

Modular operating rooms

Sundsvall Regional Hospital



New surgical centre

The purpose of the new modular operating rooms was to provide practical, purpose-built and attractive premises that would help to improve surgical services. Seventeen operating rooms required renovation and 14 new rooms would be added, including a new, 105-square-metre hybrid operating room and a converted operating room for emergency caesarian sections. The new Surgical Centre also includes a sterilization centre and goods reception, and the existing surgical building has been extended by 5,000 square metres. Emphasis was placed on creating an attractive workplace and a good working environment for staff.



Background

The existing surgical department was opened in the mid-1970s. The premises were in disrepair and could not meet modern demands for accessibility, hygiene and working environment. Many of the installations had also reached the end of their technical lifespan.

In autumn 2013 a preliminary study was carried out to draw up new proposals for a Surgical Centre that would allow premises to be updated and equipment brought up to a standard that would safeguard its performance for many years.

The preliminary study was well received and local government approved further planning in February 2014. Preparatory work went ahead in 2014 and this led to a new decision in February 2015 to continue with project planning, procurement

and implementation of the project. During this period the architects consulted with Ecophon's concept developer for care applications and the sales team to get advice on how to create a good sound environment and meet all the acoustic and hygiene requirements. The emphasis was on creating practical environments that would be compatible with long-term thinking on environmental and energy resources, combined with careful selection of technical systems and durable materials. The surgical premises were intended to be light and pleasant, and meet modern requirements for accessibility, hygiene and the working environment. It was also important to ensure the efficient movement of supplies and people to facilitate effective care.

New requirements for operating rooms

The new operating rooms are significantly larger than previously in order to accommodate the technical equipment that is needed today. Between the operating rooms are scrub rooms where preparations are made for surgery. One of the new operating rooms is a hybrid room that combines a traditional operating room and advanced X-ray equipment. The operating rooms can be adapted to suit both admitted patients and the increasingly common day surgery treatments (operations after which the patient can go home the same day).

Improved flow

The conversion and extension work has provided operating rooms that can be used much more efficiently. New premises are provided for the sterilization service in order to provide the best possible service (delivering prepared trolleys with the right equipment for each operation). This allows more operations to be carried out, which reduces waiting times and improves safety for patients.

Targets

- Create practical, future-proof and attractive premises that contribute to improved surgical services
- A combination of general operating rooms and hybrid room (operating room with high-tech X-ray equipment) and a room for caesarian sections
- Incorporate flexibility and facilitate future changes in services
- Create an attractive workplace and a good working environment
- Promote collaboration and communication
- Encourage involvement, team spirit and a positive experience for all staff
- Optimize benefit from invested capital
- Cost-effective and energy-efficient construction to ensure low running costs and long-term management
- Maintain current services without endangering patient safety

Sound measurement

For this project the client chose a complete package solution for the operating rooms, based on a modular solution that permits a high level of flexibility in response to future changes in services. All technical installations were carefully planned so that they could be integrated in the wall modules, which were then assembled on site. All technical installations and screens that are traditionally mounted on the wall are integrated in the modular units! This permits maximum use of space, as well as smooth surfaces and joints (silicone-sealed) that are practical and hygienic. Modules can easily be removed when there is a need to replace technical equipment. The visual impression of rooms is very attractive and they are perceived as clean and aesthetically pleasing.



Operating rooms 9 and 11

There is however one disadvantage to the modular solution: all the surfaces in the room, including the floor, walls and ceiling, absorb very little sound and thus impact negatively on the sound environment! This is because the modules are constructed from glass and metal, which instead contribute to a long reverberation time! According to Swedish Standard 25268 the reverberation time in operating rooms should not exceed 0.6 seconds. In bare form, without any further acoustic measures, the value for the modules is around 2.0 seconds (depending on room volume). The sound level in operating rooms can be especially troublesome, and research shows that it can affect the ability of staff to hear instructions correctly, as well as their perceived stress level and well-being. Peak sound levels can reach 110 dB when saws and drills are in use.

Solution

To create a good sound environment that would comply with Swedish building standards, it was therefore decided to replace the modular ceiling with sound-absorbing tiles meeting absorption class A (ISO 354, ISO 11654). Absorption class A is the highest grade and thus provides very effective sound absorption. The product chosen was Ecophon Hygiene Performance™, with a thickness of 40 mm. This is used to cover the entire ceiling area, with the exception of the laminar air flow ceiling, pendants and lighting, which gave a coverage of approximately 80 per cent of the ceiling area. No sound absorbers were mounted on the walls. The Performance tiles were installed in the existing grid from the module manufacturer.

Ecophon Hygiene Performance™ is a glass mineral wool with a coating of Akutex™ TH that can withstand daily dusting and vacuuming, wet wiping once a week, steam cleaning four times a year and low-pressure washing twice a year. It is resistant to disinfectant chemicals and hydrogen peroxide vapour, which makes it an excellent choice for operating rooms.

Ecophon Focus™ E and Ecophon Focus™ A were selected for all other surfaces.



Operating rooms 9 and 11

Acoustic measurement

To ensure compliance with acoustic requirements an independent acoustician was contracted to measure reverberation time and two further parameters that describe the perception of the sound environment in greater detail.

The measurements were carried out by Kristian Orellana from LN Akustikmiljö, on 29 March 2017 in operating room 9. Measurements were made using Room-Capture software. The results were evaluated using Room-Capture and by manual calculation on data exported from the software. Microphone: B&K 4006, serial no.: 1498468.

The room acoustic parameters were evaluated according to ISO 3382. The early decay time (EDT) is shown in the same graph as the reverberation time, since it correlates more closely with what we actually hear in a room than the T_{20} reverberation time.

Operating room 9, 65 m²

For an operating room, the average **reverberation time (T_{20})** between 250 Hz and 4,000 Hz according to Swedish Standard SS 25268 should be ≤ 0.6 seconds. The average measured value was 0.7 seconds. T_{20} is expected to drop slightly when all the equipment is in place. T_{20} also drops when people are in the room. Overall, the measurement may be considered to comply with the Swedish Standard.

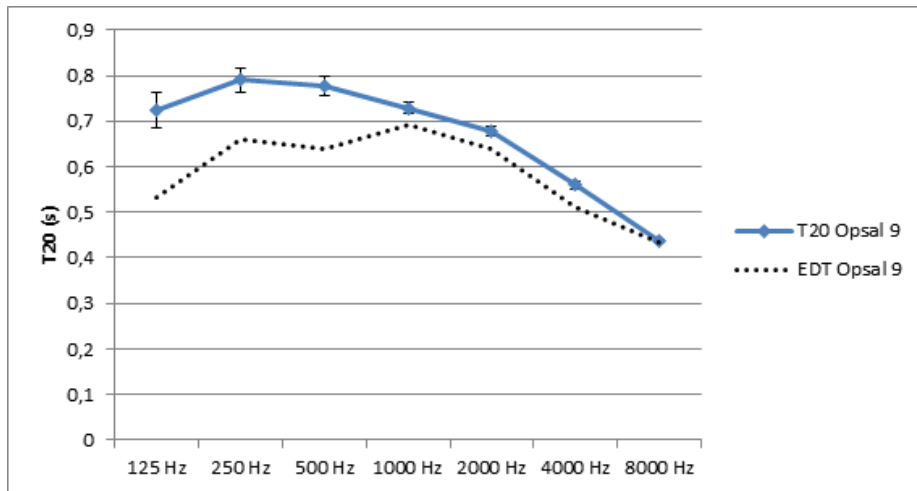


Figure 1: Reverberation time and EDT for operating room 9. Average values and standard deviations are shown for T_{20} . Average values are shown for EDT.

Speech clarity (C_{50}) is not a requirement in SS 25268, but we were interested in finding out how spoken communication in the operating room would be affected, so this measurement value is also reported. Speech clarity has an A-weighted sound level of 5.6 dB, which is close to what is usually aimed for (between around 6 and 10 dB) in a room where spoken communication is important. The operating room has a relatively high speech clarity at the higher frequencies that carry consonant sounds, which are important for speech perception. C_{50} is expected to rise slightly when people are present in the room. This is consequently an excellent result.

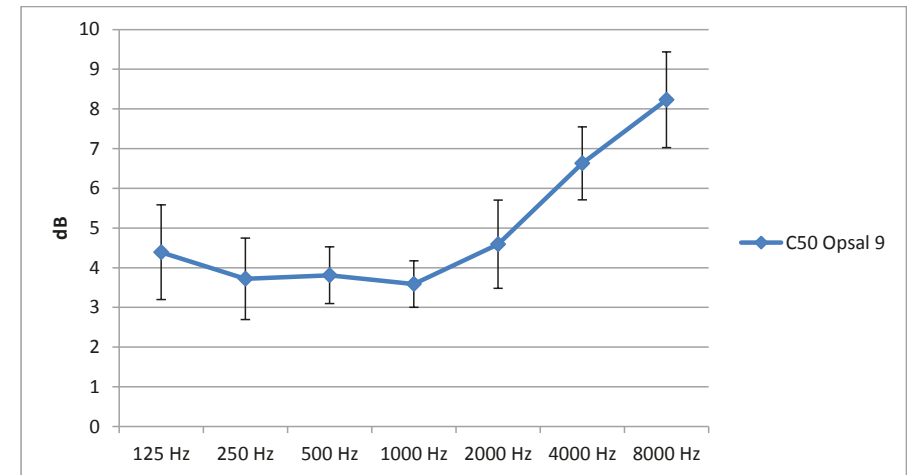


Figure 2: Clarity in operating room 9. Average values and standard deviations are shown for C_{50} .

Hybrid operating room 10, 105 m²

The hybrid operating room was given the same treatment, with a 40-mm-thick absorbent ceiling of Hygiene Performance™. This improvement alone was not sufficient, however, resulting in a reverberation time of 0.9 seconds, which is far too high. In a conventionally built operating room we would normally have added wall panels to reduce this value, but in this case it would have gone against the integrated modular approach to start screwing panels to the walls. We chose instead to add further absorption above the ceiling tiles.

Extra Bass™ with a thickness of 50 mm was installed loose above the ceiling tiles over an area of around 100 m². It consists of a glass wool core that is enclosed in a micro-perforated plastic film. This allows easy placement above the ceiling

tiles, since it can be bent to fit into tight spaces and even be stacked in layers. Extra Bass™ is especially effective at absorbing low bass frequencies and is often used in classrooms to improve speech perception for teachers and students.

The acoustician carried out a repeat measurement in the hybrid operating room, which showed that the reverberation time had now dropped to the threshold value of 0.6 seconds! This was a considerable reduction for a relatively simple measure.

In the first measurement we see that the reverberation time shows a sharp peak just above the critical frequencies of human speech, (blue curve in Figure 3). After adding Extra Bass™, the curve (red in Figure 3) is more uniform across the frequency spectrum and the sharp peak has been flattened out. This will improve the sound environment for operating staff in the room very markedly. The reverberation time now complies with SS 25268.

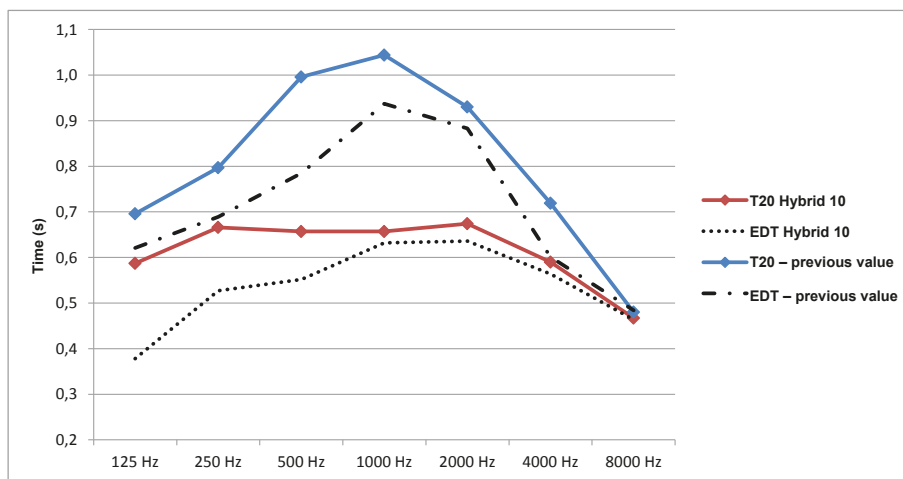


Figure 3: Reverberation time before (blue) and after measure (red), hybrid operating room

We also see a clear improvement in speech clarity (C_{50}) after the addition of Extra Bass™. The average value of C_{50} between 125 and 8000 Hz is now 5.6 dB, which is an improvement over the first measured value of 4.8 dB before the additional measure was taken. (Figure 4). The value that is usually aimed for to ensure good speech clarity is 6–10 dB.

However, the curve is still not completely flat and shows a clear dip at 1000 Hz, the frequency at which most of the information in speech is carried by consonants. This is largely due to the presence of a flutter echo in the room. Flutter echo does not affect the sound environment in the hybrid operating room when it is in use, since the staff and equipment will interrupt the sound waves and prevent this phenomenon.

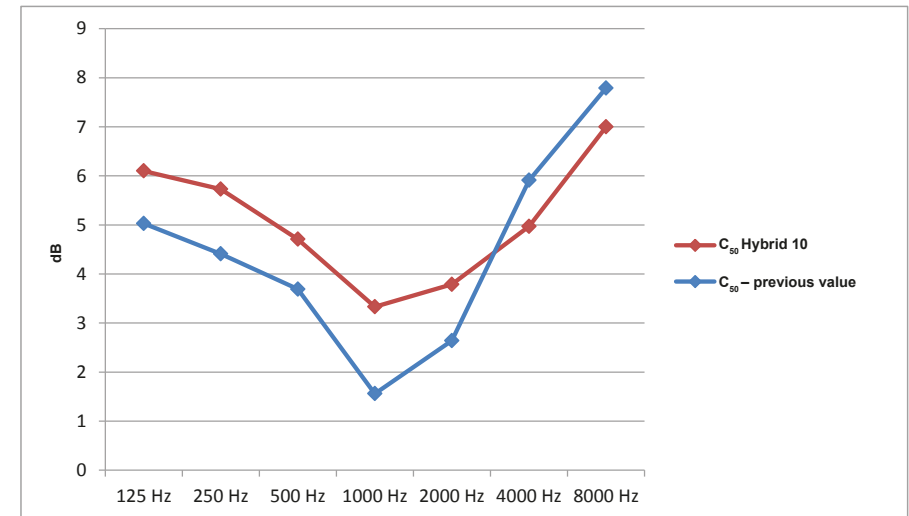


Figure 4: C_{50} before (blue) and after measure (red), hybrid operating room



Hybrid operating room 10, 105 m²

Conclusions

All operating rooms comply with SS 25268 and the sound environment is therefore likely to be perceived as very good! It is worth noting that we chose a thicker tile than normal, as a 20 mm tile would not have met the limit values. We are very pleased that speech clarity is also improved, which will make the work of the surgical team easier. Hybrid operating rooms are likely to need additional measures and more absorption due to their larger dimensions. We also encourage the client to give special consideration to the sound environment in the break rooms, since being able to recover in a relaxing sound environment is important for staff.

The surgical centre was ready for use in April 2018, on schedule, and feedback from contractors, the client and staff has been very positive! Light, practical and easy-to-use operating rooms with a good sound environment create a very attractive workplace that puts people first!

Our environmental labels



EPD

To help you compare the environmental performance of different products, Ecophon has produced third-party verified environmental product declarations, or EPDs. These provide information about CO₂ emissions, energy consumption, percentage of renewable energy used, etc.

You can find the documents on our website, www.ecophon.se.

French VOC, A+

All our products that contain 3rd generation glass wool meet the highest certification level: A+ (i.e. extremely low emissions of VOC and formaldehyde).

M1

M1 is the highest class that can be achieved in the Emission Classification of Building Materials, which measures emissions of various irritant substances.

Danish Indeklima label

The Danish Indeklima label focuses on substances in building materials that are potential allergens or irritants.

The Swedish Asthma and Allergy Association

The Swedish Asthma and Allergy Association assesses products for the presence of allergens, perfumes and irritants.

California Emission Regulation

The California Emission Regulation standard is the most widely used US standard for evaluating building materials and VOC emissions.

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