Assessment of Risk to Filling Station Employees Health as an Indicator of the Urban Environment Quality

A I Kurbatova¹, K Yu Mikhaylichenko¹, A Yu Dorontsova¹
¹Ecological Faculty, Peoples' Friendship University of Russia, Miklukho-Maklaia street, 6, Moscow, 117198, Russia

E-mail: kurbatova_ai@rudn.university

Abstract. Results of the research on assessment of risk to filling station employee's health caused by working zone air pollution with hazardous organic compositions as one of the indicators of urban environment quality are given in this article. It has been shown that even if hydrocarbons and their derivatives content are at the level of daily average MAC or less, they can have strong toxic effect on a human body, causing risks of not cancerogenic effects and cancerogenic risks.

1. Introduction

The modern city territory is a specific geological and ecosystem with peculiar components and structure of components. It is a territory where natural, natural-anthropogenic and anthropogenic components interact, where all natural components: relief, lithogenous basis, hydrogeological and hydrological conditions, climatic conditions are changed to some extent, where new natural and anthropogenic complex which functioning is badly studied is formed [1].

As of the beginning of 2015, according to the Ministry of Internal Affairs of Russia for Moscow-city [8], fleet of vehicles in Moscow-city was about 4,312 thousand units and 90.3% of them were passenger cars, 8.6% - cargo and small passenger-and-freight vehicles, 1.1% - buses. Vehicle-to-population ratio by the total number of the registered passenger vehicles (further – PV) was 320 ATS per 1000 people. In Russia number of cars per person is steadily grows that, in turn, stimulates development of the oil products market, road construction, new construction and re-equipment of already existing fuel filling stations (further – FS). More than 500 km of roads were constructed and put into operation in the last six years in Moscow that makes 12% of all road network of the city.

Today gasoline is the most demanded type of fuel all around the world. In Russia, production of a motor gasoline makes about 40 million tons a year [3].

At the end of the 20th century, various indicators of cities sustainable development were developed: general indicators (such as population of the city, area of the city, transport networks, etc.); indicators of city flows (characteristic of consumption of energy, imported and exported goods, water consumption, etc.); indicators of the urban environment quality (wastes, quality of water and air environments, etc.) [2]. Our research is focused on assessment of the risk to health of filling stations employees at pollution of working zone air with hazardous organic compositions as one of indicators of the urban environment quality.

Operation of filling stations where transport vehicles are filled with oil products is a hazard. Three main types of filling stations exist: mobile, stationary and container ones. Filling stations for cargo and
passenger vehicles belong to the IV class on hazard with the sanitary protection zone (further - SPZ) of 100 meters, and filling stations for passenger transport equipped with gasoline vapors looping back systems, with the number of filling operation not more than 500 per day, without cars service facilities - to the V class with the sanitary protection zone of 50 meters [7].

Investigation of filling stations pollutants emission was carried out in the territory of Moscow city. Sampling was made in a working zone of workplaces being the most adverse in the hygienic relation. Such places are working zones of refuellers. In total 32 filling stations were investigated, see Fig. 1.

![Figure 1. Location of FS.](image-url)

2. Methods
Air was sampled by UPRV 1-20 aspirator. Laboratory analysis of the air samples were performed by means of a gas chromatograph Crystallux-4000M.

The following substances were found out in the air: 1,2-dichloroethane, acetone, benzene, butyl acetate, vinyl acetate, hexane, isopropanol, methanol, M-xylol, O-xylol, P-xylol, styrene, toluene, cyclohexanone, ethanol, ethyl benzene, ethyl acetate, ethyl acrylate. Carcinogenicity of 1,2-dichloroethane, benzene, styrene, ethyl benzene, ethyl acrylate is clinically proved.

The health risk assessment was carried out according to technique for health risk assessment at influence of the chemicals polluting the environment [6].

Parameter of not cancerogenic effects risk for some substances was defined on the basis of hazard coefficient calculated by a formula:

\[ HQ = \frac{AC}{RfC}, \]

where HQ - hazard coefficient; AC - average concentration, mg/m³; RfC - reference (safe) concentration, mg/m³.

Index of not cancerogenic effects hazard for simultaneous impact of several substances in the same way (in this case - inhalation) is calculated by a formula:

\[ HI = \sum HQ_i \]

where HQ_i - hazard coefficients for separate components of the influencing substances mixture.

3. Results
18 kinds of hydrocarbons, five of which are carcinogenic, were found out as a result of the analysis of air samples, see Table 1. Values exceeding MAC were not observed.

| Determined element | RfC | Object №16 AC, mg/m³ | HQ | Object №126 AC, mg/m³ | HQ | Object №123 AC, mg/m³ | HQ | Object №107 AC, mg/m³ | HQ |
|--------------------|-----|----------------------|----|-----------------------|----|-----------------------|----|-----------------------|----|
| 1,2-dichloroethane | 0.4 | –                    | –  | –                     | –  | –                     | –  | –                     | –  |
| Acetone            | 31.2| 3.6•10⁻¹              | 0.12| 2.1•10⁻¹              | 0.00| 1.3•10⁻¹              | 0.00| 4.0•10⁻¹              | 0.00|
| Compound          | HF   | 1000 | 2000 | 4000 | 7000 | 11000 |
|-------------------|------|------|------|------|------|-------|
| Benzene           | 0.03 | 2.3•10^-3 | 7.72 | 1.3•10^-1 | 4.17 | 0.00 | 0.28 | 3.0•10^-2 | 0.93 |
| Butyl acetate     | 0.7  | -    | -    | -    | -    | -    | -    | -    | -    |
| Cyclohexanone     | 1    | 7.3•10^-3 | 0.73 | 5.0•10^-1 | 0.5  | 2.0•10^-2 | 0.02 | 0.00 | 0.00 |
| Ethanol           | 100  | -    | -    | -    | -    | -    | -    | -    | -    |
| Ethyl acetate     | 3.2  | -    | -    | -    | -    | -    | -    | -    | -    |
| Ethyl acrylate    | 0.048| -    | -    | -    | -    | -    | -    | -    | -    |
| Ethyl benzene     | 1    | 5.3•10^-3 | 0.53 | 2.2•10^-1 | 0.22 | 5.0•10^-2 | 0.05 | 5.0•10^-2 | 0.05 |
| Hexane            | 0.2  | 4.2•10^-1 | 2.09 | 1.0•10^-1 | 0.51 | 6.7•10^-1 | 3.33 | 1.3•10^-1 | 0.67 |
| Isopropanol       | 7    | -    | -    | -    | -    | -    | -    | -    | -    |
| Methanol          | 4    | -    | -    | -    | -    | -    | -    | -    | -    |
| M-xylene          | 0.1  | -    | -    | -    | -    | -    | -    | -    | -    |
| O-xylene          | 0.1  | -    | -    | -    | -    | -    | -    | -    | -    |
| P-xylene          | 0.1  | -    | -    | -    | -    | -    | -    | -    | -    |
| Styrene           | 1    | 4.7•10^-3 | 0.47 | 2.7•10^-1 | 0.27 | 1.0•10^-2 | 0.01 | 4.0•10^-2 | 0.04 |
| Toluene           | 0.4  | 8.0•10^-3 | 2.02 | 5.6•10^-1 | 1.4  | 5.0•10^-2 | 0.13 | 0.0   | 0.00 |
| Vinyl acetate     | 0.2  | -    | -    | -    | -    | -    | -    | -    | -    |

**HI**

| Determined element | Object №152 | Object №161 | Object №3 | Object №150 |
|--------------------|-------------|-------------|-----------|-------------|
|                    | R/C | AC<sub>m</sub> mg/m<sup>3</sup> | HQ | AC<sub>m</sub> mg/m<sup>3</sup> | HQ | AC<sub>m</sub> mg/m<sup>3</sup> | HQ | AC<sub>m</sub> mg/m<sup>3</sup> | HQ |
| 1,2-dichloroethane| 0.4 | 2.1 | 5.13 | 1.2•10^-1 | 0.3 | 6.0•10^-2 | 0.16 | 1.3•10^-1 | 0.32 |
| Acetone            | 31.2 | 4.4 | 0.14 | 6.3•10^-1 | 0.02 | 2.0•10^-2 | 0.00 | 1.1•10^-1 | 0.00 |
| Benzene            | 0.03 | 2.3•10^-3 | 7.77 | 1.6•10^-1 | 5.33 | 1.7•10^-1 | 5.6 | 4.0•10^-2 | 1.25 |
| Butyl acetate      | 0.7  | -    | -    | -    | -    | -    | -    | -    | -    |
| Cyclohexanone      | 1    | -    | -    | -    | -    | -    | -    | -    | -    |
| Ethanol            | 100  | 9.0•10^-3 | 0.00 | 1.02 | 0.01 | 8.0•10^-2 | 0.00 | 2.0•10^-2 | 0.00 |
| Ethyl acetate      | 3.2  | -    | -    | -    | -    | -    | -    | -    | -    |
| Ethyl acrylate     | 0.048| 3.1•10^-3 | 6.51 | -    | -    | -    | -    | -    | -    |
| Ethyl benzene      | 1    | 1.0•10^-1 | 0.1  | -    | 6.0•10^-2 | 0.06 | 1.1•10^-1 | 0.11 |
| Hexane             | 0.2  | 1.4•10^-1 | 0.72 | 1.8•10^-1 | 0.88 | 4.0•10^-2 | 0.18 | 6.0•10^-2 | 0.29 |
| Isopropanol        | 7    | -    | -    | -    | -    | -    | -    | -    | -    |
| Methanol           | 4    | -    | -    | -    | -    | -    | -    | -    | -    |
| M-xylene           | 0.1  | 4.0•10^-2 | 0.37 | 1.5•10^-1 | 1.47 | 6.0•10^-2 | 0.6  | -    | -    |
| O-xylene           | 0.1  | -    | -    | -    | -    | -    | -    | -    | -    |
| P-xylene           | 0.1  | -    | -    | -    | -    | -    | -    | -    | -    |
| Styrene            | 1    | 1.3•10^-3 | 0.33 | 1.5•10^-1 | 0.38 | -    | -    | 7.0•10^-1 | 1.77 |
| Toluene            | 0.4  | -    | -    | 5.0•10^-2 | 0.25 | 1.1•10^-1 | 0.55 | -    | -    |
| Vinyl acetate      | 0.2  | -    | -    | -    | -    | -    | -    | -    | -    |

**HI**

| Determined element | Object №154 | Object №93 | Object №9 | Object №134 |
|--------------------|-------------|------------|-----------|-------------|
|                    | R/C | AC<sub>m</sub> mg/m<sup>3</sup> | HQ | AC<sub>m</sub> mg/m<sup>3</sup> | HQ | AC<sub>m</sub> mg/m<sup>3</sup> | HQ | AC<sub>m</sub> mg/m<sup>3</sup> | HQ |
| 1,2-dichloroethane| 0.4 | 5.8•10^-3 | 1.46 | 5.4•10^-3 | 1.35 | 1.0•10^-2 | 0.003 | 0.0   | 0.00 |
| Acetone            | 31.2 | 1.3•10^-3 | 0.00 | 9.0•10^-2 | 0.00 | 3.9•10^-3 | 0.01 | 1.0•10^-1 | 0.00 |
| Benzene            | 0.03 | 2.0•10^-2 | 0.6  | 6.0•10^-2 | 1.86 | 1.6•10^-1 | 5.5  | -    | -    |
| Butyl acetate      | 0.7  | -    | -    | -    | -    | 1.4•10^-2 | 0.02 | 2.0•10^-2 | 0.03 |
| Cyclohexanone      | 1    | 1.6•10^-1 | 0.16 | 2.7•10^-1 | 0.27 | 3.0•10^-2 | 0.03 | 2.0•10^-3 | 0.002 |
| Ethanol            | 100  | -    | -    | -    | -    | 2.3•10^-1 | 0.002 | 5.0•10^-2 | 0.00 |
| Ethyl acetate      | 3.2  | -    | -    | -    | -    | -    | -    | -    | -    |
| Ethyl acrylate     | 0.048| -    | -    | 6.0•10^-2 | 1.19 | 7.0•10^-3 | 0.16 | -    | -    |
| Ethyl benzene      | 1    | 3.7•10^-3 | 0.37 | 1.8•10^-1 | 0.18 | 5.8•10^-3 | 0.58 | 1.5•10^-1 | 0.15 |
| Hexane             | 0.2  | 9.6•10^-3 | 4.8  | -    | -    | 1.3•10^-1 | 0.63 | 6.6•10^-1 | 3.32 |
| Isopropanol        | 7    | 1.3•10^-3 | 0.02 | 1.8•10^-1 | 0.03 | 1.3•10^-3 | 0.02 | 4.0•10^-2 | 0.01 |
| Methanol           | 4    | -    | -    | -    | -    | 1.0•10^-2 | 0.00 | 0.00 | 0.00 |
| Determined element | RfC | Object №49 | Object №20 | Object №2 | Object №110 |
|--------------------|-----|------------|------------|-------------|--------------|
|                    |     | AC, mg/m³ | HQ         | AC, mg/m³  | HQ           |
| I, 2- dichloroethane |     | 0.4 | 0.00 | 0.00 | – | 2.7•10⁻⁴ | 0.068 | 1.6•10⁻³ | 0.039 |
| Acetone | 31.2 | 2.0•10⁻² | 0.00 | 3.4•10⁻² | 0.011 | 1.3•10⁻¹ | 0.003 | 3.5•10⁻¹ | 0.011 |
| Benzene | 0.03 | 2.7•10⁻² | 1.86 | 4.3•10⁻² | 1.42 | 1.3•10⁻¹ | 4.2 | 2.8•10⁻² | 0.93 |
| Butyl acetate | 0.7 | – | – | – | – | – | – | 2.4•10⁻² | 0.003 |
| Cyclohexanone | 1 | 1.4•10⁻² | 0.014 | 3.1•10⁻² | 0.031 | 3.0•10⁻² | 0.039 | 6.9•10⁻¹ | 0.69 |
| Ethanol | 100 | 3.0•10⁻¹ | 0.00 | 1.2•10⁻² | 0.00 | – | – | 4.7•10⁻¹ | 0.005 |
| Ethyl acetate | 3.2 | – | – | 7.0•10⁻³ | 0.002 | – | – | – | – |
| Ethyl benzene | 0.048 | – | – | – | – | – | – | 1.9•10⁻¹ | 0.39 |
| Hexane | 0.2 | 1.1•10⁻¹ | 0.63 | 1.3•10⁻¹ | 0.66 | 4.3•10⁻² | 2.17 | 4.6•10⁻¹ | 2.28 |
| Isopropanol | 7 | 6.0•10⁻² | 0.00 | – | – | 3.1•10⁻² | 0.004 | 3.0•10⁻¹ | 0.036 |
| Methanol | 4 | 2.0•10⁻³ | 0.00 | – | – | – | – | 2.7•10⁻² | 0.007 |
| M-xylene | 0.1 | – | – | 1.0•10⁻³ | 0.01 | – | – | 9.0•10⁻³ | 0.3 |
| O-xylene | 0.1 | 0.00 | 0.00 | 3.0•10⁻² | 0.3 | 9.7•10⁻¹ | 9.7 | 2.6•10⁻¹ | 2.6 |
| P-xylene | 0.1 | – | – | – | – | – | – | – | – |
| Styrene | 1 | 2.0•10⁻² | 0.02 | 2.1•10⁻¹ | 0.21 | 2.8•10⁻¹ | 0.28 | 2.3•10⁻¹ | 0.23 |
| Toluene | 0.4 | 1.3•10⁻¹ | 0.33 | 2.9•10⁻¹ | 0.73 | 5.0•10⁻² | 0.13 | 3.0•10⁻³ | 0.009 |
| Vinyl acetate | 0.2 | 0.00 | 0.00 | – | – | 9.0•10⁻² | 0.45 | – | – |

| Determined element | RfC | Object №114 | Object №109 | Object №147 | Object №113 |
|--------------------|-----|------------|------------|-------------|--------------|
|                    |     | AC, mg/m³ | HQ         | AC, mg/m³  | HQ           |
| I, 2- dichloroethane |     | 0.4 | – | – | 5.0•10⁻³ | 0.125 | – | – |
| Acetone | 31.2 | 9.7•10⁻² | 0.003 | 7.0•10⁻² | 0.002 | 4.2•10⁻¹ | 0.014 | 5.0•10⁻¹ | 0.016 |
| Benzene | 0.03 | 1.8•10⁻¹ | 6.07 | 1.0•10⁻¹ | 3.3 | 1.2•10⁻¹ | 4.08 | 1.3•10⁻¹ | 4.23 |
| Butyl acetate | 0.7 | 2.8•10⁻² | 0.04 | 3.0•10⁻² | 0.04 | 1.2•10⁻² | 0.018 | 2.0•10⁻² | 0.03 |
| Cyclohexanone | 1 | 5.0•10⁻² | 0.05 | 4.0•10⁻² | 0.04 | 8.0•10⁻³ | 0.008 | 5.0•10⁻² | 0.05 |
| Ethanol | 100 | 4.3•10⁻² | 0.00 | 4.2•10⁻² | 0.00 | 2.0•10⁻¹ | 0.002 | 1.1 | 0.11 |
| Ethyl acetate | 3.2 | 7.0•10⁻² | 0.007 | – | – | – | – | – | – |
| Ethyl benzene | 0.048 | 2.5•10⁻² | 0.52 | 1.0•10⁻¹ | 2.125 | – | – | – | – |
| Hexane | 1 | 1.4•10⁻¹ | 0.143 | 4.0•10⁻¹ | 0.04 | 1.91 | 0.018 | 1(93,897),(120,906)(92,905),(120,913)(94,911),(120,919)(92,919),(120,927) | 1.1 | 1.134 |
| Isopropanol | 7 | 9.3•10⁻¹ | 4.67 | 4.0•10⁻² | 0.2 | 3.4•10⁻¹ | 1.7 | 7.4•10⁻¹ | 3.7 |
| Methanol | 4 | – | – | – | – | – | – | 4.0•10⁻³ | 0.001 | – | – |
| M-xylene | 0.1 | – | – | 1.3•10⁻¹ | 1.3 | 5.0•10⁻² | 0.46 | 4.1•10⁻³ | 0.44 |
| O-xylene | 0.1 | 1.0•10⁻¹ | 1 | 8.5•10⁻² | 0.85 | 2.6•10⁻¹ | 2.57 | 1.1•10⁻¹ | 1.09 |
| P-xylene | 0.1 | – | – | – | – | – | – | – | – |
| Styrene | 1 | 1.4•10⁻¹ | 0.136 | 3.0•10⁻² | 0.03 | 8.8•10⁻¹ | 0.88 | 3.1 | 3.085 |
| Toluene | 0.4 | 6.0•10⁻² | 0.014 | 5.0•10⁻² | 0.12 | 5.0•10⁻¹ | 1.243 | 5.2•10⁻¹ | 1.3 |
| Vinyl acetate | 0.2 | – | – | 2.0•10⁻² | 0.1 | – | – | 0.0 | 0.00 | – | – |

| Determined element | RfC | Object №17 | Object №112 | Object №8 | Object №7 |
|--------------------|-----|------------|------------|-------------|--------------|
|                    |     | AC, mg/m³ | HQ         | AC, mg/m³  | HQ           |
|                     |     |             |             |             |             |             |             |             |             |
| Determined element | R/F | Object №120 AC, mg/m³ | HQ | Object №122 AC, mg/m³ | HQ | Object №15 AC, mg/m³ | HQ | Object №48 AC, mg/m³ | HQ |
|--------------------|-----|------------------------|----|-----------------------|----|----------------------|----|-----------------------|----|
| **1,2-dichloroethane** | 0.4 | 31.2 | 5.8•10⁻² | 0.002 | 1.0•10⁻² | 0.00 | 3.5•10⁻² | 0.001 | 1.1•10⁻¹ | 0.004 |
| Acetone | 31.2 | 5.8•10⁻² | 0.002 | 1.0•10⁻² | 0.00 | 3.5•10⁻² | 0.001 | 1.1•10⁻¹ | 0.004 |
| Benzene | 0.03 | 1.2•10⁻² | 3.84 | 2.5•10⁻¹ | 8.33 | 1.0•10⁻² | 0.33 | 3.2•10⁻¹ | 10.77 |
| Butyl acetate | 0.7 | 1.9•10⁻¹ | 0.27 | 1.4•10⁻¹ | 0.19 | – | – | 1.7•10⁻¹ | 0.24 |
| Cyclohexanone | 1 | 1.6•10⁻¹ | 0.16 | 3.5•10⁻¹ | 0.354 | 1.4•10⁻² | 0.014 | 1.1•10⁻¹ | 0.11 |
| Ethanol | 100 | 6.6•10⁻² | 0.00 | 1.7•10⁻¹ | 0.002 | – | – | – | – |
| Ethyl acetate | 3.2 | – | – | – | – | – | – | – | – |
| Ethyl acrylate | 0.048 | – | – | – | – | – | – | – | – |
| Ethyl benzene | 1 | 6.0•10⁻¹ | 0.596 | 3.6•10⁻¹ | 0.358 | 1.3•10⁻² | 0.013 | 4.8•10⁻¹ | 0.48 |
| Hexane | 0.2 | 1.5•10⁻¹ | 0.76 | 4.2•10⁻¹ | 2.085 | 5.3•10⁻¹ | 0.265 | 4.5•10⁻¹ | 2.235 |
| Isopropanol | 7 | – | – | – | – | – | – | – | – |
| Methanol | 4 | – | – | – | – | – | – | – | – |
| M-xylene | 0.1 | 5.0•10⁻¹ | 5 | 1.1•10⁻¹ | 1.1 | – | – | 5.0•10⁻² | 0.5 |
| O-xylene | 0.1 | 1.8•10⁻¹ | 1.78 | 4.0•10⁻¹ | 4.02 | – | – | 1.6•10⁻¹ | 1.55 |
| P-xylene | 0.1 | – | – | – | – | – | – | – | – |
| Styrene | 1 | 7.0•10⁻² | 0.07 | 3.6•10⁻¹ | 0.36 | 3.0•10⁻² | 0.03 | 5.9•10⁻¹ | 0.59 |
| Toluene | 0.4 | 0 | 0.00 | 4.6•10⁻¹ | 1.15 | 2.4•10⁻² | 0.06 | 2.8•10⁻² | 0.07 |
| Vinyl acetate | 0.2 | 4.7•10⁻¹ | 0.235 | 2.3•10⁻¹ | 1.135 | – | – | – | – |

**II**

| Determined element | R/F | Object №98 AC, mg/m³ | HQ | Object №142 AC, mg/m³ | HQ | Object №145 AC, mg/m³ | HQ | Object №96 AC, mg/m³ | HQ |
|--------------------|-----|----------------------|----|-----------------------|----|----------------------|----|-----------------------|----|
| **1,2-dichloroethane** | 0.4 | 31.2 | 6.7•10⁻² | 0.002 | 1.3•10⁻¹ | 0.004 | 3.0•10⁻² | 0.007 | 3.0•10⁻² | 0.007 |
| Acetone | 31.2 | 6.7•10⁻² | 0.002 | 1.3•10⁻¹ | 0.004 | 3.0•10⁻² | 0.007 | 3.0•10⁻² | 0.007 |
| Benzene | 0.03 | 2.2•10⁻² | 0.733 | 6.1•10⁻² | 2.03 | 5.3•10⁻² | 1.77 | – | – |
| Butyl acetate | 0.7 | 1.2•10⁻¹ | 0.17 | – | – | – | – | 2.3•10⁻² | 0.032 |
| Cyclohexanone | 1 | 4.4•10⁻² | 0.044 | 7.0•10⁻² | 0.07 | 8.0•10⁻³ | 0.008 | 5.8•10⁻¹ | 0.578 |
| Ethanol | 100 | 3.7•10⁻² | 0.00 | 7.6•10⁻² | 0.00 | – | – | 2.7•10⁻² | 0.00 |
| Ethyl acetate | 3.2 | – | – | – | – | – | – | – | – |
| Ethyl acrylate | 0.048 | – | – | – | – | – | – | – | – |
| Ethyl benzene | 1 | 2.5•10⁻² | 0.025 | 3.0•10⁻¹ | 0.298 | 1.0•10⁻¹ | 0.102 | 3.1•10⁻¹ | 0.313 |
The assessment of the risk acceptability was carried out according to classification of not cancerogenic effects risk levels, see Table 2.

**Table 2. Classification of not cancerogenic effects risk levels on the researched FS.**

| Risk level               | Number of FS |
|--------------------------|--------------|
| Extremely high, HI > 10  | 11           |
| High, HI 5 - 10          | 12           |
| Medial, HI 1 - 5         | 8            |
| Low, HI 0.1 - 1          | 1            |

Cancerogenic risk for each carcinogenic substance found out in the filling stations air was calculated by a formula (Table 3):

\[ CR = D \times SF, \]

where \( D \) – dose, \( SF \) – cancerogenic potential.

**Table 3. Summarized cancerogenic risk.**

| № FS | Summarized cancerogenic risk, CR | № FS | Summarized cancerogenic risk, CR |
|-------|----------------------------------|-------|----------------------------------|
| 16    | 1.62 \times 10^{-4}              | 114   | 1.2 \times 10^{-2}              |
| 126   | 8.3 \times 10^{-5}               | 109   | 1.4 \times 10^{-2}              |
| 123   | 7.8 \times 10^{-6}               | 147   | 2.7 \times 10^{-2}              |
| 107   | 1.9 \times 10^{-6}               | 113   | 1.8 \times 10^{-2}              |
| 152   | 3.4 \times 10^{-7}               | 17    | 5.9 \times 10^{-2}              |
| 161   | 2.8 \times 10^{-8}               | 112   | 1.2 \times 10^{-3}              |
| 3     | 4.5 \times 10^{-9}               | 8     | 6.7 \times 10^{-4}              |
| 150   | 4.1 \times 10^{-9}               | 7     | 2.1 \times 10^{-4}              |
| 154   | 9.7 \times 10^{-10}              | 120   | 1.2 \times 10^{-5}              |
| 93    | 9.4 \times 10^{-10}              | 22    | 3.4 \times 10^{-5}              |
| 9     | 7.86 \times 10^{-11}             | 15    | 1.7 \times 10^{-5}              |
| 134   | 9.15 \times 10^{-12}             | 48    | 9.9 \times 10^{-6}              |
| 49    | 9.1 \times 10^{-12}              | 98    | 1.2 \times 10^{-5}              |
| 20    | 2.7 \times 10^{-12}              | 142   | 6.5 \times 10^{-6}              |
| 2     | 1.7 \times 10^{-12}              | 145   | 1.9 \times 10^{-6}              |
| 110   | 2.4 \times 10^{-12}              | 96    | 6.3 \times 10^{-6}              |

The assessment of the risk acceptability was carried out according to classification of individual lifetime cancerogenic effects risk levels, see Table 4.
Table 4. Classification of cancerogenic risk levels.

| Risk level                  | Number of FS |
|-----------------------------|--------------|
| High, CR $10^{-1} – 10^{-3}$| 11           |
| Average, CR $10^{-3} – 10^{-4}$| 12          |
| Low, CR $10^{-4} – 10^{-6}$ | 8            |
| Minimum, CR $10^{-6}$ and less | 1            |

18 kinds of hydrocarbons, five of which are cancerogenic, were found out in air samples taken at 32 FS in Moscow. Values exceeding MAC were not observed.

Hazard index and cancerogenic risk for employees of 32 filling stations have been calculated using technique for industrial risk assessment.

By calculation of not cancerogenic effects, it has been found out that of 32 filling stations:

- extremely high risk level is found out for 13 filling stations.
- high risk level is found out for 9 filling stations.
- average risk level is found out for 9 filling stations.
- low risk level is found out for 1 filling station.

When calculating cancerogenic risk, of 32 filling stations:

- high risk level is found out for 7 filling stations.
- average cancerogenic risk level is found out for 13 filling stations.
- low risk level is found out for 11 filling station.
- minimum cancerogenic risk level is found out for 1 filling station.

Toxicological impact of hydrocarbons and their congeners on living organisms is caused by high mobility of these substances, high cumulativity coefficient and also combined all-toxic effect and possibility of long-term effects [4]. Therefore, even if content of hydrocarbons and their derivatives is not more than daily average MAC, it can cause strong toxic effect on a human body, causing both not cancerogenic effects risks, and cancerogenic risks.

Quality of people life directly depends on quality of the urban environment. Sustainable development of the cities means such arrangement of priorities at which economic and technological development does not contradict tasks of human health maintenance and protection of the surrounding environment.

4. References

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