

ALVO®



Laminar ceilings, exhaust columns, exhaust grilles

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1. Laminar ceilings – general information

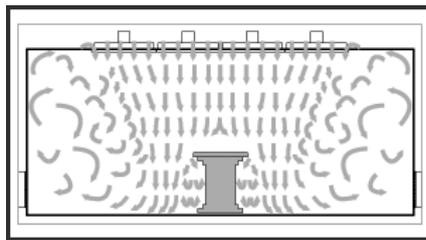
It is vitally important to properly design and install ventilation system in operating rooms and adjacent premises which together constitute an operating block. Such installation is responsible for ensuring high microbiological and dust purity of air as well as efficient removal of gaseous pollutions. It should also allow to maintain air parameters such as temperature, humidity and flow velocity, optimal for patient and medical staff.

The purpose of using laminar air flow is to bring clean air, with appropriate parameters of temperature and humidity and minimal turbulence, to replace the polluted air which is pushed off the critical area by the inflow of blown air.

Due to the requirements regarding microbiological and dust purity of air, operating rooms are divided into the following zones:

- Central area – operating field, surgeons, scrub nurse, medical staff in sterile garments, sterile tools,
- peripheral area - anesthesiologist, unsterile additional tools (such as electric scalpel, arthroscopy equipment, monitors)

Central zone is usually called a protected area.



- laminar diffuser must be selected in such a way that the supply clean air stream encompasses all areas in the operating room requiring special protection (ie. the operating field, operating team, instrument table – the size of a required laminar ceiling depends on the type of operation being conducted).
- Selected laminar diffuser should be characterized by non-turbulent flow of air (degree of turbulence <5%), surface of diffuser should be made of stainless steel mesh or polyester fabric which serves as the air flow divider used to align and stabilize the outflowing stream of air,
- The outflowing air from the laminar diffuser to the operating room must go through a highly efficient final filter of at least class H13 or H14 (filter class according to PN EN 1822-1).
- when deciding on the size of a laminar ceiling two recommendations must be taken into consideration:
 - in the peripheral area, none of the members of the operating team nor the medical equipment should be located between non-turbulent stream of clean air and turbulent flow of air in the rest of the room,
 - area called the clean air zone is limited by the temperature difference between the air temperature in the room and supplied air temperature.

2. Laminar ceilings – design and operation principles

As defined, laminar diffusers (perforated or partially perforated ceilings) - are made of perforated panels placed on the entire surface of the diffuser or with certain spacing between. In the operating rooms, air flow is always directed vertically down on the operating table and the instrument tables. In order to better protect the purity of the area around the operating table and sterile instrument tables in operating rooms horizontal air flow is not used. Even the recommended designing of the air flow from patient's legs to the head does not reduce the risk of infection as the air with pollutants, for instance coming from medical personnel, continues to flow towards the patient, partially affecting the surgical wound, instead of being forced out directly downwards from the sources of pollution, under the operating table, and then toward the wall ventilation outlets. Using horizontal flow increases also causes greater volatility of a laminar flow, since it is more susceptible to flow disturbance generated e.g. during door opening or movements of staff in the operating room. Because the surrounding air get sucked into the laminar flow, mixing zones occur on the edges of the laminar flow, which are characterized by higher turbulences compared to uninterrupted stream of air, thus narrowing the laminar flow. This phenomenon is the reason why typically a selected laminar diffuser is bigger than the protected area.

The air, preconditioned in the air-conditioning panel (or cabinet) is sucked to the laminar diffuser through the air intake vents, which are placed in one or more edges of the laminar diffuser. The outflow of air from ALVO diffuser panels is through the plane, located directly under a high efficiency air filter, made of perforated sheet, which serves as an air distributor, used to align and stabilize the outflowing stream of air. Mounted directly above the perforated metal panels are high efficiency air filters (HEPA) of at least H13 class (recommended - H14). They constitute the last stage of filtration. The air passing through the HEPA filter located in the outflow plane and through air distribution is evenly distributed across the entire surface of the diffuser.

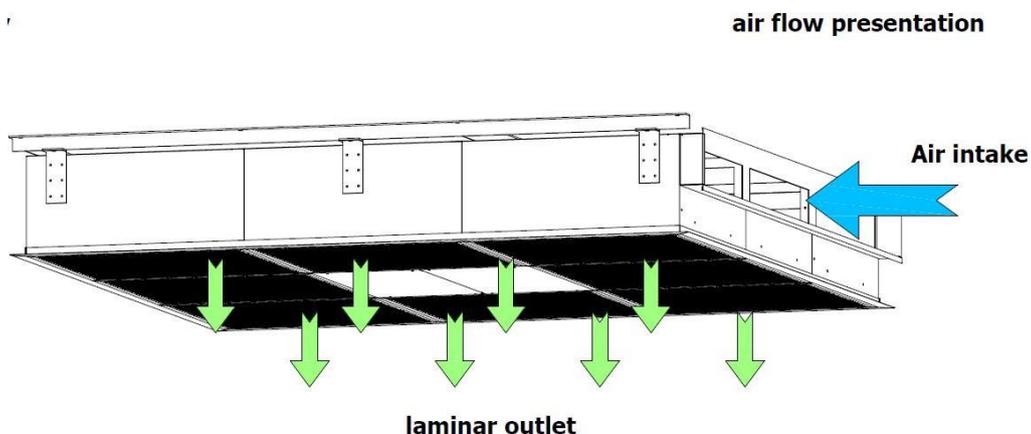


Fig. ALVO laminar diffuser type ALF - example of modular solution - module (650x650) 3/3

3. Parameters of air in the operating room.

- The supply air temperature should be slightly (approx.. 0,5 - 1°C) lower than projected temperature in the room, which should be between 22 to 25°C;
- air must flow at a certain speed, which should not exceed 0,2-0,45m/s - the optimum speed is about 0.24 m/s;
- relative humidity should stay between 55-60% (relative humidity above 65% can cause intragranular corrosion and damage medical equipment, humidity below 50% favors the formation of static electricity);
- the stream of air must be protected against interference (e.g. from operating lamps causing convection and mixing of air masses). The solution is the proper type of lamps (e.g. shadowless) and the proper height of the diffuser installation over the operating field.

In the operating rooms the outflowing air should be evenly distributed to wall mounted exhaust grilles. For this reason, the best approach is to design evenly spaced four exhaust pipes with two ventilation grilles each, for example on two opposite side walls of the room, at a suitable distance from the corners. During surgeries a large amount of shreds detaches from bandages and linens, which are then entrained by the ventilation air flowing through the room and sucked into the ventilation grilles. This pollutes the exhaust and recirculation pipe network and increases air flow resistance. Recirculation of such air from the operating room leads to significant contamination of air treatment devices (e.g. heat exchangers). Accumulated fragments of contaminated dressings are also a medium for microorganisms growing inside the installations. This adverse phenomenon can be significantly reduced by using removable fine mesh made of stainless steel - a so called pollution separator. Most often such exhaust grille is selected for air velocity lower than 2 m / s. Initial pressure loss is then about 10 ÷ 13 bar. In accordance with the recommendations contained in the "Guidelines for designing general hospitals' operating rooms air should be supplied from the top. Because in such premises there is an emission of anesthesia gases heavier-than-air to inside, air exhaust grilles are installed on two levels:

- above the floor (80% of air)
- Below the ceiling (20% of air).

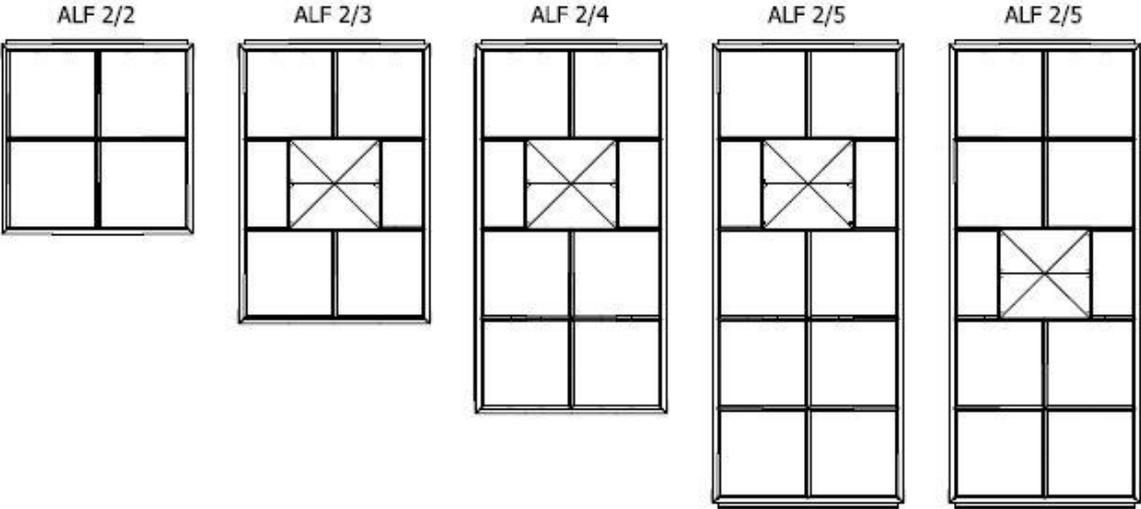
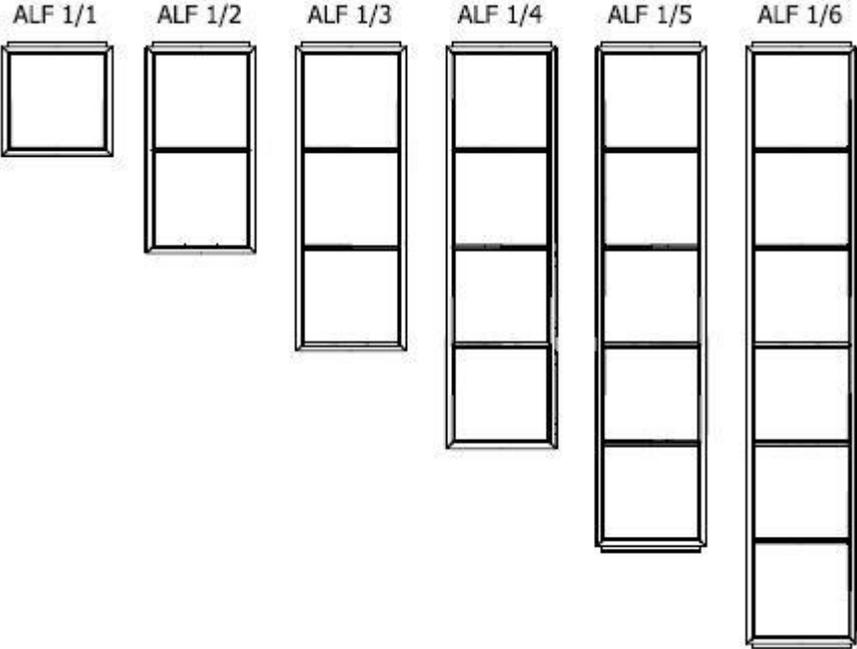
Typically grilles are placed approximately 25-30 cm from the floor and ceiling.

The size of grilles in the operating room is evaluated based on the calculations of inflow and outflow of air and the recommended flow rate.

4. Laminar diffusers ALF - characteristics:

- Guarantees optimal vertical flow of clean air in operating rooms.
- According to PN-EN-1922:2009 HEPA filters H13 or H14 are used, which guarantee safety of work. Filters are placed horizontally on entire outflow plane of the diffuser.
- Laminar diffuser is made of stainless steel 1.4301 or 1.4016, surface finishing – natural color of stainless steel or color adjusted to the color of the ceiling.
- Lower part of the laminar diffuser (modular panels), through which the air is blown downwards are made of perforated steel.
- Laminar diffuser is supplied by the manufacturer of the modular wall and ceiling system, which guarantees full compatibility of used solutions.
- Laminar diffuser has a certificate allowing it to be used in operating theaters
- The manner of installation of a diffuser guarantees convenient operation, maintenance and replacement of removable elements without the danger of damaging the diffuser.
- HEPA filters and perforated covers are supplied in a separate package and are installed in the diffuser after installation and commissioning.
- laminar flow diffusers are selected in such a way that their size guaranteed correct flows and exchanges of air in operating theaters.

Depending on the size and layout of walls of the operating theater different designs of ALVO laminar diffusers are being used. Presented below are all functional diagrams and examples of modular solutions:



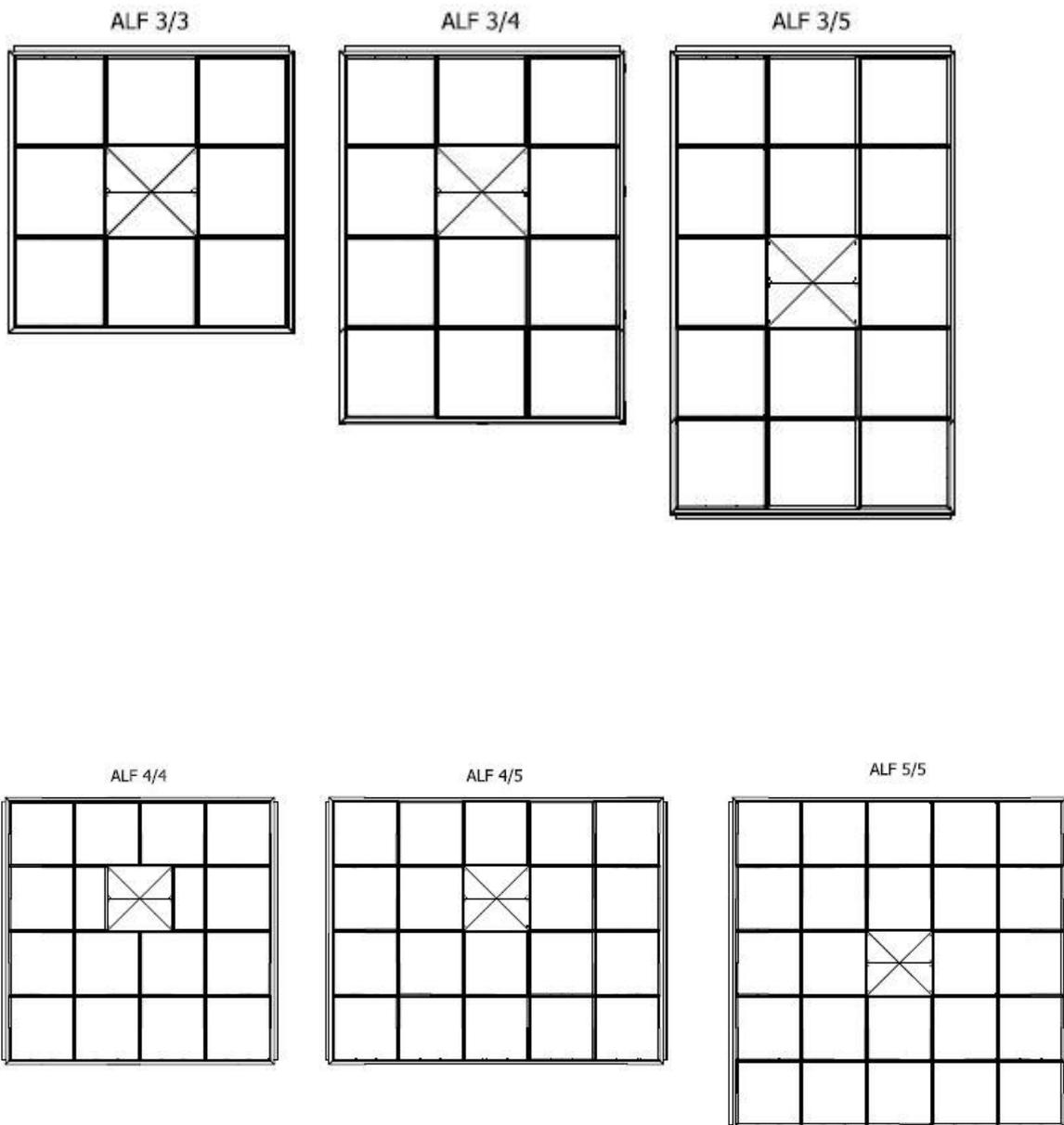


Fig. Functional diagrams of laminar diffusers type ALF

Panels marked as  represent location of operating lamps. Depending on the requirements it is possible to change that location.

Tab. Characteristics of laminar ceilings type ALF.

Diffuser type	External dimensions of diffuser [mm]	Dimensions of filters [mm]	Quantity of filters	Dimensions of filters [mm]	Quantity of filters	Filtration surface [m ²]	Air output [m ³ /h]		Diffuser mass with filter th. 80 mm	Dimensions of connecting sockets of vent.system to diffuser [mm] ***
							for V=0,2 m/s	for V=0,45 m/s		
ALF 1/1	650x650	610x610	1	-	-	0,372	268	603	20	473x148
ALF 1/2	650x1300	610x610	2	-	-	0,744	536	1206	39	473x148
ALF 1/3	650x1950	610x610	3	-	-	1,116	804	1808	58	473x148
ALF 1/4	650x2600	610x610	4	-	-	1,488	1072	2411	78	473x148
ALF 1/5	650x3250	610x610	5	-	-	1,861	1340	3014	97	473x148 (2 podejścia)
ALF 1/6	650x3900	610x610	6	-	-	2,233	1607	3617	117	473x148 (2 podejścia)
ALF 2/2	1300x1300	610x610	4	-	-	1,488	1072	2411	78	1260x148
ALF 2/3	1300x1950	610x610	4	305x610	2	1,861	1340	3014	97	1260x148
ALF 2/4	1300x2600	610x610	6	305x610	2	2,605	1875	4220	135	1260x148
ALF 2/5	1300x3250	610x610	8	305x610	2	3,349	2411	5425	175	1260x148 (2 podejścia)
ALF 3/3	1950x1950	610x610	8	-	-	2,977	2143	4822	160	1910x148
ALF 3/4	1950x2600	610x610	11	-	-	4,093	2947	6631	213	1910x148
ALF 3/5	1950x3250	610x610	14	-	-	5,209	3751	8439	270	1910x148 (2 podejścia)
ALF 4/4	2600x2600	610x610	14	305x610	2	5,582	4019	9042	290	2560x148 (2 podejścia)
ALF 4/5	2600x3250	610x610	19	-	-	7,070	5090	11453	365	2560x148 (2 podejścia)
ALF 5/5	3250x3250	610x610	24	-	-	8,930	6430	14467	465	1260x148 + 1830x148 (2 podejścia)

* angle bar to support ceiling (visible part from bottom - 25 mm) - in case of using to external dimension 2* 25 mm = 50 mm should be added)

** diffuser height in case of using filters th. 80 mm is 345 mm, in case of using filters th.150 mm is 420 mm,

*** dimensions of connecting sockets presented on fig.10

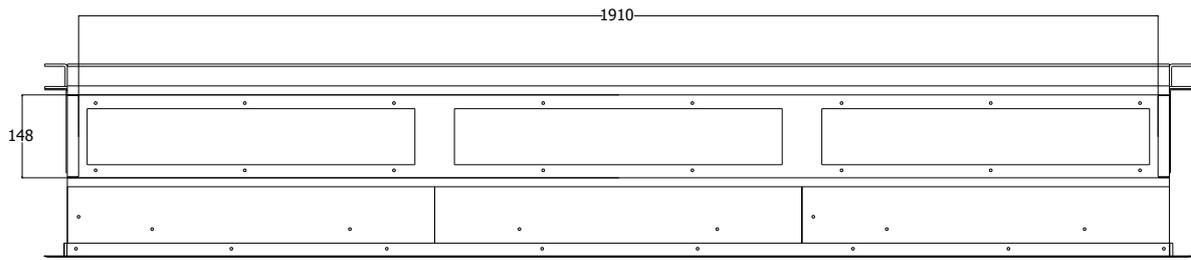


Fig. Dimensions of connecting sockets of ventilation system to laminar diffuser (in [mm]) – example of a diffuser ALF 3/3

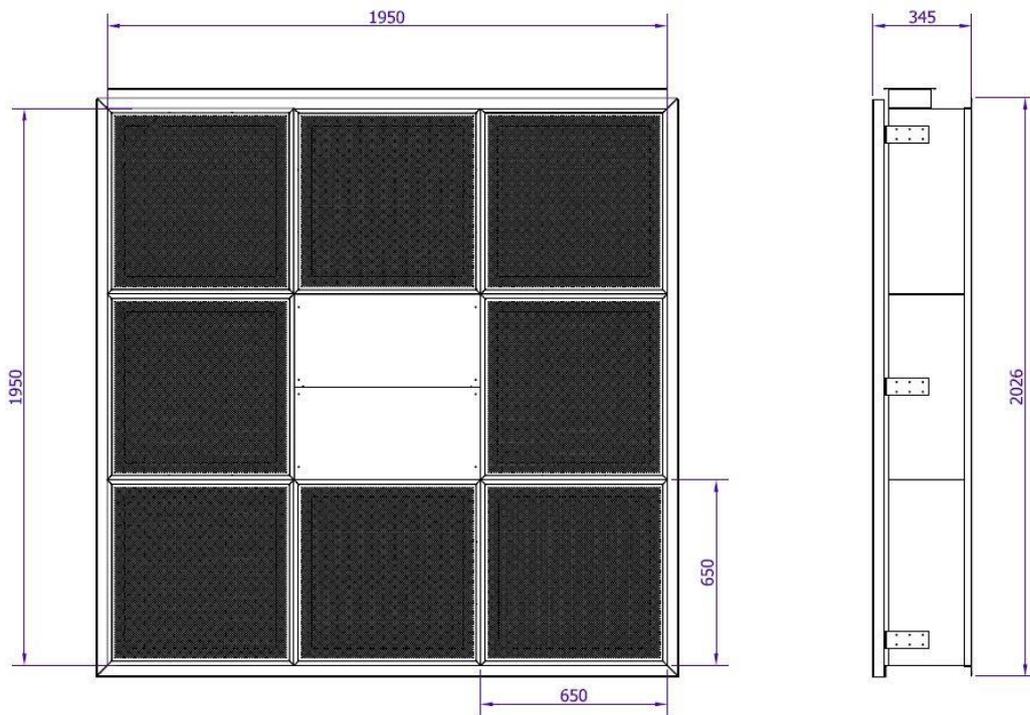


Fig. Example of modular solution – module (650x650) 3/3.

5. Components of laminar ceilings

- High efficiency air filter HEPA, depending on required efficiency of filtration: (number of filters equal to the number of ceiling modules)
 - FA-13/80 610x610x80 (or 305x610x80) class H13
 - FA-14/80 610x610x80 (or 305x610x80) class H14

Technical data:

Type:	FA-13/80	FA-14/80
Filter class according to PN-EN 1822 : 2009	H13	H14
Filtration efficiency according to MPPS, (%), min	99,95	99,995
Filter package depth, mm	80	80
Operating temperature, °C	70	70
Final flow resistance, Pa	500	500

- pressure switch terminal 2 pcs per diffuser
 - 1. Terminal is installed above the filter, 2. Below the filter – used to measure overpressure defining the status of filter contamination.
- Flexible connection – 1pc.
 - Makes it easy to connect directly and tightly the air supply channel to diffuser through the collector. Dimensions adjusted to the type of diffuser.



Fig. Flexible connection ALNOR QILA-150

- Elements to fix laminar diffuser to the ceiling:
 - Brass wall plugs KRM-10/M8x31– quantity depending on the used module,
 - Construction studs M8x1000 oc. or M8x2000 oc. Quantity depending on the used module, length depending on the distance from laminar diffuser and ceiling.

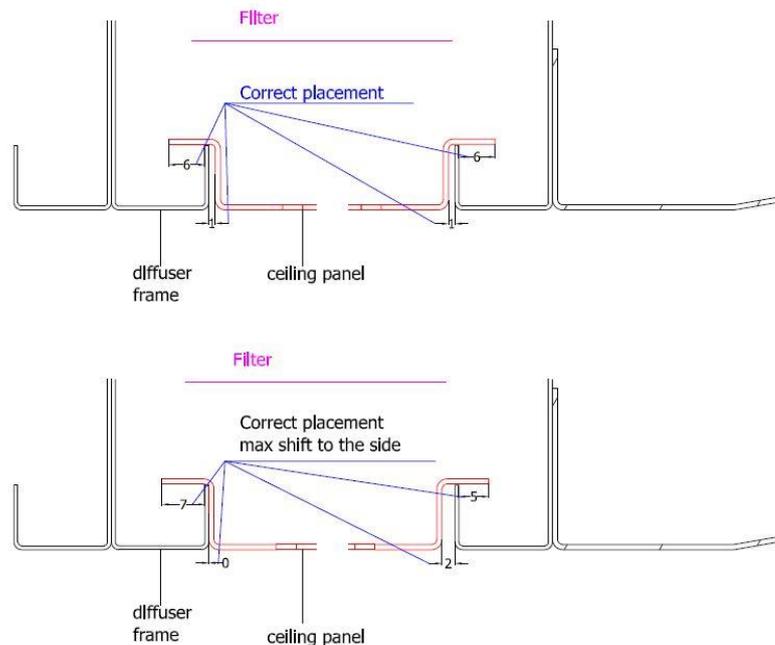


Fig. Correct placement of ceiling tiles on the diffuser frame.

6. Installation of laminar ceilings

Location of air supply and exhaust devices should be defined in the ventilation design. It should take into account the required hygienic and technological parameters of the premises. Laminar diffusers should be placed at height allowing to construct the false ceiling - flush with the bottom part of the laminar diffuser. The laminar diffuser supply pipes as well as other ventilation ducts located in the space above the false ceiling should be placed in a manner allowing easy installation of the luminaires according to the lighting plan and construction of the ceiling.

The installation of the luminaire requires 0.15 m. The installation of the ceiling CLIP-IN system requires minimum space of 0.2 m.

Laminar diffuser should be hanged so that the bottom part was exactly at the level of the planned placement of the modular ceiling. It is necessary to suspend the diffuser in precisely leveled position - this applies particularly to the lower part of the diffuser.

The diffuser shall be installed in accordance with the project, with particular emphasis on required parallelism to the finished side walls.

Air exhaust channels should be arranged in accordance with the project and shall be permanently vertically attached.

Laminar diffuser has a mounting angle bar (1) with holes through which it is suspended from the ceiling. Installation involves marking of intended points of suspension of the diffuser and then drilling holes in the ceiling, placing the metal expansion bolts in holes (4) for threaded rods M8 (5) used to hang the diffuser. Number of mounting elements (4) and

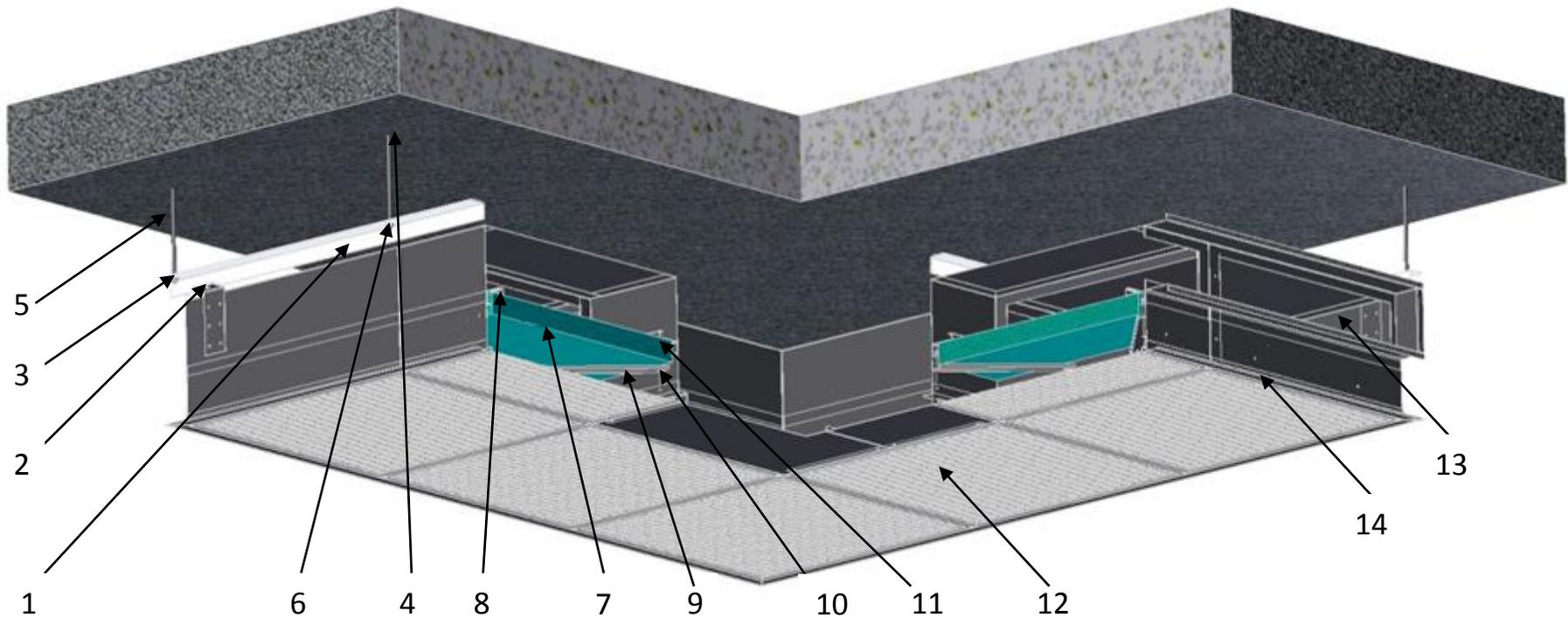
(5) depends on the type of diffuser (its size) and is defined in detailed documentation of the product. After the mounting rods are fixed, the diffuser is hanged by putting the rods in the angle bar holes (1) and screwing the nuts (6) on the studs. The nuts enable adjusting the position (horizontal) of the diffuser. During installation, the required position of the diffuser in relation to the side walls should be controlled. By loosening and tightening the screws on studs on which the diffuser is suspended you can adjust the suspension height - up / down. This can also be used to level the diffuser.

The diffuser has a connection stub (13), which is used to connect to the ventilation system. It is prepared to be attached to the ventilation channel. Its size depends on the type of the diffuser. Laminar diffuser is also equipped with an angle bar (14) (around the diffuser) which is used to support the ceiling panels.

NOTICE:

Filters are installed at the end of installation works in the operating room, after purging the ventilation system. Installation of the filter consists of unpacking it out of the protective packaging, placing on the supporting element (8), fixing the damp element (9), and screwing the clamping screw (10) to the structure of the diffuser. Tightening the screw will clamp the diffuser to the supporting element and seal the connection between the filter and diffuser mounting element. During installation, respect all the requirements set by the manufacturer of filters (guidelines) to avoid damaging the filters. Angle bars should be evenly and thoroughly tightened. All works should be performed carefully to achieve a tight fixation of filters in the diffuser.

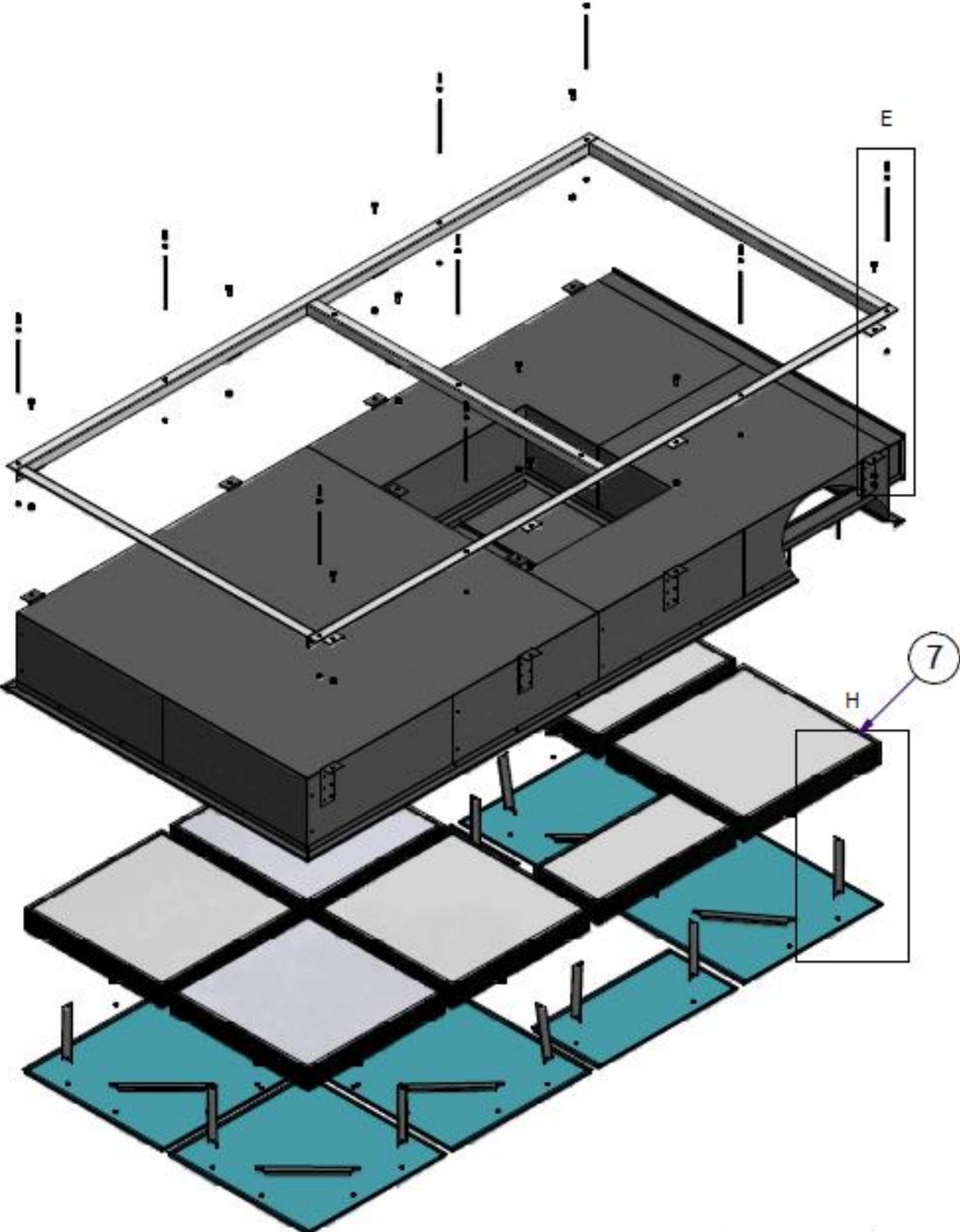
Fig. Installation diagram of laminar diffuser (example 3x3).



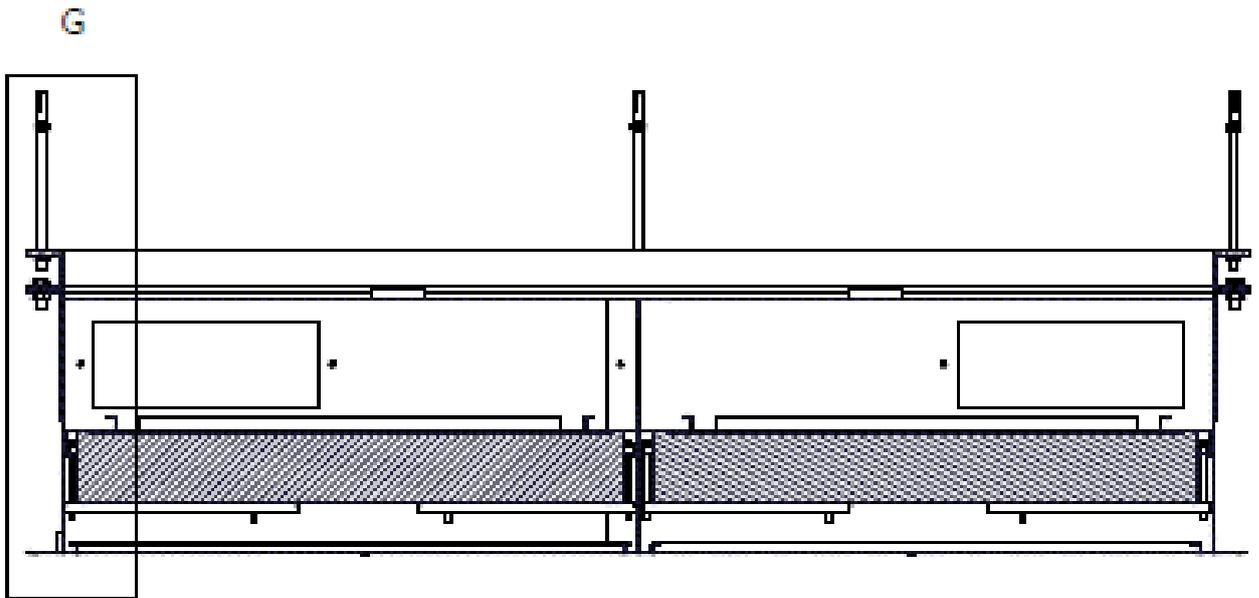
1. Mounting frame – used to suspend the diffuser
2. Mounting holes to suspend the diffuser
3. Screw connecting the mounting frame with the laminar diffuser
4. Expansion bolt – used to hook the construction stud into the load bearing ceiling
5. Construction stud M8 – used to hand the load bearing frame.
6. Nut M8
7. HEPA filter
8. Supporting element of the laminar diffuser for the HEPA filter
9. HEPA filter clamp element

10. Clamping screw
11. Construction stud tightening the HEPA filter clamp to the supporting element
12. Perforated sheet closing the laminar diffuser from the bottom side.
13. Connecting socket
14. Angle bar – support for ceiling panels.

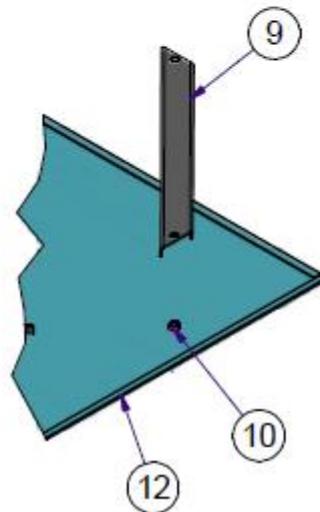
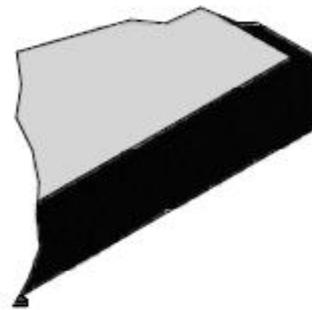
Fig. Components of the laminar flow (example 2x4):

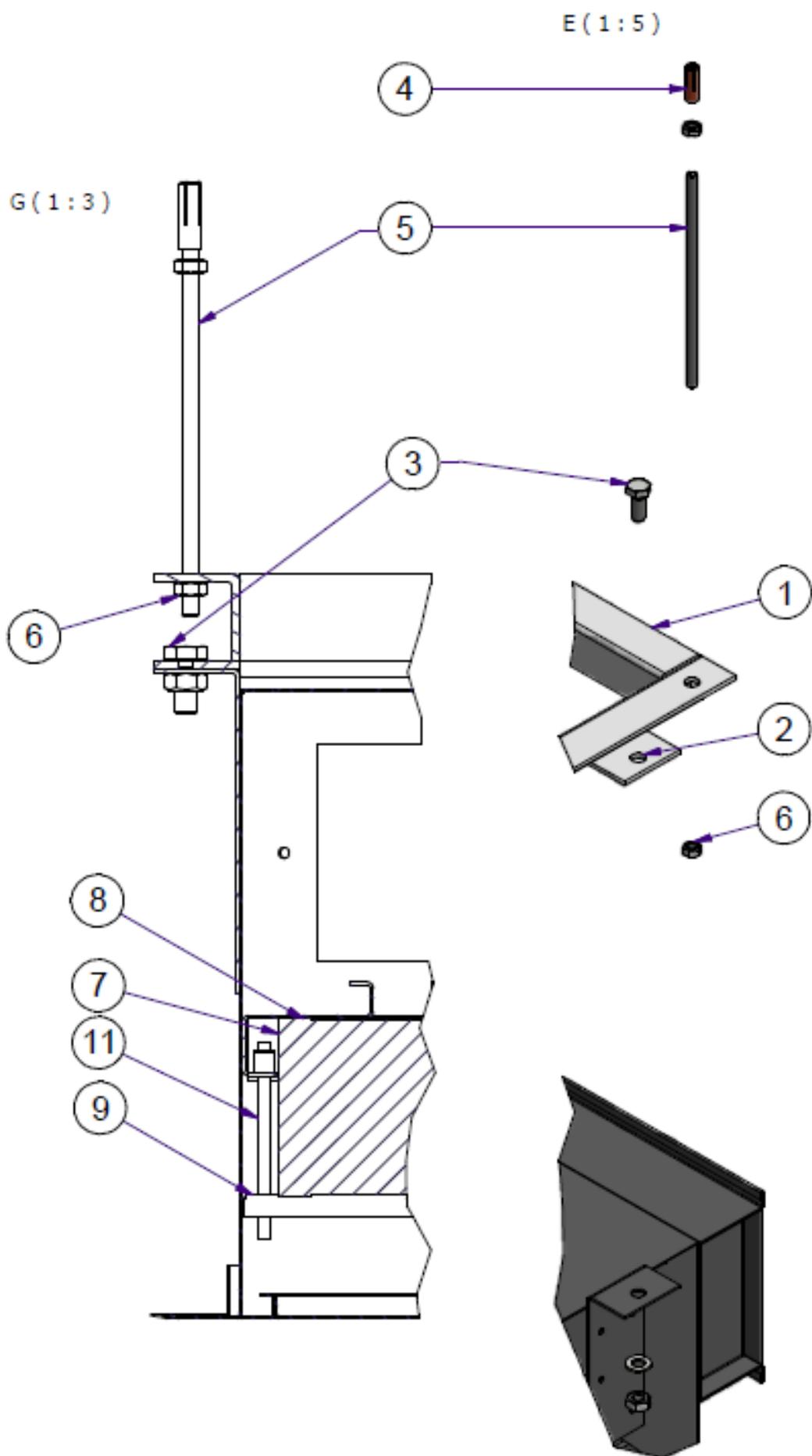


F-F (1 : 12)



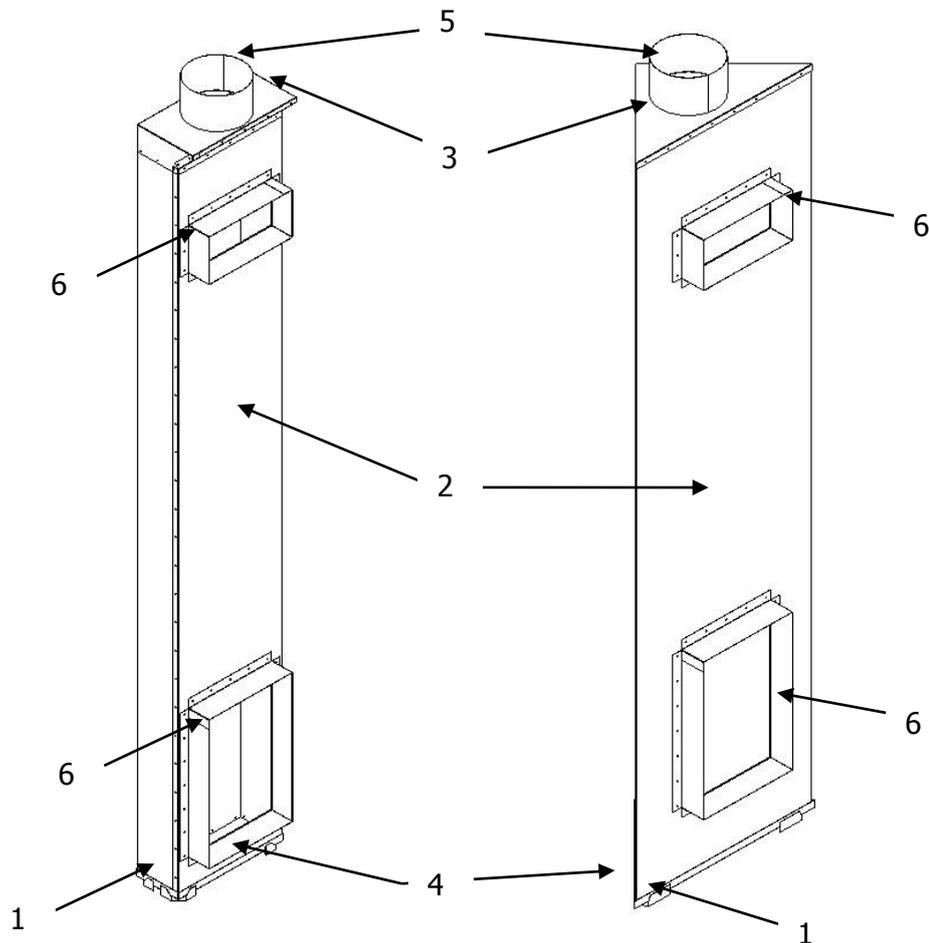
H (1 : 6)





7. Exhaust columns

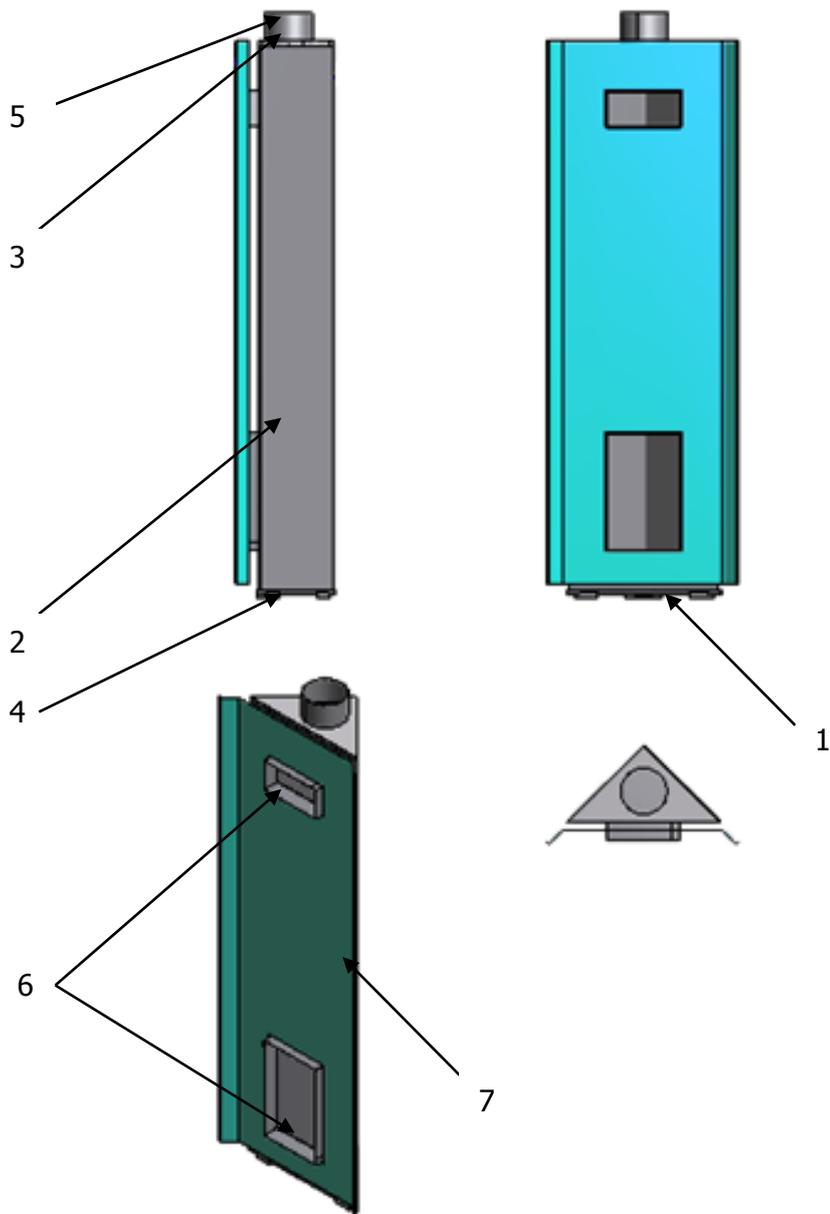
- Made entirely of galvanized steel, structure is riveted and sealed
- Cutouts for ventilation grilles adjusted to their size
- Depending on the spacing of the walls in the operating theater and the location of exhaust ducts 2 versions of ducts are produced: columns and corners.



1. Stand - galvanized steel sheet - thickness 1 [mm]
2. Body - galvanized steel sheet - thickness 1 [mm]
3. Top cover - galvanized steel sheet - thickness 1 [mm]
4. Bottom cover - galvanized steel sheet - thickness 1 [mm]
5. Exhaust pipe - galvanized steel sheet - thickness 2 [mm]
6. Collars of upper and lower grille - galvanized steel sheet - thickness 1 [mm]

Fig. Exhaust duct: column (left) and corner (right)

Fig. Exhaust column consists of:



1. Stand - galvanized steel sheet thickness 1 [mm]
2. Body - galvanized steel sheet thickness 1 [mm]
3. Top cover - galvanized steel sheet thickness 1 [mm]
4. Bottom cover - galvanized steel sheet thickness 1 [mm]

5. Exhaust pipe - galvanized steel sheet thickness 2 [mm]
6. Collars of upper and lower grille - galvanized steel sheet thickness 1 [mm]
7. Wall Panel

8. Installation of exhaust columns

Exhaust columns are a component of a ventilation system. The placement and number of columns results directly from the construction design of the operating room.

Exhaust columns mounted in the corners have bases in the shape of a triangle. Columns mounted on the walls have rectangular bases.

Exhaust columns are placed directly on the floor. In case of uneven floor finishing, the setting of the column should be adjusted by putting metal pads under the column or leveling it with concrete.

Having set up the exhaust column in relation to the support structure wall and the hole in the wall panel (which will be mounted on the column), the column must be mounted on the substructure with the use of wall structure profiles and rivets or sheet metal screws. In case of attaching any installation elements to the exhaust columns, all such connections must be made with a use of sealant (all holes made in the exhaust column must be sealed)

It is recommended not to drill screws into ventilation ducts – mounting profiles should be fixed to grip around the duct and then such strap should be attached to the supporting structure of the partition wall. If the panel system is used on the brick walls the straps should be fixed with a use of appropriate expansion bolts.

9. Exhaust grilles

KWH hygienic outlet grilles are intended for installation on a bottom part of exhaust ducts of ventilation systems in operating theaters.

- Made entirely of stainless steel, the frame of the grille is welded and sealed.
- Exhaust surface made of perforated stainless steel mounted in front frame using clips.
- This solution facilitates removal of front element for frequent cleaning and washing.
- Grilles selected so that their size guaranteed correct air flow parameters.
- exhaust grilles supplied by the system manufacturer of modular wall and ceiling system guarantee compatibility with the system.
- exhaust grilles are certified to be used in operating theaters.

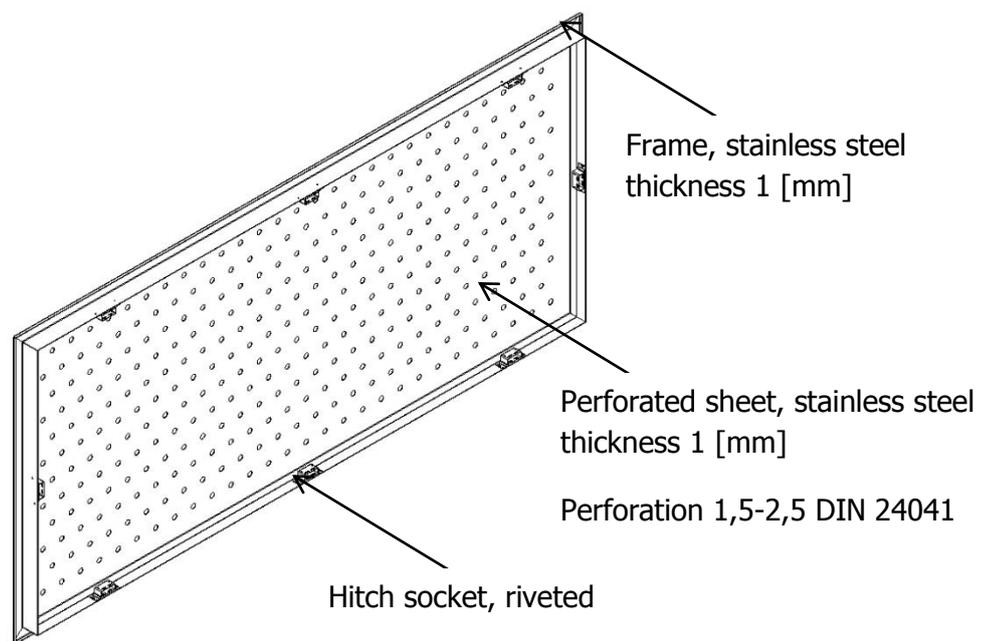
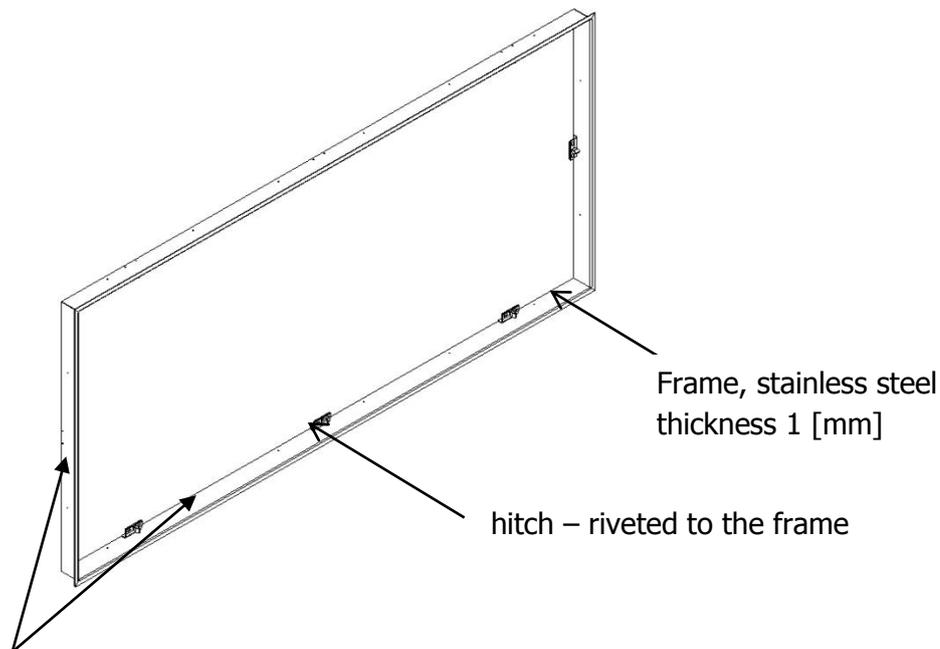


Fig. ALVO exhaust grille – front side



Mounting holes - for fixing, using sheet metal screws, to the collar of exhaust column.

Fig. ALVO exhaust grille – rear side

Tab.1. Types of ALVO exhaust grills

	Type dimensions	Channel dimensions		Clear opening dimensions		Eff. area. m ²	Grill dimensions	
		E	F	A	B		A+56	B+56
		mm						mm
1	KWH - 195x305	195	305	180	290	0,018	236	346
2	KWH - 195x395	195	395	180	380	0,024	236	436
3	KWH - 195x495	195	495	180	480	0,030	236	536
4	KWH - 305x395	305	395	290	380	0,039	346	436
5	KWH - 305x495	305	495	290	480	0,049	346	536
6	KWH - 305x625	305	625	290	610	0,062	346	666
7	KWH - 395x495	395	495	380	480	0,064	436	536
8	KWH - 395x625	395	625	380	610	0,081	436	666
9	KWH - 395x795	395	795	380	780	0,104	436	836
10	KWH - 395x965	395	965	380	950	0,126	436	1006
10	KWH - 395x1065	395	1065	380	1050	0,140	436	1106
11	KWH - 395x1165	395	1165	380	1150	0,153	436	1106
12	KWH - 509x1165	509	1165	494	1150	0,199	550	1206

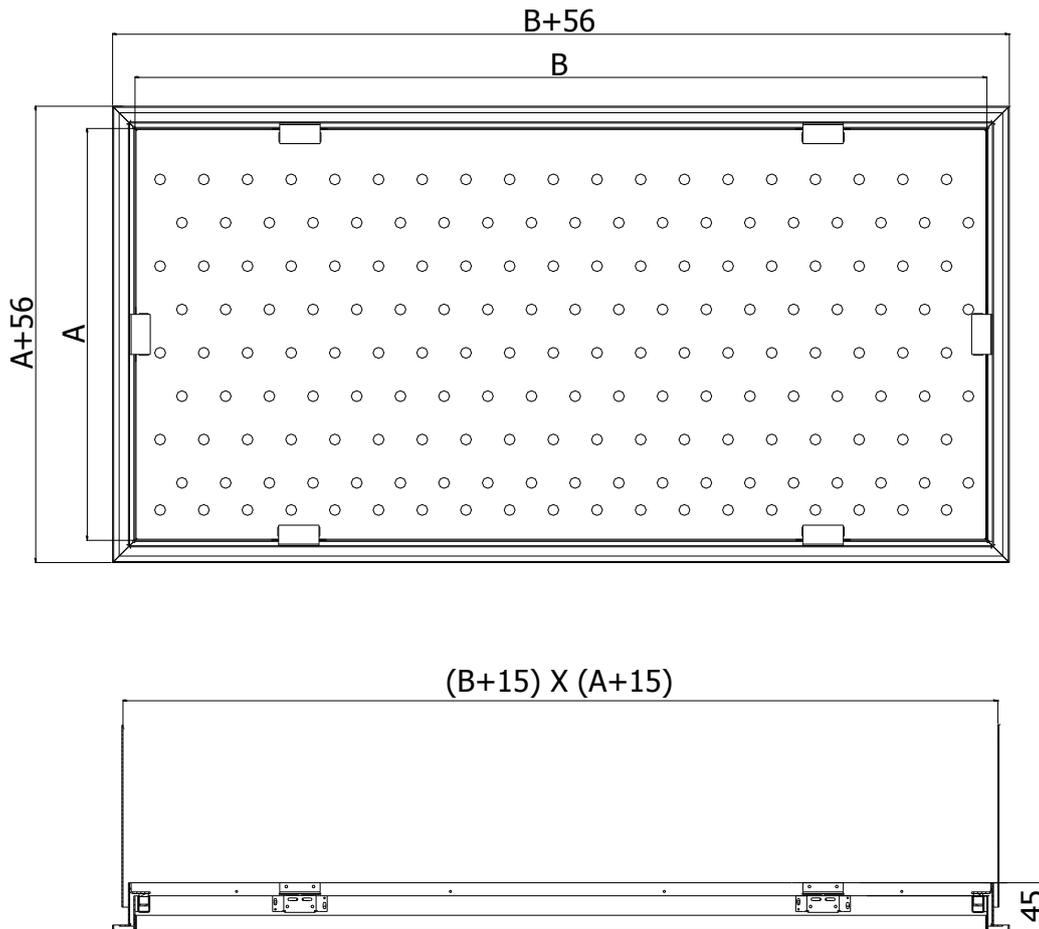


Fig. Dimensions of ALVO ventilation grilles

Aluminum ventilation grilles type KWA are intended for installation on upper parts of exhaust ducts of ventilation systems in operating theaters.. For the regulation of the air flow rate through the grilles, PRKA regulation throttles are used. Installation of grilles – depending on the type of construction – can be made directly to the channel with screws or with use of latches and mounting frame RKA.

Grills are made of anodized aluminum profiles. KWA exhaust grilles are fitted with longitudinal blades with variable pitch. Adjusting the angle of the blades allows for individual shaping of air stream profile.

Throttles PRKA, constituting additional equipment of grilles, are made of galvanized steel (casing) and aluminum (blades). Position of the throttle blades can be changed in the range from fully closed to fully open (max. grille efficiency) and is done by rotation of the adjustment mechanism with an allen key. Regulation is done on a mounted grille. Dimensions of throttles allow to place it inside the mounting frame.

RKA mounting frames are made of galvanized steel sheet. Frame connects to a rectangular duct with rivets or self-tapping screws. Grille embedded in the frame is fixed with mounting brackets (locks).



10. Installation of exhaust grilles

Exhaust grille (rear side) should be placed into the prepared cutout (collar of the exhaust column) and fixed with sheet metal screws to the column collar. Places of fixing must be sealed with silicone. During installation attention must be paid to adherence of the rear side of grille to the face of a wall panel. Front side of the exhaust grille is mounted into the fixed frame.

11. Elements subject to periodic replacement

HEPA filters – according to the specification of a laminar diffuser.

Size and quantity of filters is defined in Tab. Characteristic of laminar diffusers type ALF.

The need to replace contaminated HEPA filters is signaled by the air-conditioning control system. This paper does not cover the characteristics of this system.