VENTILATION EQUIPMENT NOISE ESTIMATION IN A DOG SERVE CENTRE

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Abstract
The examination of noise levels created by ventilation equipment in rooms of a dog serve Center is executed. It is fixed, that A-weighted sound pressure levels and sound pressure levels in octave frequency bands exceed the admissible limits in separate rooms by 3-23 dB. Acoustic calculation of the Center ventilation design is executed. The ventilation systems responsible for heightened noise are detected, the values of required noise levels decreasing for everyone ventilation system are determined and measures for noise reduction are proposed.

INTRODUCTION

Ventilation equipment for air exchange in public buildings is a source of the increased noise unless take the necessary measures for its reductions. In the present report noise of the ventilating equipment is examined in the dog serve center of the Moscow metro. Administrative, official and auxiliary rooms of the centre are placed in the three-storied (block A) and in the two-storied (block B) cases connected among themselves. The plans of the centre rooms with the ventilation equipment arrangement is submitted in Fig. 1, 2. The composition of the equipment includes 4 input systems, 20 exhaust systems in the block A, 8 input and 20 exhaust systems in the block B.

The fans of the input systems I1, I2, I3 in the block A and the input systems I1 – I3, I6 – I8 in the block B are placed in two input chambers of the cellar. The fans of

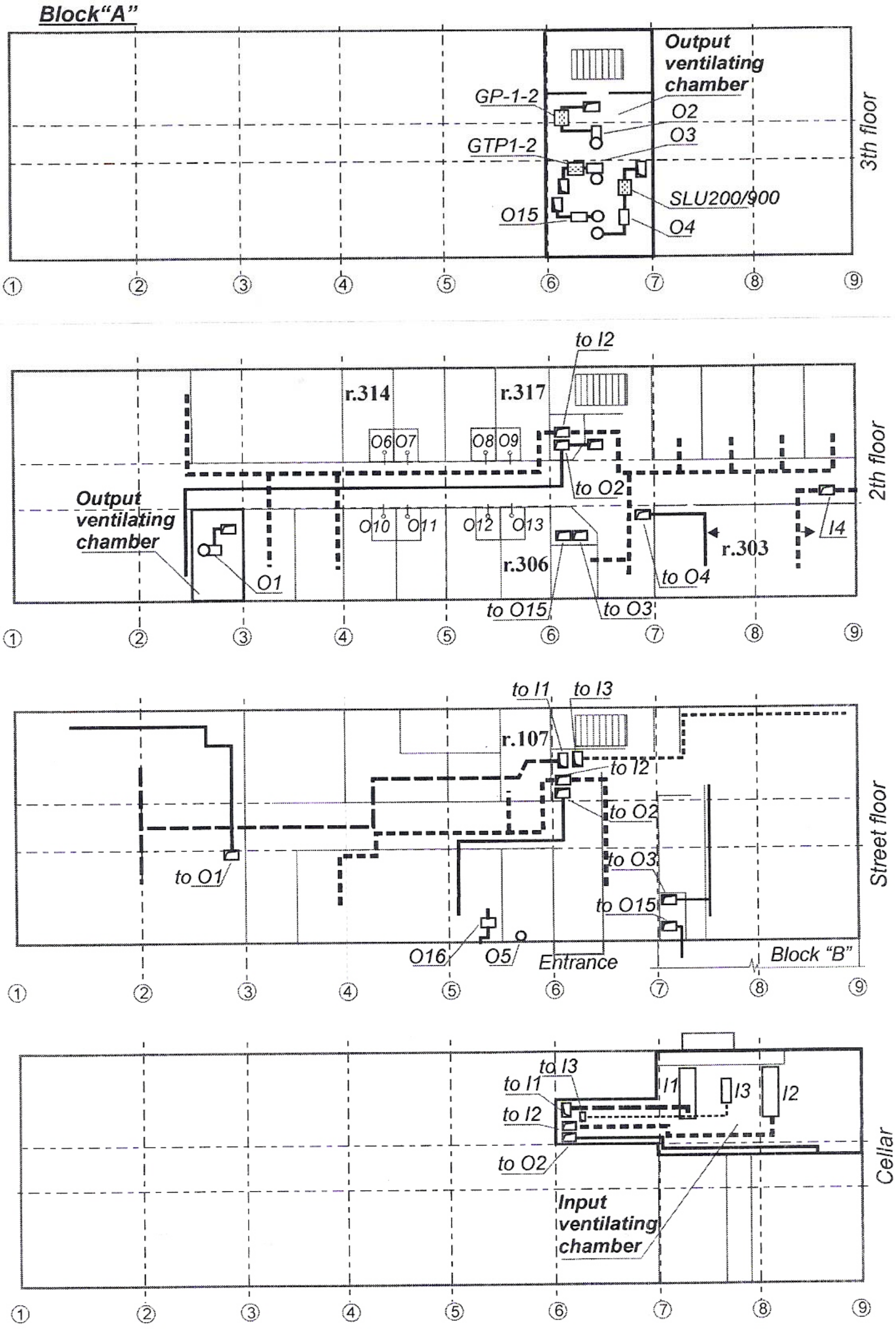

Figure 1 – Plan of the centre rooms with the ventilation equipment arrangement in the block A

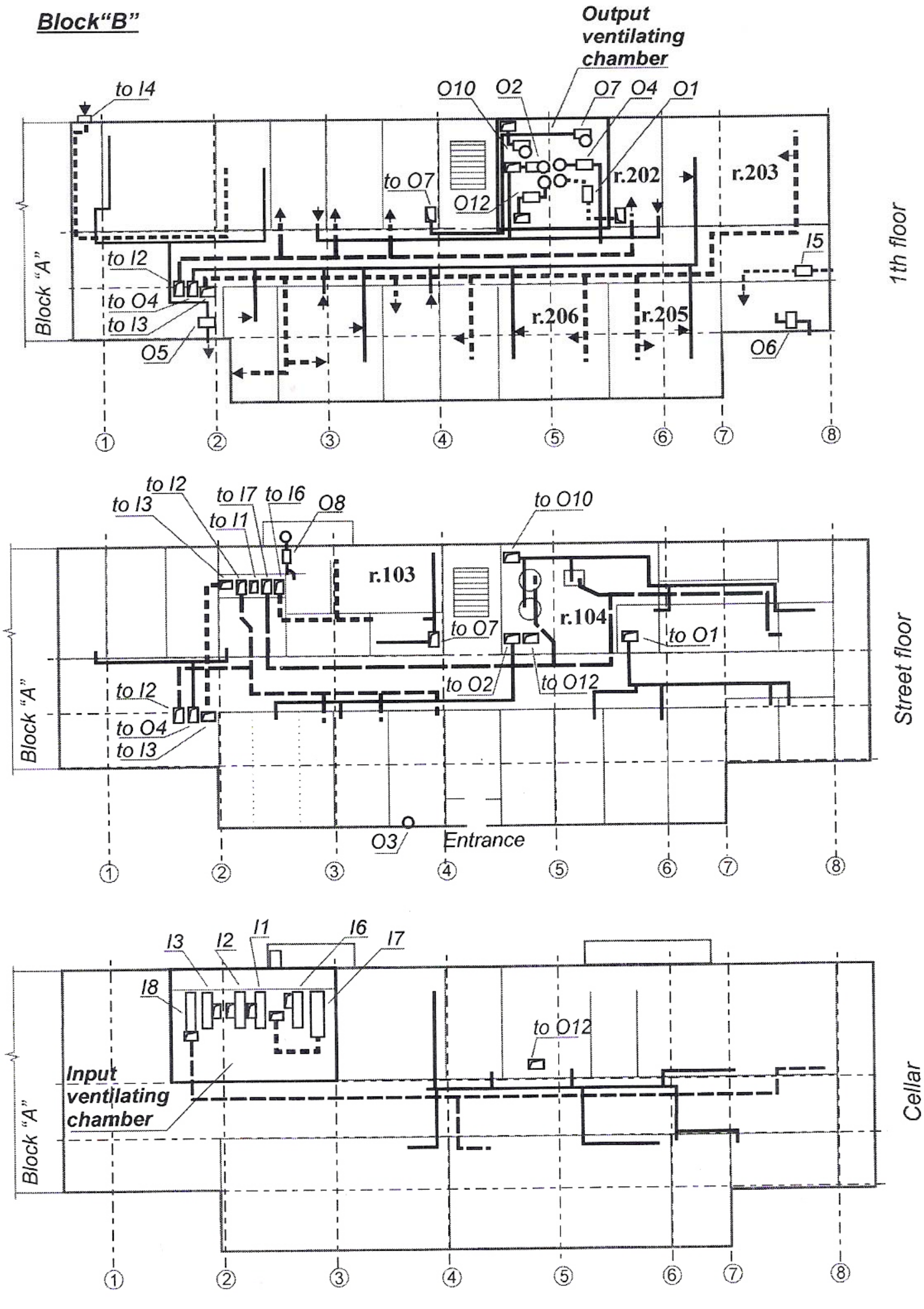

Figure 2 – Plan of the centre rooms with the ventilation equipment arrangement in the block B

the exhaust systems O2 - O4, O15 in the block A are placed in the ventilating chamber on the third technical floor, O1 - in the ventilating chamber on the second floor O1, O2, O4, O7, O10, O12 in the block B are placed in the ventilating chamber on the first floor. Three exhaust systems of the block A only are equipped by silencers.

NOISE EXPOSURE ESTIMATION FROM VENTILATING SYSTEMS EQUIPMENT

The results of measurements of the noise levels (octave spectrum – SPL and A-weighted sound pressure levels – SPLA), created in surveyed rooms by the ventilation equipment, are given in Table 1. During the measurements all ventilation systems were included.

Table 1

Place of measurement	SPL, dB, in octave frequency band with mean frequency, Hz									SPLA, dB
	31,5	63	125	250	500	1000	2000	4000	8000	
Block A										
1. Room 317	46	52	50	48	44	41	33	24	19	46
Excess	-	-	7	13	15	16	11	4	3	16
2. Room 314	45	38	41	36	30	26	17	14	15	33
Excess	-	-	-	1	1	1	5	-	-	3
3. Room 306	48	45	46	43	40	34	23	17	16	41
Excess	-	-	3	8	11	9	1	-	-	11
4. Room 308	46	47	45	43	41	36	25	17	16	42
Excess	-	-	2	8	12	11	3	-	-	12
5. Room 309	43	39	43	44	39	30	22	16	13	40
Excess	-	-	-	9	10	5	-	-	-	10
Admissible level	71	54	43	35	29	25	22	20	18	30
6. Room 303	51	56	51	47	43	41	40	34	23	46
Excess	-	-	4	7	9	11	13	9	-	11
7. Room 107	68	54	52	49	40	41	37	30	23	46
Excess	-	-	5	9	6	11	10	5	-	11
Admissible level	74	58	47	40	34	30	27	25	23	35
Block B										
8. Room 202	54	53	59	64	60	50	45	43	36	61
Excess	-	-	-	1	2	-	-	-	-	6
Admissible level	88	74	65	63	58	50	47	47	44	55
9 Room 203	49	48	48	55	59	46	46	35	21	57
Excess	-	-	-	6	15	6	9	-	-	12
10. Room 205	46	46	42	56	56	49	47	40	28	56
Excess	-	-	-	7	12	9	10	5	-	11
11. Room 206	45	45	46	53	59	51	46	38	27	57
Excess	-	-	-	4	15	11	9	3	-	12
Admissible level	81	66	56	49	44	40	37	37	33	45
12. Room 103	49	54	58	52	52	47	42	34	31	53
Excess	-	-	15	18	23	22	20	14	15	23
Admissible level	71	54	43	35	29	25	22	20	18	30
13. Room 104	70	75	75	69	68	67	64	51	50	71
Excess	-	-	1	1	5	7	7	-	-	6
Admissible level	98	83	74	68	63	60	57	55	54	65

There is excess of the admissible sound pressure levels in all 13 surveyed rooms in the low, middle and high frequency range. Under the equipment design these rooms serve the following ventilating systems:

Block A	Room 107	The rest room of a man on duty	I2
	Room 303	The conference hall	I4, O4
	Room 306-317	The hotel rooms	-
Block B	Room 103	The operating-room	I6, O7
	Room 104	The kitchen hot shop	I7, O10
	Room 202	The pantry of medicines	I2, O2
	Rooms 203, 205	The educational classes	I3, O4
	Room 206	The chief cabinet	I3, O4

To determine the systems which are the main noise sources in the rooms has been carried out acoustic calculation according to the submitted project of ventilation and conducted noise measurements at consecutive powering up of separate ventilating systems.

Acoustic calculations carried out by techniques of construction regulations SNiP 23-03-2003 [1] with use of the dates of directory [2] and manuals [3]. The control points were choosed inside rooms in a zone of the reflected field. Calculations were carried out for each branch of ventilating systems with the subsequent determination of a total sound pressure level. The received values were compared to admissible limits according to sanitarian regulations SN 2.2.4/2.1.8-562-96 [4] in view of amendments on character of a noise sources (-5 dB). At choice of the admissible sound pressure levels were taken into account a day time mode of operation of centre office accommodations and a night mode for hotel rooms.

Calculations have shown, that sources of the increased noise are the following ventilation systems:

- in block A: I2 (room 107), I4 (room 303), O2 (rooms 306 – 317);
- in block B: I6, O7 (room 103), O10 (room 104), O4 (rooms 203, 205, 206).

Results of measurements at consecutive operation of separate ventilating systems confirm these conclusions and add to the sources of the increased noise in the block A the system O4 (room 303), in the block B the systems O2 (room 202) and O12 (room 103).

At the same time the measurements gave higher A-weighted sound pressure levels and higher sound pressure levels in octave frequency bands with middle frequencies 31,5 - 2000 Hz and lower sound pressure levels in octave frequency bands with middle frequencies 4000 Hz and 8000 Hz. One of the reasons of the distinctions may be discrepancy of operation modes of ventilation units to the characteristics incorporated in the documentation on which calculations were carried out. At selection of measures for noise reduction were used the greatest values to be received on measurements and calculations.

DEVELOPMENT OF MEASURES FOR NOISE REDUCTION

For reduction of aerodynamic noise of ventilating systems it was recommended to install mufflers of noise in an air line. The length and efficiency of mufflers were accepted according to a typical album of series 5.904 - 17, release 0 [5], for the mufflers installed in the input systems of firm "INNOVENT"- according to the catalogue [6].

The comparative data on efficiency of mufflers and required reduction of noise levels in the surveyed rooms are given in Table 2. The data testify to maintenance basically of necessary decrease of noise at realization of the offered measures.

Table 2

Room, system	Quantity	Octave frequency band with mean frequency, Hz						
		125	250	500	1000	2000	4000	8000
Block A								
107, I2	Required reduction, dB	5	9	6	11	10	9	11
	Efficiency GP1-2, dB	5	18	25	20	15	12	11
303, I4	Required reduction, dB	6	9	11	13	14	10	-
	Efficiency GShK-2, dB	6	9	23	28	14	10	10
303, O4	Required reduction, dB	-	5	4	5	6	-	-
	Efficiency SLU 200/900	8	9	20	32	35	23	20
317, O2	Required reduction, dB	7	13	15	16	11	4	3
	Efficiency GP1-2, dB	5	18	25	20	15	12	11
Block B								
103, I6	Required reduction, dB	6	13	2	-	6	16	11
	Efficiency GShK-2*0, dB	12	18	46	56	28	20	20
103, O7	Required reduction, dB	16	17	16	13	11	13	13
	Efficiency GTP1-2*), dB	14	28	56	52	32	22	18
103, O12	Required reduction, dB	18	20	26	25	18	9	14
	Efficiency GTP1-3*), dB	12	22	50	44	26	20	14
104, O10	Required reduction, dB	1	1	5	7	10	9	2
	Efficiency GTK1-5, dB	7	15	20	16	11	9	8
202, O2	Required reduction, dB	-	1	2	-	-	-	-
	Efficiency GTP1-2, dB	7	14	28	26	16	11	9
206, O4	Required reduction, dB	-	4	15	11	9	12	6
	Efficiency GTP1-2, dB	7	14	28	26	16	11	9

*) It is required two mufflers with distance not less than hydraulic diameter of the air line.

Besides with a view of reduction of vibrating excitation of walls and overlap of the building fastening of air lines to them should be carrying out with the help of collars with use of antivibration linings (for example, from porous rubber 15 - 20 mm thick). At pass through overlap and walls (partition) to use condensation from soft rubber according to recommendations of the directory [2] or elastic sleeves (from porous polythene or other elastic materials) in conformity with the constructive decision given in the manual to sanitarian regulations MGSN 2.04-97 [7].

The data of measurements and also results of calculation of the noise penetrating through overlap from the ventilation chamber of the block A in room 317 testify to necessity of acoustic lining walls and a ceiling of the chamber by a sound absorbing material for the reduction of noise levels in the hotel rooms.

The ventilation chamber is on the third floor. The sizes of the chamber make 10,1x4,25 m and 2,85 m in height The area of protecting surface (the walls, the ceiling and the floor) makes 167,6 m^2. It is offered to cover the ceiling and walls with a sound-proof design at height more than 1 m from the floor. The general area of the covered surface is 96 m^2.

Sound-proof design includes a mineral sound-absorbing plate 70 mm depth, a gyps plate 6 mm thick with punching 13 % in diameter of 10 mm [8].

CONCLUSIONS

The ventilation system create the heightened noise in rooms of a dog serve centre. The most excess takes place for the operational room and the hotel rooms.

Noise measurements to be made when the ventilation systems operate separately and acoustic calculation of the center ventilation design allow to detect the ventilation systems responsible for heightened noise, to determine the values of required noise levels decreasing for everyone ventilation system and to select the mufflers providing the required noise reduction. Thus in some cases it is needed installation of two mufflers with an interval of not less than the air duct hydraulic diameter.

Acoustic handling of walls and ceiling of the ventilation room of the block A by a sound absorbing stuff is required to lower the noise levels penetrating in the hotel rooms.

In view of the essential difference in spectrum levels of the calculated and observed data it is necessary to carry out careful verification of conformity of the systems specifications and locations with the design documentation, and also inspection of performance of necessary actions for vibration protection at mounting of the ventilation systems.

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