pyrene	0.000001	1.72	1.94	2.07 (0.91–3.74)
Π	Benzene	0.005	–***	0.99	1.00 (0.89–1.12)
Π	Particulate matter	0.075	1.04	0.90	1.21(0.68–1.60)
Π	Aluminum trioxide	0.005	0.08	–	0.07 (0.07)
Π	Manganese and its compounds	0.0005	1.37	–	0.69 (0.69)
Π	Nickel oxide	0.00005	1.63	–	–
Π	Sulfur dioxide	–	–	–	–
Π	Carbon (soot)	0.025	0.02	0.03	0.08 (0.08)
Π	Formaldehyde	0.003	0.99	0.10	0.44 (0.10–0.80)
Π	Gaseous fluorides	–	0.14	0.13	0.27 (0.20–0.41)
	PM <sub>10</sub>	0.04	1.56	1.36	1.47 (0.92–2.25)
	PM <sub>2.5</sub>	0.025	2.30	1.89	2.11 (1.30–2.46)

Note: \* means a chemical is included into the priority list; \*\* means minimal and maximum values obtained at some SHM posts are given in brackets; \*\*\* means there are not enough measurements for calculating an average annual concentrations or a chemical levels was not measured at all.

Table 2

Average annual concentrations of priority pollutants in ambient air in Norilsk in 2020–2022 (according to SHM data), shares of *average annual MPC*

Chemical		av.an. MPC, mg/m <sup>3</sup>	2020	2021	2022**
Π*	Nitrogen dioxide	0.04	0.28	0.98	1.48 (1.43–1.54)
Π	Benz(a)pyrene	0.000001	–***	–	–
Π	Benzene	0.005	–	–	4.93 (4.55–5.97)
Π	Particulate matter	0.075	0.29	0.30	0.46 (0.46)
Π	Dihydrosulfide	0.002	0.13	0.28	0.09 (0.05–0.17)
Π	Manganese and its compounds	0.0005	–	–	5.58 (4.16–6.68)
Π	Copper oxide	0.00002	9.10	18.02	15.43 (5.65–32.9)
Π	Nickel oxide	0.00005	0.67	1.70	–
	Sulfur dioxide	0.05****	49.4	40.7	–
	Lead and its inorganic compounds	0.00015	0.28	0.32	0.30 (0.27–0.33)
Π	Chromium (per Cr+6)	0.000008	–	–	0.13 (0.08–0.16)
	PM <sub>10</sub>	0.04	0.53	0.52	0.20 (0.16–0.26)
	PM <sub>2.5</sub>	0.025	0.76	0.71	0.08 (0.04–0.11)

Note: \* means a chemical is included into the priority list; \*\* means minimal and maximum values obtained at some SHM posts are given in brackets; \*\*\* means there are not enough measurements for calculating an average annual concentrations or a chemical levels was not measured at all; \*\*\*\* means average daily MPC.

Table 3

Dynamics of chronic non-carcinogenic risks (for the respiratory organs) and total carcinogenic risk for people in 12 cities included into the 'Clean Air' Federal Project

City	Chronic non-carcinogenic risks of respiratory diseases (HI)*			Total carcinogenic risk (Rcr)		
	year			year		
	2020	2021	2022	2020	2021	2022
Chelyabinsk	33.5	16.5	42.6	9.1E-03	6.5E-03	5.5E-03
Mednogorsk	10.5	8.2	13.5	6.8E-05	6.7E-05	7.8E-05
Norilsk	30.9	43.6	29.0	2.8E-07	3.3E-07	1.23E-4
Bratsk	16.3	6.3	4.5	2.1E-04	2.5E-04	8.4E-05
Chita	12.2	13.1	34.3	3.2E-06	9.2E-05	1.4E-04
Nizhniy Tagil	5.0	12.5	5.0	2.8E-04	2.5E-04	4.6E-04
Krasnoyarsk	5.11	3.7	10.5	3.2E-04	2.4E-05	2.9E-05
Novokuznetsk	8.4	4.9	5.1	1.7E-04	1.1E-04	6.9E-05
Lipetsk	2.4	17.5	17.9	7.7E-06	1.0E-05	3.2E-05
Magnitogorsk	5.6	6.3	4.0	5.4E-06	5.8E-04	1.1E-05
Omsk	4.7	5.6	5.8	1.1E-04	1.3E-04	1.3E-04
Cherepovets	1.2	2.7	1.6	3.7E-07	1.2E-06	3.6E-07

Note:

	High risk, $HI > 6.0$ ; $Rcr > 1.1E-03$
	Alerting risk: $6.0 \geq HI > 3.0$ ; $1.1E-03 \geq Rcr > 1.0E-04$
	Low, permissible risk $3.0 \geq HI > 1.0$ ; $1.0E-04 \geq Rcr > 1.0E-06$
	Target negligible risk $HI < 1.0$ ; $Rcr \leq 1.0E-06$

Obviously, ambient air quality did not improve in the analyzed cities and, accordingly, exposure levels did not change either. As a result, health risks also changed only slightly. Table 3 provides the total dynamics of carcinogenic health risks and a chronic non-carcinogenic risk of respiratory diseases for people in the analyzed cities. The respiratory system is most frequently affected under exposure to ambient air pollution.

It is noteworthy that risks had not been assessed in the cities prior to 2020 relying on instrumental measurements and the data in dynamics are available only for the period 2020–2022.

Absence of any substantial changes in ambient air quality does not always correlate with data on emissions of pollutants into ambient air and data on implemented air protection activities. Thus, according to the State Report 'On the ecological situation and environmental protection in the Russian Federation in 2020'<sup>6</sup>, Chelyabinsk authorities declared that emissions

were reduced by 13 % (18.2 thousand tons) in 2020 only. As opposed to 2017, emissions went down by 17 %; this figure is very close to the target indicator fixed in the Federal Project where emissions are expected to fall by 20 %. However, public health risks in the city not only have remained high but have grown in 2022 against both 2020 and 2021 as regards chronic non-carcinogenic risks.

Industrial enterprises in Lipetsk also declare reductions in emissions. According to statistical reports, emissions went down by almost 10 thousand tons in 2022 against 2021 (mostly, due to reduced emissions of nitrogen oxide and carbon oxide). Nevertheless, this reduction has not secured any substantial improvement since risks of respiratory diseases remained high (mostly due to absence of any considerable reduction in emissions of highly toxic and carcinogenic chromium compounds). Attention should also be paid to a growth in a potential carcinogenic health risk; this growth,

<sup>6</sup> O sostoyanii i ob okhrane okruzhayushchei sredy Rossiiskoi Federatsii v 2020 godu: Gosudarstvennyi doklad [On the ecological situation and environmental protection in the Russian Federation in 2020: the State Report]. *Ministry of Natural Resources and Environment of the Russian Federation*. Available at: <https://2020.ecology-gosdoklad.ru/> (January 21, 2023) (in Russian).

Table 4

Predicted results of air protection activities implemented by the Zapolyarnyi branch of the OJSC MMC Norilsk Nickel

Emission component	Emissions, tons/year, 2019	Emissions in 2024, tons/year (20 % reduction)	Sufficiency as per health risk indicators	Residual risk (for this chemical emitted by this enterprise)
Nickel sulfate	1.12	0.90	Sufficient	Acceptable
Lead and its compounds	12.31	9.85	Insufficient	Unacceptable, alerting
Copper oxide	487.50	390.00	Insufficient	Unacceptable, high
Nickel oxide	238.19	190.55	Insufficient	Unacceptable, high
Sulfuric acid	13,454.23	10,763.39	Insufficient	Unacceptable
Benzene	3.47	2.78	Excessive; the enterprise does not contribute to unacceptable risks	Acceptable
Nitrogen (II) oxide	2001.65	1601.32	Sufficient	Acceptable
Nitrogen dioxide	12,731.81	10,185.45	Sufficient	Acceptable
Sulfur dioxide	1,802,181.58	1,441,745.26	Insufficient	Unacceptable, alerting
Carbon oxide	20,121.67	16,097.34	Excessive, the enterprise is not the major source of the chemical	Acceptable
Total dusts (particulate mater)	8473.33	6778.67	Insufficient	Unacceptable, alerting

though small, is rather stable. It is still considered low and permissible but it grew by almost four times over three years of observation.

In Norilsk, data provided by economic entities (the report forms No. 2-tp Air) give evidence that emissions decreased by more than 216 thousand tons between 2019 and 2022. However, a chronic non-carcinogenic risk of respiratory diseases remained practically the same in 2022 as in 2020 and carcinogenic risks even grew.

To analyze the situation, we made an attempt to predict what results would be achieved by implementation of air protection activities by the Zapolyarnyi branch of the OJSC MMC Norilsk Nickel (the major economic entity and a source of ambient air pollution). The prediction was made considering the necessity to provide hygienic safety for population which was taken as absence of impermissible public health risks. We considered the tasks that economic entities had to tackle during the experiment on setting emission quotas and estimated possible outcomes of 20 % reduction in emissions of hazardous chemicals. The generalized results are provided in Table 4.

Obviously, insufficient reduction in emission of copper and nickel oxides leads to persistently high public health risks (respiratory diseases, blood diseases, and some systemic disorders). At the same time, quotas for emissions of carbon oxide and benzene as well as reduction

in their levels are excessive and do not have any substantial influence on health risk rates.

The situation in Norilsk seems typical for all the cities included into the Federal Project.

Obviously, 20 % reduction in total emission volumes will not secure complete absence of unacceptable health risks even if all the project targets have been achieved.

Given all that, it seems that it is Rospotrebnadzor that can and should take on the responsibility for providing complete sanitary-epidemiological wellbeing of the population. This can be achieved by fixing health risk indicators in regulatory documents as regards the whole system for managing quality of the environment [21].

The assessment was accomplished considering a solution to an optimization task when an optimization indicator is minimum reduction in emissions able to ensure that the existing hygienic standards are met at any calculation point in a residential area within a city and carcinogenic and non-carcinogenic health risks remain within their acceptable ranges.

**Conclusions.** In general, this study has established that:

- economic entities in the cities included into the Federal Project 'Clean Air' declare such reduction in emissions that is still unable to secure absence of unacceptable airborne health risks for people in 11 out of 12 cities.

According to social-hygienic monitoring data, hygienic safety of the population is provided only in Cherepovets where health risks remain low, permissible and do not require any additional activities. Still, systemic control of the environmental situation is mandatory;

- the authorities responsible for regulating the experiment on setting emission quotas focus on the total 20 % reduction in emissions from all the economic entities included into the experiment and do not properly consider health risk rates when setting these quotas. This may lead to absence of any substantial effects on public health in the project cities and in some cases even create excessive financial costs spent by economic entities on some activities that do not have any substantial influence on the sanitary-hygienic situation;

- it is advisable to make reconnaissance estimates whether air protection activities are relevant and adequate using permissible health risk levels as estimation criteria and to assess residual health risks after implementation of both isolated activities and the whole set of air protection measures stipulated by the Complex plans on reduction in emissions; their timely improvement and / or adjustment is also advisable;

- achievement of permissible risk levels should obviously be evidenced by epidemiological data on a given territory and results of profound biomedical research aimed at creating solid evidence base of either absence or

persistence of public health harm after emissions have been reduced to a target level fixed by ecological standards;

- comprehensive analysis of integrated data within the 'dispersion calculation – results of instrumental (field) measurements of ambient air quality – health risk – actual health harm' system gives solid grounds for making optimal managerial decisions primarily aimed at protecting public health in the cities participating in the Federal Project 'Clean Air' and accomplishing the experiment on setting emission quotas;

- analysis of the Complex plans revealed the necessity to develop medical and preventive measures and to include them into plans of compensatory activities when it was temporarily impossible to reduce health risks down to their permissible levels due to some technical and / or organizational limitations. Health protection within medical and preventive programs including those funded by economic entities as sources of health risks seems to be able to have significant economic and social effects due to declining social anxiety, less intensive environmental tensions and a better image of authorities and businesses as socially responsible structures.

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