Design, Commissioning and Testing of Operating Theatres & Isolating Rooms in Norway
Design, Commissioning and Testing of Operating Theatre & Isolating Rooms in Norway

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Senior advisor, Healthcare engineering
Norwegian Hospital Construction Agency
AGENDA

1. Background
   - St.Olavs Hospital
   - Cancer scandal
2. Operating theatres
3. Knowledge centre
   - Isolating care unit
4. Test program
   - IQ/OQ
   - PQ
5. Lessons learned
ST. OLAWS HOSPITAL
ST. OLAWS HOSPITAL

1999 Foto: St. Olavs Hospital

2014
ST. OLAVS HOSPITAL
OPERATING THEATRES

- TECHNICAL
- WARDS
- WARDS
- WARDS
- ROOF GARDEN
- BRIDGE
- UNIVERSITY
- TECHNICAL
- BRIDGE
- BRIDGE
- SURGERY
- BRIDGE
- ENTRANCE
- OUTPATIENTS
- GARDEN
- CULVERT
- TECHNICAL AREA
- CULVERT
- E6
- E5
- E4
- E3
- E2
- E1
- U1

SYKEHUSBYGG
OPERATING THEATRES
OPERATING THEATRES

Design
- Ceiling supply units
- 10 CFU / 100 CFU
- Downflow ~ 0,28 m/s
- Air tight rooms
- Overpressure (5 – 10 Pa)
- 2 AHUs to serve all theatres

Testing
- Room tightness
- HEPA-filter test
- Recovery test
- Air velocity
- Functionality
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Air Flow Requirements</td>
<td>8 templates Min. 0.65m3/s (22 ACH)</td>
<td>Class 1b Min. 2400m3/h (22 ACH)</td>
<td>Class A Min. 15 ACH</td>
<td>2400m3/h 20 ACH</td>
<td>20 ACH</td>
<td></td>
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<tr>
<td>2. Pressure Requirements</td>
<td>25 Pa</td>
<td>Positive</td>
<td>Positive &amp; 15% surplus air</td>
<td>+ve $\Delta P$ 1.25 mm H$_2$O</td>
<td>Positive (5-10 Pa)</td>
<td></td>
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<tr>
<td>3. Filtration</td>
<td>HEPA H13</td>
<td>HEPA H13/H14</td>
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<td>HEPA H14</td>
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<tr>
<td>4. Location of supply</td>
<td>Ceiling</td>
<td>Ceiling</td>
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<td></td>
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<tr>
<td>5. Return/Exhaust location</td>
<td>Low level</td>
<td>Min. 1200m3/hr to be returned/exhaust air low level</td>
<td>At least 2 locations near the floor</td>
<td>Low Level (clean room standard)</td>
<td>2/3 low level 1/3 at the ceiling</td>
<td></td>
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<tr>
<td>6. Set back</td>
<td>Not stated</td>
<td>Enough to maintain $\Delta P$</td>
<td>25% of design flow</td>
<td>-----</td>
<td>1/3 of design flow</td>
<td></td>
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<td>7. Min. outdoor air</td>
<td>-Building Regulation Part F -CIBSE’s guide</td>
<td>Min 1200 m3/h</td>
<td>Min. 5 air changes/hr</td>
<td>5-10 ACH</td>
<td>20 ACH</td>
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<td>8. Site acceptance test</td>
<td>-Smoke test -BCP test in operation with clothing (&lt;180 CFU/m3)</td>
<td>Leakages test on HEPA filter Measurements of particles</td>
<td>?</td>
<td>- Scan test (particles) - Velocity uniformity</td>
<td>HEPA-filter test (ISO 14644-3) Recovery test</td>
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## ULTRA CLEAN/HIGH STERILITY OPERATING THEATRES

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<td><strong>1. Air Flow Requirements</strong></td>
<td>Ceiling size 2800x2800mm 0.38 m/s velocity</td>
<td>Class 1a Min. 9200m3/h 3200x3200 mm</td>
<td>Class B &amp; C Min. 20 ACH</td>
<td>Class 100 Design Velocity: 0.35m/s velocity</td>
<td>Air velocity 0.25 – 0.28 m/s</td>
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<td>25 Pa</td>
<td>Positive</td>
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<td><strong>5. Return/Exhaust location</strong></td>
<td>Ceiling return/exhaust next to supply ceiling shown on drawings</td>
<td>Min. 1200m3/hr low level</td>
<td>At least 2 locations near the floor</td>
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<td>-Leakage test on HEPA filter -Velocity -BCP test (&lt;10CFU/m3)</td>
<td>-Leakage test on HEPA filter -Flow visualization -degree of protection -turbulence</td>
<td>?</td>
<td>-class 100 scan test -velocity uniformity test</td>
<td>HEPA-filter test (ISO 14644-3) Recovery test Air velocity</td>
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PREVIOUS CANCER SCANDAL

The university’s former laboratories without proper safety ventilation

These working conditions led to several cancer diseases and even some deaths

The headmaster had to apologize in public
KNOWLEDGE CENTRE

- TECHNICAL AREA
- ISOLATING CARE UNIT
- WARDS
- WARDS
- BRIDGE
- BRIDGE
- ROOF GARDEN
- UNIVERSITY LABS
- BRIDGE
- STUDENT AREAS
- BRIDGE
- ENTRANCE
- GARDEN
- CULVERT
- TECHNICAL AREA
- CULVERT

SYKEHUSBYGG
BSL3 ISOLATING ROOMS
BSL3 ISOLATING ROOMS

SLUICE

WC/SHOWER

ISOLATING ROOM
BSL3 ISOLATING ROOMS
TECHNICAL AREAS
TEST PROGRAM

Validation "light"
- DQ, IQ, OQ, PQ

Risk analysis - containment
- Personnel
- Surroundings
TEST PROGRAM

IQ - Installation qualification

- room tightness
- duct tightness
- surfaces
TEST PROGRAM

OQ - Operational qualification
- air flow rates
- HEPA-filter
- electrical/water/gas supply
- door interlock
- communication system
- light
- sound pressure
TEST PROGRAM

PQ - Performance qualification
  • fire safety/fire alarm
  • electrical supply
  • technical failures
  • containment test
  • recovery test/internal airflow pattern
  • external airflow pattern (CFD)
  • temperature stability

Pressure cascade
- 5 unique tests
- 3 successful tests
SWITCHING THE SYSTEM OFF AND ON

0 Pa

-15 Pa

-30 Pa
ENTERING THROUGH THE DOORS

Corridor door

Room door

Emergency state

0 Pa

-15 Pa

-30 Pa
FAILURE – AIR SUPPLY FAN
FAILURE – EXHAUST FAN A
FAILURE – EXHAUST FAN B

0 Pa

-15 Pa

-30 Pa
FAILURE – BOTH EXHAUST FANS

0 Pa

-15 Pa

-30 Pa
SWITCHING: ISOLATING – NORMAL MODE
LESSONS LEARNED

- Enough space for technical systems
- Separate AHUs for each
  - Operating Theatre
  - Isolating Care Unit
- Technical infrastructure – accepted
- Validation "light" – no good idea....
THANK YOU FOR YOUR ATTENTION