



## AIR DISTRIBUTION IN A TELEVISION STUDIO

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### ANNOTATION

Television studios have very special requirements for air distribution which sometimes come into conflict with technical possibilities. In the described case they could have been met by means of textile distribution systems, however the solution asked for atypical arrangements and careful calculations. Some parameters were verified in advance by the simulations in real conditions. The result became a model for solving other similar premises.

### INTRODUCTION

Trivial TV soap operas are a good business and that is why their still new continuations are requested. Their shooting has to be cheap and quick and they take place fully in TV studios. A typical example can be the studios in Sofia, Bulgaria, officially called the „Sofia Studios Complex“. They are in a large area of 20,000 m<sup>2</sup> not far from the city. Their final shape will have 7 studios in 3 buildings while 5 of them were in operation in October 2009. As the first of them studio No 1 was completed already in 2008 to shoot the Bulgarian „Big Brother“. Just in this first studio common whirling diffusers and a sheet-metal distribution system with a number of noise silencers were applied. The white diffusers that were used by supplier's mistake instead of black ones were not the largest air conditioning issue. The measurement ordered by the investor from an independent company demonstrated higher than acceptable air flow speed and noise level in the stay area. As to the flow speed, the main issue was its uneven distribution. If the values were averaged, then the distribution would have been all right. Unfortunately, more than 0,3 m/s was measured on site. The noise level was above required level NR 25 in the whole stay area. Based on such results the investor requested a fundamental solution change.



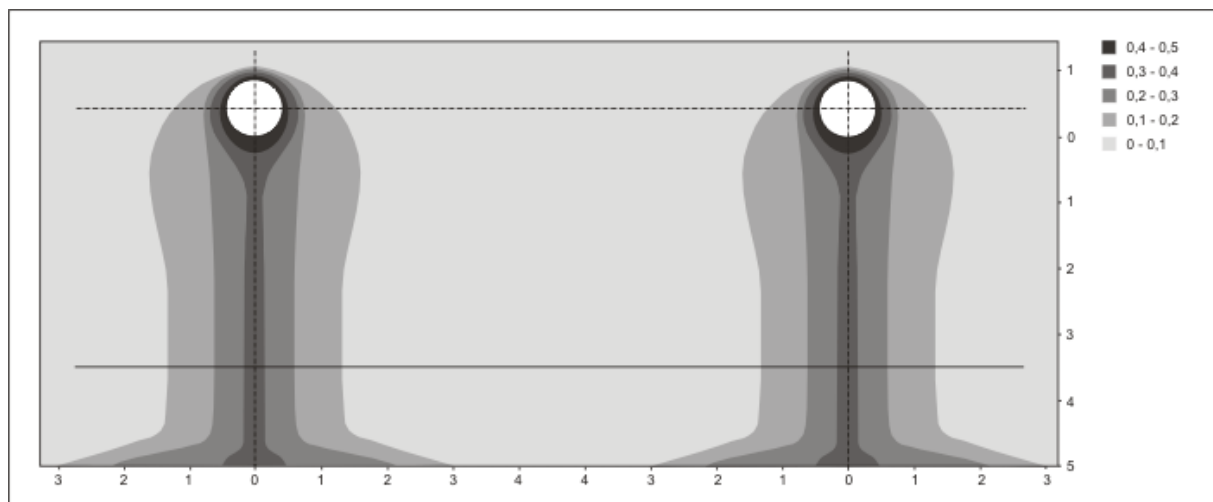
*Fig. 1 TV studios in Sofia, outside view.*

## INVESTOR'S REQUIREMENTS, TASK

The task can be summarized quite simply. The maximum flow speed of 0,3 m/s and the maximum noise level of NR 25 (NR = noise rating, see **Tab. 3**) are required in the stay area. The speed has to be fulfilled even in case of the maximum temperature difference when cooling at 15 K. Air conditioning will not serve for heating. Noise attenuation in the room is known and is 14 dB. The size of the studio in question is 30 times 36 m and the height is 7 m. Air flow was set to 36,000 m<sup>3</sup>/h, cooling output for eliminating thermal stress mainly from lighting is 180 kW. The air conditioning ducting has to be installed with the bottom edge at the height of 5 m. It is completely empty space which will be filled with scenery always based on momentary needs. Walls and ceiling are equipped with black, noise damping spray.

## SOLUTION CONCEPT, PHILOSOPHY

Due to space use variability and a need for low flow speed the maximum possible dispersion of incoming air was necessary as well as even coverage of the entire area. We opted for 4 diffusers with diameter 900 mm and length 26 m. The first idea for the air distribution solution considered textile diffusers with uniform microperforation which will disperse the air evenly in the environment. However, the calculations showed that air overcooling by 15 K will significantly affect decreasing air flow. Due to flow contraction the speed would cross the requested 0,3 m/s!



**Fig. 2** Flow at even distribution of output holes.

We tried to find the ways how to split and slow down the air flow. After long discussions we chose the following partial measures:

- a) Flow split into two paths
- b) Directing exhaust from the diffusers up
- c) Decreasing static pressure in the diffusers

### Flow split into two paths

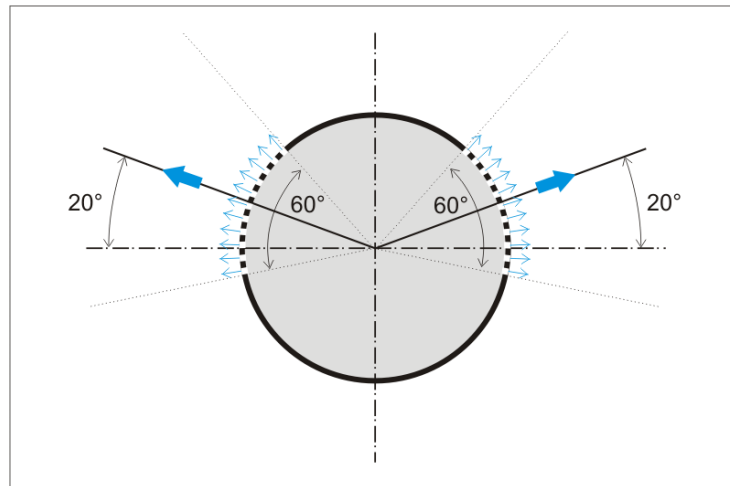
Air distribution from textile diffusers is resolved by means of microperforation holes of 0,4 mm. However, there must be a lot of such holes. For instance for 500 m<sup>3</sup>/h flow through one square meter and the overpressure of 80 Pa it is necessary to have 100 thousand of them! These holes can be almost arbitrarily distributed throughout diffuser area and thus get various flow types. For our purpose the only meaningful solution seemed flow split into two parts. If the split would be into more smaller flows, they would get for sure quickly merged and further enlarged in the form of one mighty flow.



**Fig. 3** Fabric detail with the holes of 0,4 mm diameter.

### **Directing exhaust from the diffusers up**

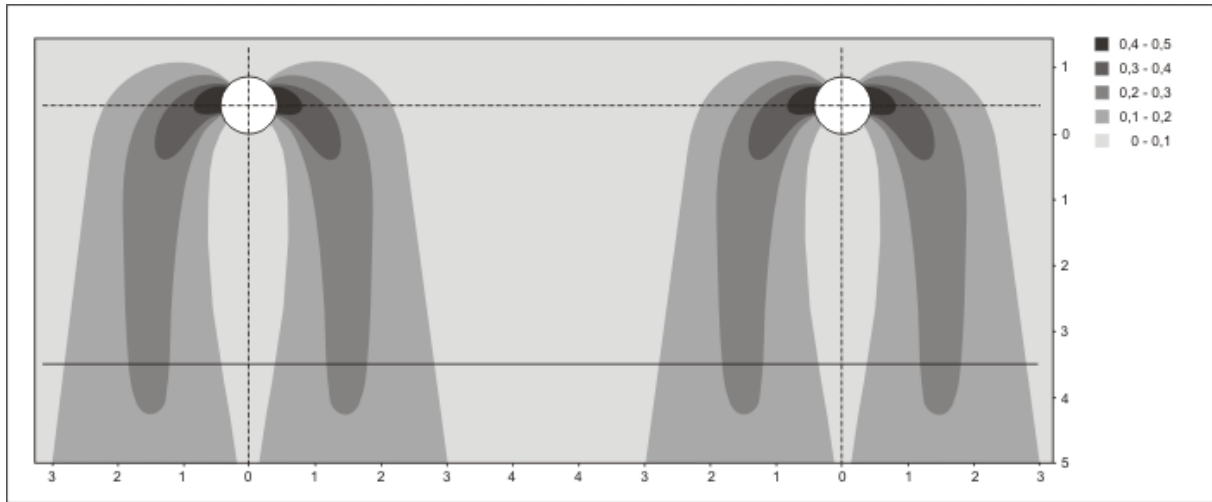
Reaching as large separating as possible and thus minimizing the possibility of their merge (the equipment will work under variable conditions) is possible when orientating exhausts into two opposite directions angle-wise up. During each shooting in the studio the lights with substantial temperature development will be used and air conditioning will always cool with a large temperature difference. That is why the flows will direct down, however always in the sufficient distance from each other and thus they do not get merged. In this way we will get 8 declining flows, each with the flow of 4500 m<sup>3</sup>/h per 26 m in length, thus 173 m<sup>3</sup>/h per 1 m. By recalculating to cooling output is gives 865 W per 1 m of diffuser length.



**Fig. 4** Cross-section of textile diffuser showing air output.

### **Decreasing static pressure in the diffusers**

The output speed from a textile diffuser fully depends on static pressure. We needed relatively low overpressure in order to either minimize aerodynamic noise level and also enable flow directing in the right distance from the diffuser. For optimum uniform distribution of the whole flow across the hall area the distance of individual streams is 3 m. That results in the necessary flow fold point approx. 1 to 2 m from diffuser perimeter.



**Fig. 5** Cross-section through diffusers showing flow folding.

### CONCEPT VERIFICATION, TESTING AND CALCULATIONS

To verify the concepts above we made model (reduced) diffusers working under the same overpressure and temperature difference. Then we verified in the testing room that our calculations were correct and the flows will not get merged but folded in the way we need.

#### Reducing noise level

Quite new for us was determining the noise level of output flow because it is not commonly required. The level of NR 25 in the stay area is extremely low. The investor specified the attenuation in the room to 14 dB and based on that we set the maximum value closely to the diffuser 34 dB measured by a unit with the weight filter A. The calculations (confirmed by measurements later on) showed that we had to lower the static pressure to the minimum i.e. 50 Pa. To maintain the proper diffuser shape under such low pressure we decided to use stiffening tyres. These will keep the textile diffusers permanently in a cylindrical shape. At the same time occasional loud slaps of stretched fabric can be avoided when switching on air conditioning. Another measure for noise minimizing was selecting low input speed into diffusers at 3,9 m/s and using a 1,5 m textile noise silencer at the beginning of each diffuser for additional silencing of noise from the unit.

**Tab. 1** Air flow noise depending on its speed.

Input speed [ m/s ]	Noise $L_{wA}$ [ dB ]
7,0	44
6,0	41
5,0	38
4,0	34

**Tab. 2** Noise of the air coming out of a diffuser depending on static pressure.

Static pressure [ Pa ]	Noise $L_{wA}$ [ dB ]
150	43
100	38
50	34

## MEASUREMENT RESULTS AFTER INSTALLATION

After installation and commissioning of the complete air conditioning equipment a company hired by the investor measured flow speed and noise level. The achieved results exceeded expectations. The measurement lasted 20 minutes at 15 sites simultaneously, always at the height of 1,5 m above floor with temperature difference 12 - 14 K. Heat gain was simulated by lights and electrical heaters with the total maximum output of 200 kW. Flow speed was from 0,18 to 0,23 m/s.

The following table shows the noise level measurement results under standard operating conditions. Also here it holds true that the task was fulfilled with a reserve.

*Tab. 3 Noise measurement results.*

<b>Octave band</b>	<b>Required value -</b>	<b>Measured value</b>
	<b>NR 25</b>	
<b>[ Hz ]</b>	<b>[ dB ]</b>	<b>[ dB ]</b>
63	55	47
125	43,5	43
250	35,5	32
500	29	20
1000	25	21
2000	22	18
4000	19,5	12
8000	18	0

## Economic comparison

The convenience of using textile air distribution is underlined by its excellent pricing. The investment expense for air distribution by means of textile diffusers for one studio was roughly 21,000 Euro. That is a huge difference as compared to 48,000 Euro which was the expense for the installation of whirling diffusers and a sheet-metal distribution system in the first studio.

## CONCLUSION

The described system of air distribution can be applied for the rooms where, similarly to a TV studio, there is high heat load, necessity to keep the lowest flow speed possible, and reducing noise level to the sheer minimum.

## LITERATURE

- [1] CHYSKÝ J., HEMZAL K. *Technical Guide 31 – Ventilation and air conditioning*. Bolit Brno, 1993

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