NHS Estates Technical Bulletin (NETB) No. 2026/1

Generating energy efficiency savings through controlling theatre ventilation

Date of issue: 20 July 2026

Applicability
This NETB applies to all healthcare settings with operating theatres.
Objective Building on the foundations set out in HTM03-01, the NHS estates community has an extraordinary opportunity to deliver measurable impact at scale. If every team takes simple steps such as implementing overnight and weekend HVAC setback and switch-off strategies, we can collectively unlock transformative efficiency savings. Evidence shows the NHS collectively could save between 132 and 286 MWh of energy per operating theatre each year, equating to annual savings of over £43 million with the potential for more savings, depending on current measures in place. To seize this opportunity, we are asking every estate team in England to act now and implement the recommendations in this guide. Real-world examples reinforce this potential and align closely with modelled estimates. While outcomes will vary by context, the scale of opportunity is clear and achievable. Implementation costs range from zero for simple schedule changes, to a few thousand pounds for full smart theatre and BMS integration, but the return on investment is undeniable. If everyone plays their part, these changes will not only cut costs but also, strengthen resilience, reduce carbon and demonstrate the power of collective action across the NHS estate

Publication reference: PRN02301

Status
The information contained within this bulletin is a supplement to the current Health Technical Memorandum 03-01: Specialised ventilation for healthcare premises, and it should be read in conjunction with this document. It does not change any guidance in the extant HTM guidance.
Content
This NETB aims to assist NHS providers in optimising the usage of heating, ventilation and air conditioning (HVAC) systems in operating theatres, to improve efficiency, in turn, making environmental and financial savings without compromise to infection prevention control requirements for operating theatres. It supports NHS providers to implement a site-specific strategy for turning down or switching off HVAC systems for periods of time where the operating theatre is not in use. The intention is to act as a guide and not a set of instructions as all sites and requirements differ. This NETB should be implemented with oversight and support of the trust Ventilation Safety Group (VSG) considering the technical and clinical nuances of each individual site. Technical changes should only be undertaken by competent, qualified staff or third-party providers with the appropriate knowledge and skill. Although not covered in this document, other spaces that require high ventilation such as endoscopy should also be considered for energy efficiency improvements in collaboration with the VSG.

NHS Estates Technical Bulletin (NETB)

With responsibility for producing Standards and Guidance for the NHS Estate, we are responsible for ensuring that the information and guidance they contain remains up-to-date and relevant for users.

This can involve revising and updating the documents themselves, but this is not the optimum approach in all cases and therefore an alternative approach is needed where such full revision is not appropriate. Where appropriate, NHS Estates Technical Bulletins (NETB) will be issued instead.

NETBs need to be considered by all applicable organisations, as noted above, and implemented as required. Boards are responsible for its assessment and application to their organisations.

Background

This NETB supplements existing guidance related to switching off or setting-back theatre ventilation systems drawing from sources such as the Health Technical Memorandum 03-01: Specialised ventilation for healthcare premises, the Royal College of Surgeons Intercollegiate Green Theatre Checklist. and the Green Surgery Report.

Monitoring of implementation

This NETB will be monitored in line with overall compliance to the HTM's and HBN's.

Point of contact/feedback

For any queries, please contact the estates and facilities mailbox.

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Executive summary

Building on the foundations set out in HTM 03-01, the NHS estates community has an extraordinary opportunity to deliver measurable impact at scale. If every team takes simple steps such as implementing overnight and weekend HVAC setback and switch-off strategies, we can collectively unlock transformative savings. Evidence shows the NHS could save between 132 and 286 MWh of energy per operating theatre each year, equating to annual savings of over £43 million[1] and potentially far greater, depending on current measures in place.

To seize this opportunity, we are asking every estate team in England to act now and implement the recommendations in this guide. Real-world examples reinforce this potential and align closely with modelled estimates. While outcomes will vary by context, the scale of opportunity is clear and achievable.

Implementation costs range from zero for simple schedule changes, to a few thousand pounds for full smart theatre and BMS integration, but the return on investment is undeniable. If everyone plays their part, these changes will not only cut costs but also, strengthen resilience, reduce carbon and demonstrate the power of collective action across the NHS estate

The current HTM 03-01 provides guidance that operating theatre ventilation systems could be switched-off or set-back when not in use however, this is not widely implemented. Co-created by engineers and clinicians, this technical bulletin serves as practical guidance to support the adoption of the existing HTM 03-01 in relation to ventilation switch-off or set back.

There are significant energy efficiency savings to be gained by implementing operating theatre HVAC switch-off or set-back protocols when theatres are not in use, resulting in both environmental and cost benefits. The operating theatre is three to six times more energy intensive than other parts of the hospital, with HVAC demands comprising of around 90% of the total operating theatre energy consumption. The approximate energy savings can be calculated using a formula that considers the influence of the period of operation on the total energy costs by calculating the fractional time that the air handling unit (AHU) is in full operation and in off / set-back mode.

[1] Calculated using the lower energy-saving limit in Table 1. The potential saving is derived as the difference in cost (£000) between a conventional theatre at full power (mixed energy, heat recovery $\alpha = 0$) and conventional theatre with evening setback (mixed energy, $\alpha = 0$), multiplied by 3,300 theatres. Energy saving data from Eames et al., (2025) Towards NetZero for hospital operating theatres. The number of theatres (~3,300) is taken from NHS correct as of 28th of August 2025 from NHS England Supporting Facilities Data.

Airborne contamination in operating theatres originated from the people present within them during use and theatre ventilation is provided to cater for this “in use” biological load. When the theatre is not in use, there is no biological source so the ventilation can be switched-off or set-back. The time taken to start the ventilation and achieve full operating conditions in an emergency will be less than the time taken to bring a patient to theatre and prepare the staff and instruments ready for emergency surgery to commence (estimated to be under 30 minutes).

Each operating theatre is different, and site-specific decisions should be made based on clinical use, and technical requirements. Each site should develop a project team, utilising appropriate project management, planning, governance and a multidisciplinary team approach supported by the executive leadership team, and engagement with the Ventilation Safety Group (VSG).

Several theatre ventilation control strategies are available, including basic timed switch-off, advanced timed systems with overrun functionality, and occupancy sensor-based approaches. Regardless of the strategy used, it is essential that theatre panels clearly display the ventilation status, and that minimum environmental standards are maintained. Care must be taken to avoid drawing air from adjacent spaces into the theatre during switch-off periods, and the temperature should be maintained between 16-25°C.

Key Recommendations

Initial Actions:

- Develop the case for change by estimating energy savings.
- Identify or establish governance structures including executive leadership and a Ventilation Safety Group (VSG).
- Form a multidisciplinary project team with clinical, technical, and sustainability representatives.
- Conduct an audit based on clinical use and technical requirements.

Operational Strategies:

- Implement basic timed control, advanced timed control with overrun, or occupancy sensor-based systems.
- Ensure theatre panels clearly display ventilation status.
- Maintain environmental conditions between 16°C and 25°C during off periods.

- Conduct annual verification of ventilation systems and ensure pressure cascades meet design tolerances.

Developing the case for change

1. Current guidance

Current guidance on switching off theatre ventilation systems from HTM 03-01 – Specialised ventilation for healthcare premises

Summary of Energy efficiency (Part B 19 – 20), please refer to HTM 03-01 for full details

The theatre ventilation system should only run at full output when needed to achieve and maintain the defined “in use” operational condition. Switching off a theatre ventilation system when not required is the most energy-efficient policy.

If the system is needed to maintain a minimum background condition, then reducing its output to the minimum necessary to achieve and maintain the desired condition is the next best option. Energy-recovery devices provide a significant portion of the heating requirement. It is essential that energy-recovery devices are well-maintained and operate as intended.

A ventilation system should not be run at full output just in case it will be needed. This can be a problem in operating departments where the ventilation is often run out of hours in the belief that it will maintain sterility in the operating suite; airborne contamination in operating theatres is caused only by the people using them.

The theatre ventilation is provided to cater for the in-use biological load. When the theatre is empty, there is no biological source from people so the ventilation can be turned off and set to automatically start at set back, to maintain a minimum required background condition. Ultra-clean Ventilation (UCV) theatre ventilation can be completely switched off when the theatre is not in use, but the room temperature should not be allowed to drop to the dew-point, typically 16ºC in winter, or rise above 25ºC in summer.

The time taken to start the ventilation and achieve full operating conditions in an emergency will be less than the time taken to bring a patient to theatre and prepare the staff and instruments ready for emergency surgery to commence. This also applies to obstetrics theatres and special delivery rooms.

Evidence demonstrates that it takes 25 (ultra-clean ventilation) to 30 minutes (conventional ventilation) of active ventilation for an operating theatre to be safe to use from a microbiological load and temperature perspective following a prolonged period of being switched off [2] [3]

2. Factors influencing theatre ventilation energy use

Operating theatres are a large user of energy in a hospital environment. The operating theatre is three to six times more energy intensive than the rest of the hospital. End user data shows that more than 90% of theatre suite energy use comes from air handling and therefore optimising usage can result in environmental and financial benefits[4]. it is important to note that there are a number of factors that will influence the energy efficiency and savings realised by switching off or setting back operating theatre ventilation systems.

Age of the air handling unit (AHU)

New AHU systems incorporate direct drive fans, high efficiency heat recovery systems and more monitoring sensors that ensure the systems run efficiently. There are a variety of AHU systems whose efficiency depends on age. As AHUs age, their ability to maintain optimal air change rates declines due to mechanical wear, inefficiencies, and system degradation.

Outdated controls and setpoints

Manual or outdated control systems may lead to less precise regulation of airflows. Malfunctioning or incorrectly set dampers, as well as sensors, actuators that are misaligned or faulty can cause inconsistent airflow and affect air change rates (ACR). Refer to HTM 03-01 Part A for specified air changes per hour for each location or room type.

Condition of filters and filter type

Filters play a crucial role in maintaining air quality, but their condition and resistance significantly impact airflow, which in turn affects the ACR. Clogged or dirty filters create a higher pressure drop making it harder for the fan to push air through, leading to reduced

[2] Dettenkofer, M., Scherrer, M., Hoch, V., Glaser, H., Schwarzer, G., Zentner, J., & Daschner, E. D. (2003). 'Shutting down operating theatre ventilation when the theatre is not in use: infection control and environmental aspects'. *Infection Control Hospital Epidemiol*, *24*(8), 596-600. https://doi.org/10.1086/502260

[3] Traversari, A. A., Bottenheft, C., van Heumen, S. P., Goedhart, C. A., & Vos, M. C. (2017). 'Effect of switching off unidirectional downflow systems of operating theaters during prolonged inactivity on the period before the operating theater can safely be used'. *American Journal of Infection Control*, *45*(2), 139-144. https://doi.org/10.1016/j.ajic.2016.07.019

[4] MacNeill, A. J., Lillywhite, R., & Brown, C. J. (2017). 'The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems.' *The Lancet Planetary Health*, *1*(9), e381-e388. DOI: 10.1016/S2542-5196(17)30162-6

airflow and lower ACR. [EPA/HEPA (high-MERV filters)] offer greater filtration but introduce higher initial resistance, reducing airflow if the system is not designed to compensate.

External environmental conditions

Extreme conditions may require adjusted airflow to maintain indoor air quality (IAQ) and energy efficiency. External factors like wind pressure or stack effect can influence airflow balance. External air temperature will influence the required level of heating or cooling of the air, and therefore the energy expended. Figure 1 depicts the outside minimum and maximum air temperature over one year.

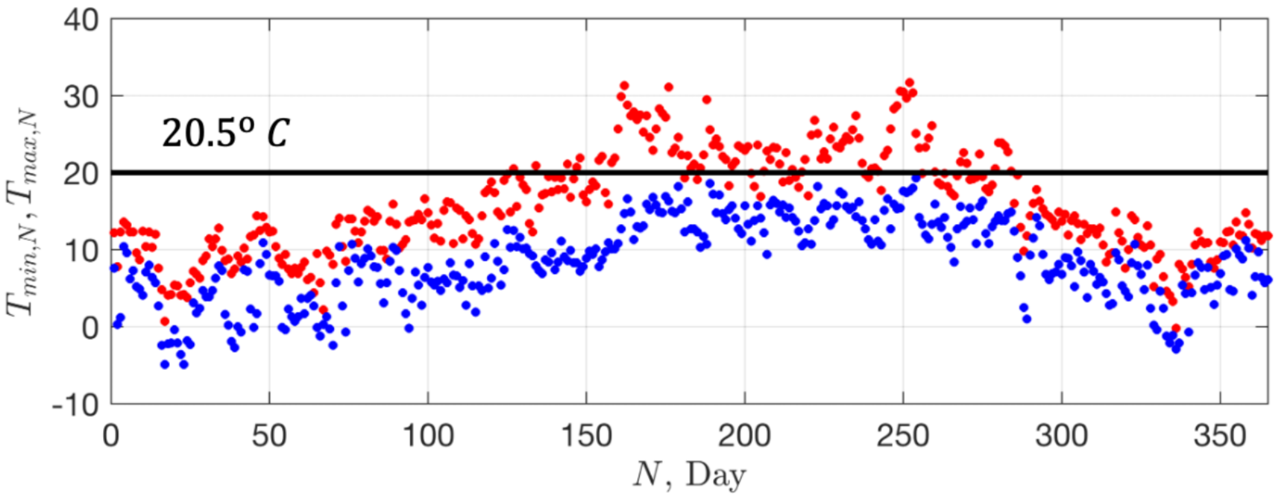

Figure 1: The schematic depicts the daily maximum (red) and minimum (blue) outside air temperature (°C) in 2024. The data is taken from here. The horizontal line is a set point of Tsp = 20.5^{o} C. (Tsp= temperature set point).

AHUs draw air from outside where it is then filtered and tempered before being discharged to the theatre suite via supply ductwork. The energy costs depend upon (in order of importance):

a) period over which the system is on,

b) the energy efficiency and recovery of the system and

c) type of heating system.

3. Calculating approximate energy reduction

A benchmark estimate of energy in kWh can be made from the electrical fan power required to drive the AHU, and the total heat energy required to bring hospital theatre air temperature to a set point.

The influence of the period of operation on the total energy costs can be approximately understood by calculating the fractional time that the AHU is in full operation and in set-back mode. For example, the reduction in energy costs for the ventilation system turned on 7am-7pm (12 hours per day out of 24 hrs) for 5 days (out of 7) is:

$$fractional\ reduction = \frac{12}{24} \times \frac{5}{7} = \frac{5}{14}$$

The reduction caused by running the AHU on full operation on 7am-7pm (12 hours per day out of 24 hrs) 7 days a week and with setback during the remaining time (running at 40% operation) is:

$$fractional\ reduction = \frac{12}{24} \times \frac{7}{7} + \frac{12}{24} \times \frac{40}{100} \times \frac{7}{7} = \frac{7}{10}.$$

A more detailed analysis shows that gains are greater than these estimates because more heating is required in the evening (when the outdoor air temperature is lower) than during the day and this is reflected in the results with different heat recovery efficiencies.

Table 1: Showing a comparative (minimum) energy, cost and CO_2e production, associated with a conventional ventilation system and an ultra-clean ventilation (UCV) system. The heat recovery is based on sensible heat. The two ventilation systems are considered along with different heating modalities. Unit price for (Reproduced, with permission- from: Eames et al, (2025)[5])[6]

Ventilation Type	Electric /Gas	Heat Recovery α	E_T (MWhr)	Cost (Co) (£ 000)	CO_2e (tonnes yr^{-1})
Conventional - full power	**Mixed**	**0**	**357**	**38**	**67**
Conventional - setback evenings	Mixed	0	225	25	42
Conventional - off evenings	Mixed	0	145	16	27
Conventional - setback evenings and w/e	Mixed	0	104	12	19
Conventional - full power	**Mixed**	**0.5**	**212**	**27**	**40**
Conventional - off evenings and w/e	Mixed	0.5	62	9	12
Conventional - full power	**Electric**	**0.5**	**108**	**29**	**21**
Conventional - setback evenings	Electric	0.5	71	19	14
Conventional - off evenings and w/e	Electric	0.5	34	9	7
UCV - full power	**Mixed**	**0**	**408**	**51**	**76**
UCV - setback evenings	Mixed	0	261	34	49
UCV - off evenings and w/e	Mixed	0	122	17	23

[5] Eames, I., Symons, A., Wilson, D., Rawas Kalaji, Y., Muirhead, L., & Groome, J. (2025). Towards NetZero for hospital operating theatres. *Journal of The Royal Society Interface*, *22*(230), 20250048. https://doi.org/10.1098/rsif.2025.0048

[6] The electricity and gas unit costs (October 2025) are electricity = 27 p kW h−1 and gas = 7 p kW h−1 respectively

UCV - off evenings	Mixed	0.5	80	14	15
UCV - full power	**Electric**	**0.5**	**158**	**43**	**31**
UCV - off evenings and w/e	Electric	0.5	52	14	10

The indicative total energy (MWhr / yr), equivalent cost and CO_{2e} (tonnes yr^{-1}), listed in Table 1, are influenced by:

(a) how the ventilation system is run, whether on full power, set back in the evenings and/or weekends (at 40% operation), or switched off in the evening and weekends.

(b) the type of ventilation system being used (conventional ventilation or ULTRA-CLEAN VENTILATION) and

i. whether the AHU is fully **electric** or heated with a gas boiler (**mixed**).

ii. the heat recovery of the AHU, α, varies from 0 (no heat recovery) to 1 (perfect heat recovery). Typically, the total effective heat recovery is $\alpha \sim 0.5$ for newly commission systems.

In addition to energy saving benefits, the working life of the plant will be extended as the demand characteristics of the system will change. This will further reduce the environmental and financial impact of the theatre ventilation system.

Establishing governance, delivery structures and site understanding

4. Key actions when getting started

4.1 Establish governance and a project team

1. Link into the most appropriate governance structure, including executive leadership, ventilation safety group (VSG) and multidisciplinary project team.
2. Engage key stakeholders early and often, including healthcare professionals, estates and facilities and private finance initiative (PFI) partners where appropriate.
3. Bring stakeholders together regularly to build relationships and enable work to progress.
4. Use governance structure to gain approval for actions required.

4.2 Executive leadership

Trust leaders are instrumental in integrating sustainability into strategic and operational practices. The Health and Care Act 2022 requires NHS trusts to contribute towards statutory emissions and environmental targets. Every trust and integrated care board (ICB) must have a board-level net zero lead to oversee or delegate responsibility for the local green plan and projects. Current green plan guidance is available from NHS England. As this project can lead to significant cost reduction, gaining early engagement and support from the Chief Financial Officer can help move the project forward.

4.3 Ventilation Safety Group (VSG)

The management of the ventilation systems of a healthcare provider should be overseen by the Ventilation Safety Group (VSG). The VSG is a multidisciplinary team responsible for ensuring that ventilation systems within healthcare facilities are designed, installed, maintained, and operated safely and in compliance with relevant standards.

Most trusts should already have a VSG in place, and this should be the starting point for any theatre ventilation project. The VSG should have clearly defined roles and responsibilities, be part of a healthcare organisation's governance structure and report to a designated person at Board level. It should be led and chaired by a person who has appropriate management responsibility, knowledge, competence and experience in specialised ventilation systems.

The VSG should be a multidisciplinary group including both technical and clinical representatives. See HTM 03-01 for a full description of the VSG.

4.4 Multidisciplinary project team

A multidisciplinary team should be responsible for progressing the activities and ensuring all technical, safety and clinical factors are being addressed.

This team should include representatives from:

- Theatres – surgeons, anaesthetists, and nurses
- Surgical divisions.
- Estates and facilities (operational team and capital delivery team including the Authorised Person Ventilation).
- Sustainability team (energy manager involvement).
- Infection prevention control team.
- Personnel from the finance department with accountability for capital and revenue evaluation.
- Co-opted expertise, for example ventilation designers, consultants and suppliers.

4.5 Understanding your site

Clinical use

- Understand what clinical areas to focus on e.g. theatres, cardiac catheterisation laboratories and/or interventional radiology suites.

- Establish and document which theatres/labs/suites may be used in an emergency e.g. CPOD or obstetric theatres.

- Ensure theatres that are occasionally used as emergency theatres (e.g. a second emergency theatre) are labelled as emergency theatres for the purpose of this exercise.

Technical ability (Project team lead)

- The project lead should request floor plans from the estates team showing which air handling units serve which theatre.
    - In older facilities, multiple theatres may be served by one air handling unit.
        - When creating a switch-off plan, an understanding of this is important, as consideration needs to be given to ensure that AHUs serving areas that are in use are not switched off.
        - Some systems may have dampers installed allowing theatres to be isolated.
    - The anaesthetic/prep room may be served by separate air handling units.
        - It is important that the switch-off is coordinated in a way that turns off all areas intended without creating backflow of less clean air, into clean areas.
        - For example, Theatre 1's anaesthetic room should not be ventilated whilst Theatre 1's ventilation is turned off as this would create a backflow of air from the anaesthetic room into the theatre.
    - Annotate on the plan which theatres are conventional theatres, and which theatres are ultra-clean ventilation theatres.
        - This will provide a better understanding of energy savings as ultra-clean ventilation theatres have a higher energy consumption.
        - It is important during the technical stage to understand whether the laminar hood controls are linked to the AHU so that the best energy savings are yielded.

- At this stage it is important to assess the capability of the Building Management System (BMS). This is the software that will help to deliver the changes to the ventilation system.
    - The strategy chosen may be dictated by the capability of the BMS.

    - In some cases, it may be cost effective to upgrade the existing BMS to accommodate energy saving projects.

- Consider utilising sub-meters or energy use monitors to assess the impact of the change programme. For accurate measurement of energy saving measures, International Performance Measurement and Verification Protocol (IPMVP) should be utilised.

- Prior to roll out across all theatres, a technical pilot is strongly advised.

Operational Strategies

5. Possible switch-off strategies

5.1 Recommendations for all operating theatres

Below is a list of recommendations to ensure that the operating theatres are safe to use.

- Ensure that the theatre panel clearly displays the current ventilation state.
    - On a digital panel this could be in writing e.g. ventilation on/off/in set-back mode.
    - Alternatively, a red (off) /amber (set-back) /green (on) light system can be used to denote ventilation status.
    - With either method, it should be very clear to see whether the ventilation is suitable or not for the theatre to be in use.

- Ensure that minimum background conditions are met during the off period.
    - This can be achieved by ensuring the temperature remains between 16ºC and 25ºC. This will prevent water damage and mould caused by the temperature dropping to dew point and damage to drugs and equipment from high heat exposure. This can be achieved by the ventilation system coming back on into a “set-back” or low power mode should the temperature approach these boundaries.

- Ensure the ventilation system is balanced.
    - Surgical theatre ventilation should undergo annual verification which should include system measurement at full speed and 'set-back' if applicable. The correct maintenance regime in line with requirements identified in HTM 03-01

should be observed. If pressure cascades are not within 80% tolerance of design requirements further investigation will be required under annual verification. Following any corrective action, further reverification should be completed to record improvements/compliance. Your engineers will be able to support this.

The range of approaches for set back and switch-off of theatre ventilation are described in the sections below.

5.2 Basic timed control option

The basic timed approach below is suitable for theatres with predictable surgical end times. It should not be used for emergency theatres. It is often suited to day surgery units and some surgical hubs.

- Following a discussion with the clinical teams, determine the usual hours of operation for each theatre e.g. operation time 7.30am to 6.30pm with full operation 7am – 7pm.
- Use data from previous years to predict likely theatre end times; ensure sufficient float to allow for unforeseen overruns. (e.g. switch-off time is set beyond the maximum time that any case has ever finished).
- Programme the BMS to set the ventilation to turn on 30-minutes prior to the theatre list starting and off at the agreed end time.
- Ensure the theatre panel provides a clear indication of the current ventilation state.
    - On a digital panel this is in writing e.g. ventilation on/off/in set-back mode.
    - Alternatively, a red (off) /amber (set-back) /green (on) light system can be used to denote ventilation status.
- Theatre staff should be warned when the current ventilation session is coming to an end by an audible and visual alarm/indicator on the theatre panel.
- When the ventilation system is off, the ventilation system should be triggered to restart in a setback mode should the temperature fall below 16ºC or go above 25ºC.

Figure 2 depicts a logic flow diagram for the basic timed control option

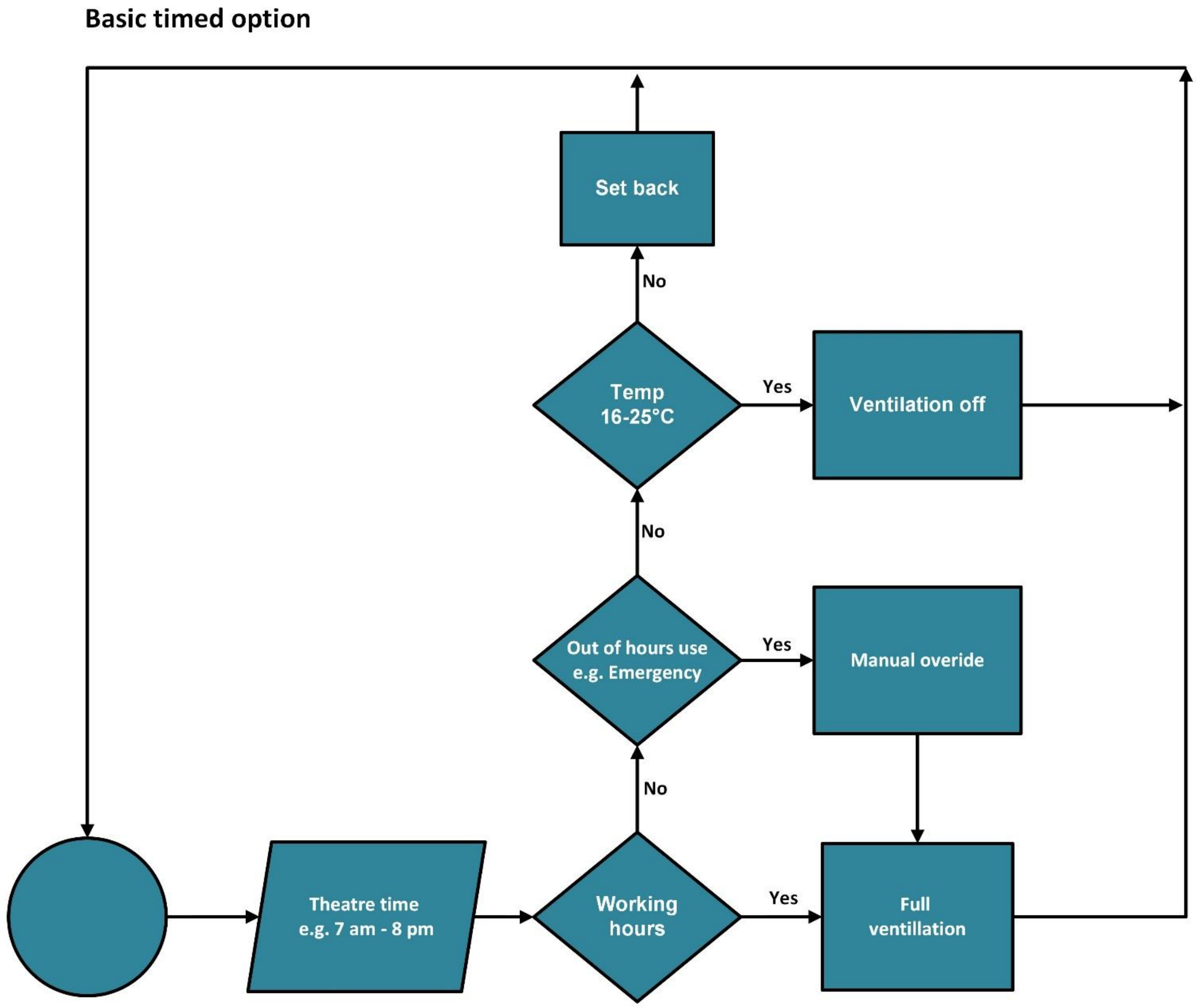

Figure 2: A logic flow diagram showing the basic timed option.

Advantages

- Low-cost option.
- Will require limited works to implement.
- Can be implemented in a short period of time.

Disadvantages

- Using these theatres for emergencies out of hours poses a significant risk as in order to activate ventilation, estates teams would need to switch ventilation on in this scenario.
- The switch-off time will likely be set quite late at night to capture cases that overrun, meaning overall energy savings may be reduced.

- Training is required to ensure theatre teams know what to do and who to call in the event of a case overrunning or taking place outside of the ventilation period.

5.3 Advanced timed option with overrun option

This option is suitable for elective theatres where the end time may not be predictable. It is preferable for out of hours emergency work as it requires the team to manually turn on the ventilation out of hours.

- Following a discussion with the clinical teams, determine the usual hours of operation for each theatre e.g. operation time 7.30am to 6.30pm with full operation 7am – 7pm.

- Via the BMS set the ventilation to turn on 30-minutes prior to the theatre list starting and off at the agreed end time.

- On the theatre panel install a clear indication as to what the current ventilation state is.
    - On a digital panel this is in writing e.g. ventilation on/off/in set-back mode.
    - Alternatively, a red (off) /amber (set-back) /green (on) light system can be used to denote ventilation status.

- At the end of the current ventilation session e.g. at 6:30pm in this instance, an audible and visual alarm/indicator via the theatre panel should let operating theatre users know that the current ventilation session is coming to an end.

- On the theatre panel a ventilation extend button should be installed to prolong the ventilation session for a further 2 hours in the event of a surgical procedure overrunning.
    - Following this 2-hour extension the audible and visual alarm/indicator should trigger again.

- In the event of an emergency out of hours, the heating, ventilation and air conditioning (HVAC) system would need to be manually turned on via the theatre panel.

- When the ventilation system is off, the ventilation system should be triggered to restart in a setback mode should the temperature fall below 16ºC or go above 25ºC.

Figure 3 depicts a logic flow diagram for user controlled advanced timer option

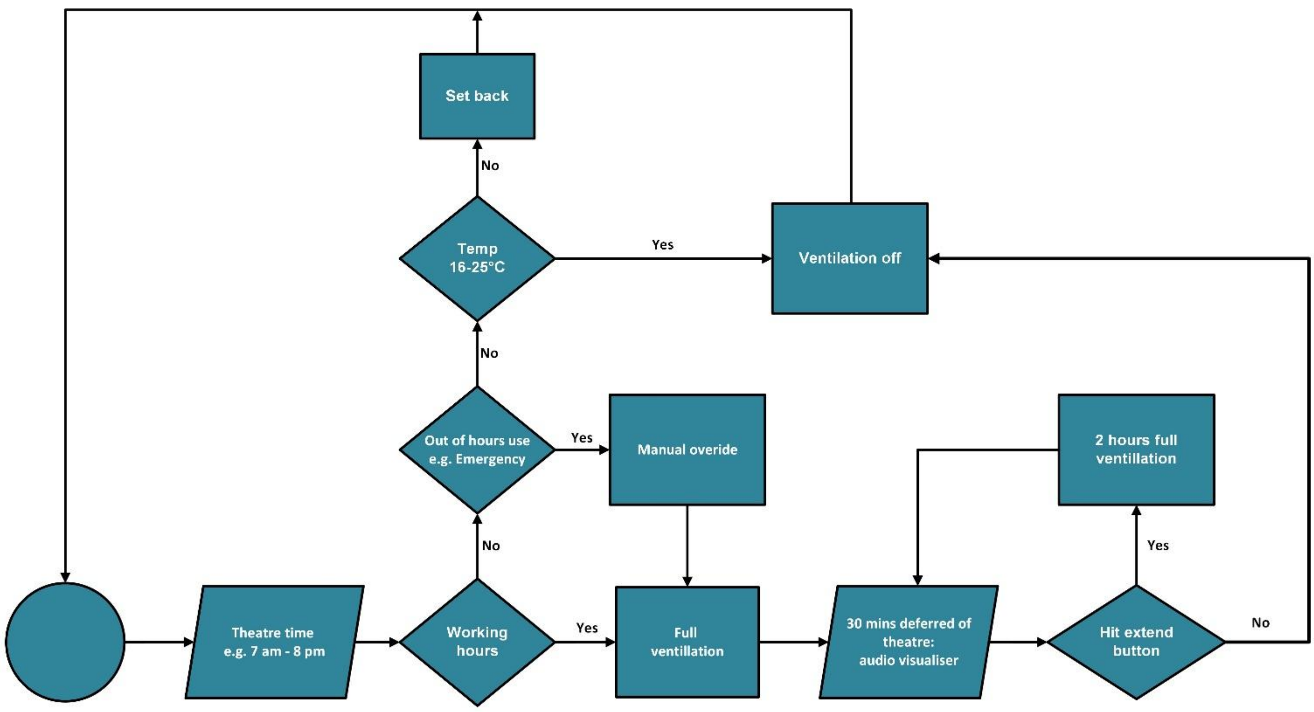

Figure 3: A logic flow diagram showing the advanced timed option with overrun.

Advantages

- Allows for theatres overrunning predicted end times.
- May be a lower cost solution to a room occupancy sensor approach (see below).
- An earlier switch-off time can be used as the ability to extend the ventilation period exists. This leads to greater potential energy savings.

Disadvantages

- Using these theatres for emergencies out of hours poses a moderate risk as in order to activate the HVAC system, the theatre teams would need to turn it on via the surgeon's panel.
- Training is required to ensure theatre teams know how to extend the ventilation session and turn on out of hours.

5.4 Room occupancy sensor approach

This approach is **well suited to all theatres** including theatres that may need to be used in an emergency.

- Room occupancy sensors are triggered to start theatre ventilation once the room is occupied.

- Once the room is unoccupied the ventilation can continue to run for an hour and then turn off until triggered again.

- During set working hours the BMS can be set to turn to set back mode during daytime periods of unoccupancy and switch-off out of hours.

- Careful positioning of the sensors to ensure they capture staff entering the room is essential.

- When the ventilation system is off, the ventilation system should be triggered to restart in a setback mode should the temperature fall below 16ºC or go above 25ºC.

Figure 4 depicts a logic flow diagram showing the room occupancy sensor approach.

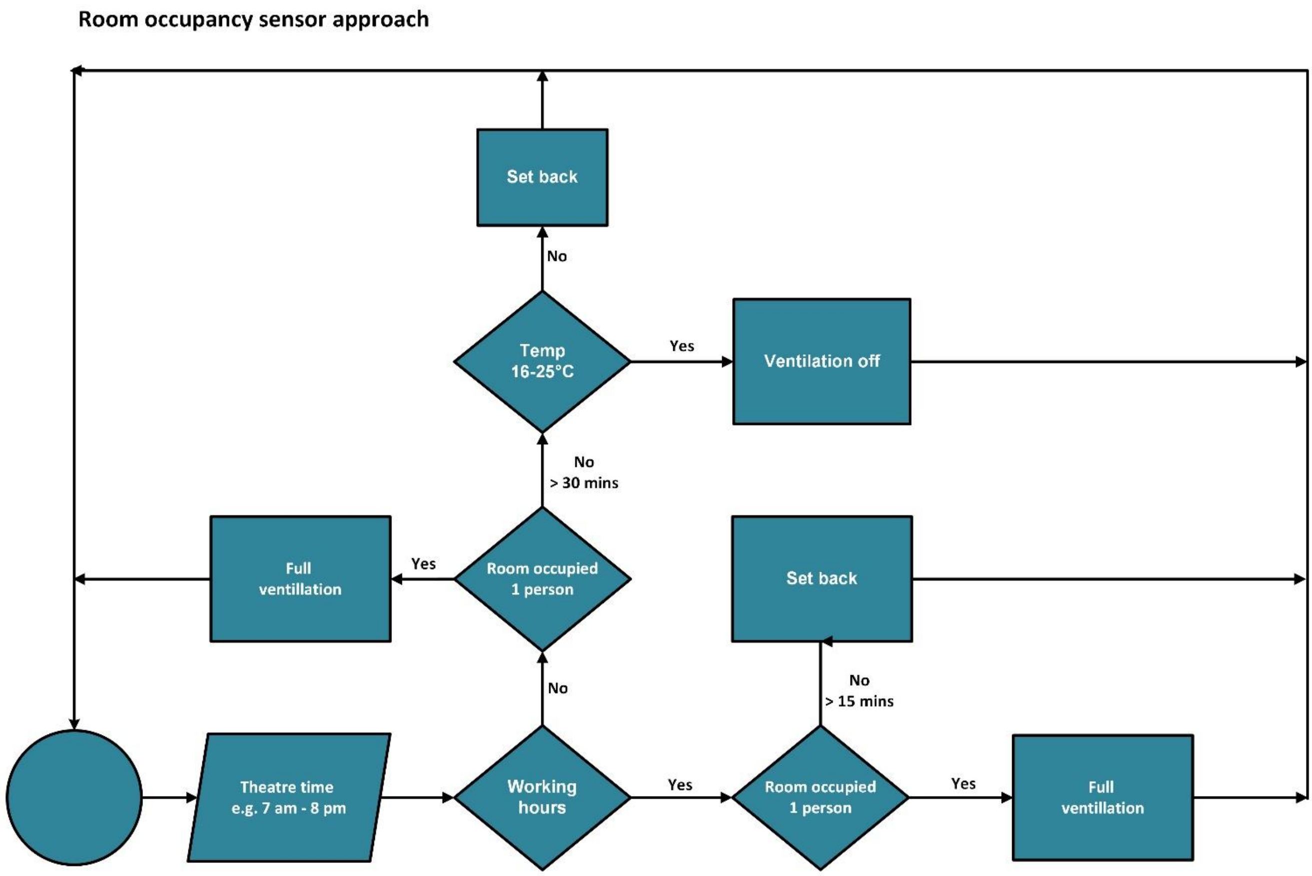

Figure 4: A logic flow diagram showing the room occupancy sensor approach

Advantages

- Suitable for most theatres.

- This has the potential for the greatest energy reduction as the HVAC would only be on full during times of theatre occupation.

- Limited training is required as it does not rely on staff pushing any buttons.

Disadvantages

- May be more expensive than other options.

- May not work with older BMS systems (mechanical timer and PIR occupancy sensors could be combined for older systems – clarity on options by a specialist or technical estates team will support here).

- May not be suitable for emergency obstetric theatres where the patient can be rushed to theatre in under 30 minutes, at times before the scrub team. In this case keeping the HVAC system on continuously may be the safest option.

There are a variety of sensors available (including others not listed), they are:

Passive Infrared Sensor (PIR)

These simple motion detectors work by measuring infrared light radiating from moving objects in its field of view. They are a low-cost option. They can be installed with a “double knock” programme so that if movement is detected twice within 10 minutes the AHU will switch on. If no movement is detected after 30 minutes the ventilation system will switch-off.

PIR sensors are unable to differentiate between a single person or multiple people, so they run the risk of inadvertent activation e.g. during the nightly clean.

mmWave Radar Sensor

These radar sensors can measure presence, distance from the sensor and velocity of the target. They are much more sensitive than PIR sensors and less prone to false activation. It can estimate number of people in the room and so can prevent inadvertent activation e.g. during nightly clean.

Thermal imaging sensor

These sensors sense heat radiation from each individual. Image processing then enables these sensors to act as a people counter and so can be used to trigger ventilation on when 2 people are detected in the room.

Other considerations:

Anaesthetic Gas Scavenging System (AGSS)

A typical AGSS pump consumes 500 – 800W per hour. This is roughly 5 times greater than a 65'' LED TV. The AGSS will never be used during a time when the theatre ventilation is not required. Interlinking these two systems on the BMS so that the AGSS turns off when the AHU does will lead to increased energy savings.

Ultra clean ventilated (UCV) theatres

When implementing a switch-off strategy it is essential that the canopy fans are interlinked with the AHU so that both turn on and off at the same time. This way you will maximise the energy saving.

6. References

NHS England Guidance

Health Technical Memorandum 03-01: Specialised ventilation for healthcare premises

Green plan guidance

Acts and Regulation

Health and Care Act 2022

Royal College of Surgeons

The Royal College of Surgeons Intercollegiate Green Theatre Checklist.

Other publications

Alsved, M., Civilis, A., Ekolind, P., Tammelin, A., Andersson, A. E., Jakobsson, J., Svensson, T., Ramstorp, M., Sadrizadeh, S., Larsson, P. A., Bohgard, M., Šantl-Temkiv, T., & Löndahl, J. (2018). Temperature-controlled airflow ventilation in operating rooms compared with laminar airflow and turbulent mixed airflow. *Journal of Hospital Infection*, *98*(2), 181-190. https://doi.org/10.1016/j.jhin.2017.10.013

Brighton & Sussex Medical School, Centre for Sustainable Healthcare, and UK Health Alliance on Climate Change (2023). Green surgery: Reducing the environmental impact of surgical care (v1.1). London: UKHACC (accessed: 27/08/2025)

Dettenkofer, M., Scherrer, M., Hoch, V., Glaser, H., Schwarzer, G., Zentner, J., & Daschner, E. D. (2003). 'Shutting down operating theatre ventilation when the theatre is not in use: infection control and environmental aspects'. *Infection Control Hospital Epidemiol*, *24*(8), 596-600. https://doi.org/10.1086/502260

Eames, I., Symons, A., Wilson, D., Rawas Kalaji, Y., Muirhead, L., & Groome, J. (2025). Towards NetZero for hospital operating theatres. *Journal of The Royal Society Interface*, *22*(230), 20250048. https://doi.org/10.1098/rsif.2025.0048

MacNeill, A. J., Lillywhite, R., & Brown, C. J. (2017). 'The impact of surgery on global climate: a carbon footprinting study of operating theatres in three health systems.' *The Lancet Planetary Health*, *1*(9), e381-e388. DOI: 10.1016/S2542-5196(17)30162-6

Morgenstern, P., Raslan, R., & Ruyssevelt, P. (2016). *Reducing hospital electricity use: An end-use perspective*. UCL Discovery. Available: https://discovery.ucl.ac.uk/id/eprint/1476873/1/Morgenstern%20et%20al.%20Energy%20end-use%20in%20hospitals%20Final.pdf (accessed: 27/08/2025)

Traversari, A. A., Bottenheft, C., van Heumen, S. P., Goedhart, C. A., & Vos, M. C. (2017). 'Effect of switching off unidirectional downflow systems of operating theaters during prolonged inactivity on the period before the operating theater can safely be used'. *American Journal of Infection Control*, *45*(2), 139-144. https://doi.org/10.1016/j.ajic.2016.07.019

7. Appendix.

7.1 Definitions: Theatre ventilation methods

Conventional Theatres / Turbulent Flow Ventilation (Conventional)

Conditioned, filtered air enters the rooms that make up the theatre suite from the air handling units (AHU) to create a pressure cascade from clean to less clean spaces and ensure an appropriate number of air changes per hour (ac/h) for dilution of airborne contaminants. Air is supplied to the operating theatre via ceiling supply diffusers or via pressure stabilisers in adjacent clean rooms e.g. from a lay-up prep. Air is extracted from the operating theatre via extract grilles or via transfer grilles to less clean spaces, e.g. anaesthetic room. The bacterial load in theatres is in effect diluted through this method. Refer to HTM 03-01 for further details. Figure 5 is a schematic of conventional ventilation.

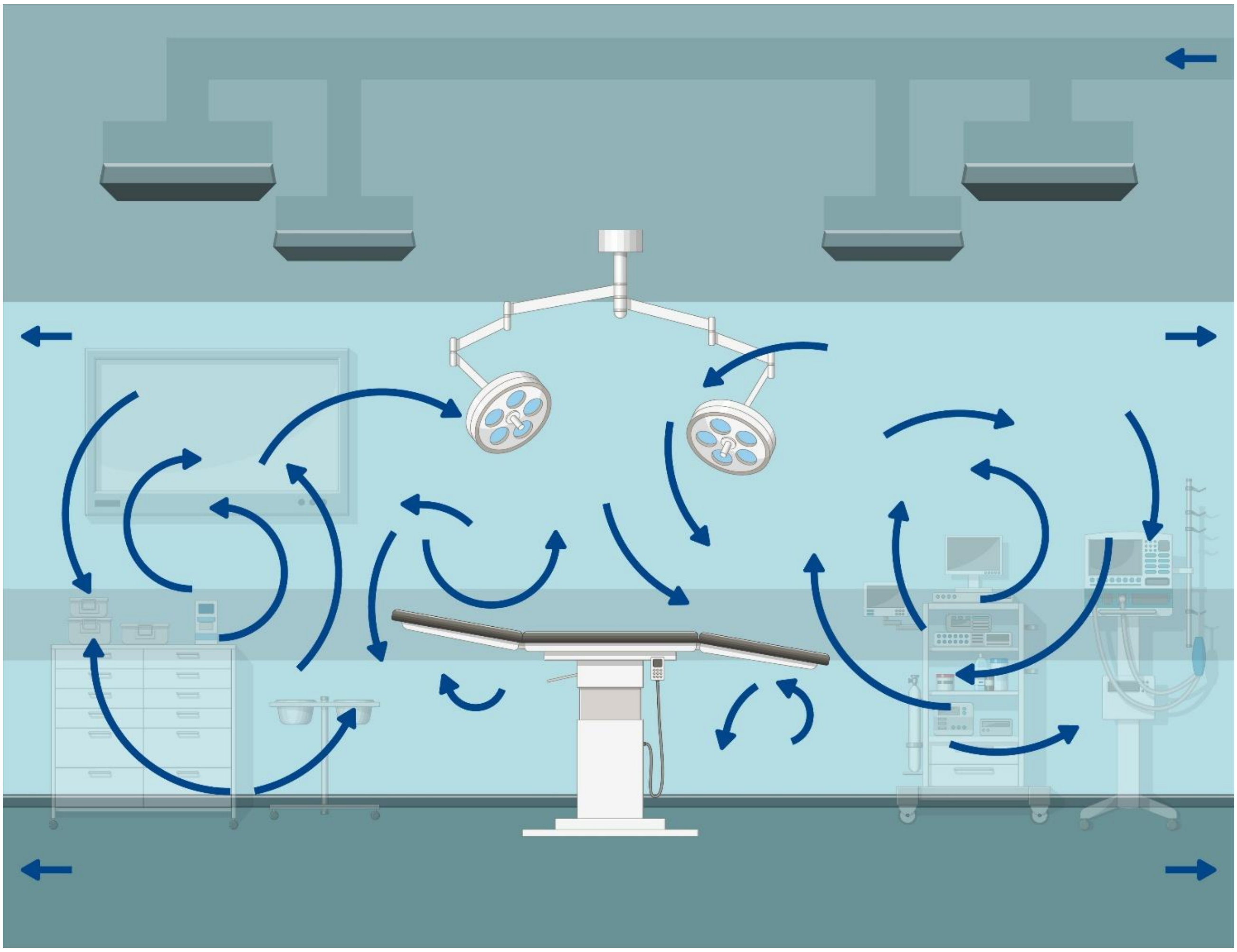

Figure 5: Schematic of the turbulent flow associated with conventional ventilation.

Ultra clean ventilated (UCV) theatres

Ultra-clean ventilation (UCV) is a means of providing a large volume of clean filtered air to the zone in which an operation is performed, and sterile items are exposed. Air is discharged above the operating zone and while not truly laminar, its downward displacement purges the clean zone of contaminants and particles generated by the activities within it. The airflow in and around the clean zone also serves to prevent particles originating outside the zone from entering it. Figure 6 is a schematic of ultraclean ventilation.

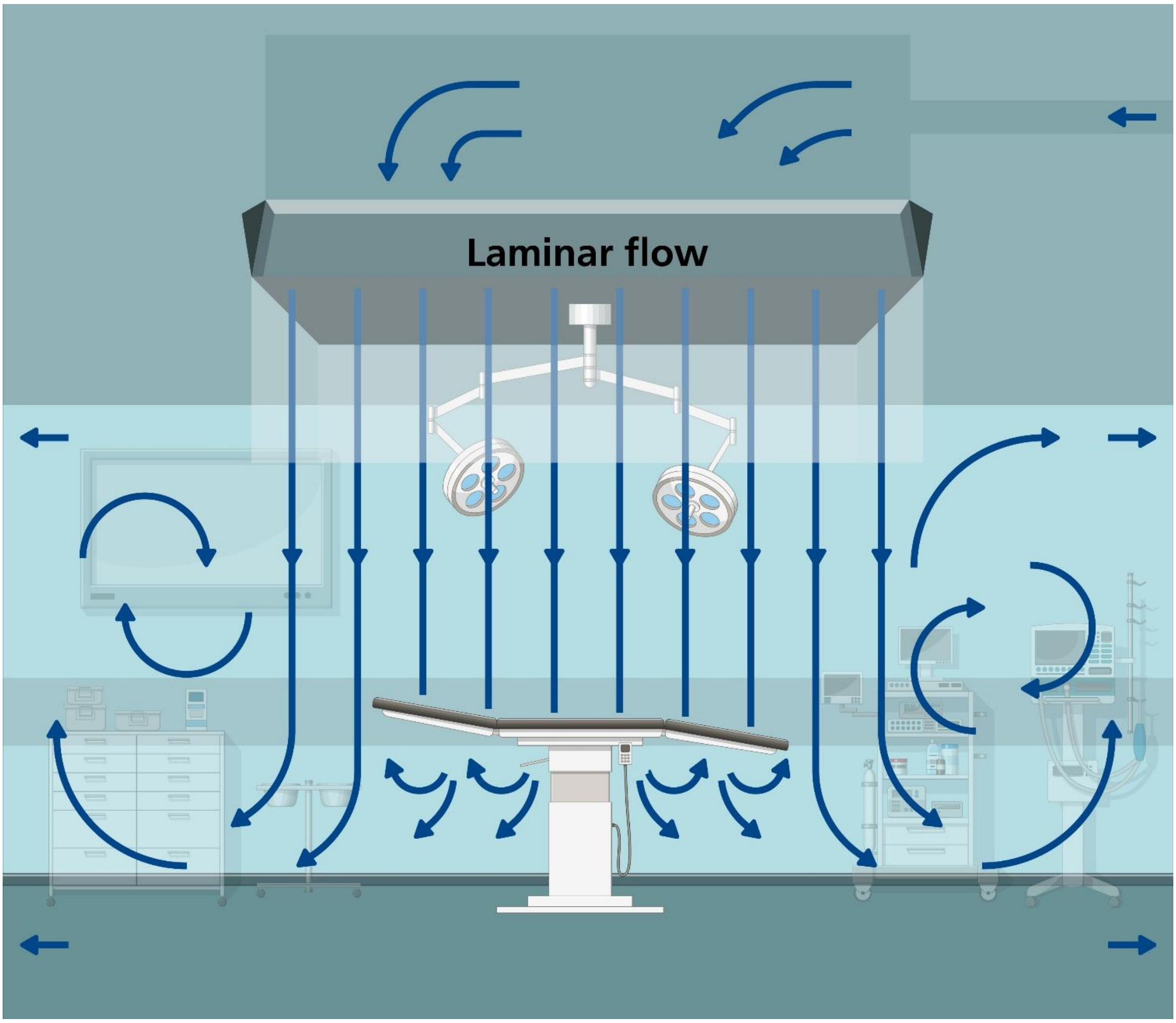

Figure 6: Schematic of the air flow associated with an ultra-clean ventilated theatre.

7.2 Glossary

Heating, Ventilation, and Air Conditioning (HVAC)

HVAC refers to systems responsible for controlling indoor temperature, humidity, and air quality in healthcare premises, ensuring a safe and comfortable environment that meets clinical and operational needs.

Air Handling Unit (AHU)

An AHU is a device used to regulate and circulate air within a building's HVAC system. It typically includes components such as filters, fans, heating or cooling coils, and humidifiers to provide appropriate air quality and environmental conditions in healthcare facilities.

High Efficiency Particulate Air (HEPA) Filter

A HEPA filter is an air filter capable of trapping a minimum of 99.97% of airborne particles measuring 0.3 microns or larger. It is commonly used in healthcare settings to remove contaminants, ensuring a clean and safe environment for patients and staff.

Ultra Clean Ventilation (UCV)

UCV is a highly efficient air distribution system used in operating theatres to create a clean airflow around the patient and surgical team, minimising the risk of airborne contamination during surgical procedures.

Ventilation Safety Group (VSG)

The VSG is a multidisciplinary team responsible for ensuring that ventilation systems within healthcare facilities are designed, installed, maintained, and operated safely and in compliance with relevant standards.

Authorising Engineer (Ventilation) (AE(V))

The AE(V) is an individual with expert knowledge of ventilation systems in healthcare settings. They are responsible for providing independent advice on ventilation design, installation, and safety, as well as for appointing and assessing Authorised Persons (Ventilation).

Authorised Person (Ventilation) (AP(V))

The AP(V) is a person appointed by the AE(V) who is responsible for the practical implementation, operation, and maintenance of ventilation systems. They ensure that systems are safe and compliant with regulations and standards.

Building Management System (BMS)

A BMS is a computer-based control system used to monitor and manage the mechanical and electrical services within a building, such as HVAC, lighting, power systems, and security, to ensure optimal operation and energy efficiency.

Theatre Panel

A theatre panel, also referred to as a surgeon's panel is a control panel located within an operating theatre that allows the surgical team to control environmental conditions, such as temperature, lighting, and ventilation settings.

Occupancy Sensor

An occupancy sensor is a device that detects the presence of people in a room or area. In healthcare settings, it is often used to control lighting and HVAC systems, improving energy efficiency and maintaining appropriate environmental conditions.

Anaesthetic Gas Scavenging System (AGSS)

The AGSS is a system designed to safely remove and dispose of waste anaesthetic gases from operating theatres and recovery areas, preventing exposure to staff and patients and ensuring compliance with health and safety standards.

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Future Standards Working Group

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