HCAi
Department of Health Care Access and Information

Beyond Code Minimums: Crafting Resilient Healthcare Facilities

Building codes set the baseline; true resilience demands more for critical infrastructure and patient safety.

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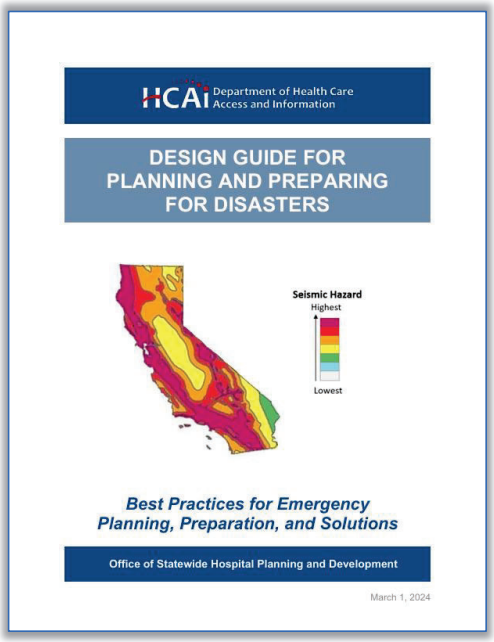
OSHPD
Office of Statewide Hospital Planning and Development

HBSB
Hospital Building Safety Board

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Why A Guide?

- Facilities managers want to know what they can do to be prepared
- Provide a resource to help evaluate how past events could impact future regulations and design requirements
- Provide a repository of information during crucial times
  - The guide presents various scenarios and design options to aid facilities, staff, and design teams in understanding additions to facilities and planning for future flexibility effectively
- Limit “Anything Goes” policies!
- Best practices for facilities to be better prepared for a disaster



How to Apply the Guide

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Alterations

- Planning for the unknown
- Providing flexibility in existing buildings
- What can be done ***now?***
- Adapting existing services and system
  - Facility access
  - Utility services
  - Emergency projects

New Facilities

- Planning for the unknown
- Go beyond code minimums during design
- Go beyond the code
- Include potential flexibility for future care types
- Identify options and provide best practices to allow for quick implementation





Who Should be Using the Guide

- Facility Operators
- Architectural and Engineering Design Teams
- Local Agencies, Planners
- Contractors
- Other people involved in planning for future impacts and reacting to situations when they arise

Purpose

At the start of the COVID 19 pandemic, facilities were struggling to find ways to provide safe patient care: safe for the staff as well as the patients.

OSHPD received many calls and questions as to what we were doing to assist.

In addition, people were asking what was going to change in how OSHPD did plan reviews and what code changes were anticipated for future code cycles.

OSHPD assembled people knowledgeable in healthcare regulations, planning, design, and operations. This included professionals, engineers, facility representatives, contractors, and many others that had experience in the many aspects of addressing and reacting to the pandemic and other emergencies.

The Emergency Design Task Force (EDTF) was born.





Emergency Design Task Force

The EDTF was tasked with identifying specific areas of concern for multiple types of events, such as pandemics, but also including wildfires and earthquakes amongst others. They were to look at how these past events could impact future regulations and design requirements.

It was determined that for normal everyday operations, the current regulations are fairly sufficient to meet the basic needs. Minor revisions are coming.

Adaptation

But what about those facilities that wanted to go above and beyond the basic needs?

Most, but not all, options to prepare for future events would most likely fit into this group.

The technology and processes learned would be optional approaches that a facility could decide to incorporate into their existing or proposed buildings. These options could include:

- switchable air volumes
- redundant services
- new technologies

If these were in place now, the facility would have flexibility in deployment in the future.

HCAI | HOSPITAL BUILDING SAFETY BOARD WEBINAR SERIES
2026 Schedule

Design Guide for Planning and Preparing for Disasters

Information at: https://hcai.ca.gov/facilities/building-safety/resources/building-safety-construction-webinars/



Agenda

Planning & Facility Design

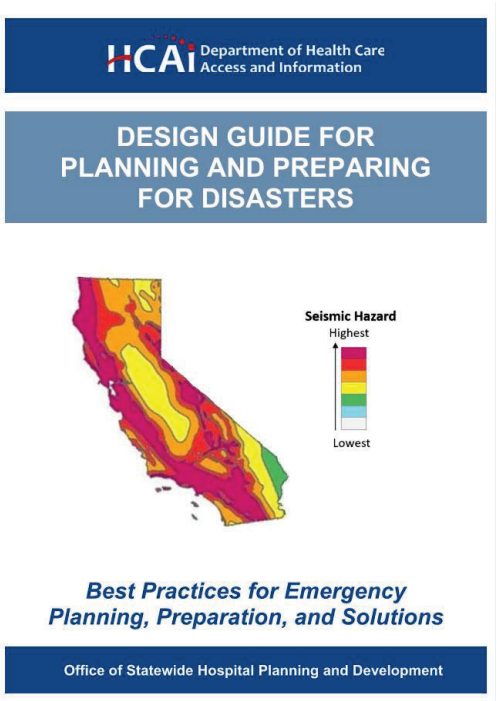
- Design Guide purpose, pandemic lessons, and surge planning
- Emergency Department, patient units, and staff support
- Designing beyond code minimums for resilience

HVAC & ASHRAE Standard 241

- HVAC strategies for infection control and resilience
- Standard 241: IRMM, ECAi, and Building Readiness Plans
- Application, examples, and key takeaways

Why This Matters?

- Hospitals must remain operational during:
  - Pandemics
  - Wildfires
  - Patient surge events
- COVID exposed critical HVAC limitations
- Ventilation impacts:
  - Infection control
  - Patient safety
  - Operational continuity



Emergency Operations Planning to Accommodate Surge Capacity

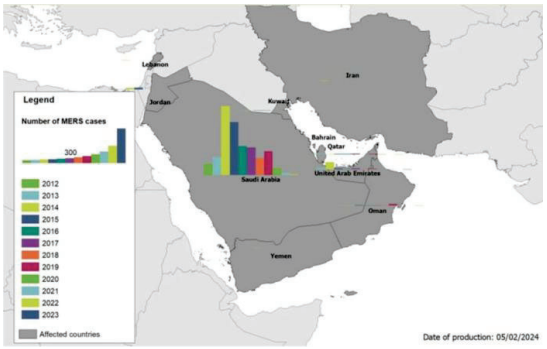
Planning Diagrams History

- The Emergency Design Task Force looked to countries with previous SARS/MERS pandemics
- **SARS pandemic 2003:** Asia (China, Hong Kong, Taiwan, Singapore, Vietnam, Philippines & Thailand), and Canada
- **MERS pandemic 2012**
- Singapore Ministry of Health 2014 Pandemic Readiness and Response Plan for Influenza and Other Acute Respiratory Diseases + DORSCON Matrix
- Pandemic patient units developed in Canada & Asia in response to 2003 SARS pandemic

Resources:

Factors Influencing the Response to Infectious Diseases: Focusing on the Case of SARS and MERS in South Korea - PubMed (nih.gov)

SARS: LESSONS FROM TORONTO - Learning from SARS - NCBI Bookshelf (nih.gov)



European Center for Disease Prevention and Control

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Planning Diagrams History

Singapore Ministry of Health Pandemic Readiness and Response Plan

Summary tables for response measures under the DORSCON matrix

Possible scenarios	Applicable response phases	Border Control	Public health measures: Temperature screening in institutions / buildings	Social distancing	School closures	Contact tracing	Phone surveillance or quarantine	Antivirals for influenza	Vaccination
GREEN - Negligible to low public health impact									
• **High virulence** • **No or limited H-H transmission** • **Disease mainly overseas**	Alert (with containment of imported cases)	Health Advisory Notices (HANs) (Posters, Cards)	No	No	No	Yes, if cases are imported	Consider to implement depending on risk	Treatment of case where necessary	No
• **Similar or lower virulence and transmissibility as seasonal flu**	Mitigation	No	Consider to implement if necessary			No	No		Vaccination for high risk groups, if available
YELLOW									
• **High virulence but low transmissibility** • **Disease mainly overseas**	Alert (with containment of imported cases)	HANs Health Declaration Cards (HDCs) and temperature screening of inbound passengers, if necessary	No	No	No	Yes, if cases are imported	Consider to implement depending on risk	Treatment of cases where necessary	Procure and offer vaccine when available
• **Local epidemic with low virulence but high transmissibility**	Mitigation	HANs	Consider to implement if necessary			No	No		
• **High virulence and transmissibility, but vaccine available**	Mitigation		No						Distribute vaccine to mitigate impact
ORANGE									
• **High virulence and transmissibility** • **Disease mainly overseas**	Alert	HANs HDCs and temperature screening of inbound passengers, if necessary	No	No	No	Yes, if cases are imported	Quarantine	Treatment of cases, consider limited prophylaxis of personnel providing	Procure and offer vaccine when available
• **High virulence and transmissibility** • **Disease in Singapore**	Containment				Yes, selective closures if cases	Yes, as far as operationally feasible	Quarantine, as far as operationally feasible		

Singapore Ministry of Health Pandemic Readiness and Response Plan for Influenza and Other Respiratory Diseases design & operations guide
Disease Outbreak Response System Condition (DORSCON) Matrix

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Planning for Surge

- Provide adequate medical evaluation and care
- The ability to survive a hazard impact and maintain or rapidly recover operations that were compromised
- Plan for large-scale events that affect many people, **which may include** chemical, biological, radiological, earthquakes, other natural or human-caused disasters
- Large hospitals typically operate at or near capacity
- Smaller hospitals faced with limited availability of resources and outside support
- When designing for resiliency, **consider designing beyond the code minimums**

Hazard Types to Plan For

- **Chemical**
- **Biological**
- **Radiological**
- **Seismic / Earthquake**
- **Natural Disasters**
- **Human-Caused**

The Importance of Resilience in Healthcare

Designing Beyond Code Minimums

Seismic Events

Threats posed by earthquakes and ground movement.

Pandemics

Widespread infectious disease outbreaks.

Mass Casualty Events

Incidents resulting in a large number of casualties.

Hazardous Materials

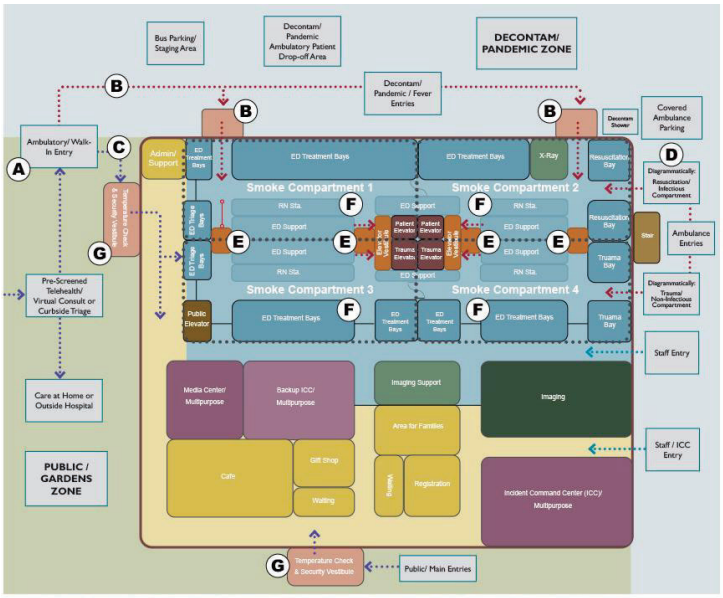
Risks associated with chemical, biological, or radiological substances.

Other Disasters

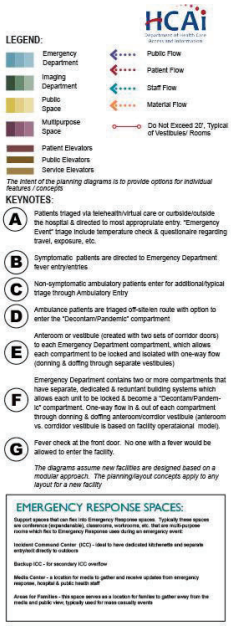
Includes both man-made and natural disasters not explicitly listed.

Designing beyond code minimums is a proactive choice for enhanced preparedness and continuity of operations.

Emergency Department Floor Plan Reference



EMERGENCY RESPONSE DIAGRAM | **NEW** EMERGENCY DEPARTMENT & ENTRY LEVEL



Strategic Entry Management

Optimizing all facility entrances for safety and control

Evaluate & Identify Entry Points

Clearly mark all entry points with appropriate instructions.

Secure Staff Access

Implement robust measures to prevent unauthorized entry into staff-only areas.

Public Entry Screening

All public entries should be provided with symptom checkpoints and security.

Vestibule Design

Size public entry vestibules to accommodate secondary screening and security checks.

ED Entry and Triage Innovations

Improving Patient Flow Management

Enhanced Entry Security

Security and temperature checks at all entry points.

Flexible Entry Configurations

Optional isolation entry vestibules for pandemic or non-pandemic scenarios.

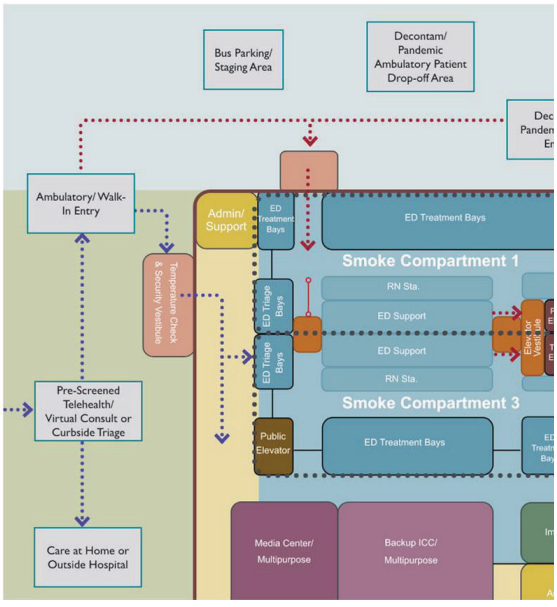
Streamlined Ambulance Access

Separate entry points for routine trauma and critical cases.

Remote Triage Solutions

Virtual and curbside triage options to manage patient influx.

Patient Arrival



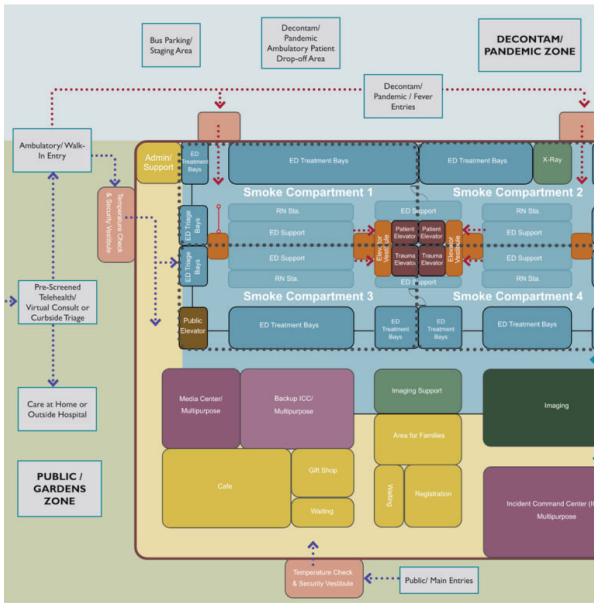
Parking & patient triage

- Ability to accommodate emergency conditions
- Virtual & curb-side patient triage

Patient waiting

- Exterior triage, waiting, and queuing areas are necessary during surge events
- Provide exterior safe & comfortable triage & waiting
- Differentiate between confirmed exposed patients, possibly exposed patients, and non-pandemic related emergencies
- Consider covered parking structures, tents, quick deployment trailers or modular
- **Consider designing beyond the code minimums**

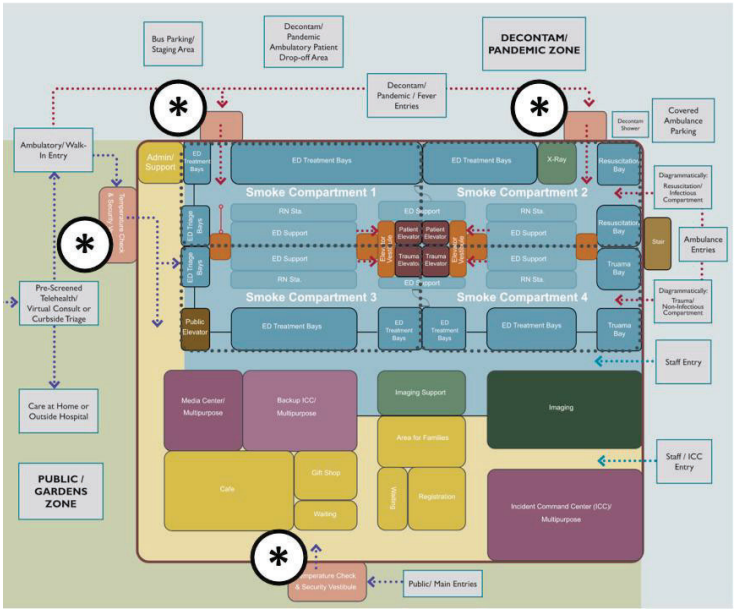
Patient Arrival



Decontamination

- Drop-off in a location separate from designated parking areas
- Provide dedicated entry vestibules designated for decontamination that can be used as an air lock
- Beyond code minimums: decontamination showers
- Provide PPE donning/doffing areas/supplies immediately available
- Can be used for secondary screening or security screening
- Decontamination entry vestibules immediately outside of each pandemic/infection compartment in the Emergency Department
- OSHPD PIN 35 Healthcare Decontamination Facilities
- **Consider designing beyond the code minimums**

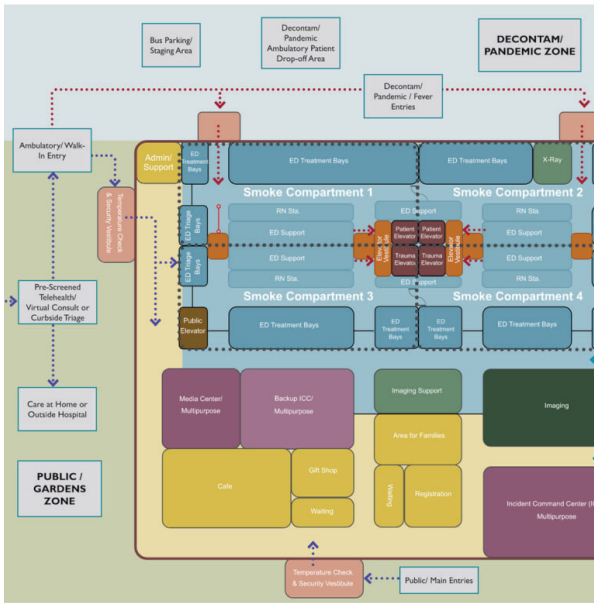
Hospital Entries



Recommendations for the Entry Level

- Evaluate each entry for appropriateness
- Entries should be clearly identified with instructions
- Entries for staff only should be identified & locked to prevent unauthorized access
- All public entries should be provided with symptom checkpoints and security
- Vestibules provide secondary opportunity to screen patients and public
- Screening prevents exposing staff & other patients
- Size public entry vestibules to accommodate secondary screening & security checks
- **Consider designing beyond the code minimums**

Emergency Department: Ambulatory Pre-Screening



Entering the ED

- Prior to arrival leverage telehealth or virtual care
- In the parking lot utilize curbside/outside screening
- Provide predetermined walk-up screening locations outside of the ED

After screening is completed

- Direct patients to the appropriate entrance based on their symptoms
- Provide separate pandemic/infectious or non-pandemic/non-infectious entrances
- **Consider designing beyond the code minimums**

Emergency Department: Enhanced Preparedness

Optimizing for Surge Capacity and Infection Control

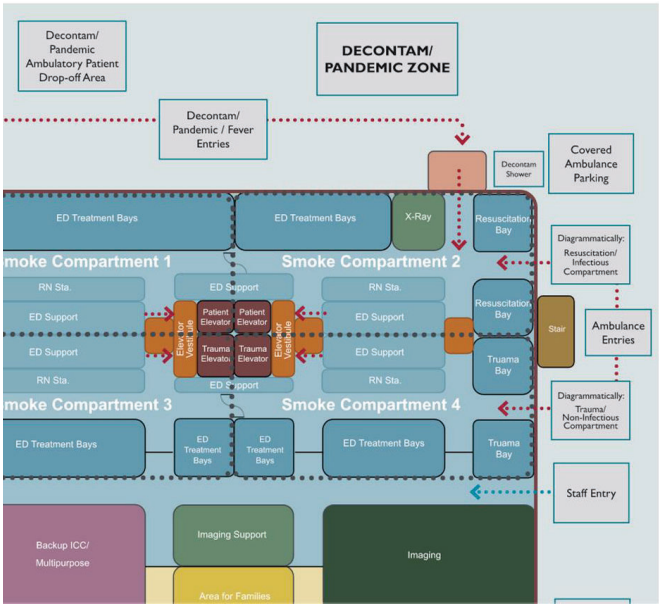
Infrastructure for Isolation & Flow

Implementing separate compartments with redundant HVAC systems, strict separation of clean and soiled flows, and dedicated elevators for different patient types to manage patient movement effectively during surges.

Integrated Patient Care

Integrating X-ray services within resuscitation and pandemic compartments to minimize patient transfers and reduce the risk of cross-contamination.

Emergency Department: Ambulance Entries

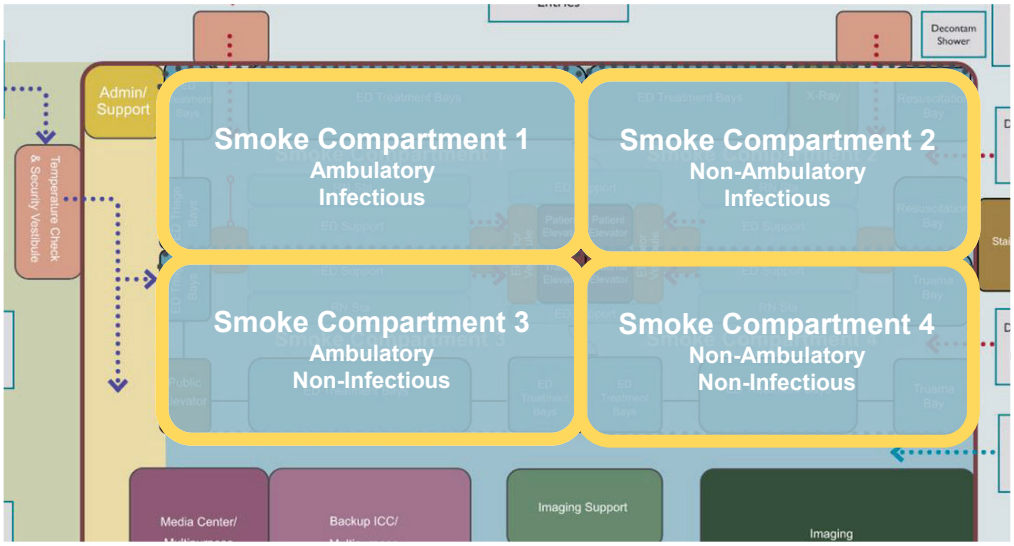


Separate ambulance entry

- Separate ambulance traffic from other patient areas
- Consider additional safeguards for pandemic, or hazardous materials exposure
- Consider separate dedicated ambulance entries into:
- **Infectious disease/resuscitation** compartment
- **Non-infectious/trauma** compartment
- **Consider designing beyond the code minimums**

ED Compartmentation

Dedicated **infectious disease/resuscitation** and **non-infectious/trauma** compartments.



HVAC Infection Control Measures

What Failed During COVID

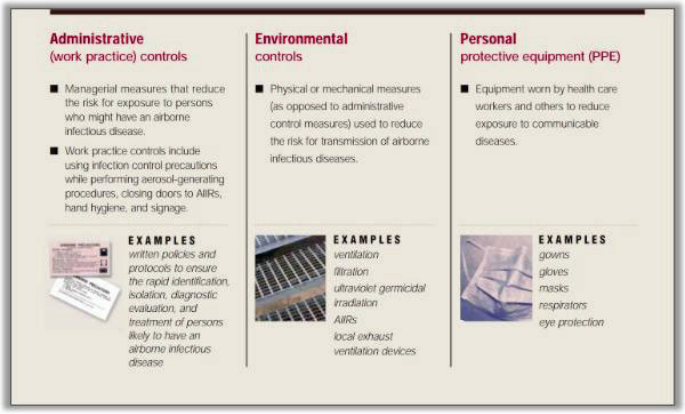
- Limited airborne infection isolation capacity
- Standard patient rooms not designed for:
  - Negative Pressure
  - High-efficiency filtration
  - Rapid conversion
- Systems lacked scalability during surge

The Core Gap

- Hospitals designed to minimum code requirements
- Not designed for:
  - Emergency flexibility
  - System reconfiguration
  - Surge-level demand

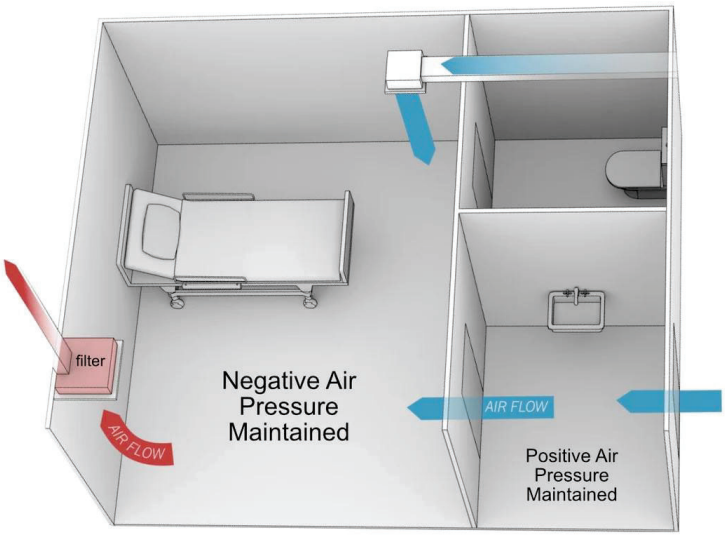
Design Objective & HVAC Framework

- Objective
  - Convert standard rooms to isolation-capable environments
  - Enable rapid (~12 hours) response to airborne events
- Four Core HVAC Strategies
  - Airflow & Pressurization
  - Ventilation (Outside Air)
  - Filtration
  - System Flexibility & Controls



Core Strategy #1 – Airflow & Pressurization

- Infection control relies on directional airflow.
- Negative Pressure:
  - Exhaust airflow > supply airflow
  - Air flows into the room (not out)
- Prevents contaminated air from spreading

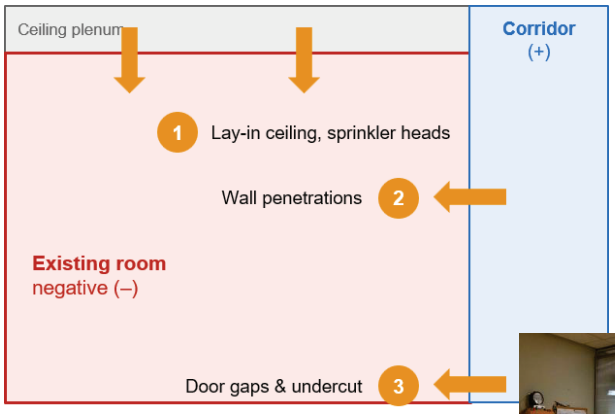


Core Strategy #1 – Airflow & Pressurization

The constraints of the real-world…

- Existing rooms are not airtight:
  - Doors, ceilings, wall penetrations
- Maintaining pressure differential is difficult
- Retrofit conditions vary significantly

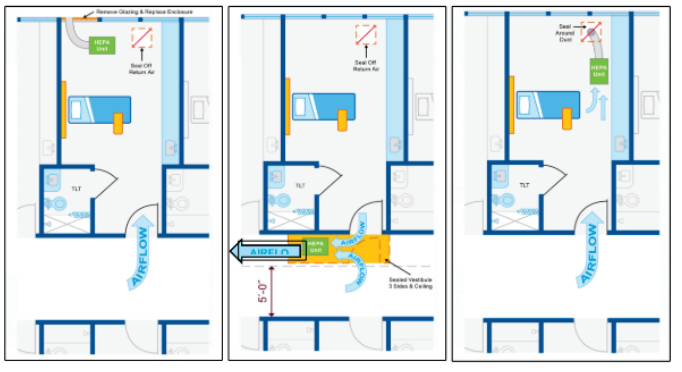
Directional airflow is more important than perfect pressure





Core Strategy #2 – Ventilation

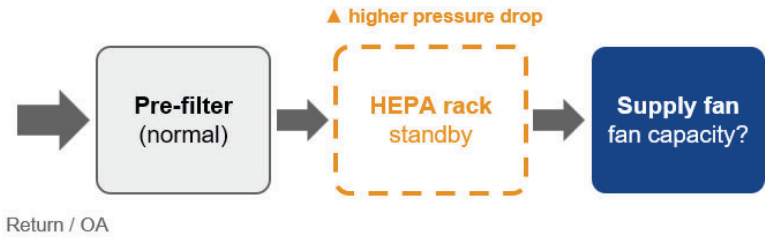
- Convert return air systems to exhaust during emergency events
- Dual return grille concept:
  - At patient bed (isolation mode)
  - At door (normal mode)
- Dedicated exhaust risers for surge scenarios
- AHU Systems must support multiple modes:
  - Normal Operation
  - High outside air (pandemic)
  - Reduced outside air (wildfire)



HEPA filtered to outside *HEPA to corridor* *HEPA filtered to return air*

Core Strategy #3 - Filtration

- HEPA filtration removes airborne pathogens
- Critical for infection control environments
- Key constraints of additional filtration to check
  - High pressure drop – does the system have capacity?
  - Higher energy usage



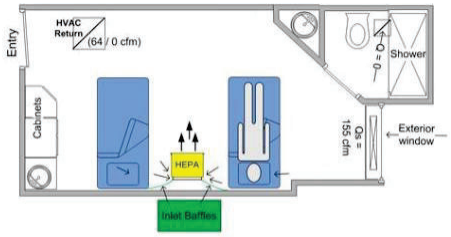
99.97%
of 0.3 µm particles captured: the standard HEPA rating

Core Strategy #3 - Filtration

Deployment Approaches

- Built-in HEPA systems (standby use)
- Portable HEPA filtration units
- Temporary ducted exhaust solutions

Flexibility is key to fit unique needs with speed



Temporary ventilation during pandemic.

Figure 3.3 – Use of Portable Air Cleaner

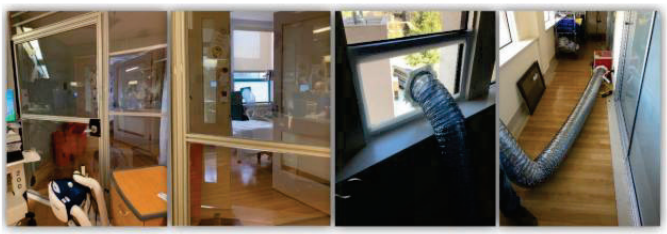
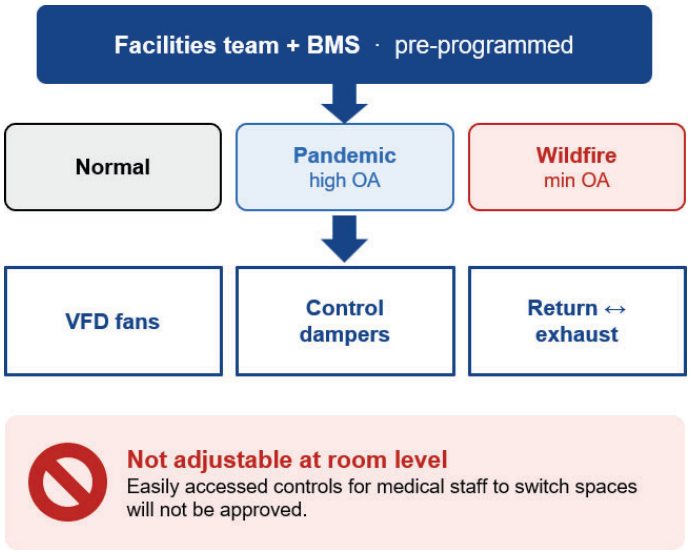


Figure 3.4 – Temporary Ducting to Outside

Core Strategy #4 – System Flexibility & Controls

Systems should be designed for adaptive operation:

- Variable speed fans (VFDs)
- Control dampers for airflow adjustment
- Switchable return/exhaust configurations
- Continuous system operation during events
- HVAC response must be:
  - Pre-programmed
  - Controlled by facilities teams
- Not user-adjustable at room level



Retrofit vs New Construction

Existing Facilities

- Limited by infrastructure
- Temporary solutions often required

New Construction

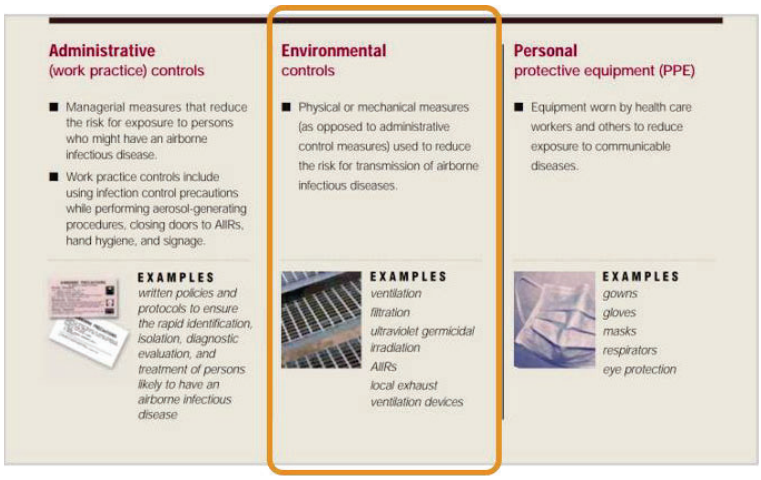
- Opportunity to design
  - Flexibility
  - Redundancy
  - Surge capability

Recommendations and Considerations for Negative Pressurization During Emergency Conditions

Patient Areas							Non-Patient Area Filtration
Temporarily Converting Existing Rooms to Negative Pressure	Creation of "Flex" Pressurization Rooms	Use of Corridor for Make Up Air	Use of Pressure Monitoring of Isolation Rooms	Filtration for Infectious Airborne Diseases	Use of Economizers on Air Intakes	Location of Patient Room Exhaust in Positive and Negative Isolation Rooms	

Key Takeaways

- HVAC is a critical infection control system
- Flexibility is the most important design priority
- Systems must operate under multiple conditions
- Planning ahead enables rapid emergency response
- Retrofit scenarios should be studied carefully to avoid unintended impacts



HVAC lives here: environmental controls

Planning for Resiliency and Flexibility

Pandemic-Ready Patient Units

Designing for Integrated Infection Control and Flexibility

Flexible Entry Points

Option for separate entries into patient units to manage patient and staff flow.

Streamlined Material Flow

Maintaining separate clean and soiled pathways throughout the unit to prevent cross-contamination.

Patient Room Entry

Ante-room vestibules at each patient room create critical buffer zones for infection control.

Acuity-Adjustable Units: Design Flexibility & Resilience

Maximizing adaptability for evolving healthcare needs.

Surge Capacity

Enable patient rooms to adapt to higher care needs during surges, crucial for pandemics and emergencies.

Design Flexibility

Incorporate varied configurations for patient toilet and shower rooms to maximize adaptability and optimize space.

Future-Proofing

Enhance facility resilience by allowing for evolving patient care demands.

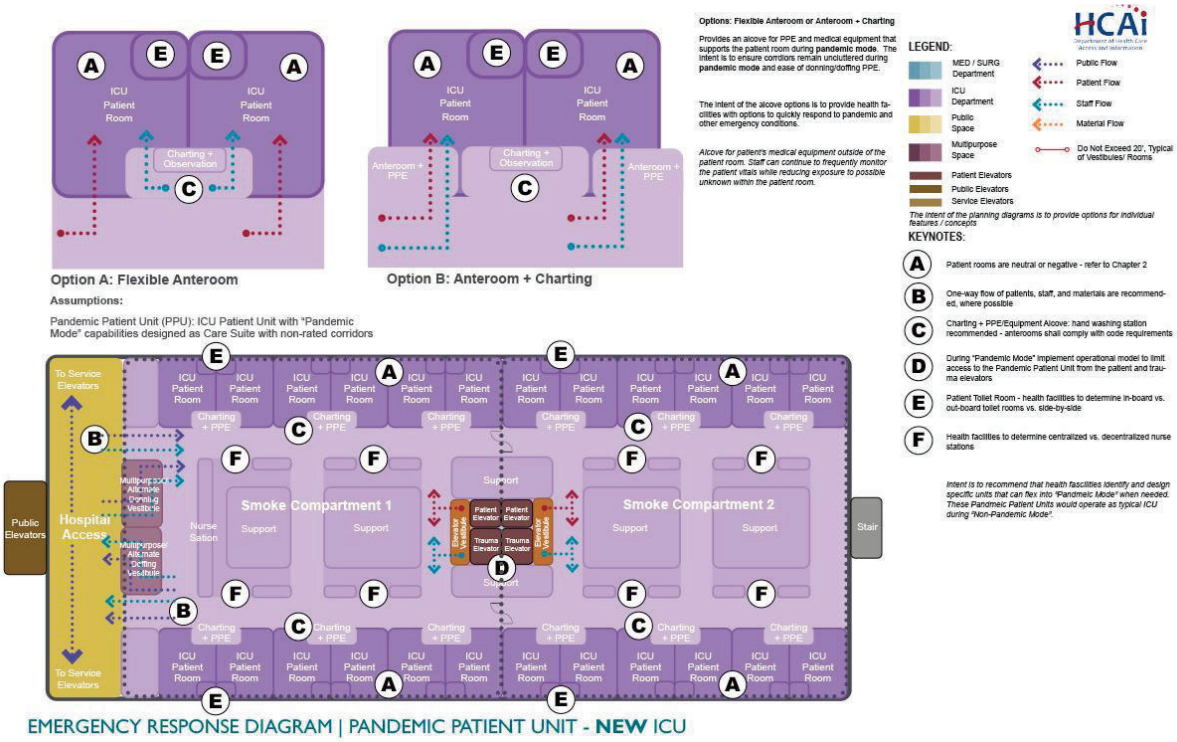
STRATEGIC DESIGN FOR ADAPTABLE HEALTHCARE ENVIRONMENTS.

AAUs provide essential flexibility to meet unpredictable healthcare demands.

California Acuity-Adjustable Patient Units



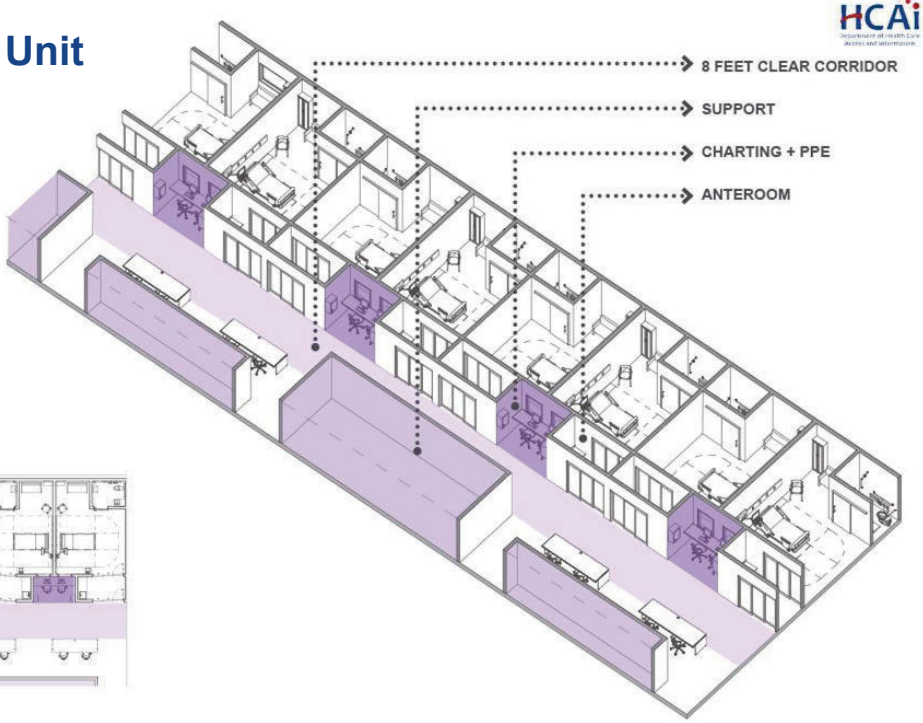
- California's Title 22 does not provide for acuity-adaptable patient rooms where a patient steps down in the same room
- California Department of Public Health will allow an entire unit to flex
- New facilities consider using the "Acuity-Adjustable" model to provide future flexibility during patient surges
- Existing units can be adapted to surge as needed
- Acuity-adjustable patient units (AAU) allow care to flex to a higher level as needed in the same room/unit
- AAUs are well-suited for pandemics and other large-scale emergencies
- **Consider design beyond the code minimums**

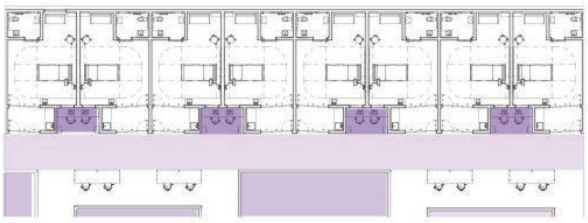


EMERGENCY RESPONSE DIAGRAM | PANDEMIC PATIENT UNIT - **NEW** ICU

Pandemic-Ready Patient Unit

Floor Plan Reference

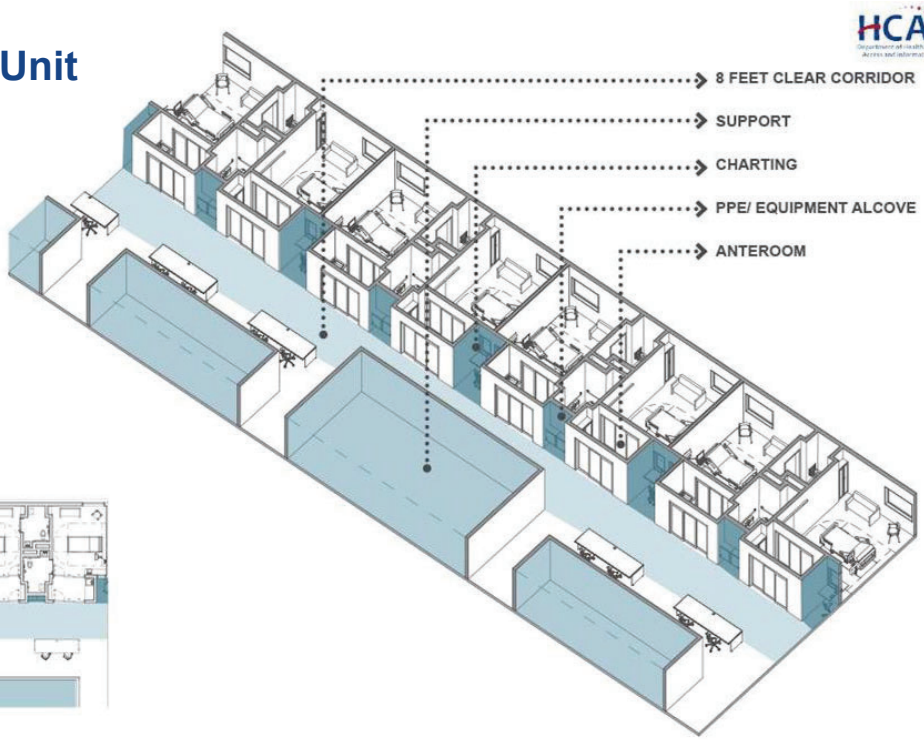




KEYPLAN

Pandemic-Ready Patient Unit

Floor Plan Reference





KEYPLAN

Key Strategies

Flexible Patient Unit Entry Solutions

Multipurpose Rooms

Designate rooms to serve as either clean or soiled areas, providing flexibility during pandemics.

Ante-Room Vestibules

Implement entry vestibules for each patient room to create critical buffer zones.

Separation of Flows

Maintain distinct pathways for clean and soiled materials throughout the unit.

Key Features and Placement

Decontamination and Entry Vestibules

Dedicated Entry Vestibules

Designed as airlocks for decontamination.

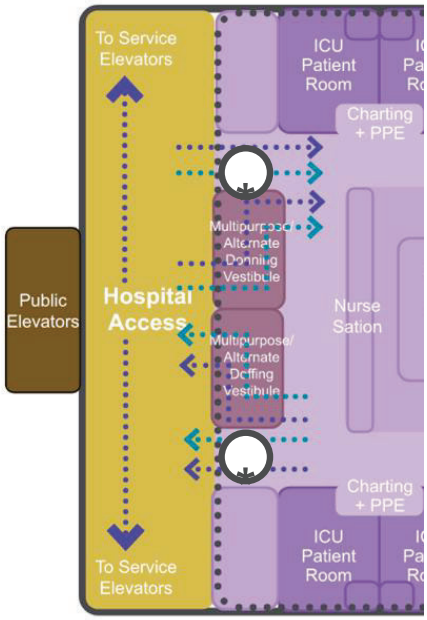
Strategic Location

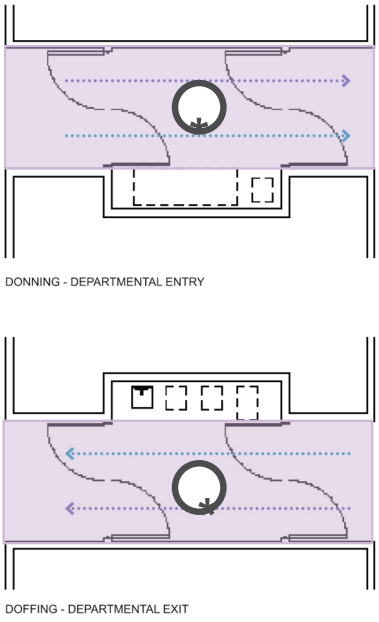
Situated immediately outside pandemic/infection compartments in the Emergency Department (ED).

Dual Functionality

Can be used for secondary screening or security screening; includes decontamination showers beyond code minimums.

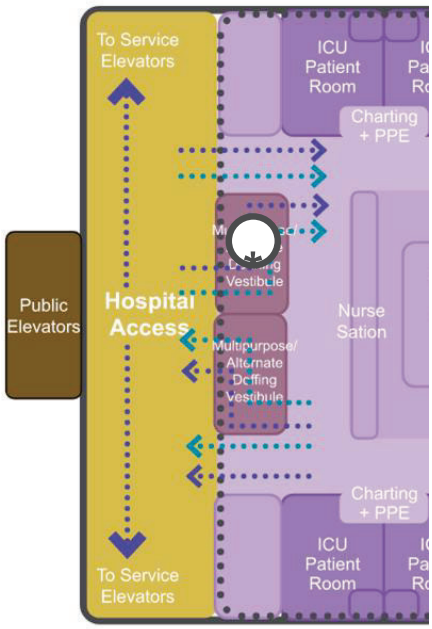
PPU Donning/Doffing Options

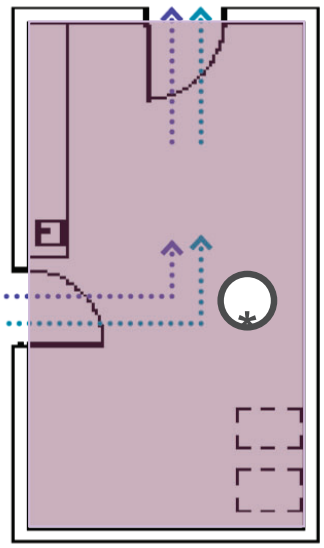




- Donning & doffing at patient unit entry was explored with California Department of Public Health (CDPH)
- International PPU:
  - PPE donning alcove at PPU entry to unit
  - PPE doffing alcove w/ trash receptacle + hand washing station at exit of unit
- **Consider design beyond the code minimums**

PPU Donning/Doffing Options





- CDPH requires donning & doffing at **patient room entry**, as opposed to unit entry
- The Guide includes donning & doffing at patient unit entry as an option
- Donning/doffing multipurpose room(s):
  - Dedicated donning & doffing
  - Combined donning/doffing
- **Consider design beyond the code minimums**

Flexible Donning/Doffing Solutions in PPUs

Adapting donning and doffing areas within patient units.

Multipurpose Room Considerations

Explore spaces that can be adapted for donning and doffing activities.

Usage Options

Consider dedicated spaces, combined spaces, or flexible use of existing areas.

Objectives

Ensure compliance with health department requirements and maintain operational efficiency.

Ensure compliance and operational efficiency through adaptable donning and doffing areas.

Design Considerations

Pandemic Patient Unit (PPU) Design

- Explore optimal locations and workflows for PPE management at unit entry points
- Dedicated donning alcoves
- Separate doffing alcoves equipped with waste receptacles and handwashing stations
- Ensure compliance with California Department of Public Health (CDPH) requirements for donning and doffing at patient room entry
- **Consider design beyond the code minimums**

Key Considerations

Staff Support and Well-being

Respite and Recharge Rooms

Offer quiet, contemplative spaces away from patient areas.

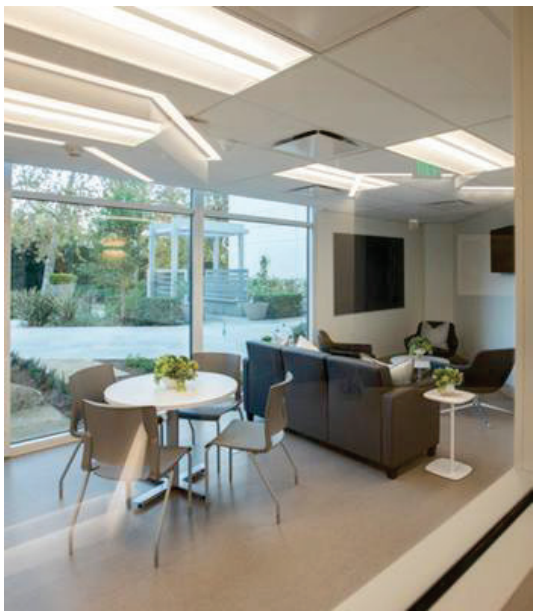
Natural Elements

Prioritize access to natural daylight and views where possible.

Flexible Spaces

Utilize flex space to accommodate staff respite during emergency conditions where dedicated spaces cannot be provided.

Use of Interior Spaces



Staff Spaces

- Provide in or adjacent to departments most utilized during emergency conditions
- During emergency conditions
  - Staff may not be able to leave the facility
  - Will be working significantly extended hours
- **Lesson learned + beyond code minimum**
- Staff lounge is not an appropriate area for staff in need of a quiet contemplative space to decompress or grieve
- Consider respite & recharge rooms
- Provide access to natural daylight and views
- Where dedicated respite spaces cannot be provided
  - Provide flex space to accommodate staff respite during emergency conditions

What happened after the guide?

Why Standard 241?

- COVID-19 exposed major gaps in HVAC guidance for infection control
- Inconsistent strategies across healthcare facilities
- Need for a unified, performance-based standard

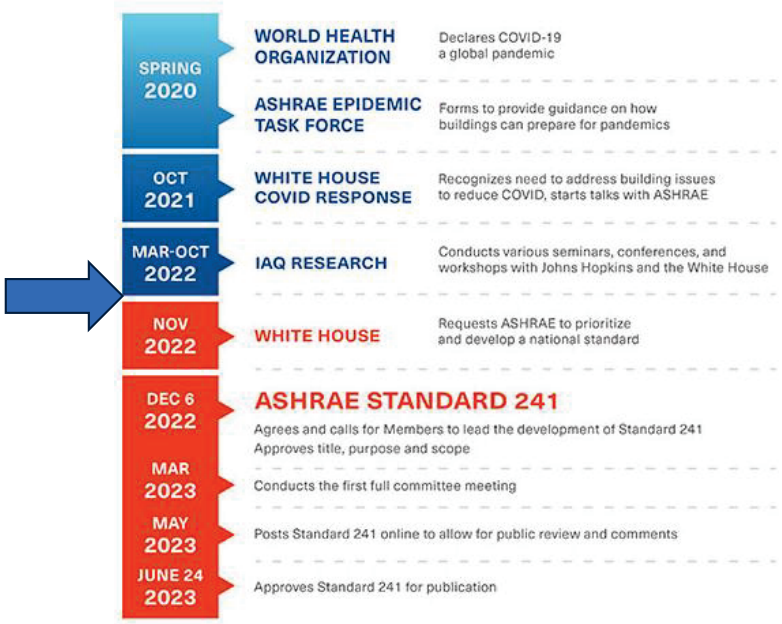


ASHRAE Standard 241-2023

Control of Infectious Aerosols

BACKGROUND

Work on HCAI/OSHPD Guide Completed



ASHRAE Standard 241-2023
Control of Infectious Aerosols

Purpose

- ASHRAE 241 establishes minimum requirements for controlling infectious aerosols to reduce disease transmission risk in new and existing buildings and major renovations, covering air system design, installation, operation, and maintenance.

Scope

- Based on reduction of *long range transmission* risk
- Does not establish overall requirements for acceptable indoor air quality but requires IAQ as a pre-requisite

1. Infection Risk Management Mode (IRMM)

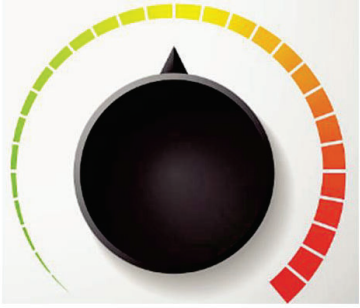
The mode of operation in which measures to reduce infectious aerosol exposure documented in a building readiness plan are active

Decision on IRMM Enable / Disable: Not specified in 241

- Public health official
- Owner
- Occupant

Why not all the time?

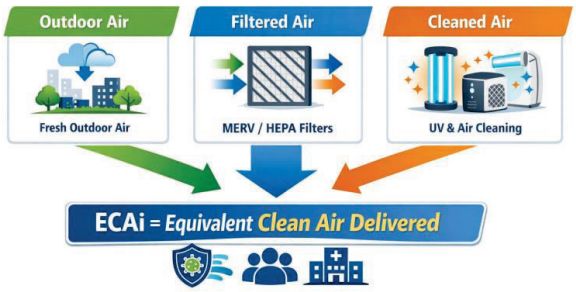
- Potential Energy use and cost increase
- Infection risk and consequences of infection vary over a wide range



Normal IRMM

2. Equivalent Clean Airflow-Infection (ECAi)

- Core concept of Standard 241
- Represents “pathogen-free” air delivered to occupants
- Includes:
  - Outdoor air
  - Filtered Air
  - Cleaned Air
- It’s not just how much air you deliver. It's how clean that air is !
- Multiple strategies can achieve the same result



2. How are(ECAi) goals determined?

- 0.1% infection probability
- 1-hour exposure
- 1% infected population (3% for healthcare)

Determining ECAi

- ECAi Depends on:
  - Space type
  - Occupancy
  - Activity level
- Typical range: 20–90 cfm/person
- Allows calculation of maximum occupancy under IRMM

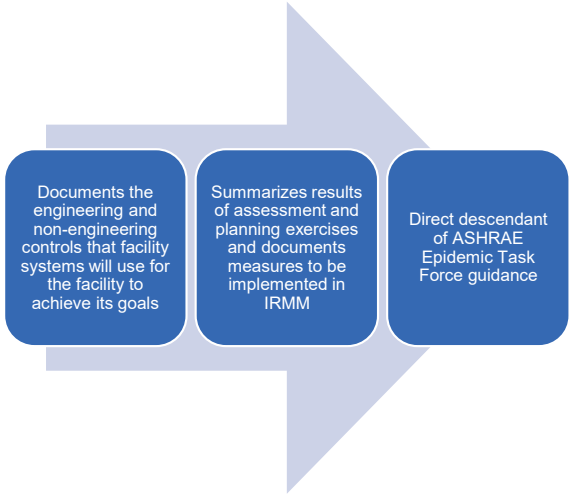
Correctional Facilities		
Cell	30	15
Dayroom	40	20
Commercial/Retail		
Food and beverage facilities	60	30
Gym	80	40
Office	30	15
Retail	40	20
Transportation waiting	60	30
Educational Facilities		
Classroom	40	20
Lecture hall	50	25
Industrial		
Manufacturing	50	25
Sorting, packing, light assembly	20	10
Warehouse	20	10
Health Care		
Exam room	40	20
Group treatment area	70	35
Patient room	70	35
Resident room	50	25
Waiting room	90	45
Public Assembly/Sports and Entertainment		
Place of religious worship	50	25
Museum	60	30
Convention	60	30
Spectator area	50	25
Lobbies	50	25
Residential		

3. Air Cleaning Effectiveness and Safety

- Major issue during COVID: lack of validated technologies
- Standard 241 addresses:
  - Effectiveness (removal/inactivation)
  - Safety (e.g., ozone, byproducts)
- Appendix A provides testing requirements
- Goal is a level playing field for all technologies

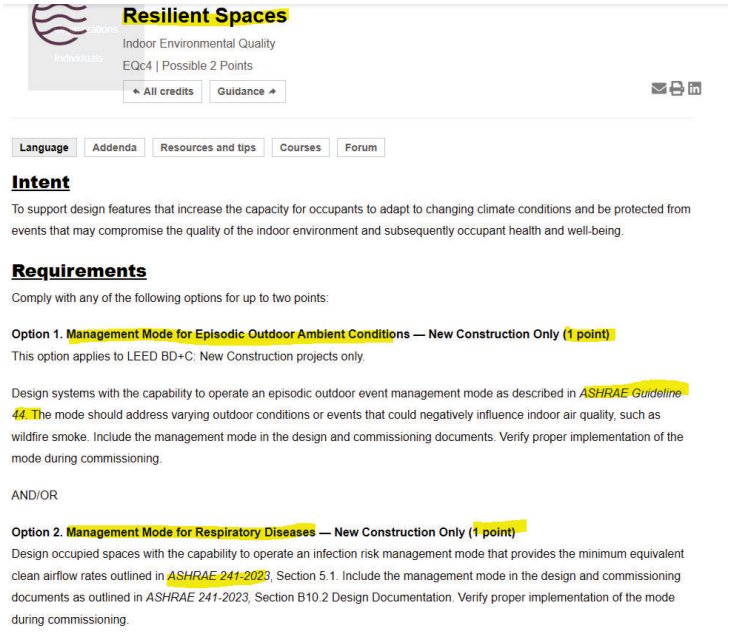
4. Building Readiness Plan

- A documented response strategy for infection events
- Includes:
  - Engineering controls
  - Operational measures
- Acts as a facility “playbook” for IRMM



Adoption

- LEED
- ASHRAE 62.1 now references both 241 and G44



Resilient Spaces

Indoor Environmental Quality

EQc4 | Possible 2 Points

All credits | Guidance

Language | Addenda | Resources and tips | Courses | Forum

Intent

To support design features that increase the capacity for occupants to adapt to changing climate conditions and be protected from events that may compromise the quality of the indoor environment and subsequently occupant health and well-being.

Requirements

Comply with any of the following options for up to two points:

Option 1. Management Mode for Episodic Outdoor Ambient Conditions — New Construction Only (1 point)

This option applies to LEED BD+C: New Construction projects only.

Design systems with the capability to operate an episodic outdoor event management mode as described in *ASHRAE Guideline 44*. The mode should address varying outdoor conditions or events that could negatively influence indoor air quality, such as wildfire smoke. Include the management mode in the design and commissioning documents. Verify proper implementation of the mode during commissioning.

AND/OR

Option 2. Management Mode for Respiratory Diseases — New Construction Only (1 point)

Design occupied spaces with the capability to operate an infection risk management mode that provides the minimum equivalent clean airflow rates outlined in *ASHRAE 241-2023*, Section 5.1. Include the management mode in the design and commissioning documents as outlined in *ASHRAE 241-2023*, Section B10.2 Design Documentation. Verify proper implementation of the mode during commissioning.

ASHRAE 241 Calculator

- Standard is free viewing at https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards
- With the purchased standard, an Excel Std 241 calculator is provided
- Let's do an example !

ASHRAE 241 Example

- ED Waiting Room – 1,500 sq.ft / 50 persons / 12 ACH/ MERV 14
- During a pandemic mode, does NOT comply with Std 241
- HEPA upgrade alone → insufficient
- Effective solution:
  - Reduce occupancy (50 → 30)
  - Increase airflow (12 → 15 ACH)
  - Maintain MERV 14
- Demonstrates multi-variable approach

ASHRAE 241 and Energy

- Which strategies to comply with Std 241 use the least energy?
- Pacific Northwest National Lab (PNNL) did a study in 2025. Published October 2025.
- Compared multiple strategies
- Findings:
  - Increasing outdoor air → most energy intensive
  - Increasing airflow → also energy intensive
  - Lowest energy options → Portable air cleaners and UV systems

Conclusion – Key Takeaways

Investing in Resilience - Design

Recap of Key Strategies

- Incorporating robust structural integrity.
- Ensuring redundant critical systems (power, water, HVAC).
- Designing for flexible space utilization.
- Implementing advanced security measures.
- Planning for pandemic and emergency readiness.

Beyond Code Minimums

- A strategic investment, not just an expense.
- Enhances patient safety and well-being.
- Protects invaluable healthcare staff.
- Guarantees enduring operational capacity during crises.

Resilience ensures the facility remains a safe haven and a vital operational asset, even in the face of unforeseen challenges.

Conclusion – Key Takeaways

Flexibility of Infrastructure

Recap of Key Strategies

- HVAC is a critical infection control system
- Flexibility is the most important design priority
- Systems must operate under multiple conditions
- Planning ahead enables rapid emergency response
- Retrofit scenarios should be studied carefully to avoid unintended impacts

Resilience ensures the facility remains a safe haven and a vital operational asset, even in the face of unforeseen challenges.

Conclusion – Key Takeaways

Investing in Resilience - HVAC

- Standard 241 introduces a new way to define “clean air”
- ECAi is the central design metric
- Multiple strategies can achieve compliance
- Planning (BRP) is as important as design
- Healthcare facilities must be ready to adapt quickly

Resilience ensures the facility remains a safe haven and a vital operational asset, even in the face of unforeseen challenges.

Questions and Answers

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