Operating Room Design:
Going Beyond ASHRAE 170 Design Minimums

Presented by: Rashida M. Pflipsen

Going Beyond ASHRAE 170 Design Minimums

Presenters

Rashida M. Pflipsen

Sales Engineer

- 3+ years with Brucker Company
- Bachelor of Science in Architectural Engineering, Milwaukee School of Engineering

Going Beyond ASHRAE 170 Design Minimums

Course Description

We will explore the future of operating room air distribution design. Going beyond current ASHRAE 170 guidelines, we will delve into methodologies to:

- Improve thermal comfort
- Improve particulate control
- Effectively manage surgical smoke

Eagle Rock Ambulatory Surgical Center | Idaho Falls, ID

Going Beyond ASHRAE 170 Design Minimums

Learning Objectives

By the end of this presentation, participants will be able to:

1. Explain the current ASHRAE 170 guidelines for operating rooms
2. Discuss the benefits of high air change operating room systems on particulate control
3. Understand impact of air distribution on hospital staff and patients (thermal comfort, surgical smoke, etc.)
4. Discuss the benefits of integrated ceiling systems in OR design

Overlake Medical Center | Bellevue, WA

Going Beyond ASHRAE 170 Design Minimums

Agenda

1. Challenges in Operating Rooms
2. Current Design Guidelines
   - ASHRAE 170 OR Design
   - Global OR Design
   - ISO 14644 Cleanroom Design
3. Advanced OR Design
4. Integrated Ceiling Systems
5. Summary
6. Questions

Mission Health Memorial Campus | Asheville, NC

Operating Room Design:
Going Beyond ASHRAE 170 Design Minimums

Challenges in Operating Rooms

Going Beyond ASHRAE 170 Design Minimums

Challenges in Operating Rooms

Patients

- Risk of surgical site infections
- Risk of hypothermia

Surgical Staff

- Working conditions & indoor environmental quality
  - Exposure to surgical smoke
  - Thermal comfort
  - Lighting quality and visibility
  - Noise Levels
- Rapid heat/cool changeover for surgical procedures

Facilities Staff

- Accessible maintenance
- Sanitation procedures

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Challenges in Operating Rooms

Design Team

- Ceiling complexity
- Constrained infrastructure
- Room heat/cool changeover
- Visibility and lighting quality
- Energy efficiency

Hospital Owner

- Renovation downtime and maintenance costs
- Attraction & retention of surgical staff
- Surgical site infections and associated costs

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Challenges in Operating Rooms

Surgical Site Infections

- In 2006, approximately **80 million surgical procedures were performed in the United States** at inpatient hospitals (46 million) and ambulatory hospitals (32 million).
- Between 2006 and 2009, **SSIs complicated approximately 1.9% of surgical procedures** in the United States. The number of SSIs is likely to be underestimated given that approximately 50% of SSIs become evident after discharge.
- Estimated **mean attributable costs of SSIs range from $10,443 in 2005 US dollars to $25,546 in 2002 US dollars per infection**. Costs can exceed $90,000 per infection when the SSI involves a prosthetic joint implant or an antimicrobial-resistant organism.

https://www.cdc.gov/hai/ssi/faq_ssi.html

https://jamanetwork.com/journals/jamasurgery/fullarticle/2623725

CDC Centers for Disease Control and Prevention

Going Beyond ASHRAE 170 Design Minimums

Challenges in Operating Rooms

Surgical Site Infections

- SSIs cost the US healthcare system an estimated **$3.5-$10 billion annually**
- Since 2008, the US Centers for Medicare and Medicaid Services (CMS) are no longer reimbursing hospitals for hospital acquired infections (HAI) like SSI.
- **SSI prevention has become a critical objective for institutions nationwide.**

- *“There is a correlation between air contamination values and infection rates"*

https://eloquesthealthcare.com/2018/07/11/financial-impact-of-surgical-site-infections-ssis/

https://pubmed.ncbi.nlm.nih.gov/6195220/

Going Beyond ASHRAE 170 Design Minimums

Challenges in Operating Rooms

Surgical Smoke

- Surgical smoke is produced by the thermal destruction of tissue by lasers or electrocautery or ultrasonic devices. It has a repulsive odor, can obstruct the view of the surgical site, and has been shown to contain:
  - Toxic gases
  - Vapors, chemicals and particulates
  - Viruses and bacteria
  - Cases of HPV transmission from patient to surgeon
- Acute health effects of exposure include:
  - Eye, nose and throat irritation
  - Headache, cough & nasal congestion
  - Asthma and asthma-like symptoms
- Laws being adopted due to AORN advocacy efforts.

https://www.hfmmagazine.com/articles/4967-surgical-smoke-codes-and-safety-issues

Image courtesy of AORN

Operating Room Design:
Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

USA Building Code Requirements

- Facility Guidelines Institute (FGI)
  - Guidelines for Design and Construction of Healthcare Facilities
  - Adopted ASHRAE 170 for all HVAC

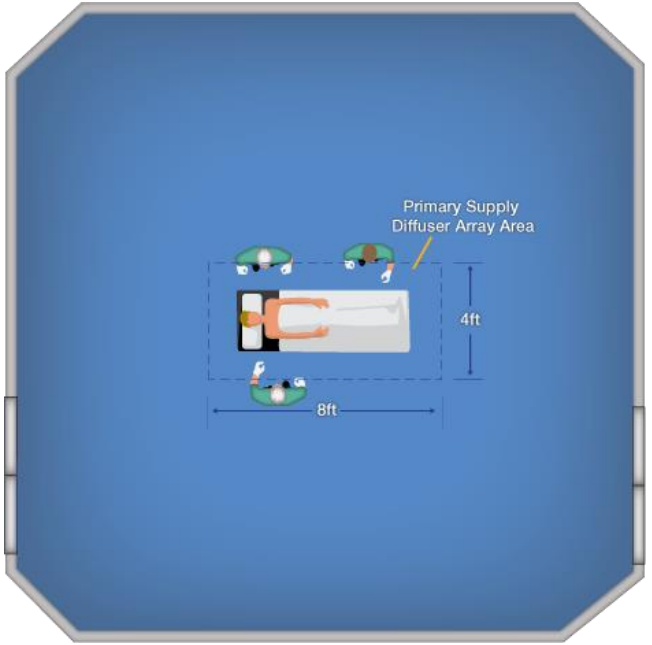
- ASHRAE (American Society of Heating, Refrigeration, Air Conditioning Engineers)
  - ASHRAE 170-2021 Ventilation of Healthcare Facilities
  - Widely adopted in North America for HVAC design in healthcare facilities (new and renovation)

Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

ASHRAE 170-2021 Design Guidelines for OR

- Minimum **20 ACH** (Air Changes per Hour) of which a minimum of 4 ACH shall be outdoor air
- The area of the **primary diffuser array** shall extend a minimum of **12" beyond the surgical table** on each side
- **No more than 30%** of the primary supply diffuser array shall be used for non-diffuser purposes (booms, med equip., etc.)
- Airflow shall be unidirectional, downwards, and the **average diffuser exit velocity shall be 25-35 fpm**(0.13-0.18 m/s)
- Minimum **MERV-16** filtration, downstream of all cooling coils
- In OR or Class 3 imaging rooms for orthopedic procedures, transplants, neurosurgery, or dedicated burn unit procedures, **HEPA filters shall be provided and located in the air diffuser**.



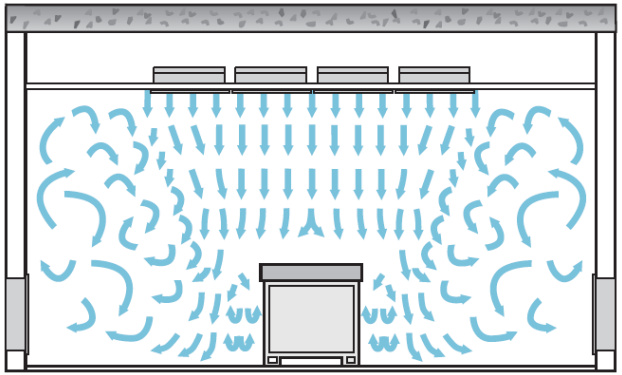
https://www.techstreet.com/ashrae/standards/ashrae-170-2021?product_id=2212971

Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

Primary Diffuser Array

- Laminar array concentrated above surgical zone
- Displace particulate to low-level returns
- Widely accepted design and supporting research
- Large footprint ideal for movable OR tables
- Optional diffuser mounted HEPA filters



Eagle Rock Ambulatory Surgical Center | Idaho Falls, ID

Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

Global Operating Room Design

United Kingdom & Australia

- Integrated systems replacing legacy mixing and cross flow ventilation
- UCV (Ultra Clean Ventilation) Design
  - 40-60 ACH (min. 20ACH)
  - 60-80 fpm (0.3-0.4 m/s) exit velocity
  - 43-86 ft^2 (4-8 m^2) diffuser array

https://aushfg-prod-com-au.s3.amazonaws.com/GL2016_020.pdf

https://www.england.nhs.uk/wp-content/uploads/2021/05/HTM0301-PartA-accessible-F6.pdf

Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

Advanced Operating Room Design - ISO 14644 Class 5 Equivalent

- Class based on particle size and particle count

ISO 14644-1 cleanroom standards

Class	maximum particles/m³						FED STD 209E equivalent
	≥0.1 µm	≥0.2 µm	≥0.3 µm	≥0.5 µm	≥1 µm	≥5 µm	
ISO 1	10	2					
ISO 2	100	24	10	4			
ISO 3	1,000	237	102	35	8		Class 1
ISO 4	10,000	2,370	1,020	352	83		Class 10
ISO 5	100,000	23,700	10,200	3,520	832	29	Class 100
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293	Class 1000
ISO 7				352,000	83,200	2,930	Class 10,000
ISO 8				3,520,000	832,000	29,300	Class 100,000
ISO 9				35,200,000	8,320,000	293,000	Room air

- Momentum shifting toward cleanroom-based approach to OR design

Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

Advanced Operating Room Design - ISO 14644 Class 5 Equivalent

- Average airflow velocity, air changes per hour, and ceiling coverage required to meet different ISO classifications

Class ISO 146144-1 (Federal Standard 209E)	Average Airflow Velocity m/s (ft/min)	Air Changes Per Hour	Ceiling Coverage
ISO 8 (Class 100,000)	0.005 – 0.041 (1 – 8)	5 – 48	5 – 15%
ISO 7 (Class 10,000)	0.051 – 0.076 (10 -15)	60 – 90	15 – 20%
ISO 6 (Class 1,000)	0.127 – 0.203 (25 – 40)	150 – 240	25 – 40%
ISO 5 (Class 100)	0.203 – 0.406 (40 – 80)	240 – 480	35 – 70%
ISO 4 (Class 10)	0.254 – 0.457 (50 – 90)	300 – 540	50 – 90%
ISO 3 (Class 1)	0.305 – 0.457 (60 – 90)	360 – 540	60 – 100%
ISO 1 – 2	0.305 – 0.508 (60 – 100)	360 – 600	80 – 100%

"Energy Efficient Low Operating Cost Cleanroom Airflow Design" – Rajan Jaisinghani, 2003

- Momentum shifting toward cleanroom-based approach to OR design
- Average airflow velocity is consistent with international OR design
- 40-60 Room ACH is ~250-400 ACH in the surgical zone

Going Beyond ASHRAE 170 Design Minimums

Current Design Guidelines

Advanced Operating Room Design - ISO 14644 Class 5 Equivalent

- Diffuser velocity required to achieve 40-60ACH exceeds ASHRAE recommended 25-35 cfm/ft^2 (0.13-0.18 m/s), however ASHRAE 170 allows for deviation from published ranges

Table 7-1 Design Parameters—Inpatient Spaces *(Continued)*

Function of Space (ee)	Pressure Relationship to Adjacent Areas (n)	Minimum Outdoor ach	Minimum Total ach	All Room Air Exhausted Directly to Outdoors (j)	Air Recirculated by Means of Room Units (a)	Unoccupied Turndown	Minimum Filter Efficiencies (cc)	Design Relative Humidity (k), %	Design Temperature (l), °F/°C
Operating/surgical cystoscopic rooms *(FGI 2.2–3.4 & Table T2.2-2; also see Class 3 Imaging)* (m) (o)	Positive	4	20	NR	No	Yes	MERV-16	20–60	68–75/20–24

Normative Notes for Table 7-1:

o. Surgeons or surgical procedures may require room temperatures, ventilation rates, humidity ranges, and/or air distribution methods that exceed the minimum indicated ranges.

- ASHRAE Research Project CO-RP3 found that "*Spaces are often operated at conditions outside those defined by Standard 170 in order to improve clinical outcomes*".

https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-d-co-rp3.pdf

Operating Room Design:
Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

Objectives

1. Reduce particle counts:
   - Reduce risk of surgical site infection
   - Reduce exposure to surgical smoke
2. Improve thermal comfort:
   - Allow surgical team to focus on primary task
   - Reduce risk of patient hypothermia
   - Reduce Noise Levels
3. Improve temperature control:
   - Provide rapid heat/cool change over

Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

Methodology

1. Reduce particle counts:
   - Increase size of sterile zone
   - Reduce obstructions within the laminar array
   - Increase air change rate
2. Improve thermal comfort:
   - Reduce Supply Air Temperature Differential (SA ΔT) by increasing air change rate
   - Reduce noise levels
3. Improve temperature control:
   - Implement dedicated fan coils for rapid temperature control

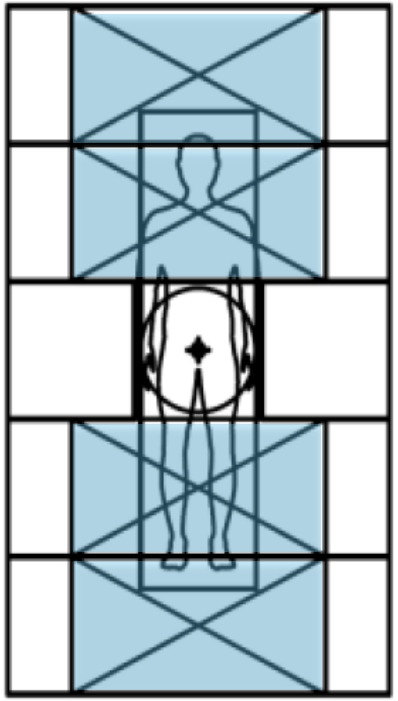
Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

1. Reduce Particle Counts

Case 1: Small, Obstructed Laminar Array

- ASHRAE 170 Minimum
- Antiquated OR design with small room and minimal diffuser coverage
- 372 ft^2 (34.5 m^2) OR with 9’ (2.7m) ceilings
- 20 ACH or 1,120 CFM
- 70% diffuser table coverage



Going Beyond ASHRAE 170 Design Minimums

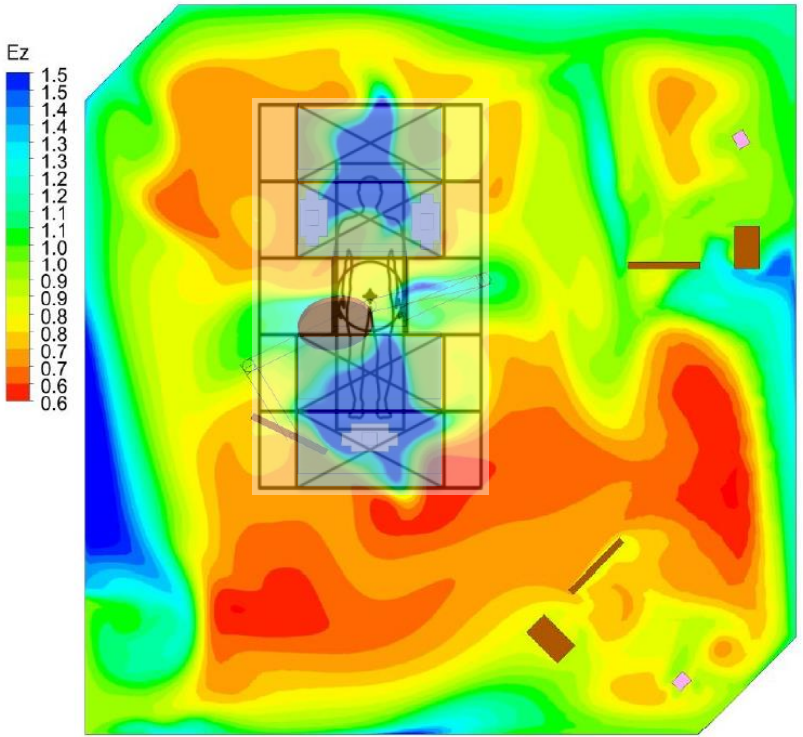
Advanced Operating Room Design

1. Reduce Particle Counts

Case 1:

Small, Obstructed Laminar Array

Shows areas of good ventilation effectiveness over the head and foot of the patient table, but limited effectiveness over the center of the table where laminar airflow is not provided.



Ventilation Effectiveness (Ez) 43” Above Floor

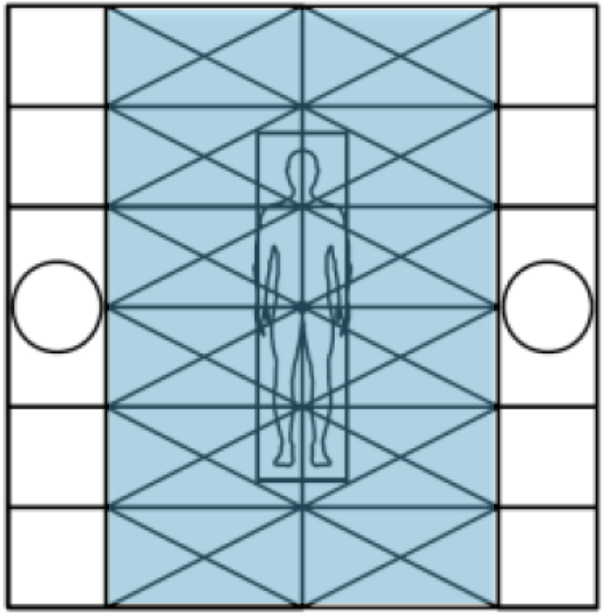
Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

1. Reduce Particle Counts

Case 2: Large, Unobstructed Laminar Array

- ASHRAE 170 Minimum
- Modern OR design with larger room and expanded diffuser coverage
- 372 ft^2 (34.5 m^2) OR with 9’ (2.7m) ceilings
- 20 ACH or 2,400 CFM
- 100% diffuser table coverage



Going Beyond ASHRAE 170 Design Minimums

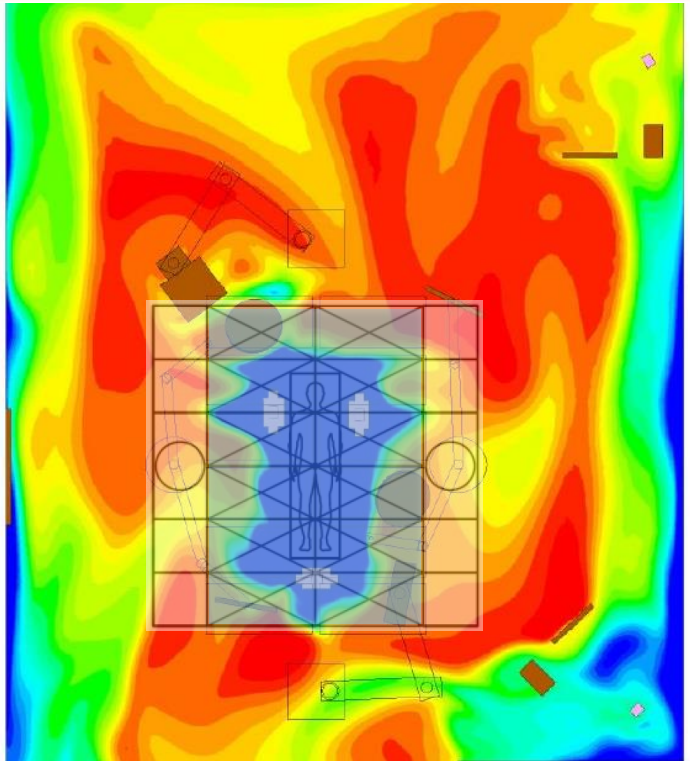
Advanced Operating Room Design

1. Reduce Particle Counts

Case 2:

Large, Unobstructed Laminar Array

Shows good ventilation effectiveness over the full patient table and surgical team



Ventilation Effectiveness (Ez) 43” Above Floor

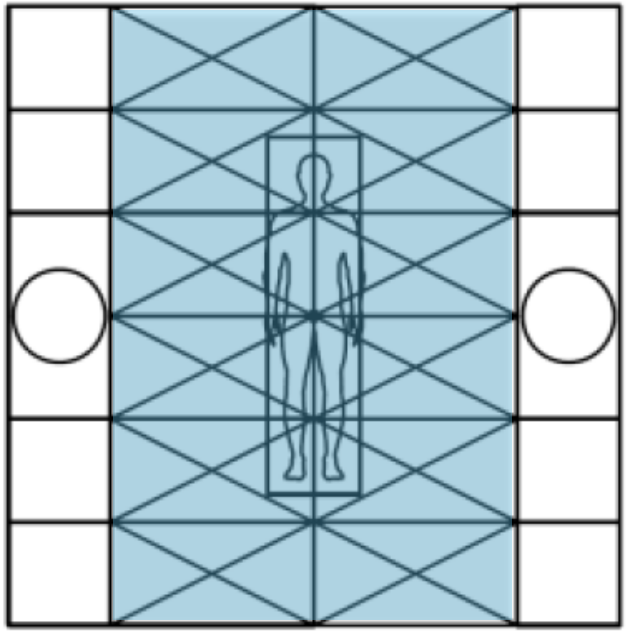
Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

1. Reduce Particle Counts - Increased ACH

- 720 ft^2 OR with 10’ ceilings
- 100% diffuser table coverage
- Supply Air Temp varied for room load

- **Case 1: 20 ACH, 2400 CFM** (1130 L/s)**, 57.9°F** (14.3°C) **SAT**
- **Case 2: 40 ACH, 4800 CFM** (2270 L/s)**, 63.5°F** (17.5°C) **SAT**
- **Case 3: 65 ACH, 7800 CFM** (3680 L/s)**, 65.4°F** (18.6°C) **SAT**

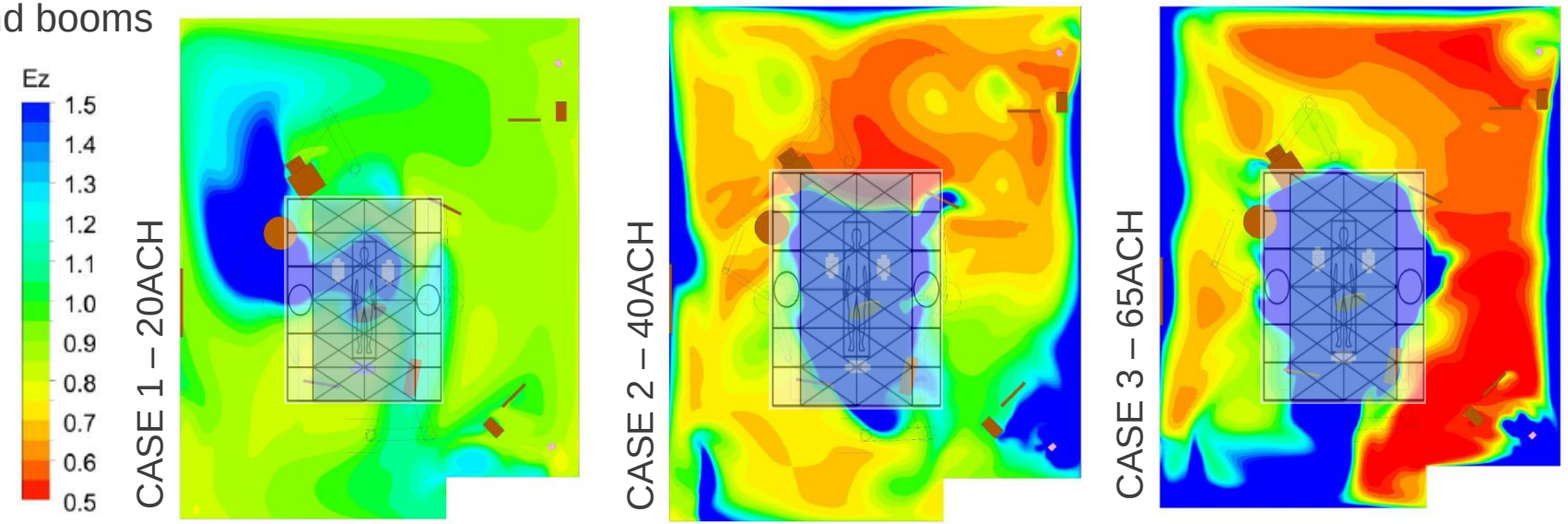


Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

Reduce Particle Counts – Increased ACH

- Case 1 – small area of high ventilation effectiveness over the table.
- Case 2/3 – largest area of high ventilation effectiveness air over the table, surgical staff and booms



Ventilation Effectiveness (Ez) 43” Above Floor

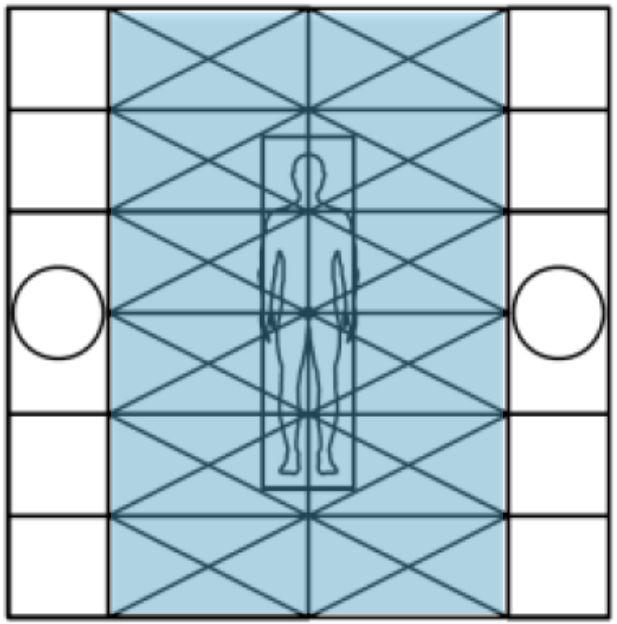
Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

Improve Thermal Comfort – Decrease SA ∆T

- 720 ft^2 OR with 10’ ceilings
- 100% diffuser table coverage
- Supply Air Temp varied for constant room load

- **Case 1: 20 ACH, 2400 CFM** (1130 L/s)**, 57.9°F** (14.3°C) **SAT**
- **Case 2: 40 ACH, 4800 CFM** (2270 L/s)**, 63.5°F** (17.5°C) **SAT**
- **Case 3: 65 ACH, 7800 CFM** (3680 L/s)**, 65.4°F** (18.6°C) **SAT**



$$Q = \rho \times \mathbf{V} \times \mathbf{\Delta T}$$

Q = Cooling load
ρ = Density of air
V= Volume of airflow
ΔT = Temperature differential between supply air and room air

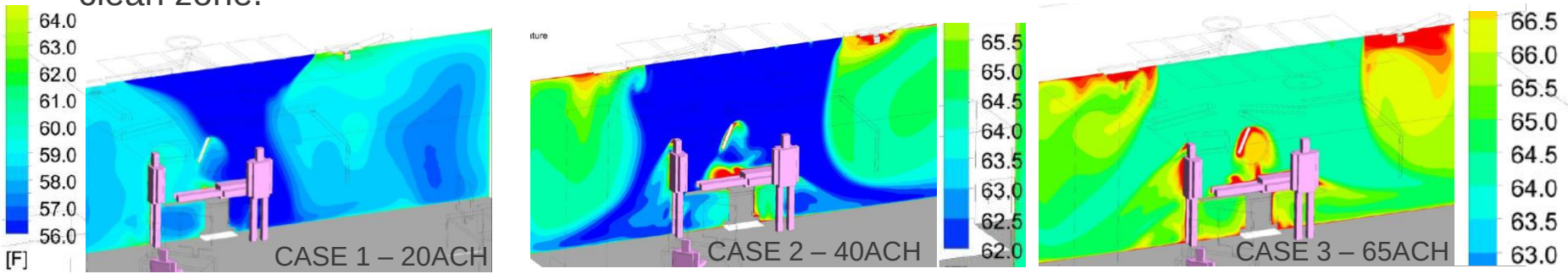
Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

Improve Thermal Comfort – Decrease SA ΔT

Temperature Plot in Vertical Plane

- Case 1 – Predominantly 56°F (13.3°C) over patient, 60°F (15.5°C) over surgical team (notably colder over patient than surgical team). Greater SA ΔT results in airflow taper and narrow clean zone.
- Case 2/3 – 62°F/64°F (16.7°C/17.8°C) over patient and surgical team (greater temperature consistency throughout room). Smaller SA ΔT results in wider airflow pattern and larger clean zone.



Temperature in Vertical Plane

Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

- **Improve Thermal Comfort – Decrease Noise Levels**

There are two “optional guidelines” as it directly relates to HVAC acoustics in operating rooms under the Facility Guidelines Institution (FGI 2022 version):

- **1.2-6.1.3b Design criteria for Acoustic surfaces**. “Operating Rooms and Class 3 Imaging rooms should be designed to reduce reverberation, noise buildup, and noise-related fatigue. The design minimum room absorption coefficient in operating rooms should be 0.10.
- **1.2-6.1.4.1 Design Criteria for Room Noise Levels in operating rooms**. Room noise levels caused by HVAC and other building systems shall not exceed the maximum values shown in table 1.2-5:

Table 1.2-5

Maximum Design Criteria for Noise in Interior Spaces Caused by Building Systems[1]

Room Type	NC[2,3]	dBA
Patient Care Units		
Patient room	40	45
NICU sleep area	30	35
NICU staff and family areas	35	40
Quiet room[4]	—	—
Diagnostic and Treatment Locations		
Multiple-occupant patient care area	45	50
Exam/treatment room	40	45
Procedure room	40	45
Class 2 imaging room	40	45
Operating room[5]	50	55
Class 3 imaging room[5]	50	55
Telemedicine room	25	30
Support Areas		

Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

- **Improve Thermal Comfort – Decrease Noise Levels**

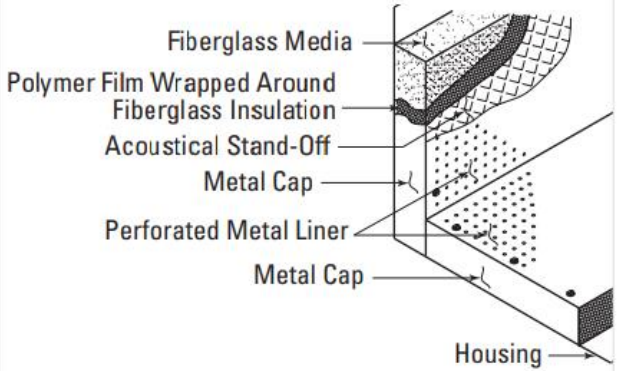
SILENCERS

- **Polymer Film Encapsulated Liner**

The PL Liner System complies with the following industry standards and tests:

+ UL 181 (Air Erosion)
+ UL 181 (Mold Growth and Humidity)
+ UL 723 (25/50) (Flame and Smoke)
+ ASTM E 84 (25/50) (Flame and Smoke)
+ ASTM C 665 (Fungi Resistance)
+ ASTM C 1071 (Physical Properties)
+ NFPA90A (Flame and Smoke)

- **Locate on inlet and outlet of fan coil units**



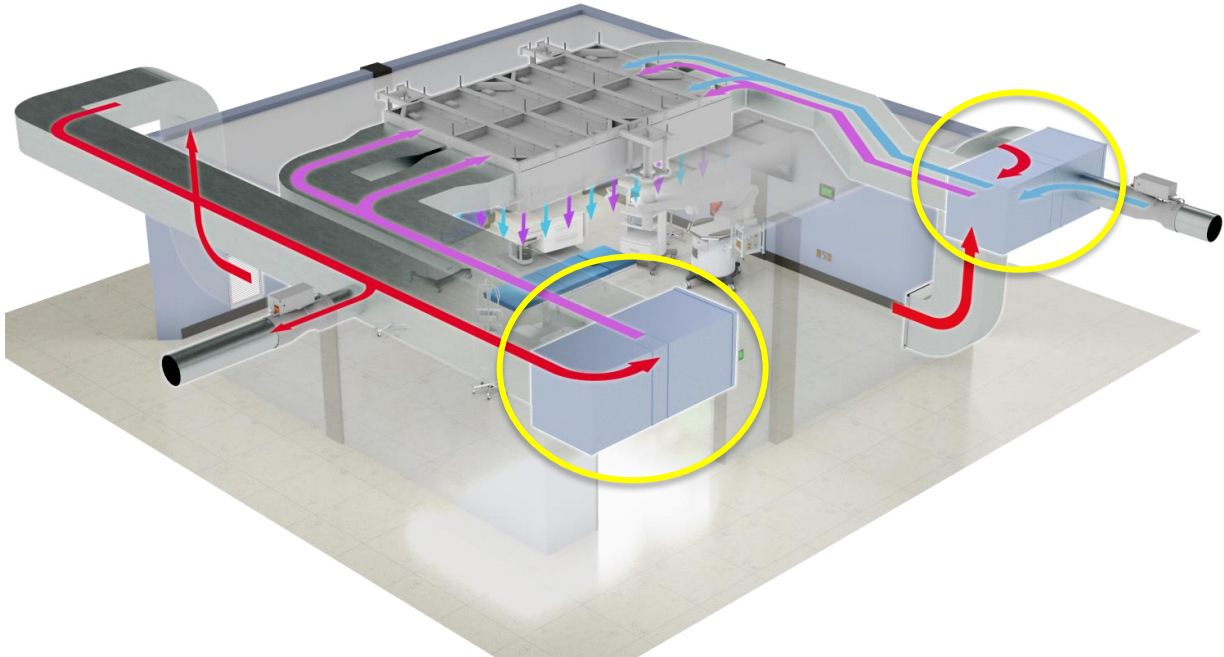
PL Polymer Film Liner

Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design

3. Improve Temperature Control

- **Locally recirculate airflow through dedicated Fan Coils**
  - –High ACH allows rapid room temperature adjustment
  - –Fan coils provide capacity for increased ACH
    - Maintain minimum outdoor air from central AHU
    - Recirculated air passes through a HEPA filter to meet ASHRAE 170 recirculation criteria



Going Beyond ASHRAE 170 Design Minimums

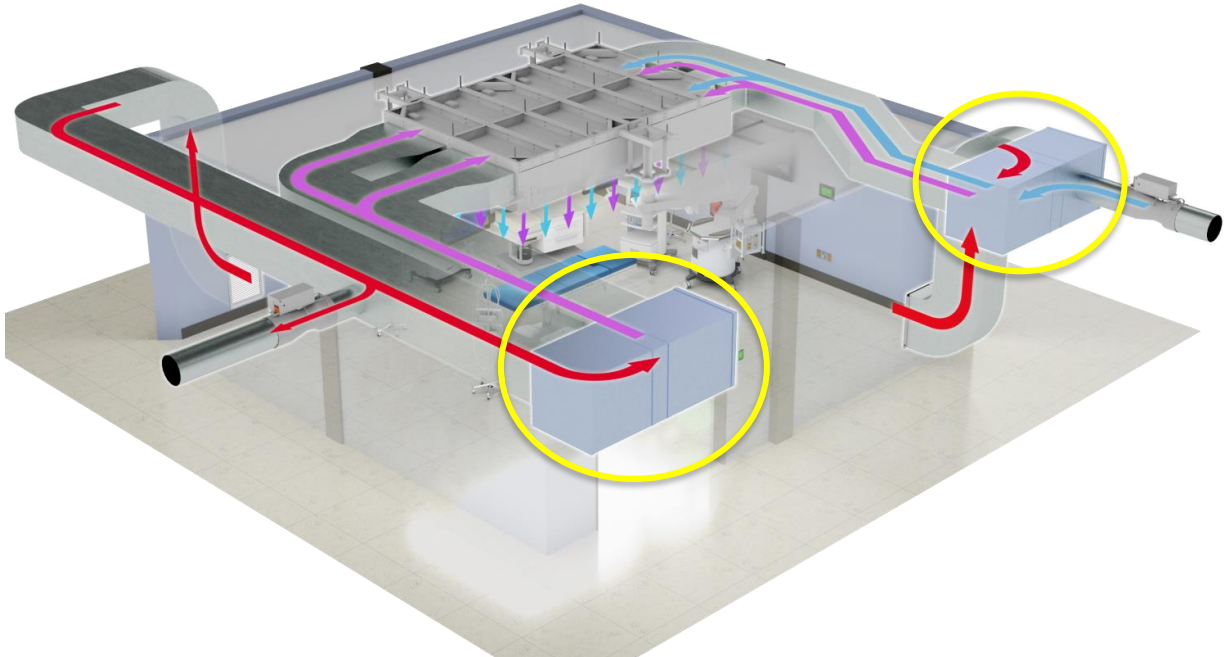
Advanced Operating Room Design

3. Improve Temperature Control

- **Locally recirculate airflow through dedicated Fan Coils**

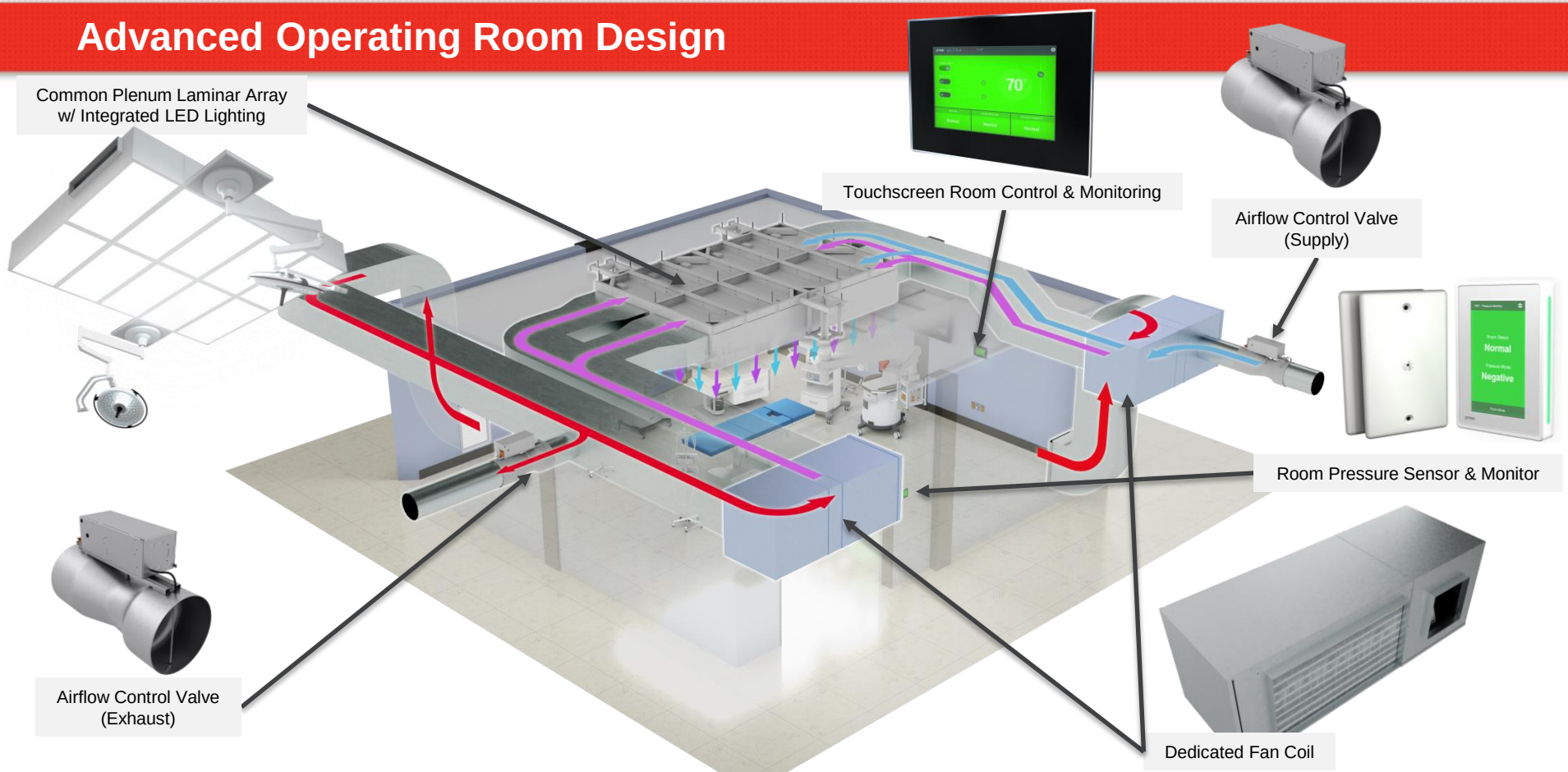
Added Benefit:
Reduced ductwork and energy consumption compared to central AHU w/ high ACH

- With central AHU if significant cooling is required in one OR all other spaces will require reheat
- Less fan power required due to decreased air pressure drop associated with decentralized system



Going Beyond ASHRAE 170 Design Minimums

Advanced Operating Room Design



Operating Room Design:
Going Beyond ASHRAE 170 Design Minimums

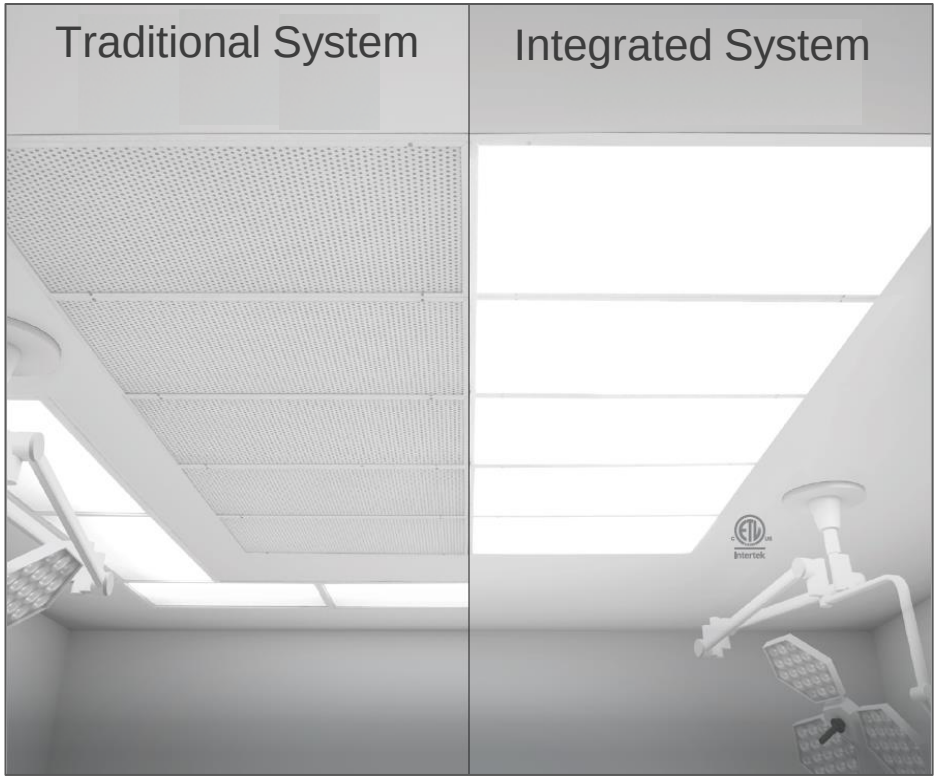
Integrated Operating Room Ceiling Systems

Going Beyond ASHRAE 170 Design Minimums

Integrated Operating Room Ceiling Systems

Integrated Lighting and Airflow

- Conserve ceiling space for simplified coordination and installation of ceiling mounted equipment
- Position lighting and airflow directly above the patient table for particulate control and improved visibility



Going Beyond ASHRAE 170 Design Minimums

Integrated Operating Room Ceiling Systems

High Quality Lighting

- Reduce shadows on the workspace
- Large light emitting surface reduces glare and associated eye strain

IES-RP-29-20 Lighting for Hospitals and Health Care Facilities

- Direct glare can be mitigated by diffusing brightness over larger surface areas.
- When designing lighting to support the function of healthcare facilities, the designer should consider that glare-free lighting improves visual acuity and reduces eye strain

https://store.ies.org/product/rp-29-20-recommended-practice-lighting-hospital-and-healthcare-facilities/

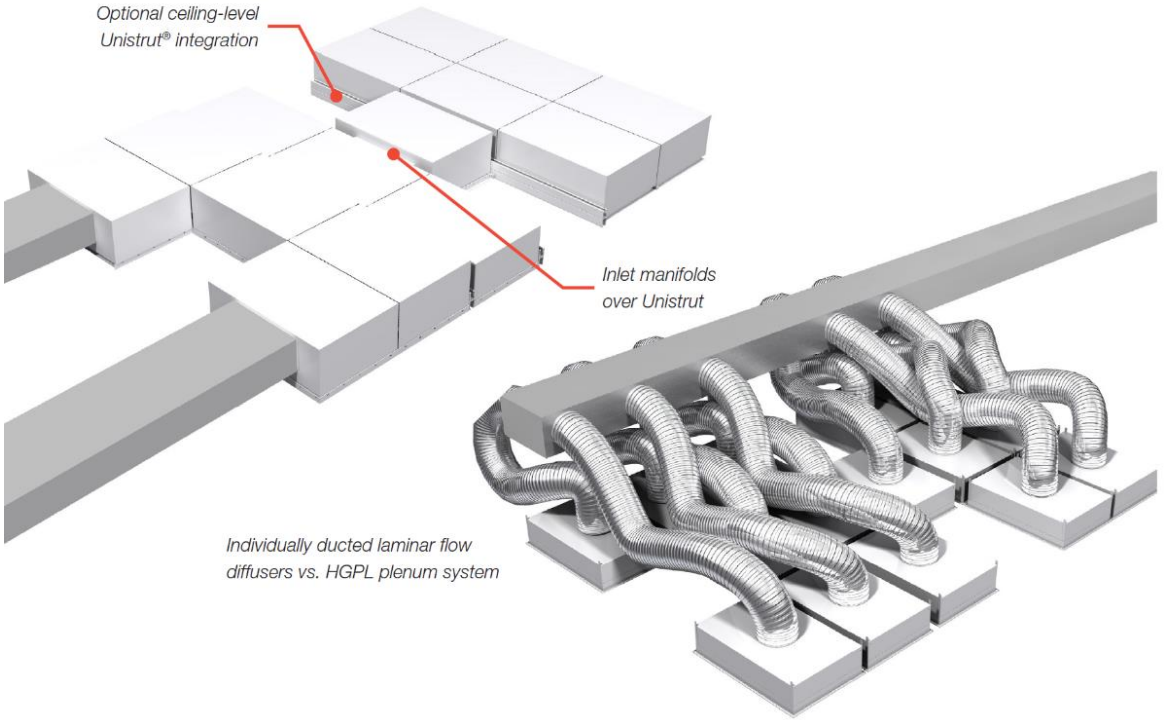
Lakewood Ranch Medical Center | Lakewood Ranch, FL

Going Beyond ASHRAE 170 Design Minimums

Integrated Operating Room Ceiling Systems

Common Plenum Laminar Array

- Shared air across full array
- Reduces inlet connections
  - Typically ~8:1
- Side inlet reduces height requirement
  - Standard 16”
  - Low Profile 12”



Going Beyond ASHRAE 170 Design Minimums

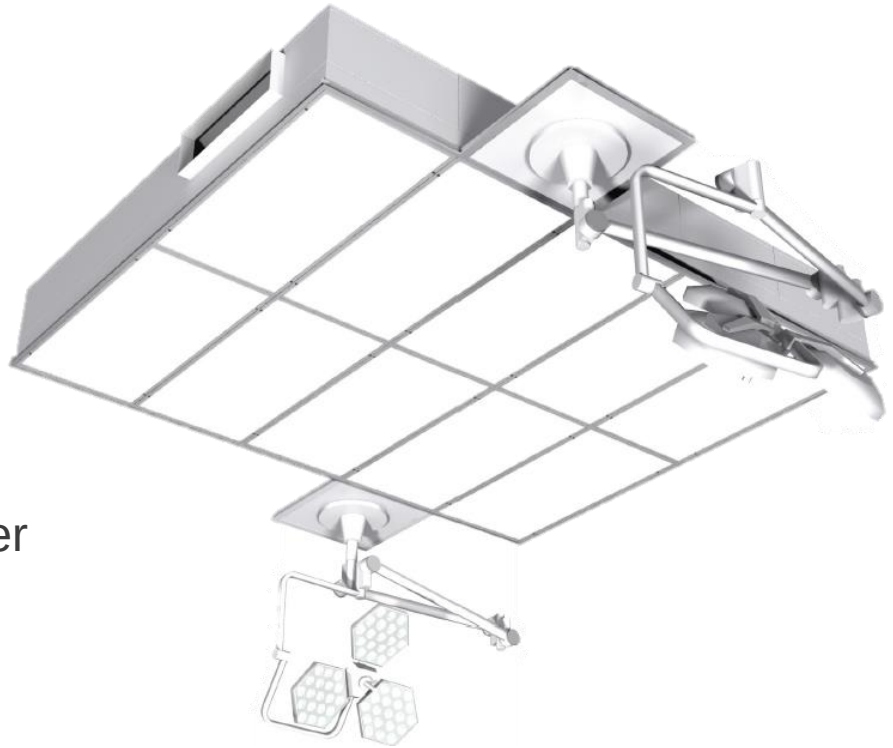
Integrated Operating Room Ceiling Systems

Equalized Laminar Array

- Equalized laminar airflow for optimal particulate control
- Prioritize easy-balancing or self-balancing capabilities

Customizable

- Size and configuration of modules
- Optional room-side replaceable HEPA filter
- Optional non-ferrous construction for MRI

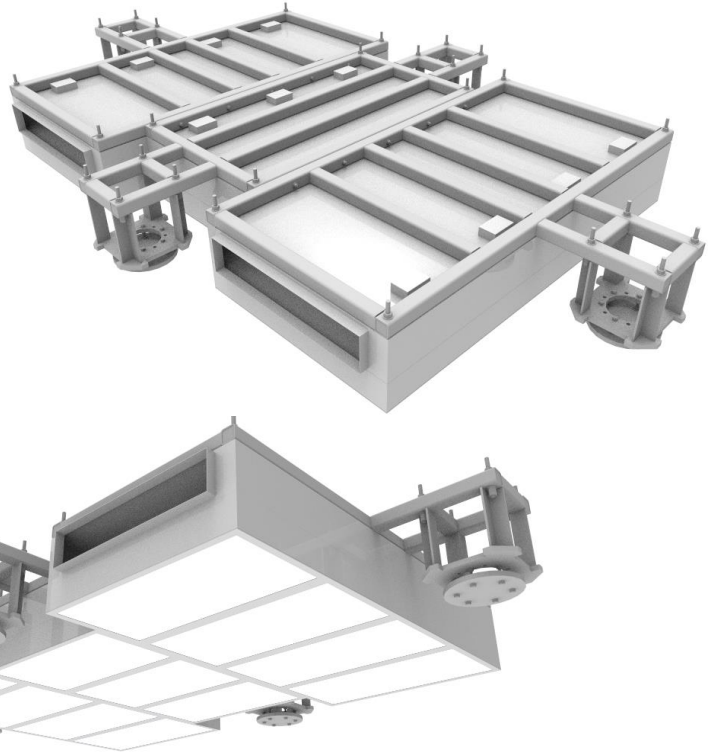


Going Beyond ASHRAE 170 Design Minimums

Integrated Operating Room Ceiling Systems

Optional Integrated Structural

- Designed to support booms and rolling loads of medical equipment to building deck through threaded rod
  - –Maintain equalized lighting
  - –Maintain modular design and flexibility through design process
  - –Minimal height increase (3”-5”)
  - –Provide stamped structural drawings



Going Beyond ASHRAE 170 Design Minimums

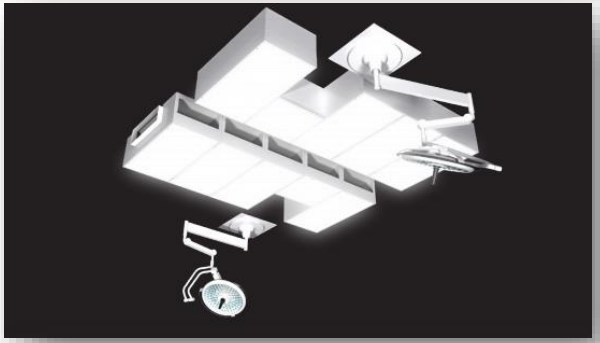
Integrated Operating Room Ceiling Systems

Fast and Easy Installation

- Large, factory pre-assembled sections minimize installation time on site

Simple Maintenance

- Room-side accessible
  - Aperture plate damper
  - Optional integrated HEPA filter
  - LED lights
- Optional remotely mounted components
  - Driver cabinets



Going Beyond ASHRAE 170 Design Minimums

Integrated Operating Room Ceiling Systems

System Benefits

- Reduced congestion
  - Accommodate medical equipment and ASHRAE 170 table coverage
- Reduced design efforts
  - Manufacturer creates design based on reflected ceiling plan, medical equipment drawings, mechanical drawings
- Single source supply
  - Reduced coordination between trades
  - Simplified timeline management
  - Seamless fit-up/installation on site
- Faster installation
  - Pre-fab modules reduce installation time

Overlake Medical Center | Bellevue, WA

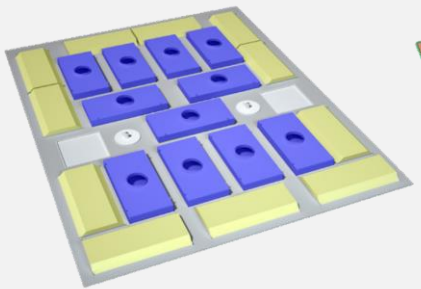
Going Beyond ASHRAE 170 Design Minimums

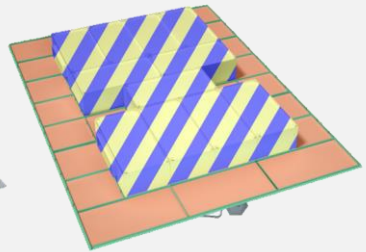
Integrated Operating Room Ceiling Systems

Cost Considerations

- Integrated ceiling systems have a higher equipment cost, but considerably lower installation cost than traditional options.
  - Results in neutral or reduced overall cost
- Integrated systems offer additional benefits
  - Reduced ceiling congestion and ductwork
  - Lighting and airflow directly over patient table
  - Single source supply
- Can save weeks of installation time
  - Downtime is costly, OR generate ~$90K per day

Hard Ceiling, Surface Mount Diffusers	Integrated System, Perimeter Drywall
Equipment: X	**Equipment: 2.23X**
Install: Y	**Install: 0.22Y**
Total: Z	**Total: 0.97Z**





Assumes $175/hour labor

Operating Room Design:
Going Beyond ASHRAE 170 Design Minimums

Summary

Going Beyond ASHRAE 170 Design Minimums

Summary

Patients

- Risk of surgical site infections
- Risk of hypothermia

Surgical Staff

- Working conditions & indoor environmental quality
  - Exposure to surgical smoke
  - Thermal comfort
  - Lighting quality and visibility
- Rapid heat/cool changeover for surgical procedures

Facilities Staff

- Accessible maintenance
- Sanitation procedures

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Summary

Patients

- Increase ACH reduces particle concentrations
- Reduced SA ΔT improves temperature consistency

Surgical Staff

- Working conditions & indoor environmental quality
  - Exposure to surgical smoke
  - Thermal comfort
  - Lighting quality and visibility
- Rapid heat/cool changeover for surgical procedures

Facilities Staff

- Accessible maintenance
- Sanitation procedures

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Summary

Patients

- Increase ACH reduces particle concentrations
- Reduced SA ΔT improves temperature consistency

Surgical Staff

- Increase ACH quickly evacuates surgical smoke
- Reduced SA ΔT improves temperature consistency
- Integrated ceiling system locates lighting and airflow over patient table
- Dedicated fan coils make rapid heat/cool changeover possible

Facilities Staff

- Accessible maintenance
- Sanitation procedures

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Summary

Patients

- Increase ACH reduces particle concentrations
- Reduced SA ΔT improves temperature consistency

Surgical Staff

- Increase ACH quickly evacuates surgical smoke
- Reduced SA ΔT improves temperature consistency
- Integrated ceiling system locates lighting and airflow over patient table
- Dedicated fan coils make rapid heat/cool changeover possible

Facilities Staff

- Integrated ceiling system can provide room-side or remotely accessible maintenance

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Summary

Design Team

- Ceiling complexity
- Constrained infrastructure
- Room heat/cool changeover
- Visibility and lighting quality
- Energy efficiency

Hospital Owner

- Renovation downtime and maintenance costs
- Attraction & retention of surgical staff
- Surgical site infections and associated costs

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Summary

Design Team

- Integrated ceiling system conserves ceiling space, reduces ductwork, locates lighting over patient table
- Dedicated fan coils allow rapid heat/cool changeover w/ less energy than central AHU

Hospital Owner

- Renovation downtime and maintenance costs
- Attraction & retention of surgical staff
- Surgical site infections and associated costs

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Summary

Design Team

- Integrated ceiling system conserves ceiling space, reduces ductwork, locates lighting over patient table
- Dedicated fan coils allow rapid heat/cool changeover w/ less energy than central AHU

Hospital Owner

- Integrated ceiling system promotes fast installation
- High ACH OR design reduces particulate, quickly evacuates surgical smoke, promotes thermal comfort

St. Michael's Hospital | Toronto, ON

Going Beyond ASHRAE 170 Design Minimums

Learning Objectives

By the end of this presentation, participants will be able to:

1. Explain the current ASHRAE 170 guidelines for operating rooms
2. Discuss the benefits of high air change operating room systems on particulate control
3. Understand impact of air distribution on hospital staff and patients (thermal comfort, surgical smoke, etc.)
4. Discuss the benefits of integrated ceiling systems in OR design

Overlake Medical Center | Bellevue, WA

Going Beyond ASHRAE 170 Design Minimums

References

- Centers for Disease Control and Prevention, *Guideline for the Prevention of Surgical Site Infection, 2017* - https://jamanetwork.com/journals/jamasurgery/fullarticle/2623725
- Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, *Health and Safety Practices Survey of Healthcare Workers - Surgical Smoke* - https://www.cdc.gov/niosh/topics/healthcarehsps/smoke.html
- Airborne Contamination of Wounds in Joint Replacement Operations: The Relationship to Sepsis Rates - https://pubmed.ncbi.nlm.nih.gov/6195220/
- ASHRAE Research Project Report, *Academic Research to Support Facility Guidelines Institute & ANSI/ASHRAE/ASHE Standard 170* - https://www.ashrae.org/file%20library/technical%20resources/covid-19/ashrae-d-co-rp3.pdf
- Surgical Smoke Codes and Safety Issues, 2024 - https://www.hfmmagazine.com/articles/4967-surgical-smoke-codes-and-safety-issues
- ASHRAE Standard 170-2021 Ventilation of Health Care Facilities - https://www.techstreet.com/ashrae/standards/ashrae-170-2017?product_id=1999079&ashrae_auth_token=12ce7b1d-2e2e-472b-b689-8065208f2e36
- NSW Health Infrastructure Engineering Services Guideline, 2016 - https://healthfacilityguidelines.com.au/news/new-reference-nsw-health-infrastructure-engineering-services-guideline
- Health Technical Memorandum 03-01 Specialised Ventilation for Healthcare Premises Part A, 2021 - https://www.england.nhs.uk/publication/specialised-ventilation-for-healthcare-buildings/
- ISO 14644-1:2015 Cleanrooms and Associated Controlled Environments - Part 1: Classification of Air Cleanliness by Particle Concentration - https://www.iso.org/standard/53394.html
- ANSI/IES-RP-29-16 Lighting Hospital and Healthcare Facilities - https://store.ies.org/product/rp-29-20-recommended-practice-lighting-hospital-and-healthcare-facilities/