

V.A. Gorin, A.S. Danielyan, V.N. Pshenichny, V.A. Egorov

**EXTERNAL NOISE OF INDUSTRIAL BUILDINGS AND THE DIFFICULTIES,  
CONNECTED WITH METHODS OF ITS DETERMINATION**

Kuban State Technological University  
Russia, 350072 Krasnodar, Moskovskaya str., 2  
Tel.: (8612) 552-088; Fax (8612) 526-826  
E-mail: ss61ad@mail.kubtelecom.ru

State Institution "Center of state medical and epidemiological  
Inspectors in Krasnodar", Russia, 350072 Krasnodar, Turgeneva str., 152  
Tel.: (8612) 244-511; Fax (8612) 246-346  
E-mail: gorses@mail.kuban.ru

*This article examined the questions, connected with execution of determination of external noise of industrial buildings and their influence upon the environment. It was shown, that the existing normative documents, worked out in our country and abroad caused the difficulties while determination of noise characteristics for industrial objects. Thus, the methods of determination of external noise for industrial buildings, based on the measurements on location, classify the industrial objects as spatial noise sources. The obtained noise characteristics in the form of sound power, give the possibility to determine in the future the expected noise levels on the territories, adjacent to industrial buildings and determine the dimensions of their sanitary protective zones, and also to choose and project the means of protection. The rated methods treat the industrial objects as the sources, consist of separate (point and line) noise sources, each of them influence the environment independently. Quite often it brings to difference in results obtained by measuring and rated methods, and it cause the certain difficulties in the decision of practical tasks. On the example of estimation of noise influence for the environment by large-scale industrial object the authors showed the difficulties, which appear while execution of such kind of works.*

Under conditions of projecting the new one, also while reconstructing the existing building in the cities and countryside, the location of the industrial buildings and other projects in many cases is executed in direct closeness with the populated territories with the fixed level of the permissible noise. Such conditions of mutual location of industrial civil construction objects often lead to the exceeding of fixed noise levels. In the aims of providing the required norms on the territories, attached to the industrial buildings, the last are to be separated from inhabited building by means of sanitary protected zones, which are obligatory element for any object with chemical, biological or physical influence for environment and human health [ 1 ].

In recent time, the information connected the noise of industrial buildings in standard literature are very limited. The difficulty in definition of noise characteristic for industrial objects is connected with the fact, that they present themselves the totality of line (transport mains) and point (buildings with established noisy equipment, suction and exhaust holes in power plants, noisy equipment, adjusted on the open areas, ventilation plants and so on) noise sources. The task became more complicated, if we deal with industrial zones and units, which constitute several industrial buildings, which influence unfavourable upon the attached populated territories simultaneously. This condition required their apportionment into independent group and classification them as «spatial», that correspond to the requirements of location the separate noise radiators on the territory of buildings, as in «immovable» state also in the state of «transference». Such classification of spatial group noise source defined the independent method of measuring and estimation of its noise characteristics.

According to the international standard ISO 8297 [ 2 ] the noise characteristic of the spatial noise source is the corrected level of sound power  $L_{PA}$ , dBA, defined by means of measurement on location. On the base of the document project ISO and numerous experimental investigations, hold on in our country, the method of estimation of the industrial buildings noise was worked out [ 3 ]. It gives the possibility by means of experimental way to obtain the noise characteristics of the industrial buildings in the form of average  $L_{PA_{avg}}$ , dBA, and maximum  $L_{PA_{max}}$ , dBA, of the corrected sound power level:

$$L_{PA_{avg}} = \bar{L}_{A_{eq}} + 10 \lg \frac{2 \cdot S}{S_0} \quad (1)$$

$$L_{PA_{max}} = \bar{L}_{A_{max}} + 10 \lg \frac{2 \cdot S}{S_0} \quad (2)$$

where  $\bar{L}_{A_{eq}}$  and  $\bar{L}_{A_{max}}$  - average value accordingly to equivalent and maximum sound level, dBA, on the measuring outline;

$S$  - area of territory,  $m^2$ , occupied by industrial building;  $S_0 = 1 m^2$ .

These noise characteristics allow in the future to determine the expected sound levels on the territories, attached to the industrial buildings, the sizes of their sanitary and protection zones, and also to choose and design the means of protection.

It is necessary to outline, that it was the first normative document, which gave the possibility to estimate the external noise of the working industrial buildings. It was worked out for industrial objects with typical technological equipment and conditions of its operation.

In fact, the unification of the separate noise sources of the industrial building into complex spatial source, can be executed, in case the following conditions are carried out:

- the sources are of equal spectrum and noise radiation power;
- the height of noise sources location over the reflected surface is equal;
- noise spreading from the noise sources up to the points of receiving is executed at equal conditions;

- the distance from the separate point noise source up to the point of receiving exceed the greatest size of the source more than in two times.

In case these conditions are not carried out, it is necessary to divide the territory of the industrial building for areas, where these requirements are carried out and each area is to be treated as the separate spatial sound source.

The another, more difficult task, is the estimation of noise influence on the environment anew designed and reconstructed industrial buildings. The existing normative documents [ 4, 5 ] allow by means of calculations to determine the noise levels in the points of receiving from the separate (point or line) noise source, located on the territory of industrial building as following:

$$L = L_p + 10 \lg DI - 10 \lg \Omega - 20 \lg r - \beta_a \frac{r}{1000} + \Delta L_{ref} - \Delta L_c \quad (3)$$

where  $L_p$  - sound power level, dB, (dBA);

$DI$  - factor of noise source direction;

$\Omega$  - spatial angle, where the noise is reflected, sr.;

$r$  - the distance from the noise source up to rated points, m;

$\beta_a$  - coefficient of sound absorption in the air, dB, (dBA);

$\Delta L_{ref}$  - the increasing of sound pressure level owing to sound reflection from the larger surfaces, dB, (dBA);

$\Delta L_c$  - the additional reduction of sound pressure level by means of elements of environment, dB, (dBA);

The obtained noise levels results in rated points are summed up (according to energy). Having such an estimation of the noise influence upon the attached industrial buildings territories or noise protected objects, the noise is not treated as spatial noise source.

Thus, it is clear, that method of approach for estimation the external noise of industrial buildings by means of measuring and rated methods is different from each other, and very often this fact led to difference in the obtained results and correspondingly caused the certain difficulties in the process of decision the practical tasks.

The authors of the given article met these difficulties while execution of work, connected with the estimation of noise influence upon the environment by the compress station «Beregovaya», being the member of gas main «Goluboy Potok». The station is located in Gelendzhik region of Krasnodar area on the distance of 1,5 km from the coast of Black Sea. It has the attached settlements and rest homes at the distance from 1,7 up to 5,5 km.

The peculiarity of the projected compress station is the absence of the same power station in the world practice. The required gas pressure at going out of 25.5 MPa must provide its delivery for large distances. The main technological equipment of the station (gas pump over plants, air cooling gas plants, turbo generators and others) also don't have the analogues and have been designed for the first time.

According to the requirement [ 1 ] the dimensions of the sanitary and protection zones of gas mains and gas supply systems are defined taking into account the minimum distances from the cities and other settlements. Such distances are regulated by construction norms and rules. According to SNiP 2.05.06-85\* [ 6 ], the minimum distance from the compress stations of gas mains of 1-st class up to settlements is to be equal to 700m.

Noise characteristics of technological equipment were determined by means of calculations. In order to do it, the company, produced the main equipment «Nuovo Pignone» (Italy) measured the noise characteristics of the separate units of the plant. Then, sound power levels calculation for the whole plant have been executed in octave frequency and according to the scale « A » using the certain method GOST R 51401-99 (ISO 3744-94) [ 7 ].

Because of complicated highlands relief of the construction site (over falls of the heights of established equipment up to 35 m) and considerable difference in the spectrums and radiation power of the separate noise sources, and also their dimensions, it was impossible to determine the noise characteristic of the compress station as a whole [ 8 ]. That's why it was divided for separate sectors; each of them was treated as independent noise source with group equipment. Noise levels in the rated points were calculated from each spatial noise source and then summed up.

Executed estimation of noise regime for compress station allowed to determine the exceeding of noise pressure levels on the limits of sanitary protection zones over the permitted values, required by SN 2.2.4/2.1.8.562-96 [ 9 ], in diapason of low frequencies up to 5 dB. At the same time, when estimating the noise according the scale «A», exceed of sound levels over the normative values have not been determined.

The detailed analysis of the results, concerning the noise characteristics of technological equipment and expected noise levels within the limits of sanitary protection zones of the compress station permitted to make the following conclusions:

- rated noise characteristics of the main technological equipment of the station (gas pump over plants, air cooling gas plants, turbo- generators ) differ for radiation spectrum from noise characteristics of analogous equipment of well known compress stations, the values of which were determined by means of measurements according to GOST R 51401- 99 (ISO 3744-94) (7) and can be accepted as approximate;

- the exceed of expected sound pressure levels and sound levels within the limits of sanitary protection zone of the compress station over the normative values are in the limits of error of the measurement method;

- the final estimation of noise regime for technological equipment and noise levels within the limits of sanitary protection zone of compress station can be obtained in the period of its test first starting up.

That's why the authors worked out construction and acoustic arrangements for reducing the noise within the limits of sanitary protection zone of compress station, and the introduction of such arrangements can be executed on any stage of construction.

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