

## Indoor air and solutions in special spaces in health care. Construction trends for the sector

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### 1 Importance of clean air in special spaces in health care

Factors affecting the quality of indoor air include the particle quantity, temperature, humidity, pressure as well as movement and flow routes of the air. The importance of the quality of the indoor climate is highlighted in health care facilities. Air quality is the most critical in cleanrooms, such as operating rooms and laboratories, isolation areas and hospital pharmacies.

A cleanroom refers to an isolated area with a special structure, where the indoor climate is subject to exceptionally high hygiene standards, in addition to a number of other factors. The purpose of indoor climate solutions for cleanrooms is to prevent particles from entering the indoor air and to remove particles already in the air, among other things. In these spaces, people are a central source of particles. The human skin sheds 3–15 grams of flakes of dry skin in one day. This equals to as much as 10 million particles. During surgery, the amount of particles shed by, for example, ten people is in the millions. About a fifth of this amount of particles are carriers or causes of infection. The latter are referred to as *colony forming units, cfus*. These cfus, that is, various microbes and viruses, are the most serious invisible enemy in health care cleanrooms. They are able to multiply, form colonies and remain infectious on surfaces, as well as spread to people via either air and/or touch, depending on the particle size. Under favourable conditions, microbes can multiply at a rate of one generation per twenty minutes.

Apart from people, the quantity of particles in the indoor air is affected by the type and quality of staff clothing, pressure differences between spaces, as well as the number of time doors are opened and the time they remain open. In 2012, VTT Technical Research Centre of Finland conducted a survey on air cleanliness in Finnish operating rooms. The survey showed that the hygiene levels in ORs in terms of particle concentration mostly passed the tests when the room was not being used. However, during surgeries, the particle concentration in some ORs rose considerably higher than the target levels. In Finland, unofficial reference values have been defined for particle quantities. A working group of the European Committee for Standardization is currently in the process of defining a Europe-wide standard for ventilation in hospitals.

In operating rooms, air quality is a particularly critical safety factor, since the microbe and particle quantities in the air are known to be the most significant external factor causing infections in the surgery area.

The standards applied to both all particles and pathogens vary by country and by hospital. For example, the New Karolinska Solna hospital in Stockholm has set the limit value of its operating rooms to <5 cfus/m<sup>3</sup>, while in most national standards, the limit value is <10 cfus/m<sup>3</sup>. Halton's solutions for operating rooms (with a patient and a staff of ten people) make it possible to achieve a level of <5 cfus/m<sup>3</sup>. In the operating room built

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in Halton's product development facility, measurements conducted in simulated surgeries have provided levels as low as 0 cfus/m<sup>3</sup>.

The quality of the indoor climate is an important component of preventing hospital infections. The existence of drug-resistant microbes also highlights the importance of a hygienic indoor climate. It is estimated that one in five treatment-related infections is contracted in the operating room, and the risk of an infected patient to die is more than double the risk of a patient who is recuperating normally.

In studies, the number of deaths caused by hospital infections is estimated to be in the same range as deaths caused by traffic. (Source: Fedotov, Aleksander 2010. Clean Rooms and Clean Zones in Hospitals. VTT Symposium 266, pp.177–178)

“Air is also an essential medium in the spreading of various microbes and antibiotics-resistant bacteria in operating rooms. In the operating room conditions, eliminating nearly all potential causes of infection is imperative,” says **Kim Hagström**, Halton's Director, Offering and Development.

However, many surgical procedures are also performed outside operating rooms, although they, too, are associated with a considerable infection risk.

“For example, radiological examinations requiring minor surgical procedures are on the increase. Nevertheless, these operations are performed in areas designed for imaging, where infection risks are higher than in the operating room,” Hagström points out.

Other examples of surgical procedures performed outside operating rooms include minor skin surgeries as well as smaller procedures on lower extremities when treating injuries caused by accidents, for example. For these situations, Halton offers mobile indoor climate solutions (please see the next chapter).

“Clean indoor air could be one of the motivators for hospitals in the battle against hospital infections and resistant hospital bacteria. It would offer a win-win situation for both patients and the society,” Hagström says.

## 2 Halton Vita – a range of solutions to be introduced on 2 June 2015

The Halton Vita product family includes **comprehensive indoor climate solutions for health care spaces** with four ranges of special products. Illustrations are provided at the end of this article and can be downloaded using the associated links.

- 1) **Halton Vita OR** (Operating room solutions). The solutions can be used to provide three kinds of clean environments in the indoor climate, in accordance with the special requirements of operating rooms and the applicable standards:
  - a. **Halton Vita OR Space** is a clean air solution for the entire operating room.
  - b. **Halton Vita OR Zone** creates a local clean zone in the indoor climate of the operating room.
  - c. **Halton Vita Cell** creates a mobile, clean micro climate locally on the operating table or instrument table. This solution can be used to implement local clean climates in operating rooms, increase the level of local hygiene in old operating rooms, or create a local clean climate required by the surgical procedure to protect the wound area or instruments, when an actual operating room is not available.
- 2) **Halton Vita Iso** Indoor climate solutions for patient isolation rooms as part of solutions for general patient areas.

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- 3) **Halton Vita Lab** Energy-efficient and comprehensive indoor climate solutions for laboratories; suitable for use in research, production and teaching in health care, pharmacies and the industry.
- 4) **Halton Vita Apo** Indoor climate solutions for hospitals' internal drug production areas ("hospital pharmacies").

In addition to the Halton Vita product family, Halton also offers an extensive range of indoor air solutions and products for hospitals and health care facilities, such as chilled beams, smoke and fire safety products, systems for general ventilation as well as comprehensive ventilation solutions for professional kitchens.

### **3 Halton to provide the indoor climate solutions for the operating rooms of the New Karolinska Solna hospital in Stockholm**

Halton will supply the New Karolinska Solna (NKS) hospital with indoor climate solutions utilising Halton's latest technology for the hospital's all 40 operating rooms. The hospital will start operations in 2016, and the construction will be finalised in 2017. It will be the largest hospital in the Nordic countries, equipped with state-of-the-art medical technology. Traditionally, the ventilation of operating rooms has been provided by means of laminar or turbulent ventilation (see the illustrations at the end of this document). Halton's new solution combines the best properties of both turbulent and laminar ventilation. The new solution helps meet the requirements concerning air cleanliness with reasonable air volumes, which also reduces draught and energy consumption.

"We conducted studies on the impact of ventilation on air quality in operating rooms in Halton's innovation centre in Kausala in cooperation with experts from Sweden. We built an operating room and used it to test the functioning of ventilation and the air cleanliness level both in an empty space and in simulated surgeries with staff. The new solution enabled us to minimise the amount of harmful microbes and particles in the OR," says **Ismo Grönvall**, Halton's product manager (health care).

"Halton's research centre was founded in 1984, and we now have unparalleled experience in operating room research. Together with experts from Sweden, we have been developing an operating room, which meets the hygiene standards of the future and which complies with the technical reference values set by the Swedish Standards Institute," Grönvall says.

The objective of the NKS hospital is to provide patient-oriented care with patient safety, privacy and comfort as a priority. The construction project also aims to obtain the *LEED Gold (Leadership in Energy and Environmental Design)* and *Miljöbyggnad Gold* environmental certificates for the hospital.

The planning of the New Karolinska Solna hospital began in 2005. Halton signed the agreement on the actual solution delivery with the Skanska construction group in 2014, and also started more detailed design work on the operating rooms with the NKS hospital.

### **4 Key trends in hospital construction**

#### **Trends:**

**Cost effectiveness and energy efficiency of operations** The costs in the health care sector are increasing as treatment options and technology become more advanced and the population ages. This situation is forcing the sector to streamline operations and optimise the use of resources. In addition to cost effectiveness, there is pressure to improve energy efficiency.

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**Increasing the level of hygiene in hospitals** Preventing the spreading of resistant microbes. The need for cleanrooms is increasing as surgeries utilising the possibilities offered by radiology are becoming more common outside operating rooms and new infectious diseases are entering hospitals.

**Building planning, space efficiency and logistics** Hospital construction is an investment with a long-term impact, which is why the focus is on the entire life cycle of the building. Construction takes into consideration factors which extend the building's economic life, such as the quality of construction, well-being of those using the building, and the adjustability of the building to new needs over time.

A key aspect: facility design from the perspective of the operations, distances and specific requirements of different spaces (e.g. cleanrooms). This will eventually affect the costs of use, since the end result will support the work of staff and the patients' quick recovery in the best possible manner. Traditionally, the cost of investing in building a hospital more or less equals the operating costs of one year.

**Patient-orientation** covers the patient's personalised care, privacy and therapeutic environment as well as the availability of care personnel according to the patient's need.

**Environmental consciousness and Regenerative Health Care** Sustainable values are the guiding principles throughout the operations. Minimising the environmental impacts of the use of energy and chemicals and handling of waste, for example.

"The focus is increasingly shifting towards functional design. A hospital is not primarily a building but part of the health care service system. Therefore, designing the hospital must also start with planning the services, functional entities and processes. The facilities will support the operations." (Tekes: Final report, 12 June 2014)

### Building health care in Europe in the coming years

Approximately EUR 20 billion is invested in health care sector buildings at the entire European level annually.

### Investments in health care buildings in Europe (MEur)

BUILDINGS FOR HEALTH <small>(million euros at 2013 prices)</small>				Estimate	Forecasts		Outlook
Country / Year	2011	2012	2013	2014	2015	2016	2017
Austria	819	839	869	898	907	920	949
Belgium	241	279	296	295	291	313	336
Denmark	317	313	329	345	432	540	647
Finland	353	473	493	648	648	587	562
France	5119	5389	4818	4536	4579	4625	4658
Germany	1781	1719	1710	1753	1780	1780	1762
Ireland	316	307	320	335	337	488	588
Italy	809	819	828	843	856	878	901
Netherlands	2013	1894	1689	1616	1697	1815	1958
Norway	338	380	412	543	788	681	681
Portugal	593	581	488	478	488	502	522
Spain	628	549	460	428	406	406	421
Sweden	105	363	424	402	338	297	311
Switzerland	464	559	619	667	734	735	738
United Kingdom	5053	4487	4302	3906	3813	3813	3889
<b>Western Europe (EC-15)</b>	<b>18948</b>	<b>18950</b>	<b>18056</b>	<b>17694</b>	<b>18093</b>	<b>18378</b>	<b>18920</b>
Czech Republic	354	364	182	225	266	290	308
Hungary	131	78	80	84	88	90	94
Poland	718	752	676	703	729	740	740
Slovak Republic	86	75	70	90	90	95	100
<b>Eastern Europe (EC-4)</b>	<b>1288</b>	<b>1270</b>	<b>1008</b>	<b>1102</b>	<b>1173</b>	<b>1215</b>	<b>1242</b>
<b>Euroconstruct Countries (EC-19)</b>	<b>20236</b>	<b>20220</b>	<b>19064</b>	<b>18796</b>	<b>19266</b>	<b>19593</b>	<b>20162</b>

(Source: Euroconstruct, November 2014, p. 61)

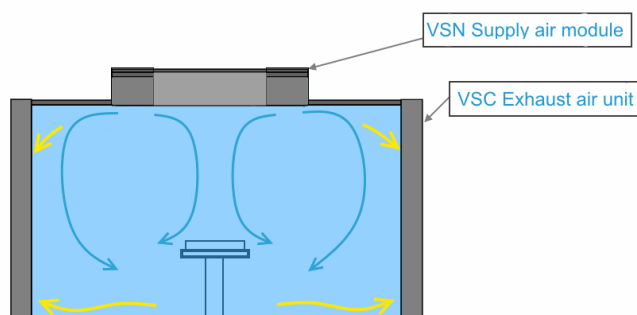
## 5 Halton has decades of experience in the special demands of hospitals and laboratories

Halton has delivered various ventilation solutions for hospitals, including chilled beams for patient rooms, to a number of hospitals in the Nordic countries, as well as in England, the Netherlands, France, Belgium, Italy and Poland.

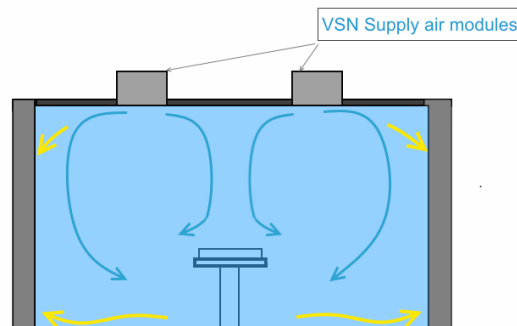
Almost without exception, hospitals also have laboratory facilities, which require special expertise due to their ventilation requirements and needs. In addition to hospitals, there are laboratories in a number of other areas, such as the industry, research and development as well as universities. Halton has been supplying laboratory solutions for these areas for nearly 30 years and established a strong presence in France and Poland, among others. Halton's important clients include the Grenoble Biology Institute, Gdansk University, L'Oréal, Total, Coca Cola and Danesco.

## 6 Illustrations and stock photos

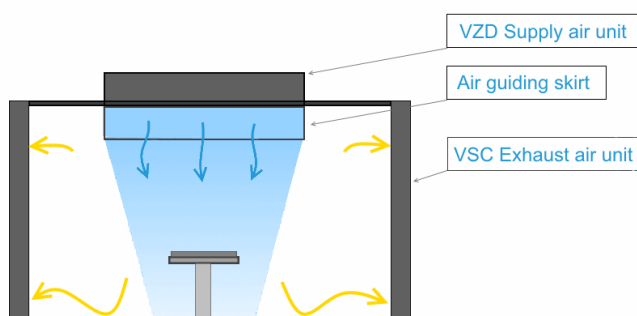
The pictures can be downloaded as separate files on the press service page.



Above: Halton Vita OR Space



Above: Halton Vita OR Space



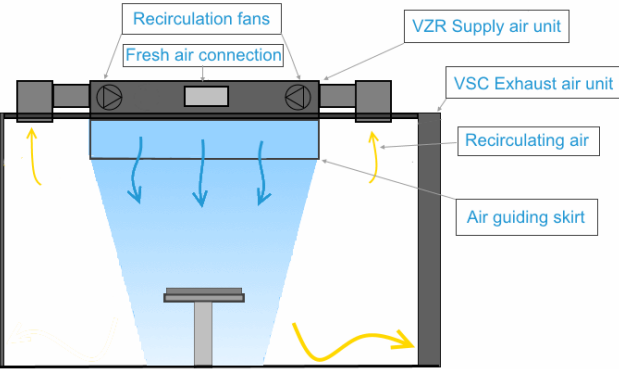
Above: Halton Vita OR Zone



Above: Halton Vita OR Space; a photo of the operating room in Halton's innovation centre in Kausala.



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Above: Halton Vita OR Zone



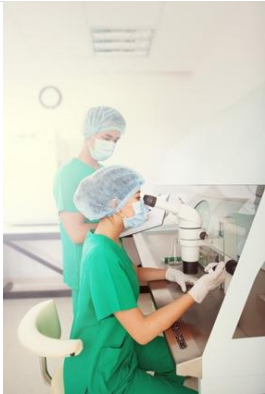
Above: Halton Vita OR Zone in a photo



Above: Halton's Ismo Grönvall with the Halton Vita OR CELL Patient (VCP) solution for protecting the patient's wound area.



Above: Halton Vita OR CELL Instruments



Above: Halton Vita Lab, stock photo



Above: Halton Vita Apo, stock photo



Above: Halton Vita Lab Solo