Efikasni KGH sistemi u bolnicama

Efficient HVAC systems in Hospitals

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Power point presentation Supported by Kristina Jager and Ana Kurtanjek

Providing comfort in patient rooms

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General technical requirements-hospitals

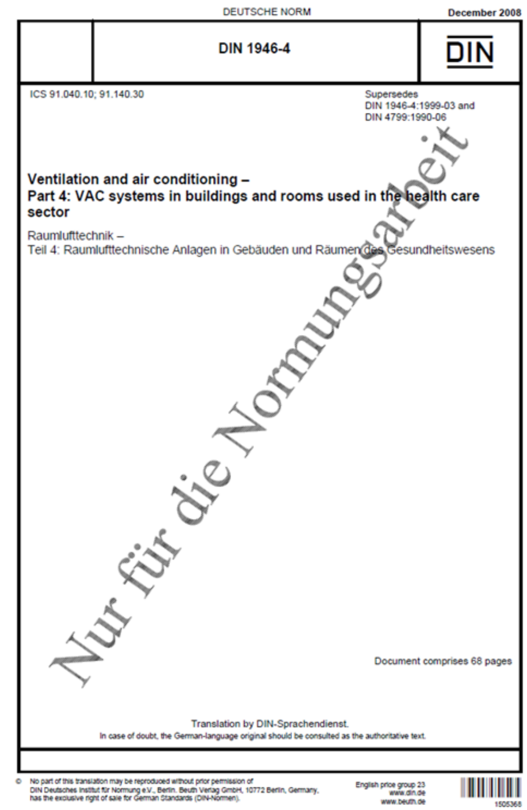
Preventing the spread of contagions is an important task for ventilation in hospitals. In some types of care, low levels of contagions in the air are absolutely crucial to the outcome, for example in transplants and patients with burn injuries. The reliability of each component is therefore absolutely crucial in ensuring the ventilation system is completely safe. Operating theatres and laboratories are complex systems with extreme hygiene requirements on materials and equipment. At the same time, all of these rooms are individual projects that require the utmost precision and flexibility – both as regards design and adaptation to the project’s specific needs.

Lindab can meet the very highest technical requirements in places where maximum hygiene safety has to be assured, such as operating theatres, laboratories and intensive care wards.

General technical requirements-hospitals

The following are also used as the basis for designing the air handling and ventilation systems :

- DIN 1946-4,2008
- TSG-12640-001:2008,Health Care Facilities)
- ASHRAE /ASHE Standard 170-2008, Ventilation of Health Care Facilities
- Rules on Efficient Use of Energy in Buildings Official Gazette of RS, no. 52/2010),
- Rules on the Ventilation and Air-Conditioning of Buildings, Official Gazette of RS, no. 42/2002),
- SIST CR 1752:1999 - Criteria for Designing Indoor Environments,
- SIST prEN 13779:2001, Required Characteristics for Ventilation and Air Conditioning Systems
- (090814 Ventilation for hospitals, Draft, February 2010)



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Ventilation and air conditioning –
Part 4: VAC systems in buildings and rooms used in the health care sector

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Teil 4: Raumlufttechnische Anlagen in Gebäuden und Räumen des Gesundheitswesens

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General technical requirements-patient room

- Maintaining the appropriate temperature and humidity has a favorable effect on the well being of the patients and good ventilation ensures the quality of the indoor environment and decreases the health hazard level for people in the room. Forced ventilation with a supply of fresh, purified air decreases the number of germs in the room and helps decrease infections.

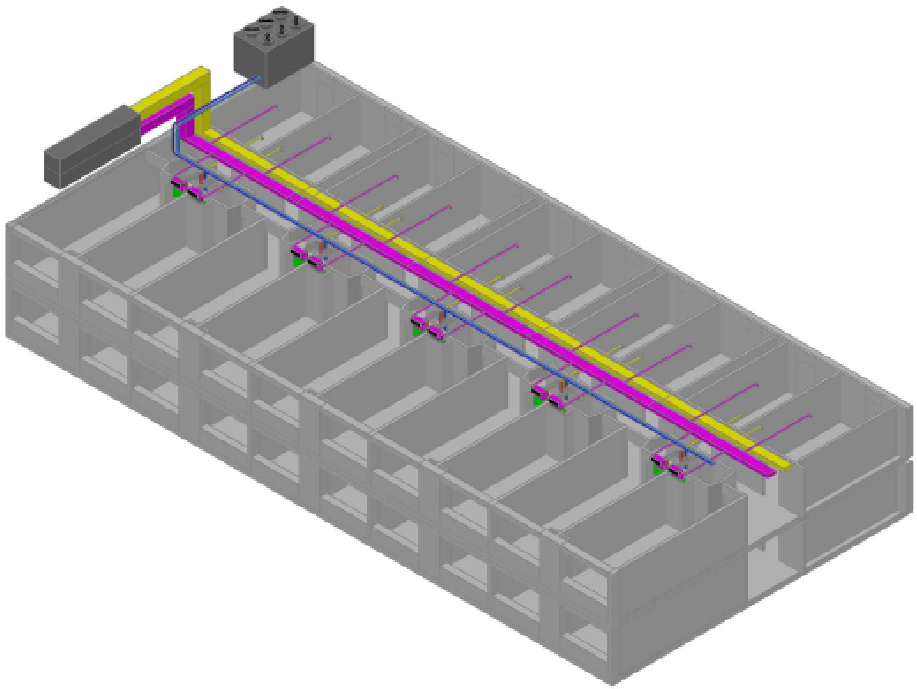
- Therefore, in hospital departments, maintaining an appropriate indoor environment can even shorten the period of inpatient stay or hospitalization.

- The task of air handling and ventilation in patient rooms is maintaining the appropriate temperature and humidity in the room, regardless of external parameters, and the supply of fresh air provides the appropriate quality of air in the room and prevents the intrusion of outside air into the room.

- It should operate as quietly as possible and the operating and maintenance costs should be as low as possible.

The subject of the project

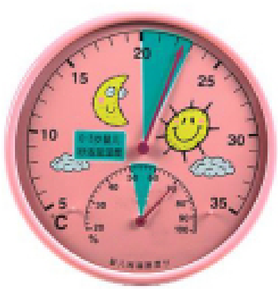
- Cooling and heating systems
- Ventilation systems
- Lighting systems
- Monitoring energy distribution and consumption by individual segments
- Ecological effects

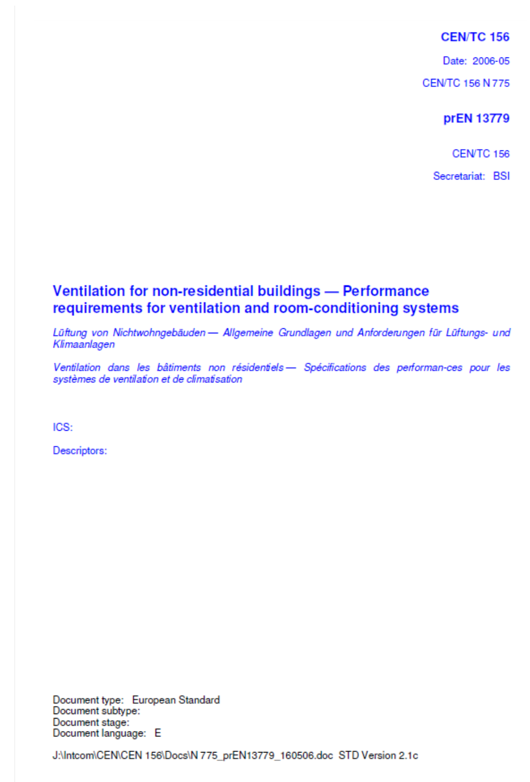


General technical requirements-patient rooms

In accordance with EN 13779, we use the following parameters for indoor environments:

- Temperature 22-26°
- Relative humidity 40-60%
- Ventilation – volume of fresh air 40 m3/h per bed
- Maximum sound level 30 dB(A)




CEN/TC 156

Date: 2006-05

CEN/TC 156 N 775

prEN 13779

CEN/TC 156

Secretariat: BSI

Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems

Lüftung von Nichtwohngebäuden — Allgemeine Grundlagen und Anforderungen für Lüftungs- und Klimaanlagen

Ventilation dans les bâtiments non résidentiels — Spécifications des performan-ces pour les systèmes de ventilation et de climatisation

ICS:

Descriptors:

Document type: European Standard
Document subtype:
Document stage:
Document language: E

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Options for individual systems

Suitable comfort in the room can be achieved with various systems.

Four systems are presented bellow:

A. radiator heating, cooling with Climmy fan coils, 2-pipe systems, natural ventilation (windows)

B. heating with Climmy fan coil, 4-pipe system and mechanical ventilation

C. heating/cooling with Climmy ceiling fan coil, 4-pipe system and mechanical ventilation

D. radiator heating, cooling with chilled beams in a set together with mechanical ventilation

Options for individual systems – version A

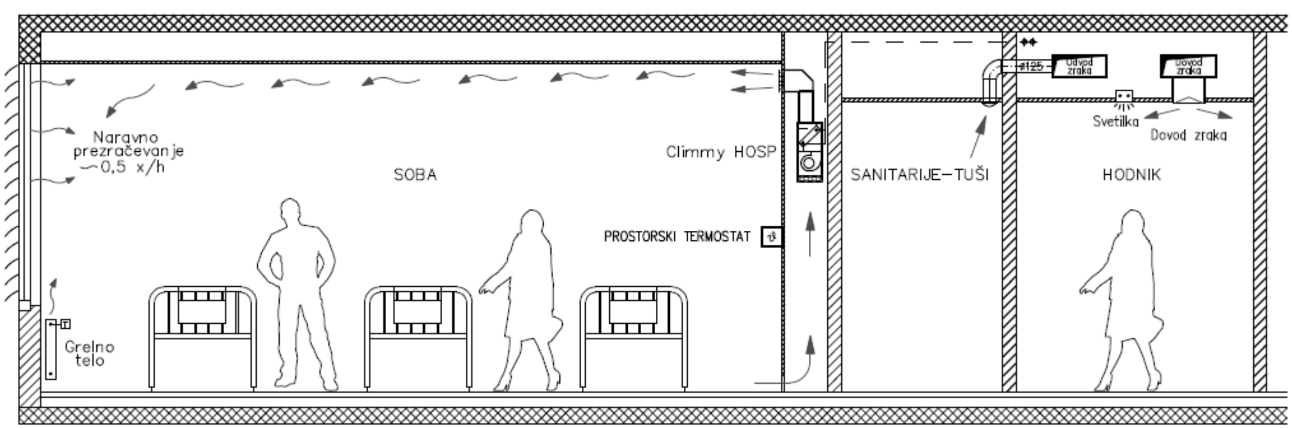
DESCRIPTION

- The reconstruction of existing projects
- Radiator heating
- Cooling with Climmy , with air dehumidifying
- WC and bathroom with forced ventilation
- High energy consumption and bad air quality are its weakness

CONTROL AND ADJUSTMENT

- Control is performed locally with automation as part of a fan coil that is connected to a room thermostat. Heating is via radiators with a built-in thermostat head and is not connected with the fan coil control-wise. The room temperature can only be adjusted locally in the room.

Varianta A

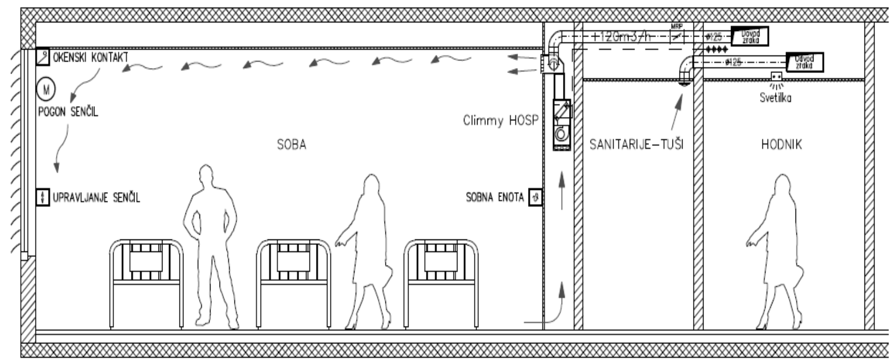


Options for individual systems – version B

DESCRIPTION

- Appropriate for new and existing buildings, where an air distribution unit is possible, 4-pipe system
- Favorable energy-wise with 75% recovery of waste air
- The selection of VK size and dry cooling without condensation are its advantages

Varianta B



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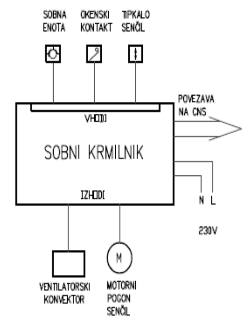


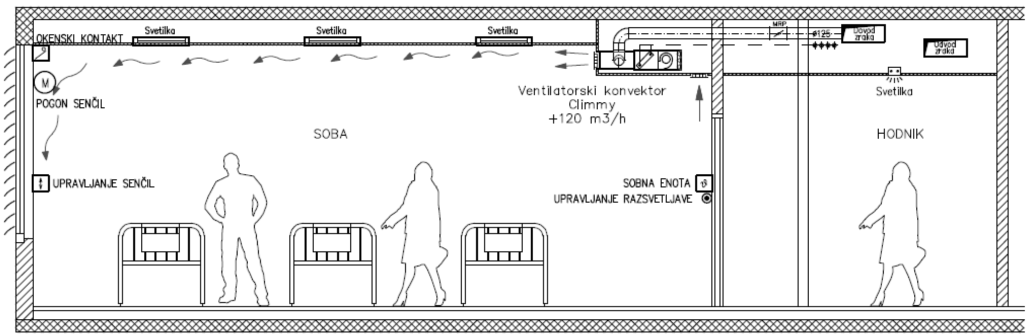
CONTROL AND REGULATION

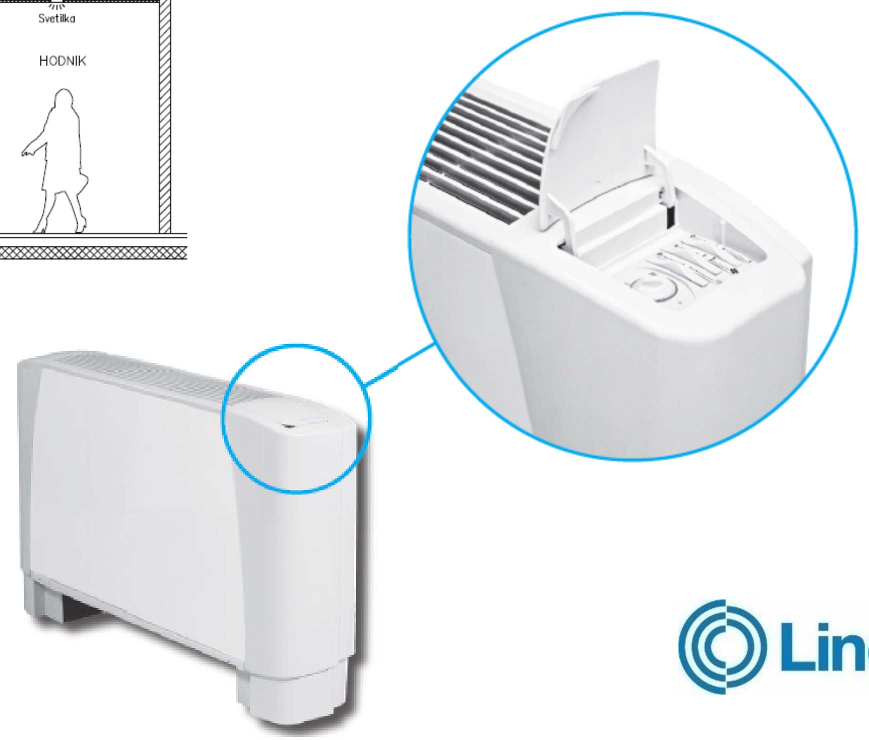
- Connectable room controller that monitors information on open windows, the desired temp. and blinds
- Temperature regulation is performed locally or remotely

Options for individual systems – version C

DESCRIPTION AND CONTROL ARE THE SAME AS IN VERSION B

Varianta C





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Options for individual systems – version D

DESCRIPTION

- Supply air or primary air serves for the operation of the chilled beam and for room ventilation. The following protection elements must be installed :
- A dew point sensor on the supply pipeline of the chilled beam – when dew appears it closes the supply of water into the chilled beam
- Window switch so that when the window is opened the supply of cold water into the chilled beam is shut off

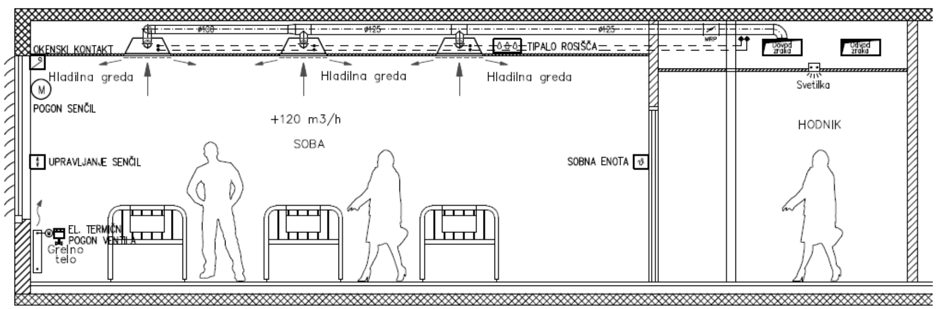
ADVANTAGES

- no mechanical elements in the room
- lower noise
- low energy consumption for heating/cooling the supply air (recovery, η>75%)
- dry cooling without condensation at the cooling register of chilled beam
- air humidification in winter
- local temperature adjustment in the room or remotely, e.g. from the nurses' base or via central control

CONTROL AND REGULATION

- The basic operation of the system is similar to type B, though it uses different heating/cooling appliances. Heating is done with a radiator, the water supply to which is reduced/increased with a thermal drive via a room controller. For cooling, the valve on the system of chilled beams is used for control. Due to the issue of dew point, the chilled beams have built-in dew point sensors that are also connected to the controller.

Varianta D

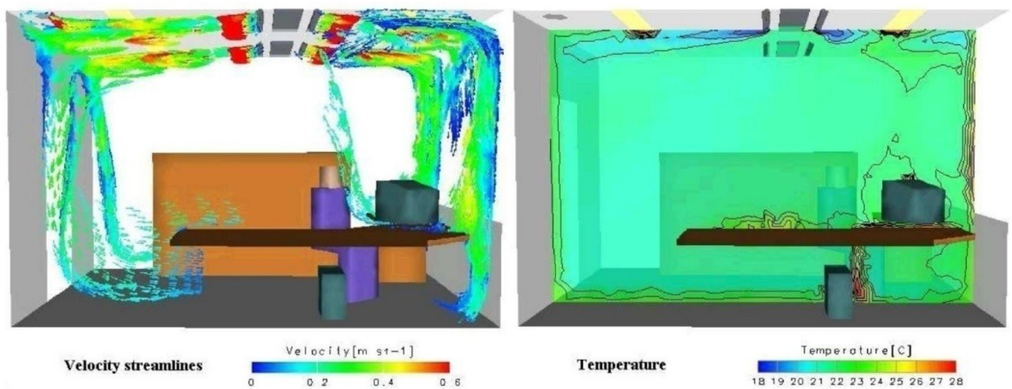


Options for individual systems – version D-hygiene

- CBs are easy to clean
- No filters in CB´s that have to be cleaned
- There is no condense water that should be handled in ACB´s, therefore no cleaning of drain pans necessary
- Moving parts in a FCU creates lower hygiene
- CB´s only need to be cleaned every 5 years
- ACB´s are using dry cooling (water temperature above dew point)
- Since using dry cooling the risk of condensation water is limited
- No need for condensation drainage in ACB´s
- Since no risk for condensation therefore also no risk for leakage problems within the drainage
- The condensation process is consuming energy which result in a higher energy consumption for FCUs
- Control is needed to keep the water temperature over dew point is necessary when using ACB´s

Options for individual systems – version D-Air velocities / Draught risk

- The air velocities from CB´s are lower than in a FCU
  → Better indoor climate and lower velocities in occupied zone when using CB´s
- Lindab’s ACB are supplied with diverging nozzles (30°) which are reducing the air velocities and the draught risk with 50%
- The air in a FCU is supplied through a small outlet gap and this creates air velocities



Straight nozzles (0°) *Diverging nozzles (30°)*

The ACB system creates comfortable air velocity and temperature conditions in the space when the overall building and ACB system is designed correctly.

System Characteristics for the Effective Cooling of Patient Rooms

Temperature and air humidity

- The system works on the principle of high temperature cooling (the cold water temperature is 12–17 °C)
- The option of a system without condensation (without the possibility of water stagnation)
- The option of a later supply of fresh air for ventilation from the central air handling unit
- Adaptability of the system for later renovation of the glazing and facade

Sound

- A concealed design of the cooling system, which basically means a lower noise level
- Highly effective centrifugal fans with several speeds

Air velocity

- The option of dispersing the stream of supplied air, even after the installation of the system
- Filtration of recirculating air
- Compliance with the Slovenian rules on ventilation and the SIST EN 7730 standard for comfort in the room, and the draft of the CEN/TR 16244:2011 standard – Ventilation for Hospitals

LCC Analysis

1. ENERGY

The required annual energy for maintaining the indoor environment of a patient room is composed of energy for maintaining the temperature environment and energy for ventilating the room.

Energy for maintaining the temperature environment depends on the building envelope, the protection of glass surfaces against solar radiation and internal gains.

2. COSTS

Capital costs - investment
Costs of energy - electrical energy, thermal energy, water consumption for humidification
Operating costs - management, maintenance, inspections
Other costs - insurance, contributions, management costs

3. INVESTMENT ESTIMATE

Like energy, the investment in the system for maintaining the indoor environment is divided into two systems: the water part maintains the thermal environment and the air part takes care of the air quality in the room.

LCC Analysis

ANALYSIS OF COSTS DURING THE LIFE OF THE SYSTEM

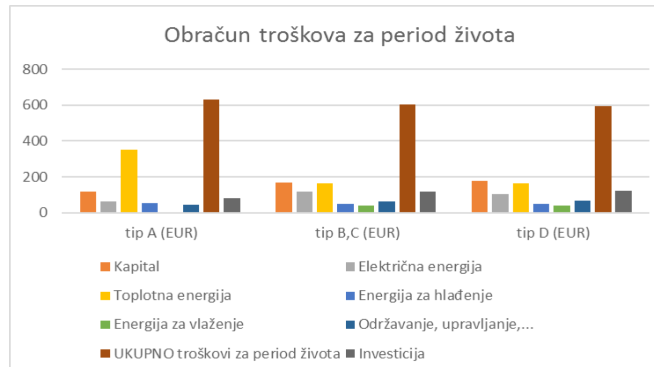
Systems with forced ventilation require less energy per year and the annual costs are also lower (even if energy is required to humidify the supplied air). But their investment is also significantly higher than for systems with natural ventilation.

If we compare the costs during the entire system life (e.g. 15 years), we see that there are no significant differences between the individual systems or that the systems with forced ventilation are even a bit more economic.

IMPORTANT

But it is important to be aware that systems with mechanical ventilation provide a significantly higher quality indoor environment (air quality, humidification) and thus the inpatient length of stay is shorter. The savings due to shorter inpatient stay contribute significantly towards the greater economy of such systems.

	Costs during life, calculated per 1m² room surface area			
	COSTS DURING LIFE (VDI 2067)	type A	type B,C	type D
1.	Capital	120	169	176
2.	Electrical energy	61	118	102
3.	Thermal energy	352	162	162
4.	Energy for cooling	54	49	49
5.	Energy for humidification	0	42	42
6.	Maintenance, management etc.	45	63	66
7.	Total cost over lifetime	632	603	596
8.	Investment	83	117	122



System Solution at UMC Ljubljana

Temperature and air humidity

- The indoor temperature in the room is 26 °C
- 50% relative humidity

Sound

- The marginal sound pressure at a height of 1.2m from the floor and 0.9m from the outer wall of the room at medium fan speed is 42 dB(A) or NC 37

Air velocity

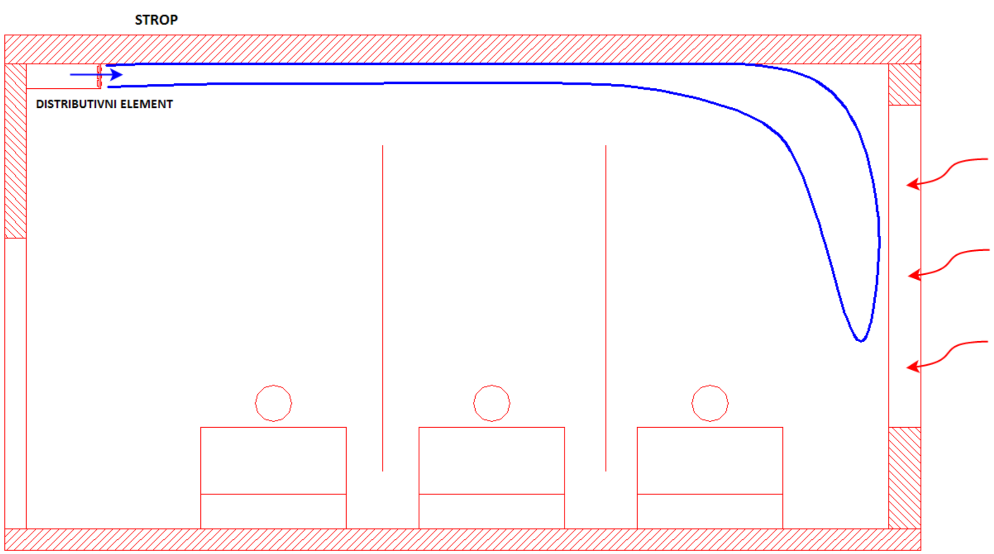
- Air velocity in the habitable zone is below the limit of 0.2 m/s (which the majority of people do not perceive as a draft)
- **Ensured Coanda effect** – the attraction of the stream of cold air to the ceiling of the room by using a highly inductive supply component (local velocities are high enough to provide attraction)
- **High induction** of primary and secondary air, which means a more comfortable temperature field in the habitable zone (no direct entry of cold air into the habitable zone)

Control

- Controlling and setting the system with room controllers that are connected to the central control system (CCS). The settings can be locked or a setting can be used only by authorized users.

Coanda Effect
The Condition for the Effective Distribution

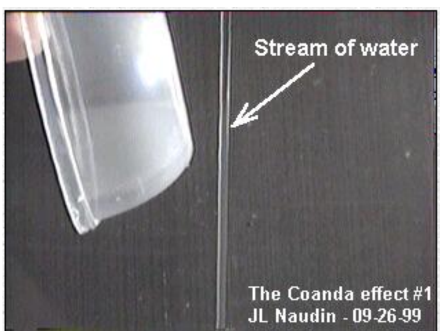
- The Coanda effect is a phenomenon where a liquid follows the surface it is moving against
- In air handling, this phenomenon is expressed as the “attraction” of the flow of cold air to the ceiling
- This phenomenon must be provided by the perfected construction of the distribution component and the proper velocity of exhaustion

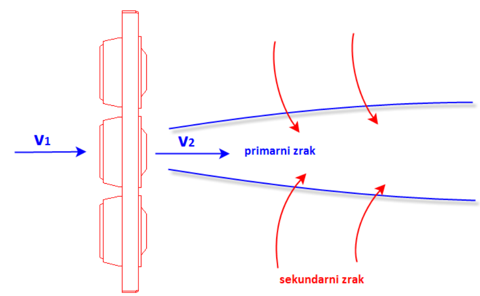


Highly Inductive Distribution Element

- The guaranteed high level of induction of secondary air in the room
- The intensive mixing of primary and secondary air is reflected in a higher average air temperature that reaches the habitable zone
- There is no feeling of draft, even at somewhat higher air velocity

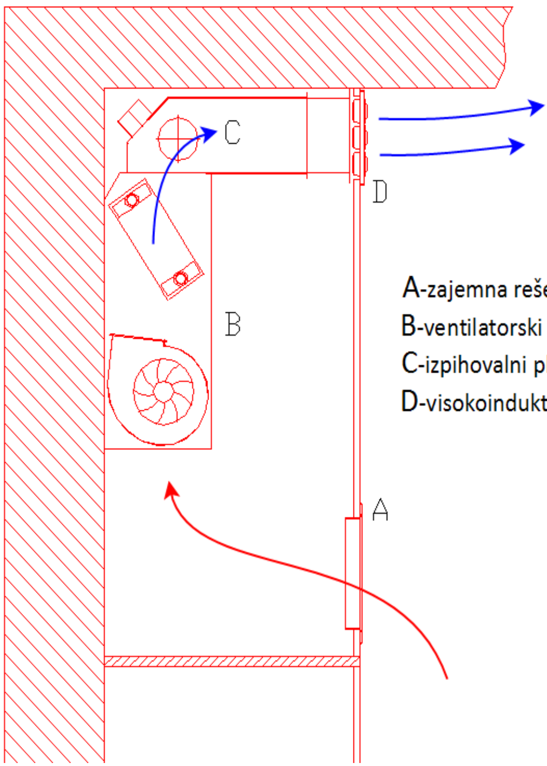
Functioning principle:





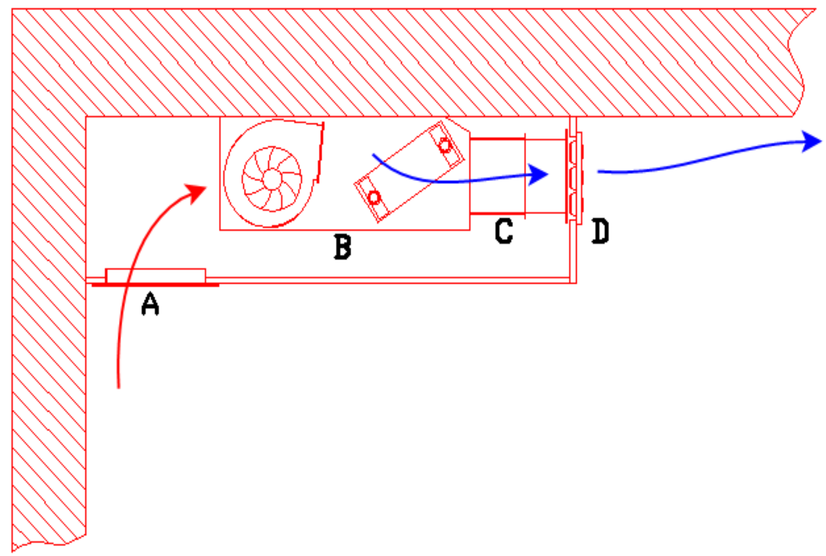
Climmy – operation scheme

Vertical concealed installation



A-zajemna rešetka
B-ventilatorski konvektor
C-izpihovalni plenum
D-visokoinduktivni distributivni element

Horizontal concealed installation



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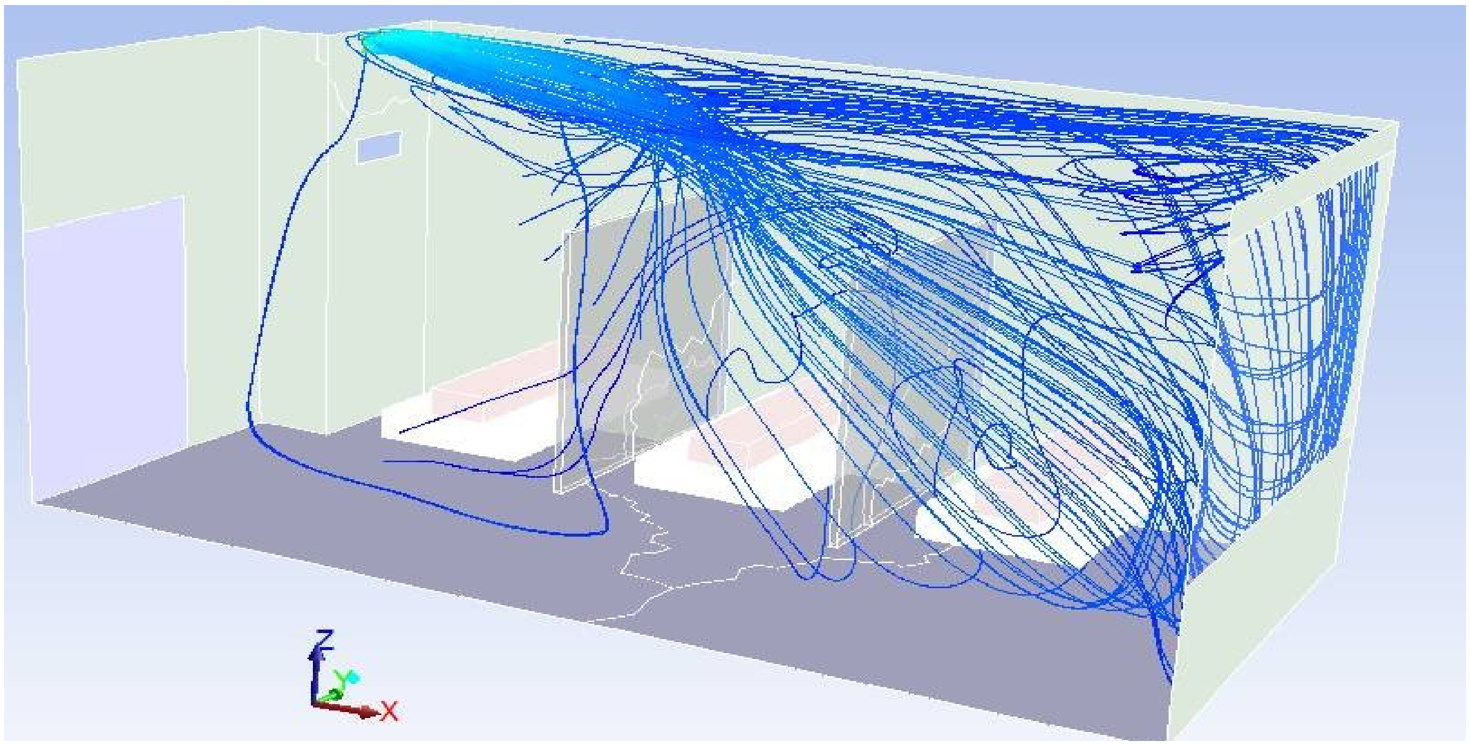
Climmy - CFD Analysis

Simulation of the effectiveness of the envisaged solution taking into account the project requirements



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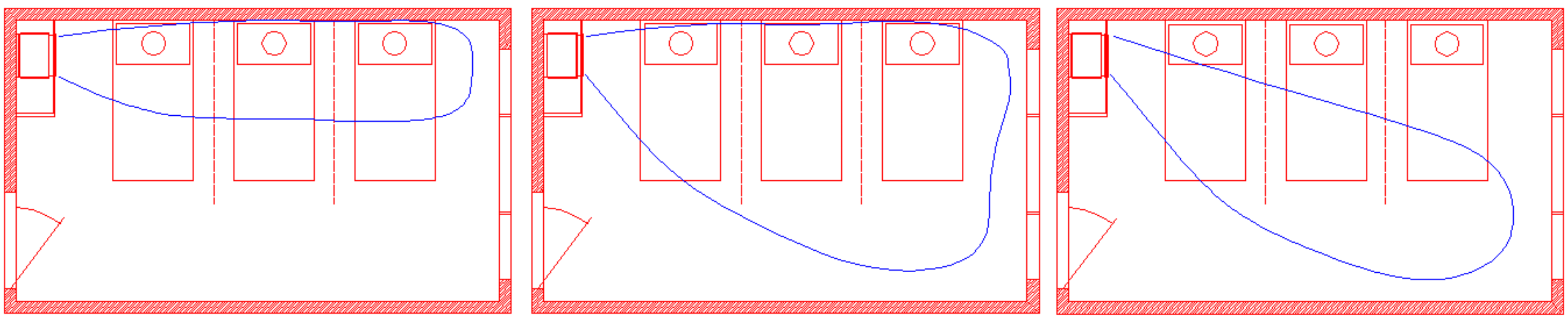
Operation Test in Realistic Conditions

- Installation in a patient room of the main building of the UMC Ljubljana
- Vertical concealed installation
- Intake grille with G1 to G4 air filter
- Exhaust plenum with added connection for supplying fresh air
- Highly inductive component for air distribution with the option of setting the direction of the air exhaustion
- Setting up real operating conditions
- Measurements performed:
  - Air flow at the exhaust from the diffuser
  - Exhaust air velocity
  - Smoke tests for min-med-max fan velocities
  - Air velocities in the habitable zone (velocity field)
  - Sound pressure 1m from the appliance and 1m from the window

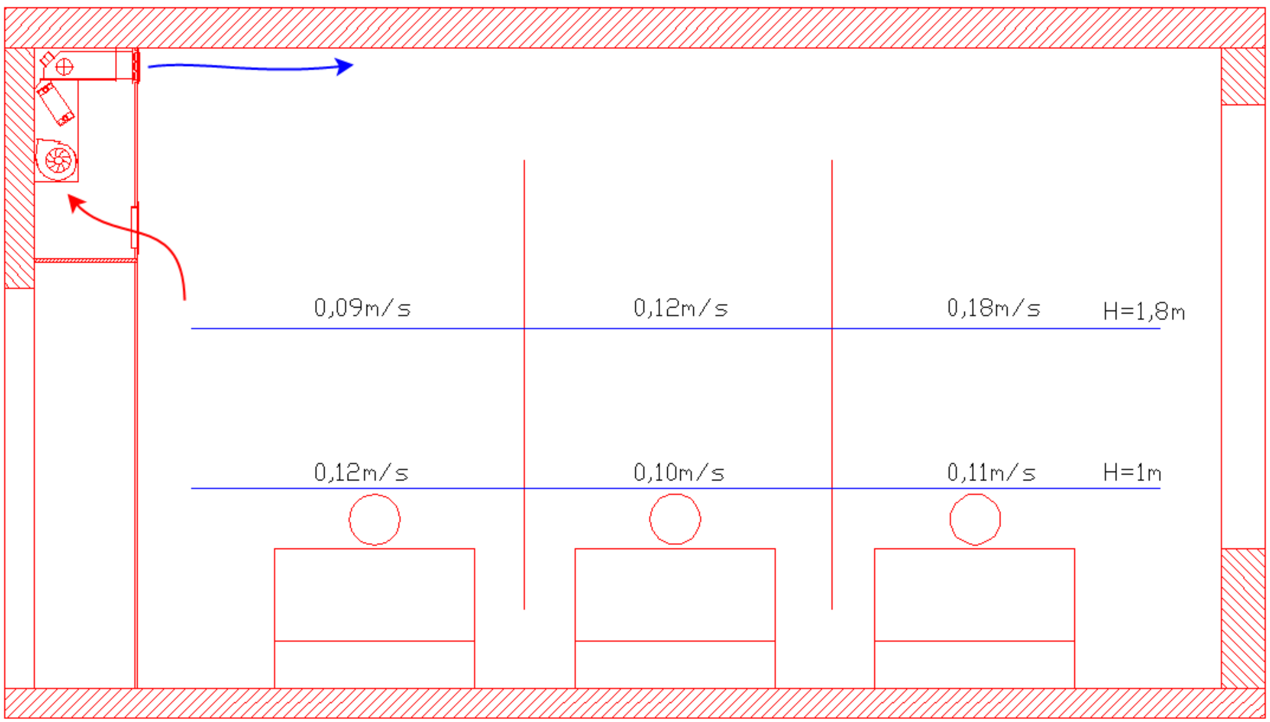
Climmy Coanda – Air Stream Dispersion

- Diffuser construction enables the flexible setting of the direction of the air stream
- Optimum conditions for every individual room



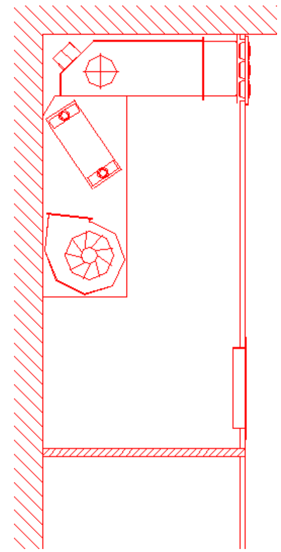
Climmy Coanda – Test Air Velocities

Average values of local velocities of air movement at medium fan speed and the Coanda effect achieved:



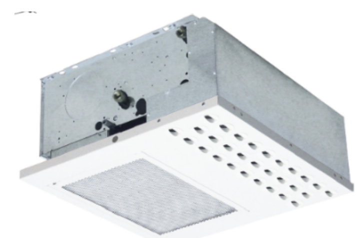
System Comparison

Climmy Coanda, concealed version



- The exhaust component is a highly inductive diffuser → increased output velocity → guaranteed Coanda effect
- High level of induction → higher average air temperature in the habitable zone → no perceived draft
- The option of directing the air stream → individual adjustment of the air stream direction for each individual room
- Optimal velocity field in the habitable zone
- Concealed installation → lower noise level, without intrusion into the habitable room, without substitute installations, optimum utilization of the existing situation
- Adaptability for a system upgrade (energy renovation of the building envelope → integrated ventilation system)

Climmy , Visible version



- The exhaust component is a standard grille → lower output velocity → no conditions for the Coanda effect
- Low induction level → lower average air temperature entering the habitable zone → unpleasant feeling
- Direction of the air stream is not possible
- The option of high local speeds in the habitable zone
- Visible installation → higher noise level, significant intervention into the habitable zone, substitute installations
- Poorer adaptability for a system upgrade →(pre-dimensioned cooling appliances, a separate ventilation system)

System Comparison

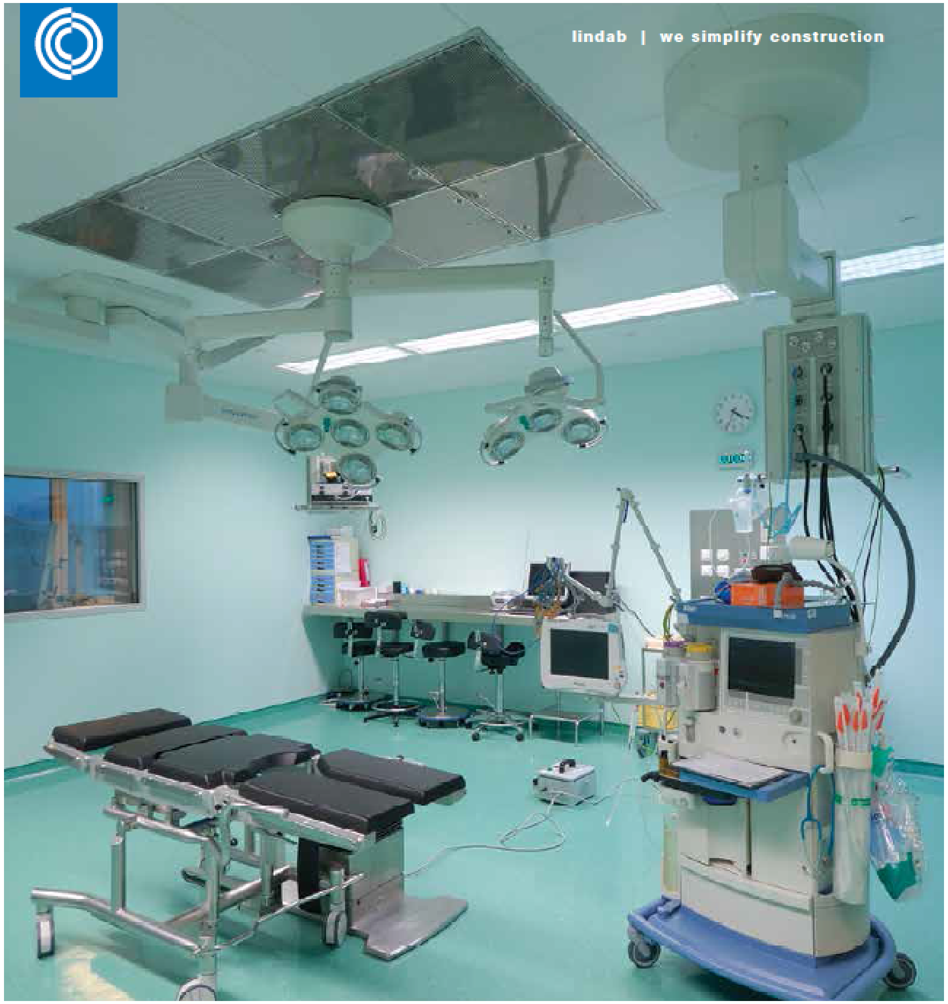
Conclusions:

- For the appropriate or effective cooling of hospital rooms, it is strictly necessary to envisage special solutions with units that provide:
  - the Coanda effect
  - a high level of induction
  - local air velocities in the habitable zone below 0.2 m/s

- Air handling with standard fan coils does not ensure the required comfort for patients and staff and as such is not a suitable solution

- In the event of the energy-related renovation of existing facilities, additional optimization is required due to unfavorable starting conditions. With its laboratories within the framework of the institute, Lindab can carry out a test set-up of the room for various options and, through measurements, determine the best final project solution.

Lindab system solution for OP ceilings

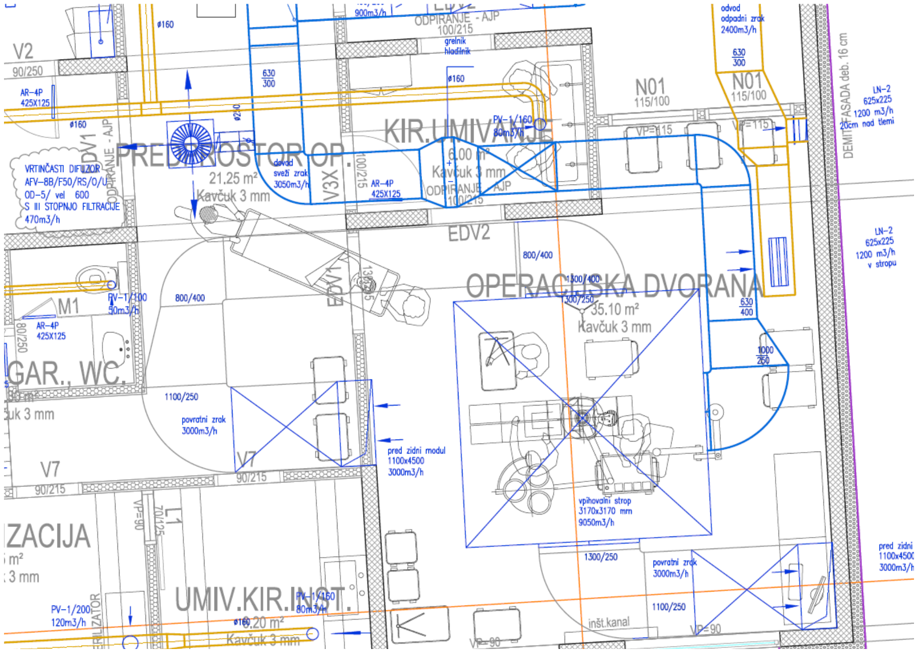


Standards for OP rooms

DIN 1946/4, HTM, SNIP,... - Hospitals

Room Class I(a)	German DIN Dec. 2008	Russian GOST R Since 21.04.2006	UK HTM 03-01 Since 2007
Size of Air Diffusor	3,2 x 3,2 m^2	Min. 9 m2	2,9 m x ,9 m New: 3,2 m x 3,2 m
Recirculation ?	Yes (1.200 m^3/h Fresh Air)	Yes (min. 100 m³/h x person)	Yes (AC/hr 25, min.2700 m³/h fresh air)
Supply air velocity Total Air Volume	≥ 0,23 m/s, 8.800 m³/h	0,24 – 0,3 m/s 9.000-11.000 m³/h	0,38 m/s on 2 m height 11.900 m³/h
Overflow into adjoining rooms ?	Yes, no figure	Yes, no figure	Yes, no figure (close to ceiling recommended)
Air Curtain	2,0 m above floor level	2,1 m above floor level	2 m above floor level
Three stage supply air filtration	Min F5 + F9 + H13	F7 + F9 + H14	G3 + min. F9 + min. H 10
Sound pressure level	≤ 48 dB (A)	Not specified	≤ 55 dB (A)
Acceptance Test	Rate of Turbulence Or Measurements by protection degree	Clean Room Class ISO 5/6	Velocity/Validation

Lindab system solution for OP rooms



Systems for OP rooms-air handling units

Hygienic type air handling units

Hygienic type air handling units (KHN) are applicable in hospitals, food industry, pharmaceutical industry and other clean room applications.

Main features:

- Construction without grooves and sharp edges;
- all functional elements (fans, coils, heat recovery units, humidifiers ...) are easy removable for maintenance, cleaning and service;
- all used elements are corrosion resistant;
- all components and materials are resistant to disinfectants;
- seals are smooth, abrasion-resistant, closed-pore;
- build-in components are tested and recognised as effective in accordance with the list of the Robert Koch Institute (RKI) or the disinfectant media list of the Association for Applied Hygiene (VAH).

The internal panels of the housing are made of painted sheet steel, while the bottom is made from stainless sheet steel 1.4301. On special request the internal panels are available in stainless sheet steel 1.4301.

All external panels are made of galvanised sheet steel, while all the joints between the frame and panels are sealed with clean room application putty.

Tested acc. to:

DIN 1946-4	ÖNORM H6020	SWKI 99-3
VDI 6022-1	ÖNORM H6021	SWKI VA 104-1

Filtration:

- First filtering stage: class M5 filters (compact, bag filters)
- Second filtering stage: class F7 filters (bag or panel filters)
- Third filtering stage: class H13 HEPA filters

The units feature plug-in high efficiency fans, epoxy coated coil frame and fins, run-around coil high efficiency system and dampers for increased tightness requirements (class 4 according to EN 1751). Sound attenuators are made of abrasion-resistant and waterproof material.

Lindab system solution for OP ceilings

Operating theatre ceilings

Supply ceilings with built-in HEPA filters are used for clean rooms where air cleanness as well as intensive air-exchange is required. They are constructed to be built in suspended ceilings of operation rooms, intensive care premises and other clean rooms.

DSS textile version with filters in connection

DSS-N textile version with filters above mask

High laminar air flow unit
DSS ventilation ceiling with polyester textile is used for air supply in clean rooms classified under DIN 1946/4 standards. It is intended to be built into suspended ceilings in operating theatres and intensive care facilities.

DPS perforated version with filters in connection

DPS-N perforated version with filters above mask

Remarkable air quality for OP rooms
DPS with absolute filter is intended for clean rooms, which require clean air, but also frequent air exchange within the working area. They are designed to be built into false ceilings to ensure the laminar flow of the clean air into the target zone, thus reducing the possibility of infection in OP rooms.

*Lindab OP ceiling are designed for type **DPS**:*
*- class **H13** is initial pressure drop 250 Pa ,class **H14** is initial pressure drop 265 Pa*

*Type **DPS-N** ceiling is initial pressure drop of 60 % of nominal airflow (Please check the diagram below) :*

- *class **H13** is initial pressure drop 130 Pa*
- *class **H14** is initial pressure drop 140 Pa*

Conclusion

Zaključak

Mašinski instalacijski sistemi u zdravstvenim objektima obezbjeđuju: grijanje objekata, snabdijevanje vodom i odvod potrošene vode te ventilaciju i klimatizaciju objekata. Za pravilno planiranje i realizaciju, efikasno djelovanje i jednostavno održavanje mašinskih instalacijskih sistema u zdravstvenom objektu je najznačajniji glavni projekat objekta koji mora uzimajući u obzir sve posebnosti pojedinačnih sistema pravilno locirati i dimenzionirati prostore za njihovu djelovanje i obezbijediti dovoljno prostora za njihove vertikalne i horizontalne instalacijske razvode.

Zadatak investitora i projektanata mašinskih instalacija je da uzimaju u obzir međunarodne standarde koji uzimaju u obzir racionalnu potrošnju energije. Pored racionalne potrošnje energije je potrebna i udobnost u prostoru, a veoma značajno je da sa savremenim sistemima maksimalno doprinesemo u smanjenju

bolničkih infekcija koje su veliki problem.

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