MEP System Design for Infection Control

Air Entrainment

CFD Modeling/Air Dispersion Studies
Generator Exhaust
Cooling Towers
Cogen Stack
All Exhaust Fans
Amtrak Vent Towers
MEP System Design for Infection Control

Air Entrainment

CFD Modeling/Air Dispersion Studies
Generator Exhaust
Cooling Towers
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Amtrak Vent Towers
FDR Drive
MEP System Design for Infection Control

Air Entrainment

CFD Modeling/Air Dispersion Studies
Generator Exhaust
Cooling Towers
Cogen Stack
All Exhaust Fans
Amtrak Vent Towers
FDR Drive
Heliport
Air Handling Systems

Operational Flexibility
- Multi-mode capability

Normal Mode
- Mixed air/ slight positive

Isolation Mode
- Full negative floors

Emergency/Triage/Outbreak Mode
- 100% OA/ 100% exhaust
MEP System Design for Infection Control

Patient Bed Floor – Pressure Relationships

- Red: Airborne Infection Isolation
- Blue: Protective Environment
Mechanical

Acute Care/ICU Rooms

Individual (Patient-Controlled) Room Environmental Conditions
- Temperature
- Lighting
- Shades

Perimeter Radiant Heat (Ceiling-Mounted)
- Continuous cleanable floor surface

VAV Tracking Pairs
- Maintain room at neutral or slight positive
- Interlocked with radiant panel – no simultaneous heating/cooling

All patient care spaces are humidified to 30% RH
Mechanical

Protective Environment Room

Individual room environmental controls and heating similar to acute care patient rooms

Rooms are maintained under positive pressure
  - Tracks pressure monitoring through BMS
  - Adjusted to maintain positive pressure to a designed set point

Supply air located over patient bed
  - HEPA filter capable
  - Low velocity non-aspirating
Mechanical

Airborne Infection Isolation Room

Individual room environment control and heating similar to acute care patient rooms

Rooms are maintained under negative pressure

- Track pressure monitoring through BMS
- Pressure monitors at patient/ante and ante/corridor

Dual (N+1) exhaust fans

- Fans located at roof
- Bag-in/bag-out HEPA filters
Mechanical

Airborne Infection Isolation/Protective Environment (All/PE) Room

Individual room environmental control and heating similar to acute care patient rooms

Rooms are maintained under positive pressure
- Track pressure monitoring through BMS
- Pressure monitors at patient/ante and ante/corridor
- Anteroom maintained under negative pressure

Supply air located over patient bed
- HEPA filter capable
- Low velocity non-aspirating
**MEP System Design for Infection Control**

**Water Quality – Disinfection**

- Initial domestic water disinfection
- Chemical treatment for cooling towers
- Copper silver ionization installed on all hot water circulation systems
  - Mitigates biofilm in the pipe system
- Domestic Hot Water System distribution of 140°F
  - Kills Legionella

<table>
<thead>
<tr>
<th>How Temperature Affects Legionella</th>
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<tr>
<td>Above 158°F</td>
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<tr>
<td>At 140°F</td>
</tr>
<tr>
<td>At 131°F</td>
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<tr>
<td>Above 122°F</td>
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<tr>
<td>Above 68°F - 113°F</td>
</tr>
<tr>
<td>Below 68°F</td>
</tr>
</tbody>
</table>

**STEP 1**
- Water passes through the flow cell chamber

**STEP 2**
- A direct current is applied across the electrodes, creating positively charged copper silver ions

**STEP 3**
- The ions seek out bacteria throughout the plumbing system, providing ongoing disinfection
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Water Quality – Pipe Distribution

- Laminar water flow at all lavatory fixtures
  - Mixing valves to prevent scalding
  - "Hands Free" sensor-type fixtures

- Hot water system – centralized
  - Full recirculation (no pipe heat tracing)

- Hot water “series” pipe distribution
  - Limit dead legs to 6 in. maximum
  - Code maximum is 20 ft.
MEP System Design for Infection Control

Water Quality – Filtration

Storm Water Reclamation System
- Used for cooling tower makeup
- 40 micron filter pods
- Ultraviolet Disinfection
  - Inactivation of pathogens, viruses and bacteria
# MEP System Design for Infection Control

## MEP Systems Redundancy/Resiliency

### MECHANICAL SYSTEMS

<table>
<thead>
<tr>
<th>System</th>
<th>Redundancy</th>
<th>On EPS Power</th>
<th>Resiliency Measures</th>
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<tbody>
<tr>
<td>Chiller Plant</td>
<td>N + 1 and Export</td>
<td>2 Chillers</td>
<td>Air-cooled chillers for IT load backup</td>
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<tr>
<td>Chilled Water Pumps</td>
<td>N + 1 and Export</td>
<td>2 Pumps</td>
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<tr>
<td>Cooling Towers/Makeup Pumps</td>
<td>N + 1 and Export</td>
<td>2 CT's</td>
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<td>Hot Water Heating Pumps</td>
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<td>Bed Floor AHU’s</td>
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<td>Units are headered together</td>
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<tr>
<td>Peri OP/ Post OP AHU’s</td>
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<td>Yes</td>
<td>Units are headered together</td>
</tr>
<tr>
<td>OR AHU’s</td>
<td>N +</td>
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<td>Units are headered together</td>
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<tr>
<td>All Exhaust Fans</td>
<td>N + 1</td>
<td>Yes</td>
<td>-</td>
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<tr>
<td>System</td>
<td>Redundancy</td>
<td>Resiliency Measures</td>
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<td>-------------------------</td>
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<td>-------------------------------------------------------------------------------------</td>
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<tr>
<td>Generators</td>
<td>N + 1</td>
<td>The (N + 1) generator can power standby loads for extended periods of loss of utility</td>
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<tr>
<td>Reciprocating Cogen</td>
<td>N</td>
<td>Ability to operate in island mode</td>
<td></td>
</tr>
<tr>
<td>Normal Power (Central Transformers)</td>
<td>N + 2</td>
<td>Any two transformers can be fully isolated for maintenance without affecting system operation</td>
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<tr>
<td>Normal Power (Double-Ended Substations)</td>
<td>2N</td>
<td>Each substation transformer can be isolated for system maintenance without affecting system operation</td>
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<tr>
<td>Turbine Cogen</td>
<td>N</td>
<td>Ability to operate in island mode to provide electric and steam upon loss of utilities</td>
<td></td>
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</table>
Infection Prevention & Design
Medical Planning & Interiors
Building Organization

- Mechanical
- Adult Inpatient Acute Floors
- Adult Inpatient ICU Floors
- Pediatric Inpatient Floors
- Café, Conference, & Children's Center
- Mechanical
- Procedure Floors
- Lobby, Building Support
Vertical Circulation

19 ELEVATORS (TOTAL)
- 4 VISITOR ELEVATORS
- 2 PEDIATRIC ELEVATORS
- 4 PATIENT ELEVATORS
- 4 SERVICE ELEVATORS
- 2 SPD CASE CART ELEVATORS (1 CLEAN, 1 DIRTY)
- 1 SPD DUMBWAITER (SPD TO CLEAN CORES)

OTHER
- PNEUMATIC TUBE
  - 2 PER INPATIENT FLOOR (TYPICAL)
  - 3 PER PROCEDURE FLOOR (TYPICAL)
- GRAVITY CHUTES
  - 1 LINEN PER FLOOR
  - 1 TRASH PER FLOOR
Procedure Floors
Procedure Floors: Infection Prevention Considerations

- Separation of populations - Clear public/visitor front of house, from clinical/service back of house
- Interventional rooms (Cath, EP) behind the red line, designed as Class 3 Imaging/Hybrid
- MRIs designed as Class 3 Imaging/Hybrid
- Continual forward flow of instruments and equipment from SPD (clean) to Clean Core to ORs, and return to SPD (decontamination)
- Clean core design with OR storage refined through Lean process
- Location of control station in the OR to best monitor adherence to IP protocol
- One centralized surgical locker rooms with interconnecting stairs
- Each peri-op unit floor has 1 specialty room (Air-borne Infection Isolation)
- Pre-fabrication of OR ceilings + headwalls
Procedure Base

LEVEL 5
PROCEDURES

LEVEL 4
PROCEDURES

LEVEL 3
STERILE PROCESSING

POST PROCEDURE
OBSERVATION

LEVEL 2
PROCEDURES

CLEAN
SOILED
Inpatient Floor: Metrics
Inpatient Floors: Infection Prevention Considerations

- Clearly defined on- and off-stage areas and circulation, minimizes mixing of populations
- Duplication of clinical support programs (one per side of clean, soiled, med), reducing # of patient rooms being supported from each, ability to create 2 units per floor
- Trash and Linen chutes in within soiled rooms
- Each inpatient floor has minimum of 4 specialty rooms (Air-borne Infection Isolation), some with additional specialty rooms (Protective Environment & Combination AIIR/PE)
- AIIR & PE/AIIR rooms have full ante-rooms
- Decentralized patient supplies outside each patient room refined through Lean process
- Dialysis boxes in 100% of ICU rooms, and 10% of acute rooms
Inpatient Floor: On-stage, off-stage, flows
Inpatient Floor: Clinical Integration Center
Patient Room: Typical
Patient Room: Decisions

1. Ceiling Zone
   The patient zone ceiling contains utilities and infrastructure that are fully accessible through the ceiling tiles. The ceiling tiles are specially designed for healthcare settings, which are anti-microbial, cleanable, and provide high levels of acoustic absorption.
   The ceiling assembly incorporates supply and return diffusers, reading and exam lights, ambient lighting, ceiling mount patient lifts.

2. Access to Natural Light
   Expansive windows provide views of the city and river. Clinical studies show benefits for both patients and staff when given access to natural light.

3. Functional Headwall
   High acuity demands readily accessible gases, electrical outlets, etc. These are neatly organized in a stainless steel band which is embedded in a custom laminate wood tone headboard. The headwall contains a pillow speaker and patient reading light controls for patient controllability.

4. Flexible Footwall
   Designed to accommodate technology in the future, the footwall has a designated area for the markerboard, clock, room identification signage and monitor. The monitor can be used for entertainment, but also may be a place for health education, MD consult (video conference), food menu and ordering and have the ability to connect to personal devices to customize the patient room.

5. Surfaces and Details
   All surfaces are non-porous, durable and easily cleanable. Cabinetry is plastic laminate and in areas where impact is concerned, solid surface (Corian) is used for cabinet fronts. All finishes are reviewed for infection control.

6. Rubber Flooring
   The floors are rubber tile and sheet (ICU) which provides additional underfoot comfort and acoustic absorption. Rubber flooring does not require additional wax finish and has a non-porous surface.

7. Clinical Work Zone
   Contains a handwash sink (integrated solid surface sink with full solid surface countertop), trash receptacle, Workstation on Wheels, and cabinetry for clinical supplies (developed by multidisciplinary teams based on LEAN principles).

8. Mobile Clinical Workstation
   Chosen by multidisciplinary teams including IT, EPR, clinicians, pharmacists and leadership for its flexibility, ease of replacement and adaptability for future technology. The workstation can be moved from docking station to headwall, eliminating the need for a permanent workstation at the headwall. The workstation supports inclusive rounding in teaching hospitals.

9. Med/Supply Cabinet
   Located outside the patient room, the cabinet can be accessed and restocked without disturbing the patient and family. Integrated into the cabinet is a task light, work counter and digital locking mechanisms for meds and supplies.

10. Sliding Doors
    Sliding doors allow for a greater width of door opening for ease of maneuverability of equipment and beds. Glass insert in door is designed to eliminate the need for privacy curtains in the room (tinted glass for acute, electrochromic glass for ICU).

11. Casted Room Design
    By canting the entry to each patient room, a rhythm is created along the corridor that individualizes each room. It also provides a “step off” space in addition to the 8’0” width of the corridor.

12. Access to Natural Light
    Each corridor terminates at an expansive window allowing for light to permeate the corridor and clinical integration stations located in the interior of the floor plan.
Patient Room: Specific attention paid to...

- Remove unnecessary surfaces
- Reduce touch
- Remove/ reduce services that are touched by both staff and patient (cross contamination)
- Provide alternatives to touching
- Encourage hand-washing
- Select low maintenance, high resilience materials
- Use of mock ups to test decisions and materials
Patient Room: Considerations for Infection Prevention

- Elimination of privacy curtains
- Elimination of contaminated waste leaving patient room by outfitting each patient toilet room with automated bed-pan washer
- Reduce need to touch “frequently touched items” - electronic sensors, patient full control of environment at bedside through use of ipad
- Organization of entry vestibule to the patient room for best IP practices, including location of hand-washing station
- Separation of clinical and patient touch surfaces, to reduce cross contamination
- Individual medication station & supply cabinet directly outside of each patient room, reduces # of staff requiring to enter room to do their work – pharmacy, supplies
- Showers in 100% of patient toilet rooms including ICU
Patient Room: Zones

**Patient Zone**
- RFID
- Headwall
- Patient Chair
- Education Screen
- Storage

**Family Zone**
- Sofa Bed
- Guest Chair
- Education Screen
- Storage
- Personalization Shelves and Surfaces
- Desk

**Education Zone**
- EPIC Monitor
- Whiteboard
- Space for Rounding

**Clinician Zone**
- Charting Area
- Handwashing Sink
- PPE
- Medicine Drawer
- Clean Supply
- Waste Bin

**Nurse Area**
- IV Cart
- Saline
- Medication On Wheels
- Hand Washing Station
Patient Room: Entry/Clinician Work
Patient Room: Elimination of Privacy Curtains Observation in ICU
Patient Room: Reduce touched surfaces
Infection Prevention & Design

Outcomes & Findings
<table>
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<tr>
<th>HA Event</th>
<th>#Event</th>
<th>Room</th>
<th>Unit</th>
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|         | 25%    | 25%     | 55%     | 60%   | 30%   | 10%   |

NYU Langone Medical Center
Thank you
Questions
This concludes The American Institute of Architects Continuing Education Systems Course