Sanitary Protection Zones of Sewage Waste-Disposal Plants and Their Justification

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Abstract. Sanitary protection zone (SPZ) are established around sources of negative impact on environment and human health. Such sources include sewage waste-disposal plants and sewage pumping stations. Existing specification documents overlook some points in the establishment of SPZ. As wastewater treatment plants construction take places in cramped conditions it is necessary to justify their reduction. The paper describes experience of such a reduction and offers additions to specification documents.

1. Introduction
It is often necessary to reduce the size of sanitary protection zone of sewage structures, which requires justification of accepted values. As specification documents do not provide insight into some nuances, and there are contradictions; justification to the reduction is provided by designers and controlling bodies (e.g. the Center of Hygiene and Epidemiology, the Russian Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing Administration). In order to simplify the justification and to coordinate the SPZ size and to standardize project decisions, it is proposed to amend sanitary regulations and standards (SanPin) and introduce the emission calculation methodology for a number of enterprises.

2. Relevance and scientific significance of the issue
At the moment, existing specification documents do not fully cover the issue of establishing and, most importantly, reducing the size of sanitary protection zones, sewage treatment facilities, in particular.

3. Problem specification
This article presents problem areas in the regulatory documents and works out draft amendments.

4. Research Theory
The existing sanitary regulations and standards (SanPin) 2.2.1/2.1.1.1200-03, entitled "Sanitary protection zones and sanitary classification of enterprises, structures and other objects" [1], put into effect by the decision of the Chief State Sanitary Inspector of the Russian Federation from 25.09.2007 № 74 [2] with amendments and additions approved by the decision of the Chief State Sanitary Inspector of the Russian Federation from 10.04.2008 № 25 [3], by the decision of the Chief State Sanitary Inspector of the Russian Federation from 06.10.2009 № 61 [4], by the decision of the Chief State Sanitary Inspector of the Russian Federation from 09.09.2010 № 122 [5] and the decision of the Chief State Sanitary Inspector of the Russian Federation from 25.04.2014 №31 [6] and the Federal Law "On sanitation-and-epidemiological welfare of the population" from 30.03.1999 № 52-FZ [7] establish sanitary protection zones (SPZ) around facilities and industries, which are sources of influence on the environment and human health in order to ensure the safety of the population. SPZ is a special area with a special mode of use. Its size ensures the reduction of pollution impact on atmospheric air (chemical, biological, physical) to the values set by hygienic standards. For enterprises
of I and II class of hazard SPZ also ensures the reduction of pollution impact to the values of acceptable risk to human health. According to its functional purpose, a sanitary protection zone is a protective barrier, ensuring the level of population safety during the operation of the facility under normal conditions.

Sanitary rules establish a class of hazard of industrial objects and enterprises. There are approximate sizes of sanitary protection zones established according to the sanitary classification of industrial facilities and enterprise. These enterprises include industrial objects and production facilities, which are sources of negative impact on human environment and health and are classified according to their power, operating conditions, nature and quantity of pollutants emitted into the environment, noise, vibration and other harmful physical factors, and with account of measures envisaged to reduce their damaging impact on human environment and health. The approximate sizes of sanitary protection zones are established as follows:

– industrial facilities and production of the first class – 1000 m;
– industrial facilities and production of the second class – 500 m;
– industrial facilities and production of the third class – 300 m;
– industrial facilities and production of the fourth class – 100 m;
– industrial facilities and production of the fifth class – 50 m.

Further requirements are applied to particular classes. However, the class for sewage installations is not established in this classification.

The sizes of sanitary protection zones for sewage treatment plants are applied according to data given in Table 1.

### Table 1. Sanitary protection zones for sewage treatment plants.

| Wastewater treatment plants                              | Distance (m) at estimated capacity of sewage treatment plants, ths. m³/day |
|---------------------------------------------------------|--------------------------------------------------------------------------|
|                                                         | up to 0.2 | more than 0.2 u. to 5.0 | more than 5.0, up to 50.0 | more than 50.0, up to 280 |
| Pumping stations and emergency-regulating tanks, local sewage treatment plants | 15   | 20 | 20 | 30 |
| Facilities for mechanical and biological purification with sludge areas for fermented sediments, as well as sludge areas | 150 | 200 | 400 | 500 |
| Facilities for mechanical and biological purification with thermo-mechanical treatment of sediments in enclosed areas | 100 | 150 | 300 | 400 |
| Fields:                                                 |          |                          |                          |                          |
| a) filtration                                          | 200       | 300                      | 500                      | 1000                     |
| b) irrigation                                          | 150       | 200                      | 400                      | 1000                     |
| Biological ponds                                       | 7.5       | 14.4                     |                          |                          |

Paper [1] also presents data on SPZ sizes. They are as follows:

– for sewage treatment facilities with a capacity of more than 280 thou. m³/day, as well as when new technologies for wastewater treatment and sludge treatment are introduces, SPZ should be established in each case by the Chief State Sanitary Inspector of the Russian Federation, if in accordance with the calculations of expected pollution of atmospheric air and physical influence on atmospheric air. Generally, they belong to the I and II classes of hazard, in other cases they are
established by the Chief State Sanitary Inspector of this particular subject of the Russian Federation or his deputy;

– for filtration fields up to 0.5 hectares, for irrigation fields of municipal type of up to 1.0 hectares, for constructions of mechanical and biological wastewater treatment with capacity up to 50 m$^3$/day, SPZ size is 100 m;

– for underground filtration fields with a capacity of up to 15 m$^3$/day the SPZ size is 50 m;

– for drainage stations SPZ is 300 m;

– for sewage treatment plants of open type, SPZ to residential areas is 100 m, for closed type plants – 50 m;

– for sewage treatment plants and pumping stations of industrial sewage, which are not located on the territory of industrial enterprises, both at self-cleaning and pumping of industrial sewage, and at joint cleaning with household, SPZ sizes should be the same as for enterprises emitting wastewater, but not less than those indicated in the table;

– for snow melting tanks and snow melting facilities, SPZ to residential areas should be 100 m.

If we compare SPZ sizes given in Table 1 and their sizes for separate classes of enterprises, the sewage treatment facilities can be attributed to 2-4 class, pumping stations – to 5 class, etc.

Let us stress that the size of SPZ for a drain station, which, in fact, is often a well on a household or a combined sewage network, in which waste water is drained from cesspoolage trucks, exceeds the size of SPZ for pumping stations and emergency-regulating tanks, local sewage treatment plants and sewage treatment plants with 50 ths. m$^3$/day productivity. It leads to the conclusion that a drainage station produces more negative impact than a sewage treatment plant, and this is not true.

The table gives a very narrow classification of structures. At present, mechanical and biological treatment facilities with mechanical sludge processing with or without reserve sludge platforms are being actively introduced. On small structures there may be no sludge treatment at all.

The table above does not take into account modern tendencies of design and construction of sewage treatment plants and pumping stations, either. Still, there are more and more constructions with biological purification of household and surface wastewater of factory enterprises appearing everywhere. These structures are often designed as containers made of composite non-corrosive materials, with pipes for the supply of source water, air and electricity and for the drainage of purified water, excess active sludge (in biological purification), sediment and surface contaminants.

Sewage treatment plants are designed for three types of wastewater. This is

– household wastewater,

– surface waste water,

– industrial wastewater.

All types of wastewater are different in quality and quantitative indicators of their composition. This difference accordingly affects the structure of cleaning facilities.

Pollutants discharge from the structures of domestic wastewater is traditionally calculated according to methodical recommendations for calculating the amount of pollutants released into the atmospheric air from unorganized sources of sewage aeration stations pollutions [8], which represent averaged concentrations of contaminants over evaporation surfaces of typical wastewater treatment plants.

In calculating discharge from surface wastewater treatment systems, it is required to use methodical instructions to determine the emissions of pollutants into the atmosphere from the reservoirs [9]. Usually, these structures contain the so-called "Deoiler", but comparing its contents with oil in the reservoir at the refinery is irrational.

On sewage treatment facilities, diesel power plants are installed to provide interruptible power supply. These diesel power plants go on working even in case of a power supply shutdown which, in fact, is not an emergency situation at an enterprise. When justifying SPZ area, emissions and noise should be taken into account.

Now, modern pumping equipment is used on wastewater treatment plants and pumping stations. As a rule, it is close coupled pump, immersed directly into wastewater. Instead of using traditional open
Grates to capture floating waste at pumping stations, it is possible to use closed comminutors or pumps with built-in disintegrators. All this allows to stop using superstructures for permanent stay of maintenance engineers with mechanical exhaust system of ventilation as such structures are a powerful source of concentrated emission of polluting substances into the atmospheric air.

Methodical recommendations to calculations of quantity of polluting substances released into the atmospheric air from unorganized sources of pollution of sewage aeration stations [8] can hardly be applied to modern small operating systems these small systems are not mentioned in the recommendations. Besides, calculations of emissions from underground (closed) structures are not explained there, either. On the one hand, underground structures are closed, but they still have ventilation and respiratory pipes. This can be considered an already organized release, and they can not be referred to as unorganized sources in the methodical recommendations. On the other hand, if there are no pipes, discharge can be released when hatches are opened during maintenance operations and so on.

As the facilities are installed underground, and their pumping equipment (the main source of noise) is still beneath the water, noise impact on the environment of modern buildings is noticeably lower than the impact form regular facilities. This fact makes it possible to reduce SPZ size in relation to the size recommended sanitary regulations and standards.

The need for sewage pumping stations often arises when it is necessary to supply wastewater from projected or existing individual buildings or entire areas to municipal sewage networks in cramped city conditions. When designing health resorts, gardeners partnership and cottage building developments, there is a need to establish local sewage treatment facilities and pumping stations, which is contrary to the requirements of the existing sanitary regulations and standards, Chapter 2.5.

Since the main goal of SPZ is to protect population from harmful factors, there should be recommendations to reduce the presence of people in SPZ, especially children. Modern constructions are installed underground, they are maximally automated and do not require constant presence of maintenance engineers.

It is stated in Chapter 2.3. of the existing sanitary regulations and standards that the criterion for determining the size of a sanitary protection zone is as follows: MPC (maximum permissible concentrations) of pollutants for the atmospheric air of populated areas and MPL (maximum permissible levels) of physical exposure to the atmospheric air on its external borders and beyond its limits should not be exceeded. However, Chapters 3.3, 4.5, etc. also mention biological impact along with chemical and physical impact.

Demands of Chapter 3.5. also seem unreasonable. According to these demands, it is forbidden to build industrial facilities and productions, which are sources of pollution and impact on human health, on the territory where background indicators exceed hygienic standards. Thus, it means it is not allowed to build wastewater treatment facilities on the territory of an existing enterprise and within the boundaries of its SPZ or It is not allowed to build sewage treatment plants within the boundaries of sewage treatment plants SPZ.

Roads and their sanitary breaks, landfills SPZ, mining, etc. are also territories with excess MPC (maximum permissible concentrations).

Though the existing sanitary regulations and standards set the size of sanitary breaks, it also should be within MPL (maximum permissible levels) for electromagnetic fields along the route of high-voltage lines starting from the voltage of 330 kV. As there are no applicable methods of EMF or vibrations distribution, it is required to carry out natural measurements already at the stage of the calculated SPZ justification. The number of EMF and vibrations measurements are not regulated, though there are requirements to those of noise and emissions.

The application of the EMF measurement protocols at enterprises is complicated by the lack of equipment description in the protocols.
5. **Practical significance**

The paper points out drawbacks in the existing specification documentations. This will allow controlling authorities and specialists who work out methods of calculation of emissions into the atmospheric air to think and introduce changes into the sanitary regulations and standards (SanPin) as well as to create methods of calculating discharge of polluting substances into the atmospheric air, methods for sewage treatment plants of surface wastewater, in particular.

6. **Conclusions**

Thus, changes in the sanitary regulations and standards (SanPin) and introduction of new methods of calculating emissions of pollutants into the atmospheric air, will simplify the process of SPZ size justification and coordination for important "environment-oriented" sewage facilities.

7. **References**

[1] SanPin 2.2.1/2.1.1.1200-03 "Sanitary-protective zones and sanitary classification of enterprises, constructions and other objects"

[2] The decision of the Chief State Sanitary Inspector of the Russian Federation from 25.09.2007 74

[3] The decision of the Chief State Sanitary Inspector of the Russian Federation from 10.04.2008 25

[4] The decision of the Chief State Sanitary Inspector of the Russian Federation from 06.10.2009 61

[5] The decision of the Chief State Sanitary Inspector of the Russian Federation from 09.09.2010 122

[6] The decision of the Chief State Sanitary Inspector of the Russian Federation from 25.04.2014 31

[7] Federal law "On sanitation-and-epidemiological welfare of the population" from 30.03.1999 52-FZ

[8] *Methodical recommendations of calculation of polluting substances quantity, released into atmospheric air from unorganized sources of pollution of sewage aeration stations* 2015

[9] *Methodical recommendations on determination of polluting substances emissions into the atmosphere from reservoirs* 1999

[10] Tishchenko S M 2017 *Ecology Operations* 12 p 52-58