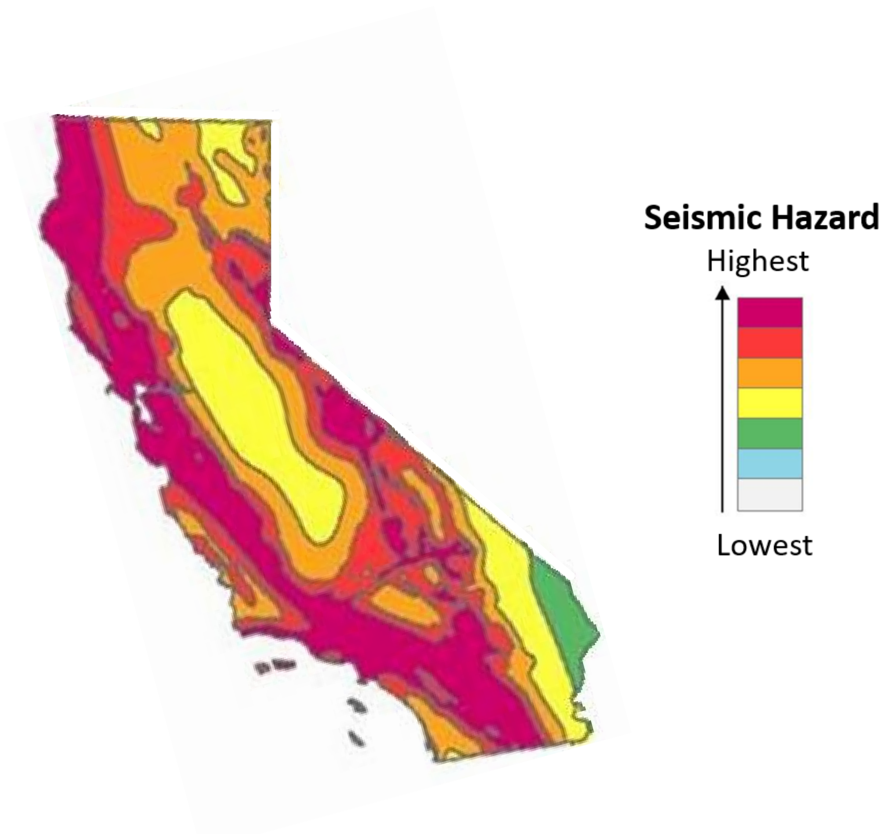
Department of Health Care Access and Information

DESIGN GUIDE FOR PLANNING AND PREPARING FOR DISASTERS



Best Practices for Emergency Planning, Preparation, and Solutions

Office of Statewide Hospital Planning and Development

March 1, 2024

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Office of Statewide Hospital Planning and Development

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PREAMBLE

Disasters, whether human caused or a natural disaster, often results in injuries, infections, illnesses, hazardous materials exposure, or other conditions that require immediate emergency treatment at a hospital. Therefore, it is important that hospitals have a plan for dealing with emergency conditions when and where they occur. Patient load caused by emergency conditions may exceed the hospitals capacity or may require special decontamination and/or isolation requirements for which the hospital is not usually equipped.

The Department of Health Care Access and Information (HCAI), Office of Statewide Hospital Planning and Development (OSHPD) is the building department for hospitals. In addition to its typical building department plan review and construction permitting duties, OSHPD responds to emergency situations and conditions at hospitals that involve construction, alternate use of spaces and equipment, etc. OSHPD has created a Policy Intent Notice (PIN) number 72 to assist hospitals seeking authorization for emergency work. The emergency work often requires temporary construction and/or installation of temporary equipment to provide immediate solutions. Emergency work should not be confused with maintenance or the lack of planning in dealing with defective or obsolete equipment, etc.

The hospital may take the necessary emergency actions to abate and make safe the emergency condition that poses an imminent danger to life, injury, or property damage. However, the California Department of Public Health, Licensing and Certification (CDPH) and OSHPD should be notified immediately after the required emergency actions are taken.

This Design Guide for Planning and Preparing for Disasters – *Best Practices for Emergency Planning, Preparation, and Solutions*, hereinafter referred to as “Design Guide” is intended to assist the hospital in planning and preparing for disasters, as well as offering solutions for resiliency and readiness for emergencies. It is not possible to cover every kind of disaster that may occur, however, there are common steps that may be taken to deal with specific kinds of disasters, such as decontamination facilities, providing for patient surges caused by mass casualties or epidemics, need for additional patient isolation capacity, keeping the facility safe from the impacts of wildfires, and others.

I want to thank the many people that have been involved with and who have assisted in putting together this Design Guide. OSHPD is fortunate to have hospital industry experts willing to donate their time and effort to create this Design Guide for Planning and Preparing for Disasters – *Best Practices for Emergency Planning, Preparation, and Solutions*. Use of this Design Guide is discretionary; however, I think that you will find its use to be valuable in preparing for a disaster before or during its occurrence.

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ACRONYMS

AAU	Acuity-Adjustable Units
AIIR	Airborne Infection Isolation Rooms
ACD	Amended Construction Document
AFL	All Facilities Letter
ASHE	American Society for Health Care Engineering
ASHRAE	The American Society of Heating, Refrigerating and Air-Conditioning Engineers
AHAM	Association of Home Appliance Manufacturers
AHJ	Authority Having Jurisdiction
AHU	Air Handling Unit
AMC	Alternate Methods of Compliance
CADR	Clean Air Delivery Rate
CALFIRE	California Department of Forestry and Fire Protection
CAN	Code Application Notice
CDC	Centers for Disease Control and Prevention
CDPH	California Department of Public Health
CMS	Centers for Medicare and Medicaid Services
CO	Compliance Officer
COVID-19	Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2)
DPOR	Design Professional of Record
DCV	Demand-Controlled Ventilation
DIY	Do It Yourself
EAP	Emergency Authorization to Proceed
ECM	Electronically Commutated Motors
ED	Emergency Department
EDTF	Emergency Design Task Force
EMSA	Emergency Medical Services Authority
EOC	Emergency Operation Center
EPA	Environmental Protection Agency
EPSS	Emergency Power Supply System
FEMA	Federal Emergency Management Agency
HCAI	Department of Health Care Access and Information

HEPA	High-Efficiency Particulate Air
HVAC	Heating Ventilation Air Conditioning
iHP	Hydrogen Peroxide Fogging
ICC	Incident Command Center
ICU	Intensive Care Unit
MERV	Minimum Efficiency Reporting Value
NEHRP	National Earthquake Hazards Reduction Program
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
OES	Office of Emergency Services
OSHPD	Office of Statewide Hospital Planning and Development
PIN	Policy Intent Notice
PPE	Personal Protective Equipment
PTSD	Post-Traumatic Stress Disorder
RCO	Regional Compliance Officer
TIO	Testing Inspection Observation
UV	Ultra Violet Light Technology
VFD	Variable Frequency Drive
VISD	Video Image Smoke and Fire Detection

SECTION 1
INTRODUCTION

1.0 Introduction

Every day hospitals provide the front line of care to the public in the event they have a personal medical emergency. Hospitals by their nature are large, complex buildings with many working components to provide a patient the care they need. To help make this happen, the Department of Health Care Access and Information's (HCAI) Office of Statewide Hospital Planning and Development (OSHPD) works to ensure all building requirements are met to provide a building that is safe to operate and safe for its occupants.

The ability to have a facility care for the public, before, during, and after an event or disaster requires careful and deliberate planning. This is reflected in the hospital's design and operations and over the years it progresses and adapts as technology, regulations, and standards change. This is compounded if there is an event or disaster which in turn affects the public health on a larger scale than is normal.

California's earthquakes have had serious impacts on hospitals, from partial to total collapse of buildings, from loss of use of partial areas and services of the hospital to the loss of functionality for an entire building resulting from nonstructural damage, and from minor injuries to fatalities of occupants. The Alfred E. Alquist Hospital Facilities Seismic Safety Act (HSSA) created the Office of Statewide Health Planning and Development, (currently the Department of Healthcare Access and Information (HCAI), to be the statewide building department for hospitals because of damage, injuries, and fatalities at hospitals caused by the 1971 Sylmar Earthquake.

Subsequent earthquakes exposed vulnerabilities in the design to resist lateral forces in hospital buildings and systems, especially those constructed prior to the HSSA. These buildings do not have the benefit of being constructed under adequate seismic building codes. There are still steps that hospitals can take to make these buildings, as well as those constructed under subsequent codes that have seismic design inadequacies, more resilient and functional at some level during and after a seismic event.

The recent COVID-19 pandemic exposed weaknesses and vulnerabilities in our healthcare system planning and preparation for such events. Many facilities had to respond to providing differing types of care for an unknown illness while keeping the patient and staff population safe. This resulted in temporary improvised projects, changes in operations, increases in Personal Protective Equipment (PPE), and many changes to how healthcare was provided.

What didn't work was revised until it did and what did work became standard. Due to trial and error that was reactionary and performed on a case-by-case basis, a lot of information was not being shared. HCAI created a COVID Resource page on its website to share what was working, what was allowed, available resources, as well as guidance to many situations and how they were being dealt with. Along with this sharing of what can be done now, came the questions about what future code changes would be coming and how learned technologies and processes can be designed into hospitals; both existing and new.

Wildfire season appears to have become an ever-lengthening season in California. The smoke caused by wildfires can be disastrous for patients confined to hospitals. Some facilities have completely shut down their heating, ventilation, and air conditioning systems (HVAC) during a wildfire event to deal with smoke intrusion into the building. This resulted in the loss of ventilation for the occupants, a loss of protection for immune-suppressed patients, and a loss of protection of staff and patients that need ventilation that is not contaminated from other patients with infectious diseases. Shutting down the HVAC systems in a hospital also make services, such as surgery, prohibited. This Design Guide will look at alternatives to dealing with smoke from wildfires that may keep the hospital functioning without undue risk to staff, visitors, or patients.

There are other kinds of disasters that are not specifically addressed in this Design Guide. However, it should be noted that many of the concepts provided herein may be adapted to deal with the harmful conditions those disasters impose on the functionality of the hospital.

1.1 Why a Design Guide?

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. To answer the questions that were streaming in, OSHPD assembled people knowledgeable in healthcare regulations, planning, design, and operations. This included assembling professionals, engineers, facility representatives, contractors, clinicians, and many others that had experience in the many aspects of addressing and reacting to the pandemic and other emergencies into an Emergency Design Task Force (EDTF). The EDTF was tasked with identifying specific areas of concern for multiple types of events such as pandemics, but also included wildfires, earthquakes, and others. They were to look at how these past events could impact future hospital planning and preparedness for disasters, as well as regulations and design requirements.

It was determined that for normal everyday operations, the current regulations and building standards were sufficient to meet the basic needs. 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 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 range from switchable air volumes, redundant services, to new technologies that, if in place now, the facility would have flexibility in deployment in the future.

With that in mind, this Design Guide outlines several scenarios and options that could be provided to assist facilities, their staff, and design teams with concepts and guidance on not only what can be added to the facility, but how best to plan for future flexibility. The guidelines and tips outlined in this Design Guide are only general and are meant to serve as reference and they are not to be considered a complete technical approach to the various applications.

When there is an emergency, be it a seismic event, wildfire, cyber-attack, pandemic, or other, many facilities do not know who to contact or where to look for additional information. Included in the Design Guide will be contact information as well as links to resource websites that will be critical at these times.

One item that is not covered in this Design Guide, although very important, is having an operational plan to better prepare for emergencies. This is not covered as it should be something that every facility already has, and they should be familiar with it and ready to place into action if needed. Refer to *CMS Manual System Publication 100-07 State Operations Provider Certification Appendix Z* and *California Public Health and Medical Emergency Operations Manual*.

1.2 How to Apply This Design Guide

Many facilities are interested in what they can do to be ready for the next event or disaster, whatever it may be. Although we do not know what the next event or disaster will be or when it will happen, there are provisions that can be incorporated now so a facility can provide the most efficient and appropriate response when it does. This Design Guide is intended to provide guidance for future hospitals, as well as alterations that can be provided within existing facilities.

This Design Guide is divided into focused sections of what is believed to be the most common concerns for facilities. Please note that there are many other areas of concern, and are not to be dismissed, but rather use the basics found in this Design Guide to apply to those as well. The areas of focus are resiliency and functionality of a hospital after a seismic event; patient room ventilation conversion from positive pressure to negative for infection and contamination control; emergency operations planning to accommodate surge capacity that may be the result of numerous kinds of disasters; spaces that can be split into multiple zones; HVAC considerations for handling smoke during wildfires; how to better expedite emergency projects through OSHPD; OSHPD's role in responding to hospitals after a disaster; and coordination with other jurisdictions for temporary surge facilities and alternate care sites. Each of these will be addressed in specific sections.

A. Alteration Projects

There are many hospitals in operation today that, during an event or disaster, find elements of their facilities lacking in terms of the flexibility to handle various unexpected scenarios that might be presented. This Design Guide is designed to help facilities to understand not only what can be done, but how to find the resources to make it happen.

Existing facilities face the burden of trying to adapt their existing services and systems to best respond to an event's impacts on the facility. This may come in the form of access to the facility, revisions in the utility services, or temporary modifications or structures. Not only do the alterations need to be made, but how to get them approved can be confusing.

Depending on the event, options may be varied. All Facilities Letters (AFL) can be issued by the California Department of Public Health (CDPH) to allow many temporary actions to be taken immediately on an emergency basis. Emergency projects can be authorized and later reviewed and approved for permanent use. Critical projects can be expedited through OSHPD plan review so little time is lost before construction can commence. This Design Guide will identify those options. Some solutions presented in this Design Guide may be implemented without submittal of a project, emergency or standard, to OSHPD. However, it is best to check with OSHPD to determine whether a project submittal, plan review, and permit are required before proceeding with any work. Refer to PIN 72 Emergency Work Authorization for more information and guidance. Also, solutions that change or affect the way inpatient care and treatment is provided must be acceptable to the CDPH.

B. New Facilities

Most hospitals are designed to the code minimums which may not allow for future flexibility in the type of care provided. New hospitals or expansions have more opportunity to "build-in" this flexibility. This Design Guide will identify some of the options available and provide best practices to allow for quick implementation of changes to adapt to the changing needs of patient care during or after an event. Although these options are not code required, they are recommended for consideration for future hospitals.

C. Planning is the Key

A foundational design goal of any hospital project should be to provide flexibility for change. With the length of time necessary to implement hospital projects in California and the quick evolution of technology, potential changes/reactions from healthcare reform, changes in future workloads (increased or decreased), and evolution of models of care, building designs need to build in flexibility in as many ways as possible to help address necessary modifications to the building as planned.

A few of the best methods to accomplish this important goal is the inclusion of shell or unassigned space, the use of a "universal" structural grid, the planning in of soft functions around critical departments for future expansion, utilization of standard size rooms, and consideration of adaptable rooms. These should not be afterthoughts in the project or only part of a value engineering effort but carefully integrated as part of the planning process. There are varying degrees of shelling (cold shell, warm shell, built out but not equipped, etc.), as well as different opinions on what is soft space vs critical, but the point is clear – plan into the project ways to adapt and adjust to the unknown changes in the future. If considering standardizing or multi-use rooms, ensure that the size is inclusive of all the potential uses, such as exam rooms that can be easily converted to minor procedure rooms, or medical/surgical patient rooms that can be easily modified to ICU, etc. Ensure that the infrastructure to support future build outs of shell or conversion of soft space or adapting rooms to higher functionality is built into the project (air changes, filtration, code requirements, etc.).

Another creative variation is to fully design and permit the project knowing that you may shell some of the building or phase the build out over time. Develop a shelling or phasing strategy, which could be implemented either as an alternate approved design or as an Amended Construction Document (ACD). Design of systems should be planned to accommodate this plan.

As a peripheral perspective, sustainable design and disaster planning need to be considered in designing flexibility into a hospital. Health facilities will continue to be challenged by constantly changing industry environmental standards. Planning for various threats (human-caused or acts of nature) requires careful infrastructure design considerations. Facilities must consider these threats as part of their overall infrastructure strategy. These events may be unique with unusual risk factors such as a major earthquake, wildfires, chemical, radiation and biological attacks, or unique to healthcare such as pandemic flu. In any case, facility infrastructure should be designed with consideration to these risk factors. Design interventions range from providing Emergency Department/inpatient bed surge capacity, mechanically isolating areas of the building, creating major outdoor triage/decontamination spaces, accommodating additional staff, etc.

This Design Guide is divided into focused sections ranging from what resources are available, who or where to contact in case of an emergency or event, what various building features are available for differing events, and how to design flexibility into healthcare facilities. To apply this Design Guide, review the sections and decide which features will be considered for your project.

1.3 Who Should Be Using This Design Guide?

The primary focus of this Design Guide is intended for healthcare facility operators and the architectural and engineering design teams they hire to coordinate and design the options that will be discussed. This Design Guide will focus on options and best practices to allow a facility to better plan and prepare for the unknowns of what the future might bring. In addition to owners and designers, this Design Guide will be helpful to local agencies, contractors, planners, and other personnel in not only planning for future impacts but reacting to situations when the arise.

1.4 Links to Resources

Resources, such as Code Application Notices (CANs), Policy Intent Notices (PINs), Websites, etc., are referenced in the Design Guide. Where deemed beneficial, hyperlinks are provided, shown in blue underlined text, so the user can go directly to the referenced resource while reviewing a topic that it is specifically related to.

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SECTION 2
PLANNING, PREPARING, AND IMPLEMENTING SOLUTIONS FOR A SEISMIC EVENT

2.0 Introduction

According to the California Earthquake Authority there are 15,500 known faults in California. Of these, more than 500 are active. There is a greater than 99% chance of one or more M 6.7 or greater earthquakes striking California. Most Californians live within thirty miles of an active fault. Figure 2.1 shows the location of known faults and indicates the probability of which may experience a magnitude 6.7 or larger earthquake in the next thirty (30) years.

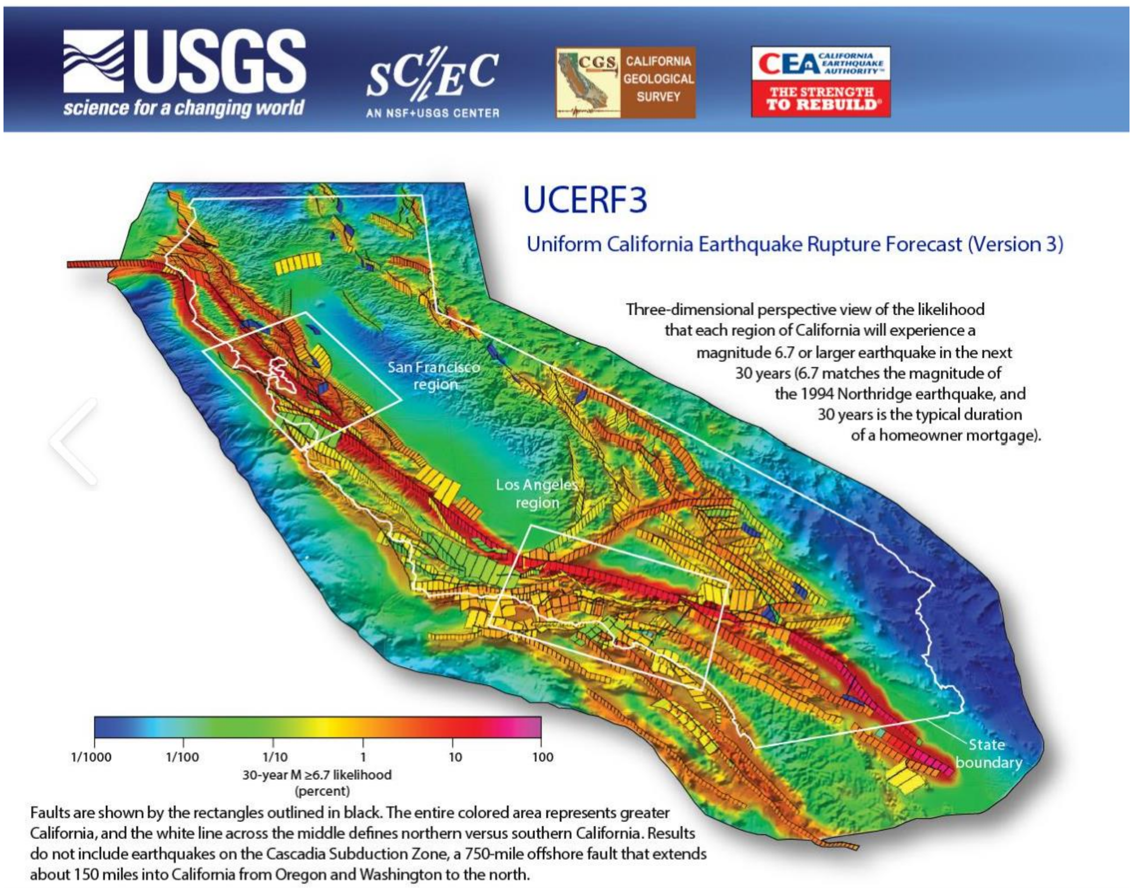


Figure 2.1 – Uniform California Rupture Forecast (Version 3)

What does this mean for hospitals in California? There is a potential for mass casualties resulting from a major seismic event. Sections 4, 5, and 6 of this Design Guide covers emergency operations for surge capacity. Many of the recommendations given in these sections can be applied to a surge in trauma patients that may occur.

However, according to OSHPD's data approximately 21% of the acute care hospital buildings in California have a Structural Performance Category designation of SPC-2.

These buildings were constructed prior to the HSSA without benefit of continuous inspection and under building codes that did not address designing for lateral (earthquake) loads at all, or perhaps inadequately, especially by today's standards. That means that most, if not all, of these buildings have structural deficiencies that can result in various degrees of damage, from minor to partial building collapse, and major repairs or even demolition may be required after an earthquake due to unsafe conditions. These structural deficiencies may include soft stories, discontinuous load paths, deflection incompatibility, torsional irregularity, etc., and many of the SPC-2 buildings have not received a full investigation and evaluation of their structural deficiencies.

Buildings constructed after the HSSA have been designed structurally to many editions of the building codes, also. The building codes have typically been amended after each seismic event to reflect changes needed based on what worked and what didn't. For example, it was discovered that the pre-Northridge steel moment frame connections unexpectedly yielded early and had brittle fractures of these connections. While it is obvious that these connections did not perform as intended this does not mean that the structures were not designed and constructed according to the standards at the time.

What this does mean is that buildings constructed to the earlier code editions will not have the same level of strengthening and seismic resistance of buildings of more recent construction. Hospitals may wish to incorporate some of the changes introduced in more recent code editions to improve their survivability, resiliency, and functionality during and after a seismic event.

2.1 Why is Seismic Safety Important for Hospitals?

The community suffers if their local hospital has been damaged to the extent that it cannot provide trauma care. Time is critical for trauma patients. Access to alternative care locations can be problematic because of road damage, lack of adequate emergency transportation, travel distance, and time to an alternate location, etc.

Hospitals are "Essential Facilities", meaning that the public expects them to be functional and to provide services during and after a disaster for the following reasons:

- Evacuation of seriously ill patients can be fatal and therefore they need to shelter-in-place.
- Provide needed medical assistance to the earthquake victims.
- For insurance, risk, and legal reasons.
- Reduce or eliminate loss of revenue due to down time after a seismic event.
- Importance to protect taxpayer, community, and investor dollars. According to the Natural Hazard Mitigation Saves: 2017 Interim Report, National Institute of Building Sciences Multi-Hazard Mitigation Council, on average society saves $6 for every $1 spent through mitigation. "Just implementing mitigation strategies would prevent 600 deaths, 1 million nonfatal injuries, and 4,000 cases of post-traumatic stress disorder (PTSD) in the long term."

- Without functioning hospitals, it takes much longer for a community to recover from an earthquake. This prolonged recovery seriously limits the community's long-term healthcare access, as well as its economic and social renewal.
- The kinds of specialized care required for trauma patients cannot be easily provided outside of a hospital setting with its Emergency Department, Surgical Units, Imaging, Intensive Care Units, Pharmacies, Laboratories, Qualified Medical Staff, etc.

Some hospitals have suffered disastrous consequences resulting from a seismic event, such as the evacuation and demolition of an unsafe building. It may take five years to replace a hospital building, or longer when factoring in approvals required from local jurisdictions, funding considerations (Federal Emergency Management Agency [FEMA]), etc. During this time the hospital loses its doctors and medical staff, as well as the patients that typically use its services. Historically, hospitals have never fully recovered to their pre-event level of service, and some have had to discontinue business operations. A closed hospital:

- Deprives the community of needed healthcare resources.
- Forces dispersion of patients to distant locations, straining their already limited resources and capabilities.
- Results in a loss of revenue and a loss of market share. Patients must seek healthcare at alternative locations, and if the hospital reopens, many do not return to the hospital after it was repaired or replaced.
- Loss of doctors, nurses, other medical staff, and support staff. Historically, these staff have sought employment elsewhere and many never returned to the hospital after it was repaired or replaced.

Therefore, an aspect of recovery that needs to be addressed by the hospital is that the restored conditions may not be identical to pre-disaster conditions. The hospital's decisions to support desirable vs. achievable recovery states can have far-reaching implications on the resilience and economic survivability of the hospital. Resilience can be expressed in terms of system functionality and the time to recover functionality following a disruptive hazard event. Figure 2.2 shows the initial disruption and loss of functionality from a seismic event, the prolonged recovery period, and the resulting diminished functionality that is obtained if recovery is accomplished. The solution is to plan and prepare for seismic events before they occur.

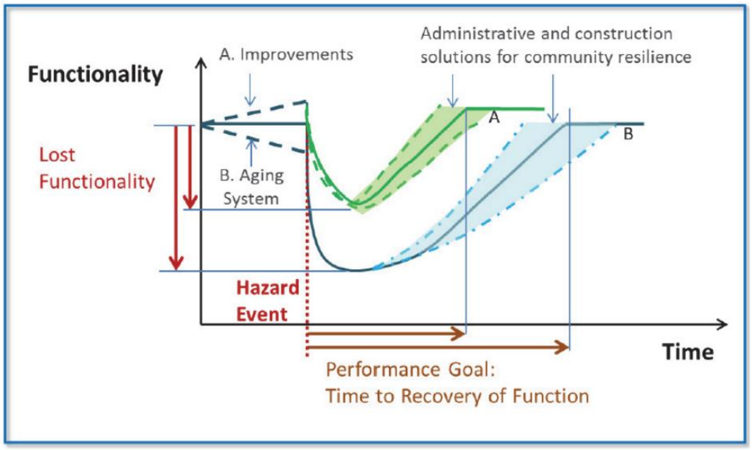


Figure 2.2 – Loss of Functionality vs. Time to Recovery of Functionality

This figure is from the Community Resilience Planning Guide for Buildings and Infrastructure Systems, Volume I: Introduction (National Institute of Standards and Technology [NIST] 2016).

2.2 Planning and Preparing for the Seismic Event

The U.S. Centers for Medicare and Medicaid Services (CMS) and the California Department of Public Health (CDPH) require hospitals to have an Emergency Preparedness Program that addresses potential risks to the hospital and the community from natural and human-caused disasters. This plan typically provides for:

- Patient care and management.
- The safety of patients, staff, families, and visitors.
- Continuing operational status of the hospital or safe evacuation from the hospital.

Some of the possible topics could include:

- **Initiate surge and response specific treatment plans:**
  - Activate triage and treatment areas and teams.
  - Assess injuries to current patients, visitors, and staff.
  - Activate the Surge Plan.
  - Initiate the discharge of patients if community infrastructure allows.
  - Activate the Fatality Management Plan.
  - Assess scheduled outpatient appointments and procedures for postponement.
  - Status of all utilities.

- **Assess damage to hospital infrastructure, including:**
  - Status of all utilities.
  - Ability to sustain operations with current impact on infrastructure and utilities.
  - Activate utility contingency plans, such as a Water Conservation/Rationing Plan. See OSHPD Advisory Guide A5 NPC-5 Water Rationing Plan
  - Activate Memorandums of Understanding as needed for generator and fuel support, water and sewage services, and medical gas deliveries.
  - Safety status of external sites including helicopter landing zones, exterior shelter sites, all buildings on campus, parking structures, fences and gates, external lighting, roadways, and sidewalks.
  - Status of negative pressure isolation rooms.

Hospitals should be developing plans that ensure continuing operations to the extent possible, improve and expedite post-disaster recovery, and improve their resilience to earthquake shaking. In this way they can better protect their vulnerable patients, protect staff and visitors, and provide a valuable service to the community when needed most. There are steps that hospitals can take to improve recovery time of the built environment, including sustained occupancy or re-occupancy.

2.3 Steps to Consider

Several steps are offered below for hospitals' consideration. This is not a complete list of options. The paths chosen for earthquake safety will be based on each hospital's needs, physical and other constraints, and abilities to provide for continuous operations or functional recovery following a seismic event. The incorporation of robustness, redundancies, and temporary workarounds in the lifelines and distributed systems in the areas where critical trauma care is planned to be given after a disaster may be essential for a hospital to serve the injured in its community when the services are most needed:

- Have all buildings in which acute care services are provided or that provide services to acute care buildings evaluated by a California licensed Structural Engineer who is an expert in retrofitting existing buildings to make them more earthquake resistant. Be sure to consider structural and non-structural when preparing your hospital to withstand shaking. Give equal attention to nonstructural elements, such as fire-sprinkler and plumbing systems, ceilings, decorative cladding, as well as medical equipment and contents. Unless properly designed, installed, and anchored, such elements can break or fall in an earthquake, injuring people, causing damage, blocking egresses, and putting the hospital out of action. Based on the evaluation, develop a strategy for performing the necessary work. Create a budget and time frame for accomplishing the work. To the extent possible, prioritize buildings, or portions of buildings, that are essential for the critical care needed by trauma victims.

- Single-story wood-framed hospital buildings have typically fared better in earthquakes than multi-story buildings that are constructed of concrete or steel. However, these buildings can also be susceptible to collapse, partial collapse, or other substantial structural damage if they contain structural deficiencies, such as soft stories, discontinuous force resisting systems, inadequate sill plate anchorages, inadequate shear transfer from diaphragms to load bearing and/or lateral-resisting walls, inadequately reinforced or inadequately anchored veneers, etc. In addition, nonstructural damage may occur that will cause the hospital to be partially or totally unoccupiable. Therefore, it is important that these kinds of hospitals also have their buildings evaluated by a California licensed Structural Engineer. Based on the evaluation, develop a strategy for performing the necessary work. Create a budget and time frame for accomplishing the work. To the extent possible, prioritize buildings, or portions of buildings, that are essential for the critical care needed by trauma victims.
- Consider having a Structural Engineer on retainer to provide emergency inspection and to develop plans for needed repairs after a disaster. This may reduce the time to bring the building and its systems back into service, even if on a limited basis.
- After recent earthquakes affecting hospitals, some buildings were not structurally damaged to the point of being unsafe, and thus requiring evacuation; however, some areas within the building had nonstructural damage that made them unusable. This includes water line breaks that flooded entire units, critical equipment that failed due to inadequate anchorage, etc. Older building codes did not require flexible connections between water lines and fixed equipment. Earthquake shaking caused the pipes to break at these inflexible joints causing major flooding in the affected areas. Consider adding flexible connections where rigid ones occur, especially in areas deemed essential for diagnosing and treating trauma patients during and after a seismic event. The units, rooms, spaces, etc., to consider would include emergency departments, rooms that contain needed imaging equipment, trauma rooms and surgeries, intensive care units, stat laboratories, pharmacies, essential sterilized supplies, and sterilizing equipment, etc.
- Adding flex connectors may still be insufficient to ensure the continuing operation of a unit, room, or space when the lines feeding the space become broken. Piping materials for quick repairs should be kept on hand. While there may be a temporary delay in the use of the unit, room, or space it may be possible to make repairs as needed to get them back in service as quickly as possible. Alternatively, consider ways in which domestic water lines, fire sprinkler water lines, gas lines, refrigeration machinery equipment, alarm functionality, or the needed utility system, can be provided to the area on a temporary basis. This may involve running temporary lines or hoses to areas providing services, using temporary equipment, using temporary systems, such as nurse calls, oxygen, and other medical gases, etc., and bypassing the damaged areas or systems that have caused a disruption in the flow or system.

- Ensure that all equipment that serves the critical care areas are adequately anchored. Equipment failure caused by inadequate anchorage caused some facilities to be incapable of providing the much-needed care in their community after a seismic event.
- If a hospital campus consists of multiple buildings of various structural and nonstructural rating categories and the services needed for trauma patients exists in a building(s) of a lower performance category, consider developing a plan for how trauma diagnosis and treatment may temporarily be provided in a more seismically resilient building on the campus. This approach is like that given in Sections 3 and 4 of this Design Guide for patient surge, but with an emphasis on trauma patients. This may involve adding medical gases, adding electrical outlets (powered from the essential electrical system), possibly upgrading, or modifying HVAC systems, having available mobile imaging equipment with the means to power the equipment, maintaining sterile supplies and sterilizing capabilities, and other means needed to provide critical care for trauma victims.
- Consider the need for emergency water supply through the development of a Water Conservation/Water Rationing Plan. Following the requirements in the California Plumbing Code, Section 615.5, and/or the OSHPD Advisory Guide A5 NPC-5 Water Rationing Plan are good ways to accomplish this.
- Provide for the storage of “red bag” waste, either in a room dedicated for this purpose or in an enclosure on the outside of the hospital. Following the requirements in the California Plumbing Code, Section 727.1, is a good way to accomplish this.
- National Fire Protection Association (NFPA) 110 requires that the Emergency Power Supply System (EPSS), including components like generator sets, transfer switches, circuit breakers, fuel systems, batteries, and other equipment, be inspected weekly. In addition, the EPSS must be run under load at least monthly, and have minimum maintenance activities completed annually. It is very important that the EPSS functions during loss of normal power. To improve resilience, hospitals should also consider fuel cells, solar power, batteries, etc., to supplement and/or replace their complete reliance for normal power from public utility systems/services.

2.4 Recommended Resources

American Society of Civil Engineers, *Seismic Evaluation and Retrofit of Existing Buildings*, Standard ASCE/SEI 41-23, 2023

Federal Emergency Management Agency, Risk Management Series, *Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds*, Providing Protection to the People and Buildings, FEMA 577/June 2007

Federal Emergency Management Agency, Risk Management Series, *Incremental Seismic Rehabilitation of Hospital Buildings*, Providing Protection to People and Buildings, FEMA 396/December 2003

Federal Emergency Management Agency, *Reducing the Risks of Nonstructural Earthquake Damage – A Practical Guide*, FEMA E-74/December 2012

Federal Emergency Management Agency, Emergency Power Systems for Critical Facilities: A Best Practices Approach to Improving Reliability, FEMA P-1019/September 2014

Centers for Disease Control and Prevention and American Water Works, *Emergency Water Supply Planning Guide for Hospitals and Healthcare Facilities*, Atlanta: U.S. Department of Health and Human Services; 2012. Updated 2019

National Earthquake Hazards Reduction Program, Strategic Plan for the National Earthquake Hazards Reduction Program (NEHRP) for Fiscal Years 2022–2029, *April 2023*

SECTION 3
EMERGENCY PATIENT ROOM VENTILATION CONVERSION

3.0 Introduction

Tuberculosis cases and rates rose steadily in California from the early to mid-1900s. In response, OSHPD issued PIN 4 Review of Existing Facilities for Airborne Infection Isolation Rooms and Projects Related to Isolation of TB Patients. While this policy seemed adequate in dealing with the surge in TB cases, it fell very short in dealing with the patient needs created by the COVID-19 pandemic. Airborne infectious diseases, such as TB, Influenza, RSV, and COVID-19, and others are usually handled through negative pressure ventilation and patient isolation. This section will deal with steps that can be taken to deal with these kinds of pathogens, especially when the event results in a surge of infected patients. While the content is intentionally centered around the COVID-19 pandemic because of its more recent occurrence and the many challenges hospitals faced in dealing with it, it should be noted that the steps provided in this Design Guide can be applied to many types of contagious airborne diseases.

As hospitals responded to the COVID-19 pandemic with temporary retrofit solutions to meet the surge requirements, many interventions were focused on augmenting or modifying existing heating, ventilation, and air conditioning (HVAC) systems to create negative pressure in a standard medical/surgical patient room. It is important that the best practices from the retrofits be applied to continuing efforts in existing hospitals, as well as the design and engineering of new hospitals.

Hospitals generally have insufficient facilities to provide airborne infection isolation for large numbers of patients with airborne infectious diseases presenting in a short time. While the numbers of Airborne Infection Isolation Rooms have been increased recently due to the requirements of the National Bioterrorism Hospital Preparedness Program, availability is still well short of the demand during an airborne disease outbreak. Without adequate environmental controls, patients with airborne infectious diseases will pose a risk to other patients and to healthcare workers. HVAC expertise is essential for proper environmental management when planning control of airborne infectious disease outbreaks.

One clear takeaway is: hospitals will need to consider investing in HVAC systems with the appropriate components and infrastructure to provide safe environments capable of supporting acuity adaptable isolation spaces for airborne and droplet-borne pathogens like COVID-19 or other infectious diseases. A timely response is crucial for identification and containment of potentially infectious patients. The goal is for facilities to develop a 12-hour response to implement containment measures. Temporary negative pressure isolation methods are a safe alternative for hospitals that lack engineered Airborne Infection Isolation Rooms. These can be utilized in facilities to meet increased surge capacity for patient isolation. Temporary negative pressure isolation should also be used during hospital construction projects to reduce risks associated with airborne infectious diseases. These temporary measures should be incorporated into the facility’s infection control and emergency response plans.

Airborne infection isolation is based on the following hierarchy of control measures. (See Figure 3.1).

- Administrative (work practice) Controls
- Environmental Controls
- Personal Protective Equipment

These measures are intended to reduce the risk for exposure to infectious disease agents by uninfected persons. Airborne Infection Isolation Rooms and hospital systems in general must be monitored to provide continual protective measures.

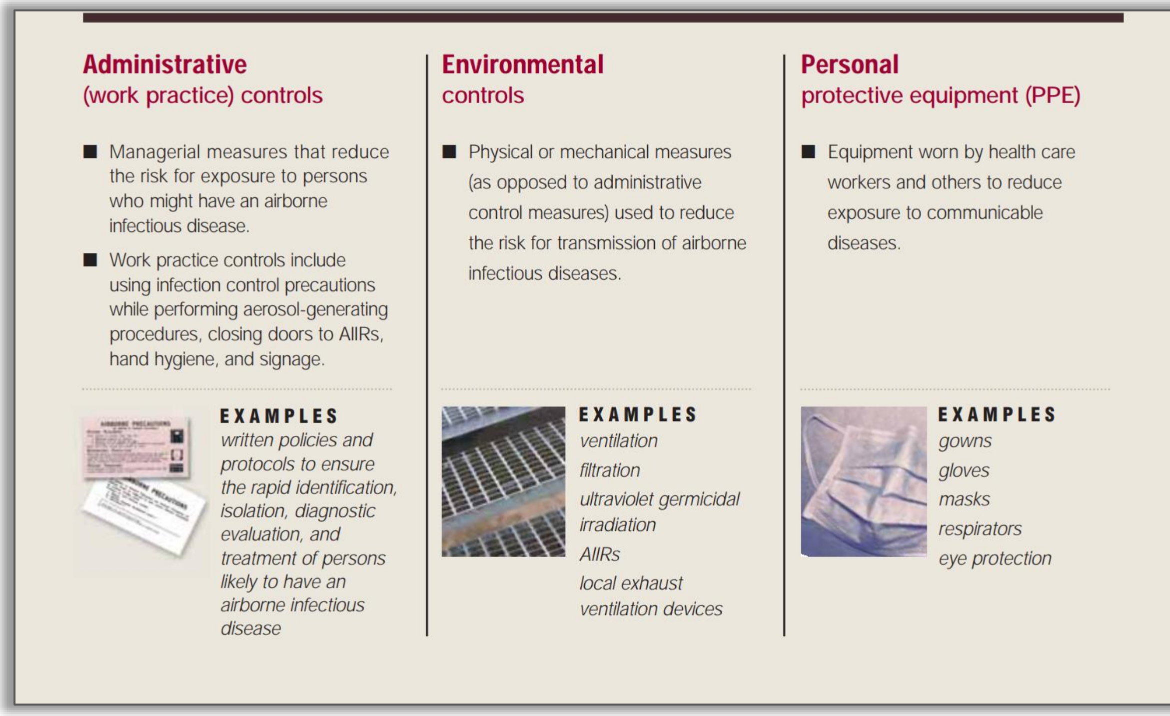


Figure 3.1 – Hierarchy of Control Measures

This section will address Environmental Controls that should be considered to reduce the transmission of infectious diseases through air movement. Below are some considerations and potential solutions for providing a robust HVAC system that can support future flexibility.

3.1 Air Handling Unit (AHU) Recommendations

Recognizing the importance of bringing outside air into hospitals in a pandemic situation when planning a new hospital, designers should consider engineering AHUs to handle multiple conditions for heating and cooling coils: normal quantities of outside air intake for normal conditions, high volumes of outside air for pandemic and emergency conditions, and minimal outside air during wildfire events. Standby heating and cooling capacity should be considered for increased outside air during these conditions.

Standby cooling equipment should use chilled water-cooling systems if possible. Air cooled, direct expansion systems, commonly used in smaller facilities, do not have extra capacity available to increase outside air without compromising comfort nor can outside air be limited or shut off while maintaining ventilation inside the building. Most building codes already require standby heating equipment for normal daily use and for use during emergency conditions.

Current hospital code requires a minimum of twenty-five (25) feet separation between exhaust source and intake source of outside air. If an air handling unit is designed to be switchable from a normal supply and recirculation configuration to a 100% outside air intake and 100% exhaust configuration, the facility will need to investigate this requirement to confirm the location of outside air intakes will comply with code during emergency operations.

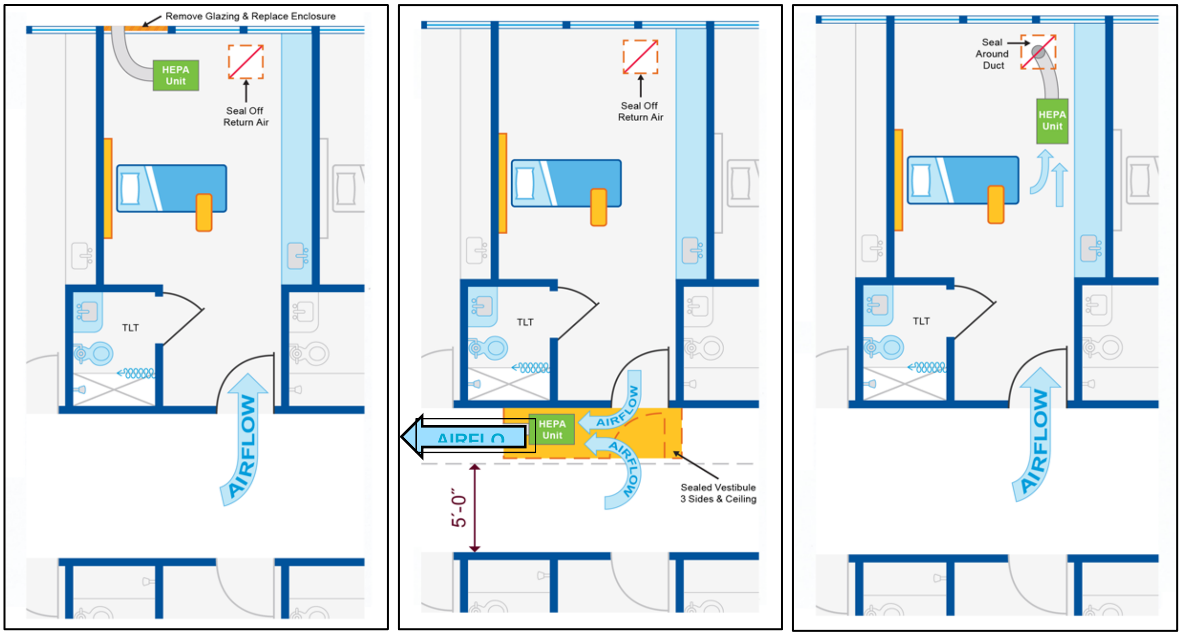
Hospitals should consider use of high intensity UV lights (or other similar air treatment systems) which are very effective at killing bacteria and viruses that would otherwise accumulate on the cooling coils. Due to air velocities typically present though air-handling equipment the main application in air handlers for UV is to disinfect surfaces like cooling coils, filters, and condensate pans. UV might be effective at disinfecting air in lower velocities if applied carefully in areas of lower velocity such as above the breathing zone, near ceilings in rooms. Note that UV can be harmful to people and many construction materials.

3.2 HEPA Filtration Recommendations

To minimize the chance of viruses and other infectious agents from spreading through hospital HVAC systems, implementing, and maintaining proper particle filtration with High-Efficiency Particulate Air (HEPA) filters is recommended. HEPA filtration systems are extremely effective at capturing and removing airborne particles, microorganisms, and other contaminants from a facility's indoor air; however, installing a HEPA filtration system will impact air distribution due to the increased pressure drop that accompanies the use of HEPA, so it is critically important that your HVAC system be designed with enough fan power to support their use.

An option to consider would be the installation of HEPA filter racks in air handlers with recirculating air, that would not be used during normal operations but could be immediately put into operation in a pandemic situation or airborne pathogen event. This would alleviate concerns about operations and maintenance costs related to HEPA filters during normal day-to-day operations.

For existing facilities, flexible ducts and fans can be secured, sized, and tested to exhaust air to the exterior of the building and routing supply air through HEPA filter to create clean air environments in key departments or portions of the building.



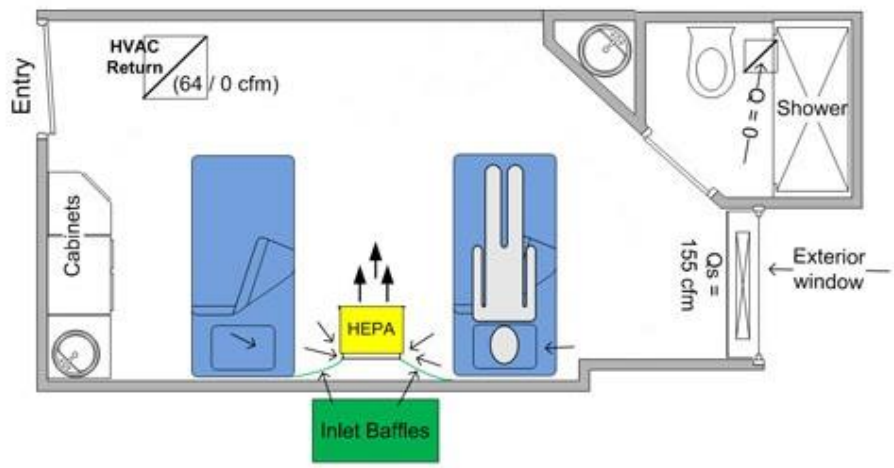
HEPA filtered to outside *HEPA to corridor* *HEPA filtered to return air*

Figure 3.2 – HEPA Unit Applications

For the three HEPA unit application shown in Figure 3.2, the AHU return fan speed and airflow may need to be decreased if enough rooms have their return air grilles sealed. By sealing return grills in blocks of rooms or entire units, the facility would be cutting off a considerable amount of return airflow, and the return fan should be adjusted to ensure overall building pressurization is not adversely affected.

A cleaner air space can be created using one or more portable air cleaners with a HEPA filter (or other high-efficiency filter) in a closed room as shown in Figure 3.3. A portable HEPA device will not create a negative pressure room unless it can be discharged directly to the outside as shown in Figure 3.4. It is important to have a correctly sized air cleaner(s) for the space. Multiple devices may be needed for larger rooms.

The use of the portable filtration unit within the facility should be guided by a written policy and should be customized specific for the hospital with appropriate reviews and approvals from infection control, administration, maintenance, and the departments in which the units will be used.



Temporary ventilation during pandemic.

Figure 3.3 – Use of Portable Air Cleaner

Do-it-yourself room air cleaners can be used consisting of a fan(s) and a MERV 13 filter to provide negative pressure and air cleaning but with more noise which may limit their usefulness.

Figure 3.4 – Temporary Ducting to Outside

3.3 Return Air and Exhaust Air Recommendations

Not only is intake of outside air important, but it is also important to address return air and exhaust air best practices in new hospital design. Keeping exhaled, infected patient air in a space increases risk during airborne pandemics. Hospitals should consider having HVAC systems designed and installed to have return fans be reconfigured to become exhaust during emergencies. Some facilities have return or relief air that discharges into ventilated mechanical rooms; this should be avoided in new designs. During a pandemic, for existing hospitals that discharge air into occupiable space, consider use of flexible ducts that route the potentially contaminated air to the exterior of the building.

In airborne infection isolation rooms, the California Mechanical Code requires exhaust registers to be located on the wall behind the patient's head and located close to the finished floor. Moving forward, designers should consider a similar configuration for medical/surgical patient bedrooms. However, a doorway location is more appropriate for non-infected patients that are susceptible to being infected or immunosuppressed. Because these are conflicting strategies, the location of the return/exhaust registers in the med/surg patient rooms should be thoroughly reviewed with the hospital during design. An option to consider would be to put two return air grilles in a patient room, one by the door and one by the bed, each sized for 100 percent airflow. That would allow the facility to isolate one of the grills depending on operation, i.e., normal, or pandemic mode.

In lieu of using return fans for emergency exhaust, another option to consider is installing dedicated pandemic exhaust risers with exhaust fans sized to exhaust the entire floor or other designated area.

Current code does not allow switching or changing the pressure relationship in a room from positive to negative or negative to positive. However, this configuration could be considered as an Alternate Method of Compliance for these emergency situations if strict and specific procedures are implemented at switchover. A main concern is that the rooms are not actively switched back and forth. Switching room pressure relationships needs to be a structured process reviewed with the hospital, implemented only by the hospital engineers, authorized by the code authorities, and performed as specified in an approved emergency response plan.

A. Negative Pressure Environment Recommendations

Negative pressure rooms feature mechanical ventilation systems which maintain the pressure of the room at a slightly lower level than the pressure of the entry area; this allows air to flow into the room but not escape from the room as air naturally flows from areas with higher pressure to areas with lower pressure, thereby reducing incidences of contaminated air escaping from the room.

Construction of a negative pressure room requires special attention be given to details that include sealing all wall penetrations and use of monolithic, gypsum board ceilings. Door seals and sweeps are also commonly used. As a result, these rooms are much more expensive to construct.

Negative pressure rooms may be provided either by an airflow differential or by a relative pressure differential. The California Mechanical Code utilizes both methods, however the Centers for Disease Control relies on the airflow differential method for spaces such as airborne infection isolation rooms.

Some building elements such as sprinkler heads, door gaps, etc., allow air to escape a room. This can make the pressure differential method more difficult to maintain. The airflow differential approach may be preferred for this reason.

When converting existing standard rooms to negative pressure environments, negative pressurization may be compromised due to existing construction details that cannot be changed. Although proper directional airflow can be achieved, the measured pressure differential may be less than expected.

B. Conversion to Negative

When considering constructing or converting rooms, suites, floors, or other spaces for use with a negative pressure configuration, there are many factors to consider. These factors should be studied with a licensed architect or mechanical engineer, an HVAC contractor/designer, a fire alarm contractor/designer, facilities managers, owner/owner's representative, infectious disease specialists, and all authorities having jurisdiction (AHJ), including but not limited to OSHPD, the local fire department, CMS, CDPH, and all other required entities.

New designs and installations must comply with the prescriptive requirements of all applicable codes and standards; Alternate Methods of Compliance (AMC) are generally performance-based and require extensive consideration by all stakeholders. A team approach that includes all the parties listed above is recommended for efficient design and to eliminate spending time on proposals that may not ultimately be acceptable to the regulatory bodies.

For existing spaces, the original design of the space(s) must be considered when changing the space to a new use or pressure relationship. The intended duration of the change can play a significant role in these considerations – is the change temporary or permanent? If temporary, what is the anticipated timeframe? The scope of the change is also important. Does the change impact a single room? A suite? An entire smoke compartment, wing, or floor? If a healthcare suite will be created from what was originally a fire-resistance-rated corridor, is the means of egress adversely impacted? Is a non-healthcare space being converted to patient care? These, and many other questions, need to be asked and answered before proceeding with the design.

Once the proposed use of the space is determined, there are more technical issues to consider:

- What is the current airflow and air balance of the proposed space?
- Is the space currently positive or negative and being converted to a different pressure relationship?
- Do the adjacent areas have continuous fan operation, such as restrooms or soiled utility rooms?
- What is the relation of airflow and balance to adjacent/connected areas that will remain as unchanged?
- Will the air supply need to be increased or decreased?
- What are the normal operations and conditions of airflow as compared to airflow under fire alarm conditions?

- How does fire/smoke damper operation affect the pressure relationships?
- Will door pressure changes result in excessive opening forces or the inability for doors to self-close and latch?
- Will HEPA/MERV filters be used and is there sufficient fan power?
- Will automatic sensors be used for switching to/from 100% outside air supply and to/from 100% exhaust/return?
- Will the proposed demand on existing air moving equipment overtax the existing systems?
- Will temporary air moving equipment be used?
- Where will temporary air moving equipment be located?
- How will temporary equipment be energized?
- Is emergency power required and available?

Modern building management systems with pressure-independent constant and variable-flow terminal boxes integrated into the controls protocols lend themselves to adjustments being made (positive to negative, negative to positive, etc.) to spaces but should only be implemented by knowledgeable building management staff. Easily accessed controls for "switchable" spaces to be used by medical staff will not be approved.

Special attention must be paid to the use of fire-resistance-rated egress corridors for conveying air to or from rooms. This is a fire and life safety code concern that is intended to prevent smoke from contaminating the means of egress. In healthcare occupancies, corridors are not only used for egress, but also for safe refuge areas when moving patients from one smoke compartment to an adjacent compartment during a fire emergency. However, in areas caring for immunocompromised patients, corridors may need to be negative in relation to the patient rooms, essentially treating the corridor as an anteroom. For proposed designs using this concept, each facility needs to be individually evaluated for its own merits and additional safeguards may need to be put in place during design and construction. Because of all the variables, these situations must be evaluated on a case-by-case basis by way of a formal Alternate Method of Compliance submittal.

Regardless of which changes are being considered, proper documentation must be submitted to all required regulatory entities for review and approval prior to the installation unless an emergency condition exists.

3.4 Operating Rooms

Healthcare providers often consider putting an operating room into a negative-pressure condition, likely over concerns for the staff and patients outside of the operating room when surgeries are being performed on patients with airborne-contagious conditions. This is expressly discouraged. History has shown that when invasive surgical procedures are being performed, the level of susceptibility to contagions and Hospital-Acquired Infections rate is disproportionately high, greatly exceeding that infection potential to gowned and masked staff in the operating room or surrounding areas.

An alternative to negative-pressure operating rooms is as follows:

- Do not adjust airflows in the operating room to the point they no longer comply with the requirements for normal operating rooms as specified in the California Mechanical Code and ASHRAE 170.
- Determine if any openings (doors) from the operating room to adjacent spaces are not necessary and possibly seal them temporarily.
- Construct a temporary negative-pressure anteroom outside the staff entrance door, preferably with the scrub sink internal to this anteroom.

3.5 Recommended Facility Ventilation Design

The design of ventilation systems following the ASHRAE/ASHE Standard 170-2021 and ASHRAE Standard 62.1 guidelines appears adequate for the control of airborne spread of SAR-CoV-2 (COVID-19) in hospitals and other work areas during non-aerosol-generating activities or procedures.

There has been no documentation of transmission and airborne spread of SARS-CoV-2 (COVID-19) by HVAC systems during non-aerosol-generating activities or procedures. Additional practices for masking, hand hygiene and social distancing have reduced the risk of exposure.

Additional considerations beyond use of ASHRAE/ASHE Standard 170-2021 and ASHRAE Standard 62.1 guidelines are recommended and include:

1. Increasing outside air intake to maximum allowable level to enhance mixing and elimination of recirculating air.
2. Improving filtration efficiencies, if practical.
3. Providing negative pressure to patient rooms.
4. Running systems continuously and eliminating economized function.
5. Disabling demand-controlled ventilation (DCV) provisions.

Where you want to include the flexibility to “flex” rooms from normal operating pressure relationships to negative pressure in new buildings you could incorporate additional control dampers in their return/exhaust distribution system, or in ducts serving specific rooms, where flex pressurization is desired. Supply air to negative pressurization flex areas should continue to satisfy the California Mechanical Code Table 4-A for total and outside air requirements, therefore, return/exhaust ductwork and fans should be sized for the increased airflow needed to provide negative pressurization, and the return/exhaust fan motor should have variable speed capabilities.

In existing facilities, the ability to modify the existing mechanical system to allow for flexing from normal to negative pressurization is dependent on the existing equipment and distribution. For facilities with constant volume air handling equipment and no zone level control, the following could be considered:

- Replace air handling unit fans if necessary and install new Variable Frequency Drive motors to allow for variable speed operation.
- Identify zones or rooms requiring the flexibility for negative pressurization and identify the size and routing of supply and return ductwork serving the area, including locations of fittings. Find feasible locations for the installation of new control dampers or terminal units.
- Airflow measuring capabilities should be considered with new control dampers. These new airflow control devices could potentially only be installed on the return side distribution, varying only that airflow to flex between normal and negative pressurization.
- The ductwork and return fan sizes would need to be verified as being adequate for the greater airflow required for negative pressure operation.

Regardless of the approach, careful planning is critical, and designers and contractors must be very familiar with the regulatory requirements for the desired outcomes. When critical situations arise, OSHPD will partner with facilities and designers to achieve the desired goals and will assist with streamlining the process to implement these emergency changes in an expedited manner. The table which follows provides a matrix listing the various recommendations and considerations for negative pressurization of rooms during emergency conditions.

3.6 Implementation

Solutions that involve modifications to existing systems that are intended to be permanent that changes air flows, pressure differentials, equipment, adding filter banks, other changes to filtration, adding or relocating ducting, etc., requires the submittal of a project to OSHPD. For emergency related projects refer to PIN 72 Emergency Work Authorization.

3.7 The Opportunity

"The COVID-19 crisis highlighted the impact of HVAC systems in keeping both patients and front-line caregivers safe and has taught us the importance of designing flexibility into our future hospitals. Following World War II, President Harry Truman signed the "Hospital Survey and Construction Act" into law that ignited a healthcare construction boom in the 1950s and 1960s. In 1975, the Hill-Burton Act supported the financing of an additional 6,800 facilities. The impact of both pieces of legislation resulted in one of the most extensive and advanced health care systems in the world. The COVID-19 pandemic offers the A/E/C community and healthcare leaders an opportunity to reimagine the design of the next generation of hospitals." Scott Winfrey, P.E., P. Eng., LEED AP, HFDP, Specialized Engineering Solutions.

Recommendations and Considerations for Negative Pressurization During Emergency Conditions

	Patient Areas							
	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**	**Non-Patient Area Filtration**
New Facilities Approach to Work	Negative air balance can be achieved in almost any room by any combination of increasing the air being removed (return and/or exhaust) and/or decreasing the air being supplied. Cooling load and code-required minimum ventilation shall still be met. Table 4-A air change rates need to be maintained, though return/exhaust airflow can satisfy the required air change rate. Per code, a room in a medical facility with a pressure requirement may impact the airflow of an adjacent, rated corridor. See "Use of corridor for make-up air" column.	Flex rooms (or units) may be approved via an AMC to be included in the design of a new facility if the BMS can control room-level airflow and monitor all airflow conditions. A flex room would operate under code required air change and pressurization conditions (e.g., 6 ACPH minimum, and no pressurization requirements for ICU) for normal conditions, and switch to a negatively pressurized room for emergencies. Hospital facilities staff would need to be in charge of switching between normal and emergency modes, and an operator user station would need to note that the emergency mode is in use via an alarm. Design supply air ductwork to flex rooms to include terminal units or control dampers to provide normal and emergency airflow conditions. - Include VFD on supply and return fans for AHUs serving areas with designed flex spaces for fan speed control. - Decrease supply airflow to flex rooms while maintaining normal airflow for return air to create negative pressurization during emergency mode. - Both normal and emergency modes will need to be balanced and commissioned. - See "Use of corridor for make-up air" column for make-up air discussion.	**Use of the corridor for make-up air will be considered via an AMC if air handlers and exhaust fans within a smoke compartment are shut down via total-coverage smoke detection system.** Corridor airflow should be reset to support the additional makeup airflow required for patient room flex operation. In addition to the two airflow settings in the patient rooms (see "flex" column), there should be a normal and emergency airflow setting for the corridors that would be providing makeup air. The project air balancer will need to measure both normal and emergency modes and verify that both modes do not negatively impact door pull requirements at doors leading into and out of units with flex pressurization rooms.	Pressure monitoring is not required for temporary negative pressure rooms created in response to a pandemic. Rooms that are designed to switch from neutral to negative pressurization will be required to provide the ability to measure supply and return/exhaust airflow for each flex room, to report via the BMS that the room's negative airflow differential (SA-RA) is being maintained during emergency operation. If return air terminal units are included in room design, use the supply and return airflow readings from both boxes to ensure airflow differential is maintained during emergency condition. If no return air terminal units are included in room design, include a return airflow measuring device for each flex room. The BMS will calculate airflow differential for reporting during emergency operation.	Size fan & filter bank for HEPA filters but use MERV 14 (90%) filters for typical use. Consider adding a third slot for a specialized filter for wildfire smoke. Recommend for new construction designing filter boxes with dedicated slots for each filter width to avoid air leakage. Fans need to be sized for full operation of filter types and loading.	Consider expanding the use of the airside economizer for an AHU serving flex rooms during emergency operation through the following options: - Resetting room temperature setpoints to code allowed maximum. - Resetting setpoints for economizer control (e.g., OA temp). - Resetting AHU discharge air temps for expanded economizer usage on warm/hot days, while still maintaining room temperature setpoints.	In airborne infection isolation rooms, the California Mechanical Code requires exhaust registers to be located on the wall behind the patient's head and located close to the finished floor. Moving forward, designers should consider a similar configuration for medical/surgical patient bedrooms that may be used as flex rooms for emergency conditions. However, a doorway location is more appropriate for non-infectious patients that are susceptible to being infected or immunosuppressed. Because these are conflicting directions, the location of the return/exhaust registers in the med/surg patient rooms should be thoroughly reviewed with the hospital during design. An option to consider would be to put two return air grilles in a patient room, one by the door and one by the bed, each sized for 100 percent airflow. That would allow the facility to isolate one of the grills depending on operation i.e. normal or pandemic mode.	2019 code requires MERV 8 (30%) filtration. Recommend sizing fans and filter banks for MERV 14 (90%) filters to be used during pandemic situations Recommend for new construction designing filter boxes with dedicated slots for each filter width to avoid air leakage.

	Patient Areas							
	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**	**Non-Patient Area Filtration**
Existing Facilities Approach to Work	Whether done manually or by an installed control device, rebalance of existing rooms can only be achieved if make up air comes from an adjacent ante room or corridor; additional CFM will be required to offset the increase in return/exhaust air.	Flex rooms (or units) may be approved via an AMC to be included in the renovation of an existing facility if the BMS can control room-level air flow and monitor all airflow conditions. A flex room would operate under code required air change and pressurization conditions (e.g., 6 ACPH minimum, and no pressurization requirements for ICU) for normal conditions, and switch to a negatively pressurized room for emergencies. Hospital facilities staff would need to be in charge of switching between normal and emergency modes, and an operator user station would need to note emergency mode in use via an alarm. - Fans or fan motors may need to be replaced on exiting AHUs to be able to vary speeds for switching between normal and emergency operation. - VFDs may need to be installed for fans currently operating at constant speed. - If no room level airflow control is included on existing rooms to be used for flex operation, supply side airflow control (e.g., terminal unit, control damper, etc.) will need to be installed. - Decrease supply airflow to flex rooms while maintaining normal airflow for return air to create negative pressurization during emergency mode. - Both normal and emergency modes will need to be balanced and commissioned. - See "Use of corridor for make-up air" column for make-up air discussion.	**Use of the corridor for make-up air will be considered via an AMC if air handlers and exhaust fans within a smoke compartment shut down via total-coverage smoke detection system.** Corridor airflow should be reset to support the additional makeup airflow required for patient room flex operation. In addition to the two airflow settings in the patient rooms (see "flex" column), there should be a normal and emergency airflow setting for the corridors that would be providing makeup air. If there is no airflow control to the corridor that would be used to makeup air for the flex rooms, supply side airflow control (e.g., terminal units, control dampers, etc.) will need to be installed. The project air balancer will need to measure both normal and emergency modes, and verify that both modes do not negatively impact door pull requirements at doors leading into and out of units with flex pressurization rooms.	Pressure monitoring is not required for temporary negative pressure rooms created in response to a pandemic. Rooms that are designed to switch from neutral to negative pressurization will be required to provide the ability to measure supply and return/exhaust airflow for each flex room, to report via the BMS that the room's negative airflow differential (SA-RA) is being maintained during emergency operation. If no room level airflow measuring is included on rooms to be used for flex operation, supply and return side airflow measuring devices will need to be installed. The BMS will calculate airflow differential for reporting during emergency operation.	Verify if existing supply fans can provide enough static pressure for both HEPA and MERV 14 (90%) filters under all loading conditions. If so, verify if existing filter rack can accommodate both filters. Consider replacing fan and filter rack to be able to provide HEPA filtered air during emergency operation.	If an existing AHU serving flex rooms has an airside economizer, consider expanding its use during emergency operation through the following options: - Resetting room temperature setpoints to code allowed maximum. - Resetting setpoints for economizer control (e.g., OA temp). - Resetting discharge air temps for expanded economizer usage on warm/hot days, while still maintaining room temperature setpoints. The facility should determine the limit of their AHU running in economizer mode. On a 100+ degree summer day, the AHU will most likely not be able to meet its supply air setpoint if the economizer is at 100% OA. An emergency control sequence can be added to the BMS using the options above to allow a wider range of operation for the economizer.	In airborne infection isolation rooms, the California Mechanical Code requires exhaust registers to be located on the wall behind the patient's head and located close to the finished floor. Moving forward, designers should consider a similar configuration for medical/surgical patient bedrooms. However, a doorway location is more appropriate for non-infected patients that are susceptible to being infected or immunosuppressed. Because these are conflicting directions, the location of the return/exhaust registers in the med/surg patient rooms should be thoroughly reviewed with the hospital during design. An option to consider would be to put two return air grilles in a patient room, one by the door and one by the bed, each sized for 100 percent airflow. That would allow the facility to isolate one of the grills depending on operation i.e., normal or pandemic mode.	2019 code requires MERV 8 (30%) filtration. If the existing AHU has available static pressure and the existing filter rack can accommodate, recommend using MERV 14 (90%) filters to be used during pandemic situations. Consider air cleaners and/or recirc HEPA designs for in-room filtration.

SECTION 4
EMERGENCY OPERATIONS FOR SURGE CAPACITY

4.0 Introduction

Medical surge is the ability to provide adequate medical evaluation and care during events that exceed the limits of the normal medical infrastructure of an affected community. It encompasses the ability of the healthcare system to survive a hazard impact and maintain or rapidly recover operations that were compromised. The ability to respond effectively to events producing a massive influx of patients that disrupt daily operations requires surge capacity. Effective emergency preparedness in the healthcare arena requires planning for large-scale events that affect many people. These events may include chemical, biological, radiological, earthquakes, or other natural or human-caused disasters. The aftermath of Hurricane Katrina provides a vivid example of a large-scale, natural-disaster event. Mass casualties from an accident, riot, or other uprising, or from a major earthquake may result in a surge of patients in need of immediate emergency care. Infectious disease outbreaks, such as COVID-19 or pandemic avian flu, provide yet other examples of potentially, large-scale events. A critical component of the ability to respond to large-scale disasters is surge capacity.

Hospitals of all sizes and in all settings face challenges to their ability to meet surge demands. Large hospitals, particularly those that anchor community safety nets, typically operate at or near capacity. Therefore, their ability to serve a large influx of critical patients is limited. Smaller hospitals, particularly those in rural areas, are faced with limited availability of resources and outside support. These limitations include smaller or nonexistent local public health departments, limited communication technology, reliance on volunteers, inadequately equipped medical transport units, and greater distances from other potential lifesaving or supportive resources. While hospitals are the first structures that come to mind in healthcare, extended care facilities, community health centers, laboratories, and public health departments also comprise the structure component of surge capacity.

This section of the Design Guide provides best practices and key points to consider when designing new healthcare facilities or renovating areas to be resilient and functional during large-scale events. For a graphic representation of the concepts presented in this section, see Section 5, Emergency Response Diagram 1.

4.1 Hospital Entryways

One of the key issues to consider in the post-COVID-19 hospital is better restriction of the hospital's entryways. This restriction is an infection and/or exposure control, design, and engineering issue. The typical Emergency Department (ED) entrance vestibule is a small space that is not designed to hold people, but it may become a screening area during a pandemic or other emergency event of large scale. Once individuals are screened, the ED should have separate areas to wait in. Individuals exhibiting symptoms of the pandemic, or other conditions with the possibility to contaminate others, should be separated from other patients, which will prevent spread and better facilitate tracking of patients that are potentially infected or exposed to chemical, radiological, or biological contaminants. Taking this concept, a step further, “multimodal entry portals” could help steer infected or contaminated patients into the right path and away from non-infected and non-contaminated patients. This entry could use technology such as air sensors or biometric identification to sense patients who are ill before they enter the ED waiting room and redirect them to pandemic or decontamination entries. While this section primarily discusses infectious versus non-infectious persons, it should be noted that there are other reasons that patient populations need to be kept separate to avoid the spread of disease, contamination, etc. The concepts and principles provided in this section apply to all situations where patient segregation is paramount.

4.2 Conceptual Approach

The design of health facilities should facilitate the separation of infectious or contaminated patient care to keep the rest of the patient and staff population safe while supporting the continuity of operations. This should include a variety of emergency conditions such as, but not limited to, infectious diseases, mass casualty events, natural disasters, man-made disasters, and chemical/hazardous materials exposure; however, the design must work for everyday use and noninfectious patient care to be financially viable.

In 2014, an Ebola outbreak occurred. Although patients appeared to be at low risk for spread of Ebola, many hospitals took precautions by performing emergency construction projects for specialized isolation and care. Many of the actions taken to isolate and care for Ebola patients can be applied to other kinds of diseases that are transmitted in a different way than through air-borne pathogens.

Flu outbreaks occur seasonally, often creating surges of infected patients. During these events, some hospitals have had to take steps, such as tents, temporary structures, mobile units, etc., to accommodate the patient influx, provide for separation of infected from the uninfected, and to provide space for patient treatment and care. Refer to CAN 2-108 Temporary Systems, Utilities and Equipment for additional information and guidance.

In most hospitals, one of the primary paths of travel tends to be from the ED, where patients are first assessed and discharged or admitted to other departments or areas within the building. Buildings and units that have a shorter and more direct path of travel from the ED warrant greater consideration for limiting the chances of infectious disease or contamination spread. When considering these protected paths of travel, design considerations should facilitate the following basic concepts.

A. Separate the Infected and Non-Infected Patient Flow

Where possible, provide separate compartments for infectious and non-infectious patients with separate HVAC systems that have redundancies. Options for the separate compartments are ambulatory infectious, ambulatory non-infectious, resuscitation/infectious (entry from ambulance drop-off), and trauma/non-infectious (entry from ambulance drop-off).

B. Prevent Infected, or Possibly Infected, Patients from Entering the Building

Provide an x-ray room on the resuscitation side of the trauma/resuscitation portion of the ED. This allows for chest x-ray of pandemic/infectious patients without traveling through the hospital into the imaging department and unnecessarily exposing other patients and staff. Consider locating the x-ray room adjacent to the ambulance entry for ease of access and speed of diagnosis.

4.3 Considerations for Patient Arrival

Hospital planners should begin controlling patient flow with a thorough risk assessment, evaluating the hospital’s ability to accommodate any type of widespread pathogen or contaminant, and identify areas that may need to be strengthened. Even though such a risk assessment would not be definitive, it could guide the planners in securing necessary resources and staging them in key locations. Even though the next pandemic may not be airborne, such as the Ebola outbreak in 2014, air quality issues are always important in hospitals. Similarly, some hospitals may determine that creating a devoted infection isolation unit is a worthwhile use of resources.

In any case, hospitals should be prepared to accommodate a wide range of potential pathogens with varied transmission pathways. Keeping infectious or suspected infectious patients outside of the hospital, but in designated areas where hospital staff can monitor them and provide initial treatments, is an obvious advantage over bringing infected patients inside the hospital. Considerations for locating and designing these areas are included below.

A. Parking

Exterior spaces need to be identified that can accommodate various activities and keep patient populations separated. Private vehicle and bus parking areas should be designated and well-marked with adequate lighting and large signs. These areas should be able to accommodate regular patient arrivals, as well as emergency conditions or mass casualty incidents where patients may be brought in by bus.

B. Patient Waiting Areas

Inevitably, exterior triage, waiting, and queuing areas are necessary during surge events that overrun hospital resources. Ensuring safe and comfortable areas where patients can be triaged and wait for treatment is an important consideration. Exterior triage, waiting, and queuing areas should differentiate between confirmed exposed patients, possibly exposed patients, and non-pandemic related emergencies.

Exterior triage, waiting, and queuing areas should be provided with exterior weather protection and heating or cooling depending on the environment. To facilitate protection from the elements, consider use of covered parking structures, tents, quick deployment trailers or modular structures for temporary holding or treatment.

C. Decontamination

Decontamination and pandemic ambulatory patient drop-off areas should be provided in a location separate from designated parking areas. These areas can be used during an emergency incident involving hazardous materials contaminated patients arriving at the ED, and can also be used as a special, separate drop-off area for ambulatory patients or curbside screening of patients.

Entry vestibules designated for decontamination of patients exhibiting signs of exposure to hazardous materials should include vestibules with dedicated entrances and decontamination rooms that can be used as an air lock. Where possible, consider providing more decontamination showers than code minimum. These areas should be provided with PPE donning/doffing areas and supplies immediately available which facilitate the ability to respond to chemical, biological and radiological exposures. These areas can be used for secondary screening or security screening when not being used to decontaminate patients. Whenever possible, it is recommended to provide these entry vestibules immediately outside of each pandemic/infection compartment in the ED.

Refer to PIN 35 Healthcare Decontamination Facilities for additional information and guidance.

D. Separate Ambulance Entry

Keeping ambulance traffic separate from other patient areas is an important consideration for emergency operations, as well as for patient and emergency responder safety. During times of pandemic, or hazardous materials exposure, additional safeguards should be considered. Where possible, separate ambulance entries to provide dedicated entries into the ***infectious disease/resuscitation*** compartment of the ED and dedicated ambulance entries into the ***non-infectious/trauma*** compartment.

E. Identification

Providing properly located visible signage allows patients and emergency responders to proceed directly to the correct location without necessitating infectious patients entering non-infectious areas or approaching staff for directions. Signs should be large and well-lit for nighttime viewing and should provide explicit information and directions for all arrivals. Signs should be in multiple languages based on the prominent cultures served in the community. Locations to consider for directional signs would include the locations of exterior triage areas, decontamination showers, separate covered ambulance entries, staff, and Incident Command Center (ICC) entries, and infectious waiting areas vs. non-infectious waiting areas.

Use technology to your advantage. Where possible, provide self-check-in kiosks or web-based pre-screening systems so that patients can answer a questionnaire prior to contacting staff which is transmitted to care providers when patients are accepted for treatment. Patients that are non-symptomatic and non-infectious can quickly show clearance to security staff and avoid long queues. Consider posting wait times on-line and at the ED entry so the less-emergent patients can make an informed decision on seeking an alternative treatment location.

- Limit non-emergent exits and monitor them so that opportunities for visitors or staff to admit un-screened persons are reduced.
- Consider providing dedicated, non-public-facing entries for staff and the Incident Command Center to ensure separate flows of staff/ICC, public/patient, and materials.
- Limit the entrances that staff, patients, and visitors can use to enter the facility.
- Provide exterior (covered) screening/temperature check at entrances that staff and visitors can approach enter the facility. If symptomatic, direct patients to the exterior triage, ED (if warranted), or back home, depending on the facility's operational model.

4.4 Considerations for Entry into the Hospital

Based on lessons learned from the COVID-19 pandemic, one of the key issues that should be considered is better control of the hospital's entryways. Considerations for this control are an infection control, design, and engineering issue. For example, the typical ED vestibule is a small space that is not designed to hold people but became a screening area during the COVID-19 pandemic for many facilities. Other entrances were often uncontrolled or located infected patients in the same space as those presenting with symptoms.

The nature of how individuals present at the hospital needs to be better addressed, because the presentation is very different depending upon the event type, and the response may necessitate various treatment options. Typically, an infectious disease happens slowly over time and may evolve to the point where the infection rate is very high, with the potential that suddenly there are so many patients that a hospital may become overwhelmed. This is completely different than the chemical plant explosion where, for example, 50 people present with chemical burns or contamination, and how the ED entry functions during this type of surge event must be different from other surge events.

Future EDs should have separate areas for individuals to wait in. Individuals exhibiting potentially contagious symptoms should be separated from other patients, which will prevent spread and better facilitate tracking of patients that are potentially infected or exposed to chemical, radiological or biological contaminants. Beyond the ED, the concept of a "multimodal entry portal" will aid to direct infected patients into the right treatment path and away from non-infected patients. These entries could use technology such as air sensors or biometric identification to sense patients who are ill before they enter the building or waiting room and redirect them to pandemic or decontamination entries.

A. Recommendations for the Entry Level into the Hospital

Each entry into the hospital needs to be evaluated for appropriateness as an entry portal to the hospital. Entries should be clearly identified with instructions for arriving patients. Entries for staff only should be identified as such and locked to prevent unauthorized access.

All public entries to the facility should be provided with symptom checkpoints and security. These vestibules can provide a secondary opportunity to screen patients and public to prevent exposing staff and other patients to an infectious pathogen or contaminant. Based on this concept, public entry vestibules should be sized to accommodate secondary screening and security checks.

B. Use of Interior Spaces

Locating patients and public after entry is an immediate need. Large multipurpose spaces, such as conference rooms and dining rooms, may be needed during high patient and public census should be identified in advance and properly furnished. As part of emergency condition planning, identify multipurpose rooms that can provide an area for families in the event of unusual occurrences, such as mass casualty events. If possible, separate rooms for patients presenting with symptoms should be provided to allow uninfected public to wait in a room that limits their exposure. When not being used for high census or mass casualty events, these multipurpose rooms are able to flex into spaces commonly needed during emergency conditions such as:

- Incident Command Center (ICC)
    - Provide staff-only entrance to this area.
    - Provide adequate emergency power and data access capabilities for emergency conditions with extended durations – as long as three days or more.
    - Include provisions such as handwashing sinks, refrigerator, microwave oven, storage, and counter space for staff nourishment.
- Backup ICC – for overflow or separate command structures/events.
- Media Center
    - Provide a dedicated space for members of the media to gather, work and receive updates and briefings.
    - The media center should be located away from the public waiting areas to afford privacy for families affected by the emergency event.
    - The media center can be a multipurpose or conference room during non-emergency conditions.

C. Staff Spaces

Dedicated staff spaces should be provided in or adjacent to departments most utilized during emergency conditions for staff respite and breaks. During emergency conditions staff may not be able to leave the facility and will be working significantly extended hours. When possible, provide staff respite immediately adjacent to the department that staff work in.

One of the lessons learned from past pandemics and mass casualty events is that the staff lounge is not an appropriate area for staff in need of a quiet contemplative space to decompress or grieve. In response to this need, healthcare facilities have responded by providing a respite room that is separate from the staff lounge.

Where dedicated respite spaces cannot be provided, flex space should be provided to accommodate staff respite during emergency conditions. When possible, provide a staff respite area with access to natural daylight and views, as well as amenities which provide respite from the stress of emergency conditions.

4.5 Emergency Departments

Another issue at the intersection of hospital design and emergency event management is patient flow. Hospitals in general are not designed to restrict movement, and that normally is not a problem. But during the COVID-19 pandemic, hospitals learned that the more infected patients moved around the facility, the more likely they were to spread the virus.

Managing patient flow can be further extended with design changes throughout the hospital. When a patient enters for a procedure, they typically visit a registration area, waiting area, exam room, lab, or blood draw, and perhaps pre-op and post-op area, among other spaces. Each stop increases the potential for pathogen spread and if the patient’s intrahospital travel could be reduced — such as by having some functions combined, the risk would go down.

A design solution to reduce the spread of pathogen transmission is to create spaces and corridors that encourage unidirectional flow. One-way corridors – like the one-way aisles that appeared in many grocery stores – can reduce the risk of pathogen transmission between people and can reduce surface transmission of pathogens.

For example, in spaces where staff remove their soiled personal protective equipment (PPE), having an exit that is separate from the entrance prevents people from touching garments or surfaces that may harbor the pathogen. Therefore, separating donning and doffing with unidirectional flow prevents potential cross-contamination. In hazardous materials operations, one of the protocols for proper decontamination is unidirectional flow.

A. Patient Flow

Controlling patient flow is instrumental in limiting the spread of pathogens and contaminants. This requires planning and rigid enforcement of boundaries from entry to exit. One opportunity to reduce patient traffic is by encouraging the use of telehealth. By eliminating the need for patients to physically come to the hospital, the risk of spreading an infectious pathogen is eliminated.

- Pre-screening
  - Patients and public entering the ED must be pre-screened; this can be achieved prior to arrival using telehealth or virtual care, in the parking lot using curbside/outside screening, or in predetermined walk-up screening locations outside of the ED.
  - After screening is completed, patients can be directed to the appropriate entrance based on their symptoms.
  - Patients who need to enter the ED will enter either a pandemic/infectious or non-pandemic/non-infectious entrance.
- Triage
  - Patients may only enter the ED triage areas after passing through pre-screening.
  - Non-urgent infected patients are triaged in an area or compartment separate from non-infected patients.
  - Temperature checks and security checks at entry to the ED may be used to prevent non-urgent infected patients from spreading airborne infection.
- Non-ambulatory/Ambulance Entry patients. Patients entering the ED via ambulance must also be segregated as either infectious or non-infectious and separate entries should be provided.

B. Compartmentation

Where possible, the ED should be designed and constructed with separate compartments. These compartments should be defined by smoke barriers, creating a minimum of four (4) separate smoke compartments within the ED. This design facilitates both emergency relocation of patients during a fire emergency without necessitating movement of infected patients to other areas of the hospital and allows for separation of the mechanical HVAC systems to isolate infected patient areas from non-infected patient areas.

As previously stated, the ED should be divided into ‘infectious’ and ‘non-infectious’ compartments. Within the infectious compartments, areas can be further divided to accommodate Level 3 - 5 patients into one compartment and Level 1 & 2 patients (more acute & resuscitation) into another compartment. Similarly, within the non-infectious compartments, Level 3 - 5 patients can be in one compartment and Level 1 & 2 patients (more acute & trauma) into another compartment. Separating the Level 3 - 5 patients and Level 1 & 2 patients is a common approach to assist in the triage and treatment of patients by severity level and number of interventions.

For more information on zoning emergency departments and other areas of the hospital, see Section 5, Spaces That Can be Split into Multiple Zones.

4.6 Pandemic/Isolation Patient Units

Another important consideration in designing the post-COVID-19 hospital is considering spaces that are devoted to pandemic patients or those patients that need to be isolated. Many hospitals have some type of isolation room or rooms, but a key to future design of such units may be to cohort pandemic patients. Hospitals typically have one or two Airborne Infection Isolation Rooms (AIIR) per unit, but the unit may have 24 patient rooms, spreading the AIIR over 12 units making it much more difficult to manage during a pandemic.

Conceptually, isolating pandemic patients to one part of the hospital could extend to dividing the entire hospital, but only if patient and staff traffic between the sectors can be limited. Utilizing buildings outside the main hospital, such as surgery centers or outpatient treatment facilities, to isolate non-infected patients while providing excellent care and treatment would allow the main hospital to be devoted to pandemic care.

COVID-19, caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) rapidly developed into a worldwide pandemic and ICUs were simultaneously challenged on multiple fronts. These include resource limitations, infection control, protection of healthcare workers, and adaptation of services to a rapidly evolving pandemic situation.

Designation of an isolation ICU or conversion of ORs and PACUs into functional ICUs to accommodate significant numbers of critically ill patients was a common response during the peak of the pandemic. These Pandemic Patient Units, geographically separated from other clinical areas, allow for concentration and segregation of equipment and staff, contributing to more effective containment.

Pandemic Patient Units should ideally consist of negative pressure Airborne Infectious Isolation Rooms (AIIRs). AIIRs are kept at negative pressure relative to surrounding areas and ventilated with at least 6–12 air changes per hour, with any recycled air being filtered before recirculation. For hospitals without AIIRs, containment may also be maximized with a dedicated ICU and strict infection control measures. If single rooms are unavailable, cohorted patients should ideally be treated at least 6 feet apart with engineering controls (separation with physical barriers).

A. Pandemic Patient Unit Considerations

When faced with sporadic cases or defined clusters in the community, maximizing containment to reduce community impact and buy time for preparations is the key priority. Within healthcare institutions, this is achieved with rapid identification and isolation of suspect or confirmed pandemic cases, and strict infection control measures to minimize intra-hospital transmission and prevent incapacitation of essential services.

Designation of an isolation ICU or other segregated space within the hospital, geographically separated from other clinical areas, allows for concentration and segregation of equipment and staff, contributing to more effective containment. These Pandemic Patient Units should ideally consist of negative pressure airborne infectious isolation rooms (AIIRs). For hospitals without AIIRs, containment may also be maximized with a dedicated Pandemic Patient Unit and strict infection control measures.

B. Designing New Acuity-Adjustable Hospitals

The lack of available patient rooms leads to the overcrowding of the ED as patients wait for admission. This condition is known as 'boarding' and has become a major issue in many hospitals. The extensive boarding time of patients leads to several problems: ambulance refusals, prolonged waiting times, and increased suffering for those waiting on gurneys for hours in corridors. When EDs are overwhelmed, the hospital's response to community emergencies and disasters is compromised. By reducing the number of patient transfers, the acuity-adjustable patient unit has proven to reduce delays for placement of patients in holding areas. As hospitals around the country struggle with overcrowding, the acuity-adjustable patient unit model is quickly becoming the response to this challenge. Acuity-adjustable patient units that serve ICU patients, Medical/Surgical, and Intermediate Care (also called Step-Down) units allows patients to stay in a centralized room throughout their stay, from admission through discharge.

Any new medical/surgical patient units should consider using the "Acuity-Adjustable" model to provide future flexibility during patient surges, and existing units can be adapted to surge as needed. Acuity-adjustable patient units are a cutting-edge approach which allows care to flex to a higher level as needed in the same room. These units provide the ability to flex up to ICU-level care to faster accommodate infectious disease patients. Medical gases, outlets, patient monitoring, room clearances, ventilators, and mechanical and HEPA filtration requirements should all meet ICU-level care.

Acuity-Adjustable Patient Units are well-suited to be used during pandemics and other large-scale emergencies as patients will likely present at hospitals with varying degrees of illness. While there is no single, isolated solution, flexibility and adaptability will need to reflect the overall mission for the hospital of the future. Acuity-adjustable patient units benefit all stakeholders - patients, families, care providers, and administrators - addressing major issues such as patient safety, decreased length of stay, and a cost-effective care delivery model.

Lessons learned on how Acuity-Adjustable Units (AAUs) can be incorporated into hospital design, with the aim to identify strategies for success, are as follows:

- AAUs must be designed to meet the strictest code requirements for all intended uses, for instance: ICU and Med/Surg room size, medical gas outlets, emergency power outlets, clearances, etc.
- AAUs must be provided with all necessary equipment, including telemetry, monitors, ICU headwalls, etc., to facilitate immediate care for each specialty.
- PPE donning and doffing should be considered at the entrance of each unit and the entrance to each patient room.
- Space should be defined for flexible anterooms. Corridors need to look at the required 8-foot clear dimension with a critical eye and allow space for the anteroom, as well as space to remove all unnecessary equipment and store medical equipment just outside the patient room. This space should be considered outside of the clear 8-foot traffic zone and be a minimum of 4 feet wide to allow for maximizing the space.
- Cardiology is a recommended specialty most conducive to AAUs because patient progress is predictable. As such, patient care should be predictable because AAUs require a predictable staffing arrangement to meet the necessary workload.
- Medical patients have an unpredictable workload volume, patient admission volume, and unpredictable changes in patient acuity, making it difficult to create AAUs around this patient pool.
- AAUs can be clustered together so that when there is higher-than-expected volume of ICU patients, nurses can readily float from one unit to another.
- When designing an AAU, healthcare facility planners and the facility should work with the California Department of Public Health to ensure compliance with Title 22 requirements, including the operational model for program flex between bed license categories and nursing ratio requirements.

C. Final Considerations

Healthcare operators, architects, and designers must take a leading role in creating safer healthcare spaces in a post-COVID-19 world. Implementing the types of innovative strategies discussed in this chapter, along with the CDC's recommendations of distancing, hand washing, and avoiding contact, will allow patients to receive care in a safer environment.

New cleaning protocols will need to be evident to the public, so they have confidence in their safety while visiting healthcare facilities. As the Infection Control and Environmental Services teams increase their knowledge of the COVID-19 pandemic, and plan for future pathogen scenarios, new protocols will be developed. Many products and finishes have proven anti-microbial properties, but assessment is still needed to determine if they are effective on new viruses and pathogens. Reducing physical contact of surfaces is another way to limit exposure to viruses and pathogens. Use of hands-free devices on doors, plumbing fixtures, and other high-touch items can reduce exposure and minimize the items that need to be wiped down in between each patient.

Implementing new technologies is yet another consideration. Two techniques have come into focus recently – Ultra Violet (UV) Light Technology and Hydrogen Peroxide Fogging (iHP) that should be considered to decrease pathogens within healthcare settings. Smart technology will certainly need to be integrated into healthcare. Physicians are using virtual appointments at a higher rate to accommodate patients during a crisis, and telemedicine has aided in the monitoring of ICU patient rooms, providing distancing, and connectivity to help treat patients.

A few last simple facility improvements should be considered in advance of the next large-scale event:

- Extend emergency power to support refrigerated trucks (morgue).
- Place yellow tape barriers around exhaust fans on roofs to avoid accidental exposure to maintenance staff.
- Dedicate an elevator for the transport of infectious/contaminated patients.
- Implement a transport protocol to clear corridors when transporting infectious/contaminated patients.
- Clean air ducts and rebalance in areas with infectious/contaminated patients to maximize air flow and confirm proper air balancing.

4.7 Implementation

Solutions that involve modifications to existing buildings that are intended to be permanent that changes space or room size and/or configurations, uses or functions of spaces or rooms, or any construction involving the built environment, etc., requires the submittal of a project to OSHPD. For emergency related projects, refer to PIN 72 Emergency Work Authorization.

The California Department of Public Health (CDPH), “Standards and Guidelines for Healthcare Surge during Emergencies”, 2008, provides information and resources for healthcare providers, payers, local government, and local communities to help better plan to sustain a functioning healthcare delivery system during a catastrophic emergency.

SECTION 5
SPACES THAT CAN BE SPLIT INTO MULTIPLE ZONES

5.0 Introduction

Design flexibility inside a hospital building serves as an enabler for health services to accommodate their needs to be responsive to the accelerating need for change. The COVID-19 pandemic highlighted gaps in the design and workflow of healthcare facilities that could impact patient care, staff safety, and represent a risk to public health.

This section builds on the concepts discussed in Section 4, Emergency Operations for Surge Capacity, and provides diagrammatical approaches to address issues and principles around health facilities design and workflow by highlighting situational awareness, surveillance, and perimeter defense; staff protection; surge capacity management; and recovery. As all facilities are different with varying capabilities, these suggested design considerations may help hospitals be better prepared for infectious disease outbreaks and other emergencies.

While these diagrams primarily lend themselves to new hospitals or major remodels of existing facilities, there are examples of relatively simple approaches to reconfigure existing departments to address the principals described in Section 4, Emergency Operations for Surge Capacity. These diagrams are not all-inclusive; other less-costly features can be used to limit the spread of infectious pathogens, such as touch-free control for lighting, temperature, and other building functions, building with materials that are less hospitable to microbes, such as copper, and eliminating window shades, which can easily become contaminated, by installing windows made of e-switchable privacy glass that is easy to clean. New hospital designs can help patients stay connected to friends and family by incorporating widely available technologies such as video chat and virtual reality headsets. They can also do more for health care workers. Some hospitals have moved toward eliminating sleeping quarters for hospital staff and reducing the number and size of break rooms and rest areas; the current pandemic has shown the need for giving health care workers a place to rest in between grueling shifts.

5.1 New Emergency Department & Entry Level (Diagram 1)

As previously stated in Section 4, Emergency Operations for Surge Capacity, considerations should be given to how a patient arrives, is screened, and tested, and is admitted to the hospital. One of the primary paths of travel tends to be from the Emergency Department (ED), where patients are first assessed and either discharged or admitted. If the ED is designed and constructed with specific zones or quadrants, caregivers can treat a contagion source directly and shrink the containment zone to minimize risk to the bedside, reduce possibility of migration, and effectively address the emergency.

During the pandemic, hospital waiting rooms proved to be a challenge as infected patients were near uninfected patients. Upon entry, there should be a body scan at the touch-free automatic doors which scans for infectious temperatures. Sick patients should be led to color-coded isolation room or directed to fever entries. Those deemed healthy should be sent to waiting rooms with alcoves and private areas for social distancing and conferencing. Both waiting areas should be outfitted with cleanable surfaces, new face masks for patients, and hand sanitizing stations located in strategic areas. Medical check-in kiosks and smartphone apps can provide an important solution to the goal of maintaining proper physical distance. Healthcare kiosks are easily disinfected and can be outfitted with special attachments to hold sanitizing wipes or gel for patients and smartphone apps provide a hands-free solution to check-in. Waiting areas should be operated at a negative air pressure in relation to surrounding rooms and areas.

Diagram 1 depicts a suggested configuration that can address these considerations. Key takeaways from this design are described in detail below.

A. Design Considerations

- EDs are designed with separate smoke compartments to facilitate separation of non-infectious and infectious patients and to allow HVAC reconfiguration to provide positive and negative pressure relationships.
- Each compartment must be strategically equipped to treat the anticipated patient type.
- The compartments should each be provided with elevators specific for the patient type – trauma elevators with direct access to operating rooms for ambulance patients or ambulatory walk-in trauma patients. Patient elevators for non-symptomatic medical patients with access to blood draw, labs, or observation units.
- Separate entries are provided for ambulatory patients, both symptomatic and non-symptomatic, and ambulance patients, both symptomatic and non-symptomatic.
- Urgent care clinics saw a 58% increase in visit volumes due to the demand for COVID-19-related episodic care, with testing and vaccinations accounting for more than 60% of total visits. A clinic may be a key element in providing prompt healthcare as an alternative to ED care. Freestanding clinics that are near the ED or hospital entrance can be used for testing, vaccines, triage, and many other critical functions. This approach allows the ED to treat the more acute patients and provides for the opportunity to treat patients in the most appropriate setting.

B. Pre-screening and Arrival

- Prior to arrival, pre-screening can be accomplished using a robust telehealth and virtual consultation program. Clear instructions should be available to the public via signs, website instructions, and public information announcements.
- For patients who arrive unscreened, space for curbside or drive-through screening with temperature and symptom checks should be provided; depending

on outcomes, direction to specific parking, waiting, and entry locations can be given.

- Make use of technology when possible. Keeping patients outside and isolated in their vehicles until they receive a text message from staff to enter will keep patients safer and more comfortable.
- Healthcare facilities located in temperate climates should consider increasing availability for patients and visitors to wait outdoors. Outdoor seating and gardens also provide an opportunity for visitors and staff an alternate location for respite.
- Ambulatory patients who are non-symptomatic should be directed to a separate public entrance leading to a well-person waiting area, while symptomatic patients should be directed to a dedicated entry into the ED.

C. Entry

- Hospital staff entry should be separate from the public entry for patients and visitors.
- Well patients should be re-screened before entry into the ED waiting room. Waiting rooms need to be large, provided with new face masks, sanitation stations, and the furniture arranged to allow for physical distancing.
- Symptomatic patients should be directed to a dedicated entry into the ED with dedicated resuscitation and imaging resources. Sufficient waiting area, either inside or outside the ED, needs to be provided with equipment for care and treatment of patients.
- Non-symptomatic patients requiring emergency treatment should be directed to a separate entrance for triage.

D. Emergency Department Treatment Areas

- Smoke compartments should be segregated into four areas:
  - Symptomatic medical patients
  - Symptomatic resuscitation patients
  - Non-symptomatic medical patients
  - Non-symptomatic trauma patients
- Smoke compartments should be provided with an HVAC system that can individually control each compartment to make symptomatic compartments negative in relation to surrounding compartments. See Section 4, Emergency Operations for Surge Capacity, for more information.
- Smoke compartments should be equipped with the specific needs of each compartment in mind to eliminate or reduce the need to move symptomatic patients through other compartments or areas. Portable x-ray or dedicated

imagining rooms within the resuscitation compartment is an example of this consideration. Redundancy in each compartment further limits the need to expose non-symptomatic patients to infectious pathogens and reduces the amount of sterilization needed for equipment after each use.

- The flow from smoke compartments to other departments within the hospital should be via dedicated routes with controlled use. Dedicated elevators in each smoke compartment are an example of how this can be achieved, along with controlled, patient-only corridors.
- Additional medical gas outlets should be provided in key areas throughout the ED for high census/high demand occasions. The location of the emergency oxygen connection on the outside of the building should be identified and maintained clear and accessible in the event the main supply is unable to keep up with demand inside the hospital.

5.2 ICUs and Pandemic Patient Units (Diagrams 2, 3, and 4)

Once a patient is evaluated and treated in the ED, admitting the patient to a critical care unit may be necessary. Limiting movement within the hospital as they are transferred to critical care areas is of primary importance to reduce or eliminate the spread of infectious diseases.

Pandemic Patient Units that are flexible and adaptable have been shown to provide the best patient care and staff safety. This can range from permanent design features built-in to the units when initially constructed or remodeled to planning and providing temporary wall configurations for times of patient surge. The HVAC system must be carefully evaluated, designed, and configured to allow rooms to be switchable from positive to neutral to negative pressure. See Section 3, Emergency Patient Room Ventilation Conversion.

In normal unit mode, special consideration is given to ICUs that will need high future flexibility; and in pandemic unit mode, the built-in flex spaces must be able to be converted to new uses such as materials staging, donning, and doffing of PPE, and infectious isolation capabilities. Diagrams 2, 3, and 4 depict possible configurations for ICUs that can address these necessities.

A. Patient and Staff Flow

- As stated in Section 4, Emergency Operations for Surge Capacity, limiting the movement of patients and equipment as much as possible limits potential exposure and transmission of diseases. Direct access to the ICU via dedicated patient elevators in or near the ED can limit movement significantly.
- One-way flow of patients, staff, and materials should be used wherever possible.
- Dedicated rooms or areas at the entrance and exit points of the ICUs should be provided and equipped with PPE for donning before entering and doffing before leaving the units. The donning and doffing areas or rooms should be separated

to prevent cross-contamination and doffing areas should be adjacent to a hand washing fixture.

B. Design Considerations

- HVAC systems should be designed and configured to provide an airflow from staff areas to patient areas by maintaining a negative pressure relationship in each of the patient rooms. Patient toilet rooms should always be negative in relation to surrounding areas.
- In addition to permanent Airborne Infection Isolation Rooms (AIIR), temporary or moveable partitions may be needed to create anterooms outside of patient rooms for additional patients with airborne infections. Decentralized nurse stations may become necessary to maintain visual surveillance of patients and rooms within the Care Suite.
- Connections inside the patient room for patient monitoring equipment should be provided that allow the equipment to be in charting areas immediately outside of the room. This will allow patients to be monitored while reducing the need for staff to enter the patient room.
- Alcoves outside of patient rooms should be provided in strategic areas for quick access to medical equipment.

5.3 Medical Surgical Unit Flexibility (Diagrams 5, 6, 7, and 8)

Medical Surgical Units are the next facet of care for patients who are recovering but are still symptomatic and infectious. During surges, patient rooms in med-surg units often need to function as a quasi-ICU; as such, hospital planners and designers need to consider how a room could quickly and safely flex into an isolation room, and adapt to provide higher acuity care, while keeping both the staff and patients safe. This includes clearly marked donning and doffing zones at the door to the patient room with convenient access to personal protective equipment PPE).

Different room configurations offer trade-offs in flexibility to support pandemic care. A bathroom adjacent to the corridor can create a natural area for a flex anteroom but the bathroom exhaust creates a negative pressure in respect to the patient room, in which case a bathroom on the external building wall can serve to better isolate infectious particles. However, either room type can be transitioned into an isolation room.

During the pandemic, many hospitals passed cords under corridor doors to access equipment like IV pumps and monitoring equipment to limit the need for staff to enter the patient room. Some hospitals installed vision panels in corridor doors to be able to view the patient without entering the patient room. Providing code-compliant features and options to address these practices should be accomplished before the need presents itself.

Because these rooms may need to flex into a critical care area, many of the concepts discussed for ICUs apply to Medical Surgical Units. Diagrams 5, 6, 7, and 8 depict suggested configurations that should be considered for future design and construction.

A. Patient and Staff Flow

- As stated for the ICU, limiting the movement of patients and equipment as much as possible limits exposure to, and transmission of, diseases. Direct access through corridors closed to the public should be identified and used whenever possible.
- One-way flow of patients, staff, and materials should be used wherever possible.
- Dedicated areas at each patient room should be provided and equipped with PPE for donning before entering and doffing before leaving the room.

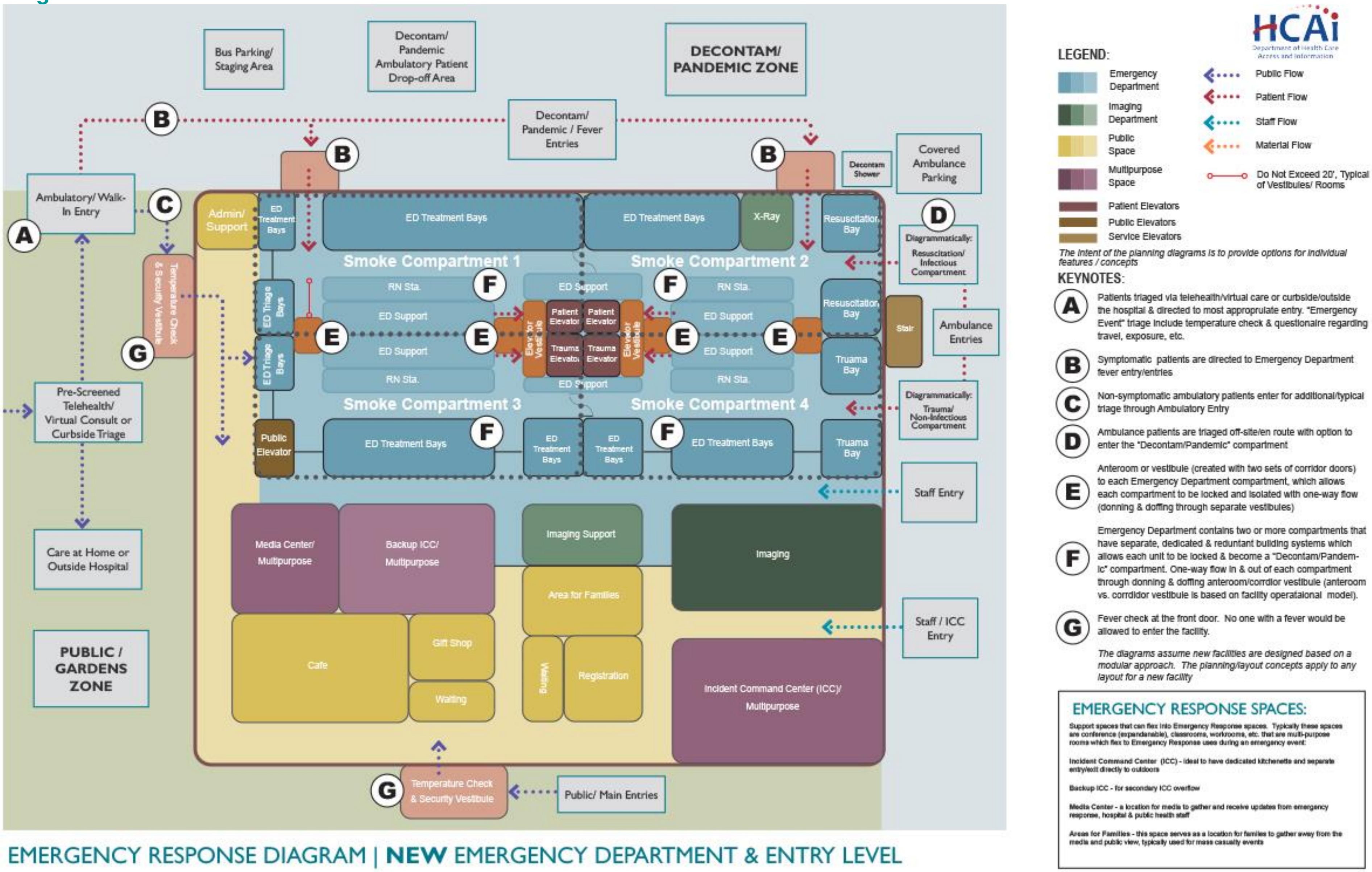
B. Design Considerations

- HVAC systems should be designed and configured to provide an airflow from corridors to patient areas by maintaining a negative pressure relationship in each of the patient rooms. Patient toilet rooms should always be negative in relation to surrounding areas.
- In addition to permanent Airborne Infection Isolation Rooms (AAIR), temporary or moveable partitions may be needed to create anterooms outside of patient rooms for additional patients with airborne infections.
- Connections inside the patient room for patient monitoring equipment should be provided that allow the equipment to be in charting areas immediately outside of the room. This will allow patients to be monitored while reducing the need for staff to enter the patient room.
- Alcoves outside of patient rooms should be provided in strategic areas for quick access to medical equipment.

5.4 Implementation

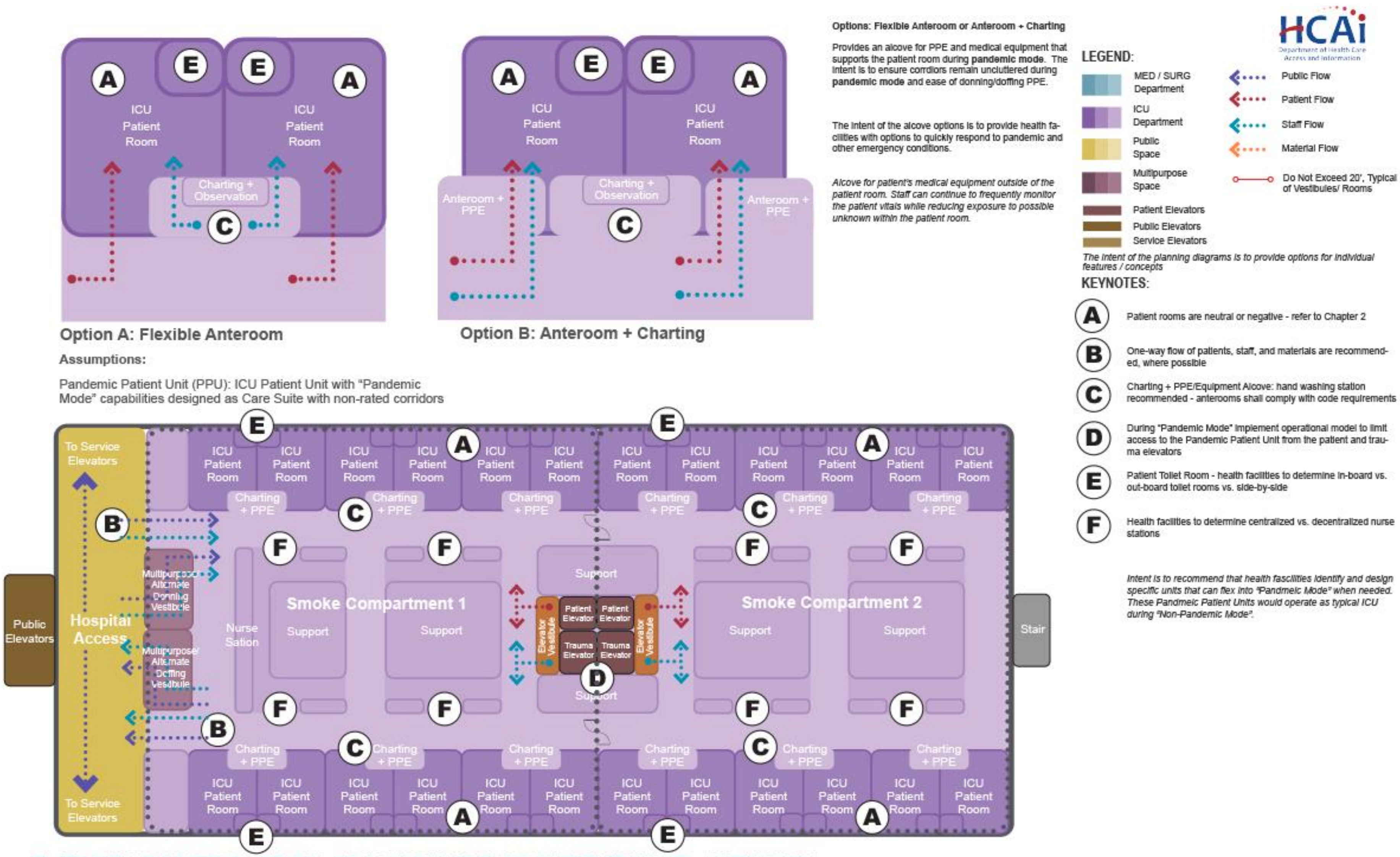
Solutions that involve modifications to existing buildings that are intended to be permanent that changes space or room size and/or configurations, uses or functions of spaces or rooms, or any construction involving the built environment, etc., and modifications to existing systems that are intended to be permanent that changes air flows, pressure differentials, equipment, filter banks, other changes to filtration, adding or relocating ducting, etc., requires the submittal of a project to OSHPD. For emergency related projects refer to PIN 72 Emergency Work Authorization.

Diagram 1



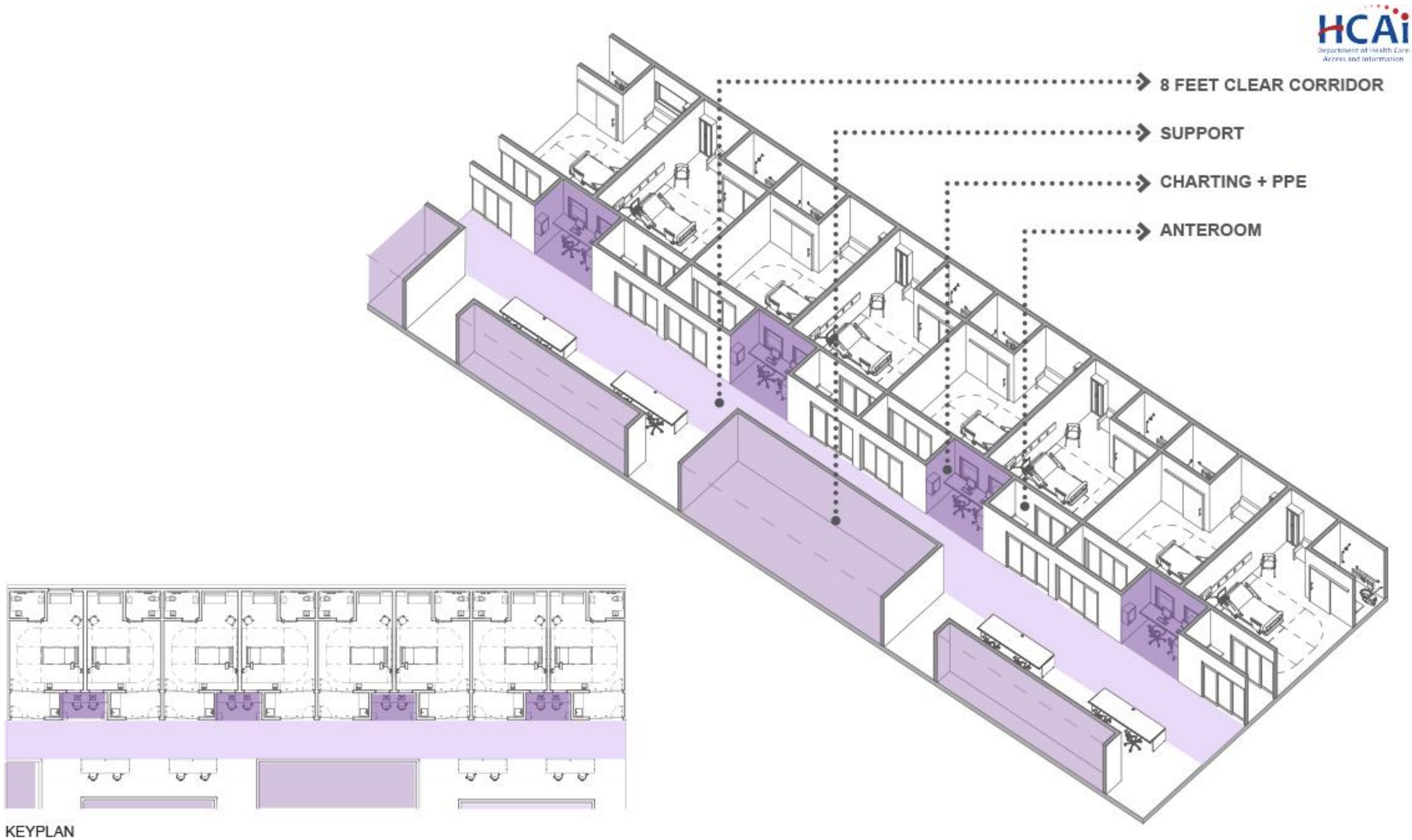
EMERGENCY RESPONSE DIAGRAM | **NEW** EMERGENCY DEPARTMENT & ENTRY LEVEL

Diagram 2



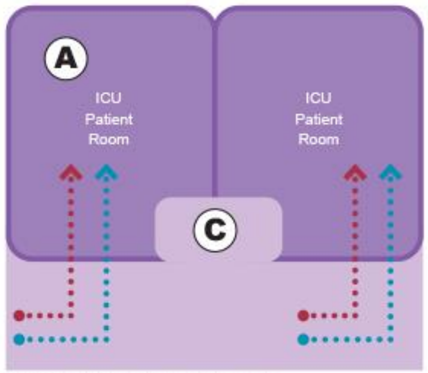
EMERGENCY RESPONSE DIAGRAM | PANDEMIC PATIENT UNIT - **NEW** ICU

Diagram 3



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

Diagram 4



Charting/Equipment Alcove

Provides an alcove for PPE and medical equipment that supports the patient room during **pandemic mode**. The intent is to ensure corridors remain uncluttered during **pandemic mode** and ease of donning/doffing PPE.

Alcove for secondary connection of patient's medical equipment outside the patient room. Staff can continue to frequently monitor the patient vitals while reducing expo-

Charting/Equipment Alcove

Assumptions:

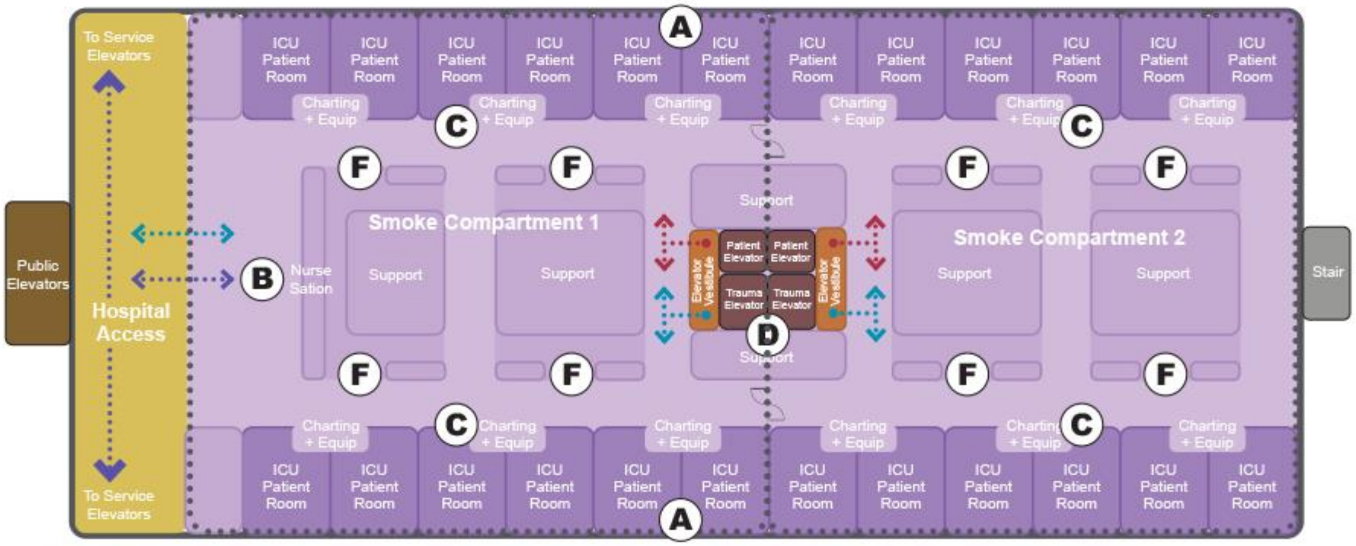
Pandemic Patient Unit (PPU): ICU Patient Unit with "Pandemic Mode" capabilities designed as Care Suite with non-rated corridors

The intent of the planning diagrams is to provide options for individual features / concepts

KEYNOTES:

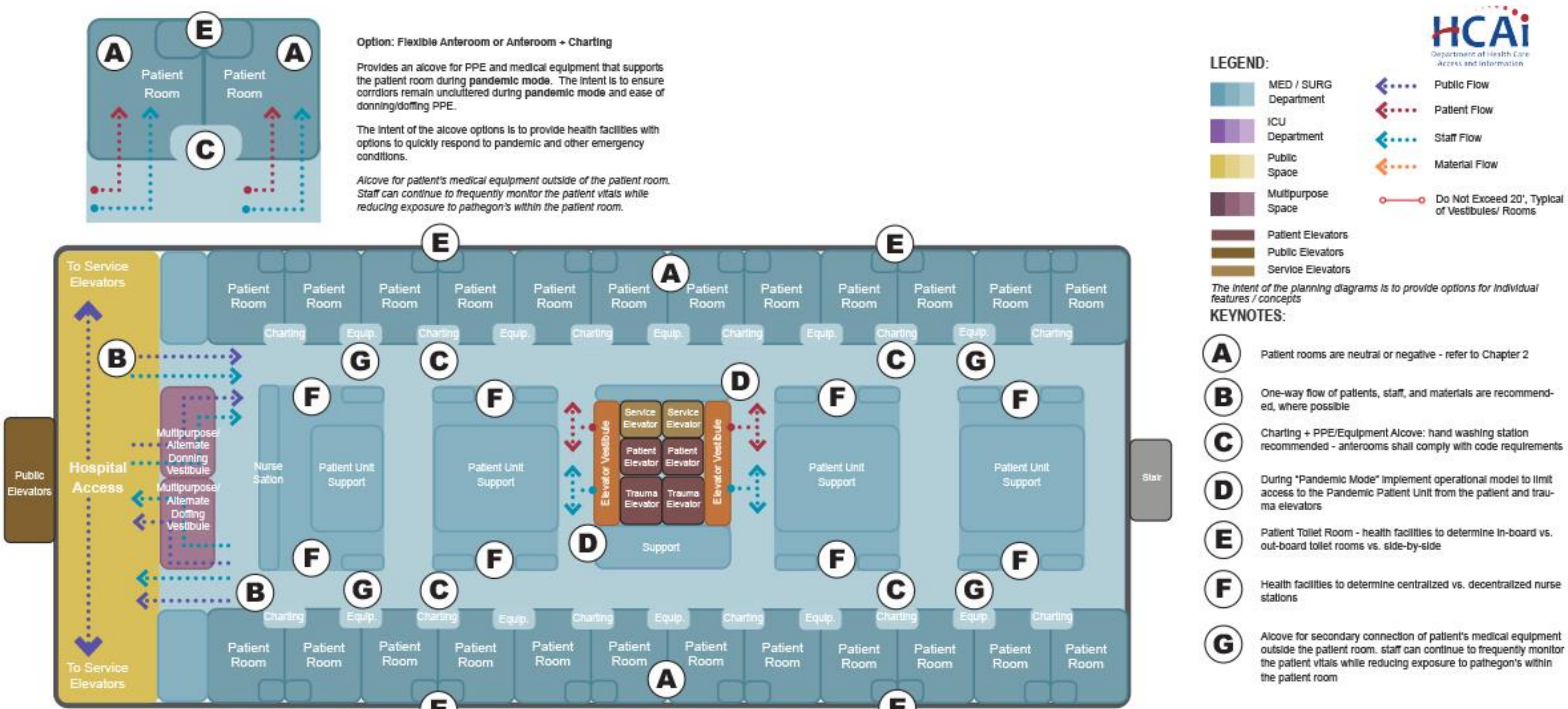
- **A** Patient rooms are neutral or negative - refer to Chapter 2
- **B** One-way flow of patients, staff, and materials are recommended, where possible
- **C** Existing Equipment Alcove
- **D** During "Pandemic Mode" implement operational model to limit access to the Pandemic Patient Unit from the patient and trauma elevators
- **F** Health facilities to determine centralized vs. decentralized nurse stations

Intent is to recommend that health fascilities identify and design specific units that can flex into "Pandmeic Mode" when needed. These Pandmeic Patient Units would operate as typical ICU during "Non-Pandemic Mode".



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

Diagram 5

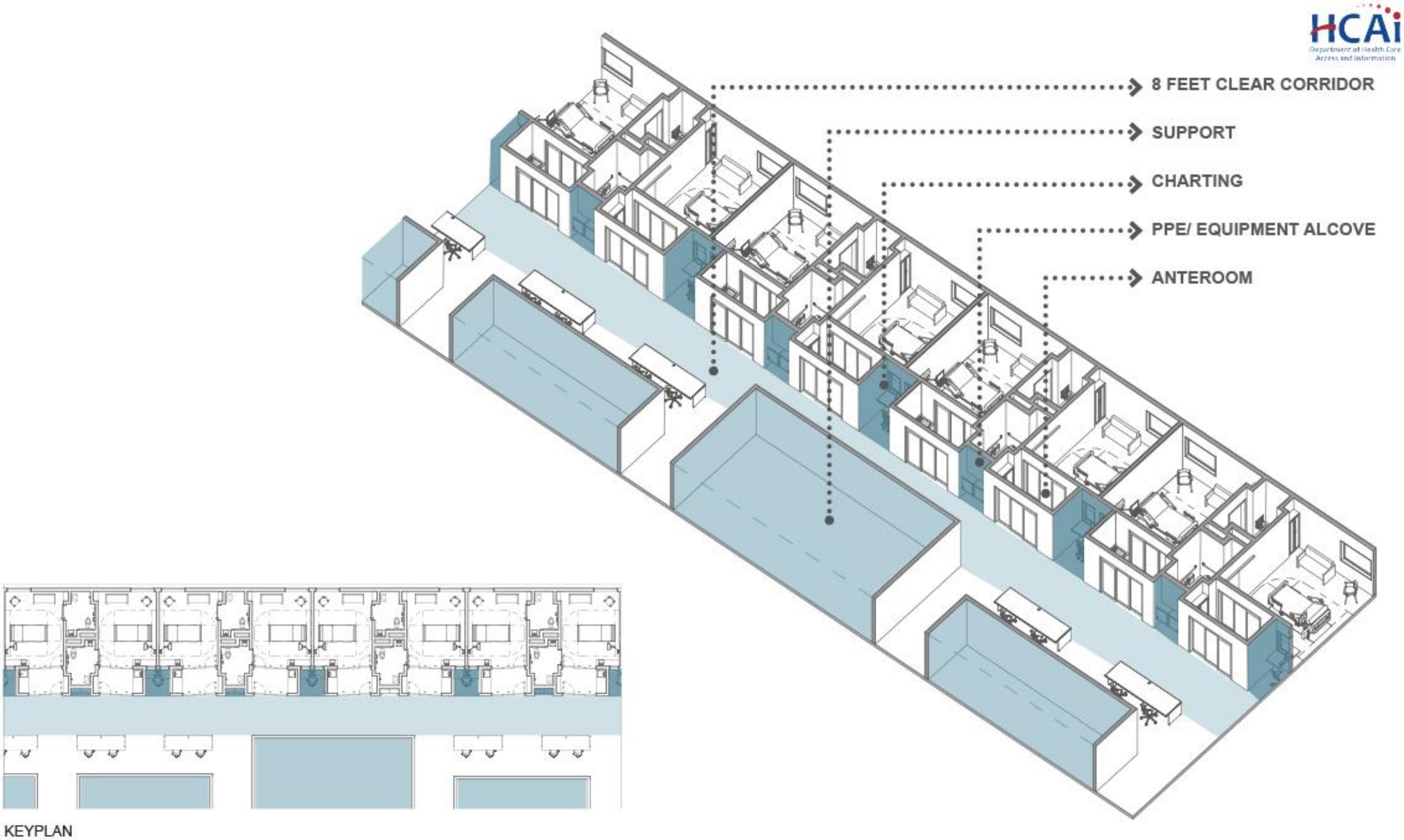


Assumptions:

Med/Surg Patient Unit - with rated corridors

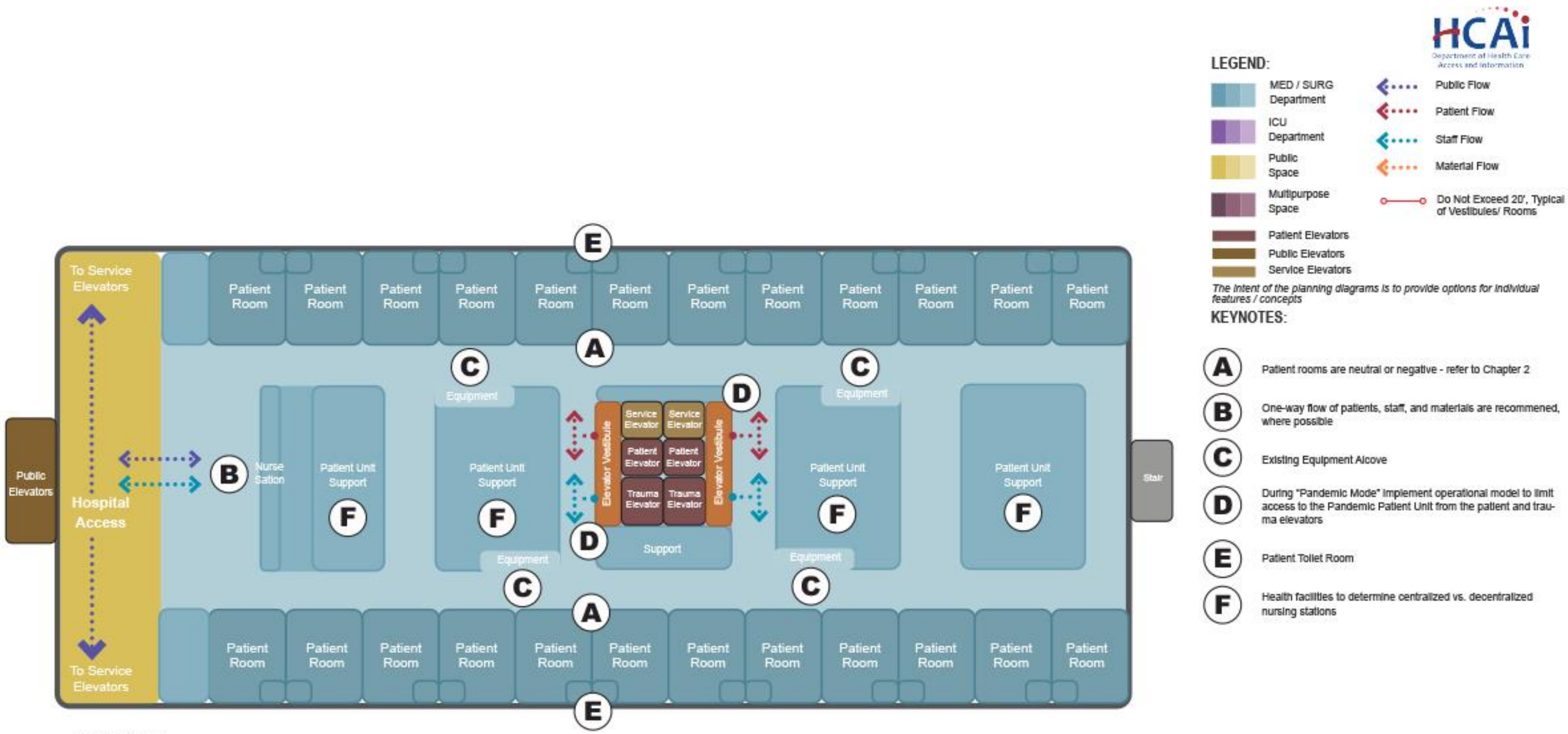
EMERGENCY RESPONSE DIAGRAM | PANDEMIC PATIENT UNIT - **NEW** MED/SURG

Diagram 6



EMERGENCY RESPONSE DIAGRAM | PANDEMIC PATIENT UNIT - **NEW** MED/SURG

Diagram 7

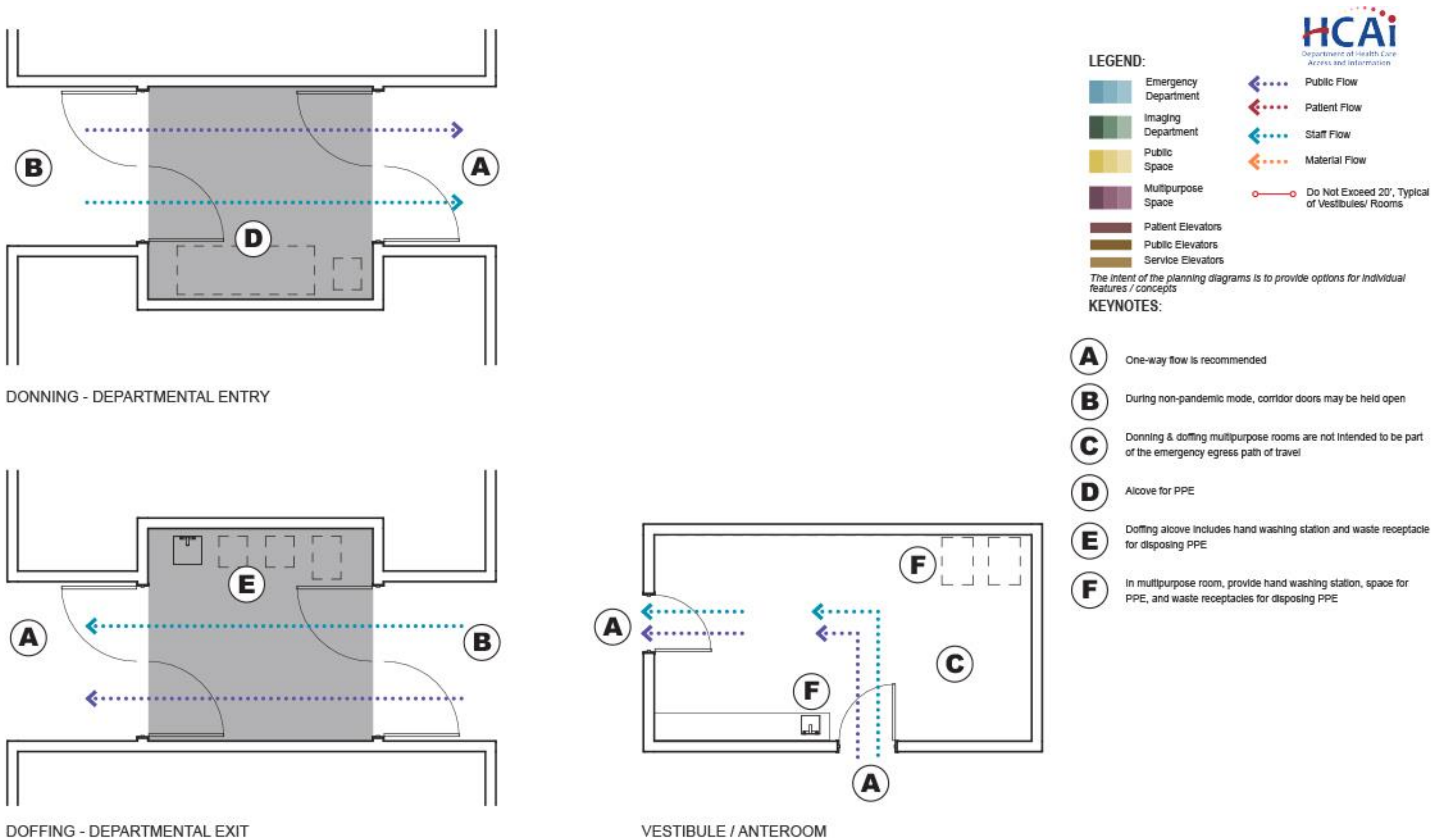


Assumptions:

Med/Surg Patient Unit - with rated corridors

EMERGENCY RESPONSE DIAGRAM | PANDEMIC PATIENT UNIT - **EXISTING** MED/SURG

Diagram 8



EMERGENCY RESPONSE DIAGRAM | DONNING/DOFFING VESTIBULE OPTIONS

SECTION 6
OTHER CONSIDERATIONS FOR SURGE CAPACITY

6.0 Introduction

In addition to the guidelines provided in Section 4, Emergency Operations for Surge Capacity, and Section 5, Spaces That Can be Split into Multiple Zones, there are other alternate sites for patient care surge that do not have to be off site from the hospital. There are options to provide extended care within the hospital itself or on the same campus.

6.1 In the Hospital

- Shell space: In extreme cases, existing shell space may be considered for temporary uses, even patient care, but precautions need to be taken to ensure a safe environment is provided.
  - Proper ventilation is provided to the areas needed.
  - Adequate medical gases and oxygen.
  - Adequate exhaust is maintained.
  - Surfaces and finishes (if any) are cleanable and will not cause any additional concerns.
  - Adequate electrical power and capacity.
  - Maintain a compliant path of egress.
- Vacant patient rooms. Suspended or vacated patient rooms may be placed back into service. Adequate electrical and med gas shall be provided if not already present.
- Adding beds to existing patient rooms. It is important to be able to provide or extend utilities such as medical gases and electrical to the temporary bed locations without diminishing what is available for the existing bed(s). The use of splitters may be considered for temporary purposes.
- Using O_2 cylinders – Many facilities found that they needed additional oxygen during the COVID pandemic however the suppliers were unable to meet demand due many facilities not returning their empty containers. So, it wasn't a matter of being able to provide resource but not having a conveying method to transport the product.
- A pandemic or patient surge caused by a respiratory infection can overburden the hospital's bulk oxygen system because of the number of ventilators in use. Hospitals can take steps to avoid some of the potential causes of failures of the bulk oxygen system.
- Medical bulk oxygen supply systems consist of liquid oxygen tanks, ambient vaporizers, and a reserve oxygen supply (the reserve can be liquid or gas, depending on the size of the main tank). The vaporizers are sized based on the

original design criteria and are used to convert the liquid oxygen into gaseous oxygen. If the usage requirement of gaseous oxygen exceeds the original design requirements, the system may be overdrawn and will cause an excess buildup of frost/ice. An excessive ice buildup will reduce the capacity of the vaporizers. Icing of the vaporizers needs to be addressed to prevent a potential harm to patients, and hazards to others working around the systems related to falling ice.

- Equipment Evaluation and Monitoring:
  - Hospitals should visually inspect their bulk oxygen system daily for the buildup of frost/ice. The hospital's bulk oxygen supplier should be contacted immediately if the accumulation covers 50% or more of the surface area of the vaporizer or if frost is visible on piping entering the building.
  - It is also recommended that hospitals notify its bulk oxygen supplier of any recent or upcoming changes that could impact the operation of their bulk oxygen system - significant increase in the quantity of oxygen being used, changes in the type of oxygen treatments administered, opening of additional wings of the hospital, etc., may all have an impact on the vaporizers ability to meet the supply demands of a hospital.
- Mitigating Actions:

  If the build-up of ice exceeds the normal levels described above, contact your bulk oxygen supplier for support. Be prepared to discuss:
  - Estimated % of frost/ice (pictures are very helpful).
  - Current oxygen demand (cubic foot/hour, cubic foot/month).
  - Available equipment to assist with deicing - steam, water, fans with a power supply.
  - Availability of high-pressure back-up cylinders.
  - Accessibility to the emergency oxygen supply connection.

  Caution: Do not hammer on the ice to remove it. That could potentially damage the equipment. Do not use portable heaters on any portion of the oxygen system.
- Installation of Shower Heads/ Sprinklers:
  - Another option is to install shower heads/ sprinklers over the top of each main vaporizer(s) if your existing vaporization system is approaching 50% ice/frost or if the facility will be administering high flow oxygen treatments. The shower heads should be installed 12" above each main vaporizer(s) and can be secured to the vaporizer frame using clamps only. Drilling is not permitted. Unistrut can also be used as bracing for shower head placement but must be clamped. The shower heads could be installed as a precautionary measure in case of future high-volume use of oxygen.

  - When constructing a new hospital consideration should be given to upsizing the bulk oxygen system and other medical gases to accommodate possible patient surges.
- Conversion of existing spaces to pandemic units:
  - Existing nursing units may be adapted for use only as pandemic units where all beds in the unit serve only patients with the infectious disease. These units can be converted to negative pressure with approval of CDPH.
  - Other areas of the hospital can be considered for temporary housing of patients or provisions for patient care. Conference rooms, chapels and even lobbies may be considered for temporary uses. All required utilities will need to be provided in these improvised areas for the duration of their use.

It is very important to keep in mind that infectious conditions require exhausted air. Placing infectious patients in non-exhausted rooms only exacerbates the problem. Pre-planning for surge capacity would allow facilities to provide additional exhaust capacity now for possible future needs.

If patient population is being expanded beyond normal capacities, consideration needs to be made to what other services may have increased demands. Other services and utilities should be considered such as adding oxygen vaporizers, acuity adaptable rooms, and oversized generators for added demands. With more people usually comes the need for more capacity of drugs, food, and other supplies. Mobile or temporary units may assist in filling this need such as mobile pharmacy trailers, refrigerated Conex boxes for food storage, or mobile kitchen facilities.

6.2 On-Site

- Tents provide a quick and inexpensive option to provide shelter for patient care during an emergency. They are more readily available and can be purchased prior to an event so they are ready to deploy if and as needed. If a facility plans, umbilicals can be provided for quick connections to utilities. When tents are deployed, special care must be taken as to where they are located for egress and fire protection, as well as weather considerations such as rain and high winds. If high winds are prevalent in an area, hard-shelled enclosures should be considered.
- In addition to tents, there are other temporary structures available such as trailers, modular units, and coaches specifically designed for emergency patient care. All are viable considerations when disaster planning.
- Triage areas are a critical aspect of patient care during a pandemic, as well as any other emergency. Planning for different scenarios should consider anticipated influx of patients, be it a pandemic, earthquake, or airplane crash. A location and means to triage potential patients and keep them safe while doing so is paramount.

- For pandemics, consideration to triage areas should be given to location and providing adequate separation of possibly contagious people while waiting to be evaluated. This may be done by keeping people in cars until ready to be seen; use of external tents, or separate and controlled entrances to the facility.
- Mass casualty events may require additional space which may include exterior environments such as courtyards, parking lots or garages, or interior spaces if there is sufficient space.
- Wildfire events may have less surge but may likely require triage spaces to be interior with proper ventilation controls to prevent the insurge of smoke.

6.3 Off-Site

Reopening closed facilities. During the COVID pandemic, several facilities that were closed previously were looked at for temporary use. For those facilities that were deemed acceptable for reopening a survey will need to be conducted to identify any deficiencies that need to be corrected, even for temporary use. This may include adequate power, heating, and ventilation, as well as oxygen or medical gas supply. Water purity, medical gas, and other testing will need to be done prior to reopening a closed facility. Once the survey is completed and reviewed, the facility could then apply to CDPH to provide patient care. There may be restrictions on the type of care provided and that will have to be coordinated with CDPH.

6.4 Temporary Surge Facilities and Alternate Care Sites

After the hospital has exhausted its surge capacity or is incapable of providing healthcare to the community as the result of a disaster, consideration may be required to providing healthcare temporarily in a non-hospital building or an alternate care site. If this alternative is needed steps can be taken to ensure that the highest level of healthcare can be provided that is possible under the circumstances. This solution usually involves working with local jurisdictions because the buildings being considered may be outside of OSHPD’s authority. Section 11, Coordination for Temporary Surge Facilities and Alternate Care Sites, provides information regarding how such alternate care sites may be developed and used to provide needed healthcare during a disaster.

SECTION 7
HVAC SYSTEM CONSIDERATIONS
FOR HANDLING SMOKE DURING WILDFIRES

7.0 Introduction

Nowhere is human health more of a consideration in terms of air filtration than health care facilities like hospitals, urgent care centers, out-patient facilities or doctors' offices, and even dental care facilities. Building occupants in many of these settings are already immune compromised, making these people much more susceptible to airborne contaminants that would otherwise be handled by our body's natural protection system. Similarly, doctors, nurses, medical staff, and visitors are more at risk because of increased exposure and the increased density of sick people within a given space. According to the Centers for Disease Control and Prevention (US CDC), more than one out of six patients leaving a hospital leaves with a hospital-acquired infection. Each type of healthcare facility presents its own unique challenges.

Hospitals can have hundreds of beds increasing the possibility of airborne contaminants just based upon the probability of so many sick people in such a confined area. Air distribution systems are often centralized incorporating prefilters and final filters as required by building codes. Some hospitals even apply High-Efficiency Particulate Air (HEPA) filtration as an additional stage to protect their employees and patients. They also have additional areas of concern that include:

- Operating room suites, a location with the person undergoing invasive procedures, are much more susceptible to infectious agents. In modern facilities these high-risk patients are protected with in-ceiling or in-duct HEPA filtration modules that deliver ultraclean air in a downward washing pattern across the patient during the procedure.
- Nurseries and pediatric care, an area occupied by our most at-risk patients, have newborns and infants who have not had the opportunity to develop the body's natural protection systems regarding airborne contaminants. Many newborns spend their first days in an incubator that includes the highest level of contaminant protection, a HEPA filter.
- Patient waiting and out-patient care areas: the typical first stop of those suffering from a variety of ills that may include colds or the flu. One sneeze can produce over one million particles that can infect others. The air filtration applied in these areas is a first line of defense for employees and non-infected visitors.

During wildfires, smoke can travel on air currents for many miles and can infiltrate hospital buildings. Smoke is made up of a complex mixture of gases and fine particles produced when wood and other organic materials burn. The biggest health threat from smoke is from fine particles. These microscopic particles can get into your eyes and respiratory system – whether you are outdoors or indoors, where they can cause health problems such as burning eyes, runny nose, and illnesses such as bronchitis. Fine particles also can aggravate chronic heart and lung diseases and are even linked to premature deaths in people with these conditions. However, in healthcare facilities, occupants with respiratory challenges are generally unable to tolerate smoke particulates; additionally, gasses and other products of combustion are also potential dangers and special consideration should be given to the design of heating, ventilation, and air conditioning (HVAC) systems well in advance of fire season.

As wildfires encroach, hospitals can be forced to evacuate for the health safety of the patients, even if the fire itself is not near the building. Hospital ventilation systems require a fresh supply of outdoor air to maintain indoor air quality and pressurization relationships inside the building; if outdoor air is contaminated by heavy smoke, it may be impossible to safely house patients and staff within the building. During wildfires, however, hospital emergency departments near the fire must remain operational to treat firefighters and affected community residents. To deal with smoke risks, hospitals in fire-prone areas may be able to isolate emergency department ventilation systems and enable recirculated air during emergency conditions. In addition, portable air scrubbers or HEPA filters can be placed in various units to capture smoke, fumes, and airborne particles if outdoor ventilation systems must be shut down.

7.1 Purpose

This section of the Design Guide provides best practices for HVAC design and building measures to minimize occupant exposures and health impacts from smoke during wildfires and prescribed burn smoke events.

As previously stated, wildfire smoke is composed of fine particulate matter and gases, and it contains multiple contaminants. Breathing high concentrations of these pollutants has many potential acute and chronic health consequences, including reduced lung function, pulmonary inflammation, bronchitis, exacerbation of asthma and other lung diseases, exacerbation of cardiovascular diseases, such as heart failure, and even premature death. While most healthy people will recover quickly from exposure to smoke during a wildfire episode, patients in healthcare facilities are at greater risk of adverse health effects and healthcare facilities should rely on qualified HVAC staff and consultants to determine the proper procedures and processes for limiting smoke from entering buildings.

State and local health departments may issue air quality notifications and guidelines when actions are needed to protect the public; facilities managers can use these notifications to know when to initiate smoke mitigation efforts. Below is a decision matrix that can be used for decisions on when to take actions to mitigate smoke infiltration into healthcare facilities.

7.2 Decision Matrix for Implementation of Smoke Readiness Plan

Being prepared to make quick modifications is key to protecting indoor air quality from high levels of smoke-related particulate matter and odors. Ideally, implementing these measures will help clean the air coming into the building and prevent infiltration of wildfire smoke. However, some buildings and HVAC systems are not designed and/or maintained to accommodate the modifications recommended in this guidance. In these cases, use of appropriately sized portable air cleaners can help to create temporary cleaner air spaces. Building managers and facilities engineers will need to assess whether these measures are sufficiently reducing the levels of smoke particulate matter and odors.

Assistance from an HVAC professional or a Mechanical Engineer is generally required to assess existing HVAC equipment capabilities and to implement changes to accommodate these recommendations. When air cleaning is the desired solution, the air needs to be cleaned as much as reasonably achievable whether ventilating with outdoor air or recirculating indoor air. A chart of actions to achieve this goal, including assessing whether these actions have been effective, is included in Figure 7.1. This flow chart illustrates how and why these actions should be taken before and during wildfire smoke episodes:

Smoke Conditions	Answer	Action
Currently smoky? Forecasted to be smoky in the coming days?	No No	Carry on with normal operations. Have your Smoke Readiness Plan prepared and ready.
Currently smoky? Forecasted to be smoky in the coming days?	Yes No	Consider implementing Smoke Readiness Plan.
Currently smoky? Forecasted to be smoky in the coming days?	No Yes	Consider implementing Smoke Readiness Plan.
Currently smoky? Forecasted to be smoky tomorrow?	Yes Yes	Implement Smoke Readiness Plan.

Figure 7.1 – Chart of Actions to Assess Smoke Conditions

7.3 Develop a Smoke Readiness Plan

Create a written Smoke Readiness Plan specific for each building. Checklists can be generated using the items listed in Subsection 7.3, A through J, and in Subsections 7.4 and 7.10. The building-specific plan should address the following elements:

A. Smoke Preparation Supplies

Before wildfire season, purchase materials and supplies needed for the plan. For example, purchase portable air cleaners and extra filters in advance, as they may become difficult to find during a smoke event. Wildfire smoke can quickly load filters and they may need to be changed as frequently as daily. Purchase additional high-quality air filters; ones that have a Minimum Efficiency Reporting Value (MERV) rating of 11 to 13 and higher can remove smoke particles. Consider carbon filters for patient care areas. Preparedness is vital for smoke readiness. **Plan ahead!**

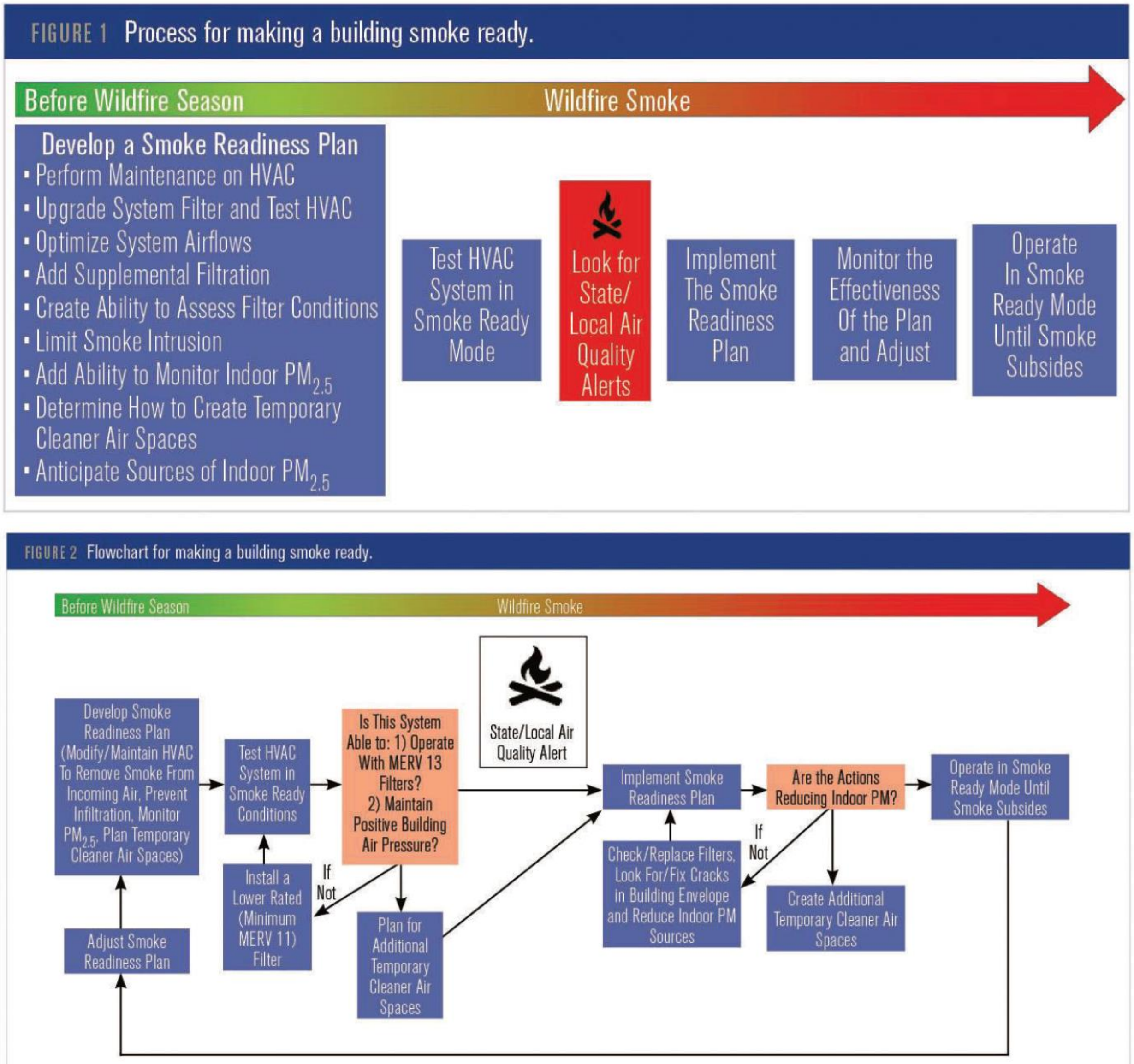


Figure 7.2 – Process and Flow Chart for Building Smoke Readiness Plan

Figure 7.3 – Filter Before and After Load From Wildfire

B. Upgrade HVAC System Recirculation Filter(s)

MERV 13 or higher filters are recommended during smoke events. However, prior to wildfire season, HVAC systems must be assessed for ability to function properly with the upgraded filters. Before using higher MERV filters, check that your system can accommodate them (see Section 8, Upgrading Air Filters).

C. Maintenance of the HVAC System

Repair broken dampers, actuators, and HVAC controls prior to fire season. Pay special attention to economizers because they can be complex and may not be installed correctly. Well maintained equipment with known operating conditions is critical to providing good indoor air quality. See Subsection 7.5 for Special Note on Economizers.

D. Optimization of System Airflows

Economizer operation questions will often be the most difficult to answer and take the most time to research, so put them high on your list of things to address when making your Smoke Readiness Plan. Assess and maintain adequate airflows that are protective of human health and equipment health during smoke events. Prior to wildfire season, determine an outdoor air intake level that controls odor, temperature, CO_2 levels, and maintains a positive building pressure consistent with building and HVAC system design. Reduced ventilation may be acceptable for short periods to protect patients and staff; however, care must be taken to avoid reducing the intake air too much for too long, as this may create a negative building pressure, drawing smoke-laden air into the building through cracks around windows and doors as well as other unintentional openings in the building enclosure. Conducting a trial run of the system in smoke-readiness mode is described in Subsection 7.9.

E. Supplemental Filtration

During a smoke event, add additional filtration at the intake air vent where possible. A MERV 13 filter installed on an intake air vent will capture a large fraction of smoke particulates; however, a filter with activated carbon may help control odors and the gases that patients may be sensitive to. Prior to fire season, inspect the air intake and make a list of filters (including the specific quantity and size of the filters), tape, temporary ducting materials and other items needed to mount filters to the air intake with minimal bypass around the filter (include these items in a list of Smoke Preparation Supplies). Ensure that proper installation instructions have been developed and are up to date. Consult a licensed HVAC design professional or contractor to prescribe the right filter for your system. Consider having a contractor install permanent filter racks on the outdoor air intake.

Figure 7.4 – Filtration Added to Air Intake

F. Assessing Filter Conditions

Prior to fire season, add a port or pressure gauge to measure the filter pressure drop on at least one air handling unit. This will simplify determining when to change filters. A rule of thumb is to change the filter when two times the initial pressure drop is observed.

G. Limit Smoke Intrusion

Prior to wildfire season, weatherize the building envelope, doors, and windows to reduce infiltration by sealing and caulking cracks. Keep doors and windows closed to limit smoke intrusion. Incorporate your plan to limit entrances into the building to be entrances to ones with a vestibule or airlock. If this is not possible, prepare to limit door use to only the doors on the opposite side of the building from prevailing winds during the smoke event. In advance, prepare signage to use on doors that will remain closed and investigate options to secure the doors in a closed position while maintaining required means of egress.

H. Indoor Air Monitoring

Prior to wildfire season, purchase one or more low-cost air monitors equipped with a $PM_{2.5}$ sensor and install it in the facility. These monitors will not be as accurate as regulatory monitors but do serve to identify fine particulate matter inside buildings to help determine if filters and/or keeping doors and windows closed is effectively reducing exposure inside when there are very bad air conditions outside. For example, upward trends in Particulate Matter under 2.5 microns ($PM_{2.5}$) levels can indicate that doors or windows are open, air filters are degrading, or portable air purifiers should be turned on. Plan for how the data from the monitor will be accessed and the actions that will be taken during a smoke event.

I. Temporary Cleaner Air Spaces

Determine how to create temporary cleaner air spaces within the building prior to fire season. Use portable room air cleaners of the appropriate size for the room with HEPA filters (or other high efficiency filters) and other methods to clean the air. Some portable air cleaners come with indicators that change color as the air quality improves. If the air cleaner does not come with an indicator function, it may be helpful to purchase a low-cost air monitor to determine whether the air is being cleaned. A low-cost air monitor may also help to verify that the $PM_{2.5}$ concentration is, in fact, lower in the cleaner air space relative to other spaces in the building. Avoid air cleaners that produce ozone or are ion generators.

J. Anticipate Sources of Indoor PM

Cooking, vacuum cleaning, printers, copy machines, and smoking are examples of activities that increase indoor $PM_{2.5}$ levels. Understanding potential sources in the building can assist in the reduction of these sources during wildfire or prescribed burn events.

7.4 Checklist to Determine if the HVAC System is Ready for Smoke

1. Do the outdoor air dampers function correctly?
2. Are the damper blades, linkage, and edge seals in good condition?
3. Does the building have a commercial thermostat or control system that allows the outdoor air dampers to remain closed when the system is set for an unoccupied state?
4. Are there record drawings, blower door tests, commissioning reports, equipment installation and service manuals or other information available?
5. Does the outdoor air economizer work correctly?

Figure 7.5 – Warped Damper Blade Unable to Close

6. Can the minimum damper set point be changed, and the economizer function be temporarily shut off? How is this accomplished for each air handler?
7. Is it possible to disable or reduce the relief fan air flow?
8. Can the unit use MERV 13 or higher filters? If system cannot use MERV 13, use the highest MERV rated filter possible. There are alternative filtration technologies that allow filtration at a range of pressure drops. An HVAC air balancing technician will be able to evaluate if installing MERV 13 filters will cause too much pressure drop for the system. Beyond the filters in the unit,

system characteristics such as the duct configuration and dirt on air coils can also affect pressure drop.

9. Confirm that all filters are properly seated, and edges are sealed. Air leakage around the filters will greatly reduce their ability to clean the air.

10. Check that the filter and fan access doors are fastened and sealed.

11. Have the building envelope, doors and windows been weatherized to reduce infiltration?

12. Where are the exhaust fans and how are they controlled?

Figure 7.6 – Filter Not Seated Correctly

13. Which exhaust fans are critical for safety? Examples are those serving isolation rooms, commercial kitchen hoods, oxygen storage rooms and other hazardous locations.

14. Where are the locations of exhaust grills? Can they be partially blocked to reduce flow?

15. If the building has more than one air handler or rooftop AC unit, can some of them be set to recirculation and a small number used to provide filtered outdoor air?

16. Does the building have an air conditioning system or portable cooling units to prevent heat-related illness?

7.5 Special Note on Economizers

Most roof top units and larger HVAC systems are equipped with an outdoor air economizer. To save energy, the economizer uses outdoor air to replace the mechanical cooling system when temperatures allow. This can bring in large amounts of smoke and particulate matter into a building during wildfire season. The economizer control also maintains a minimum outdoor air damper position for ventilation and controls relief fans. Care and regular maintenance are recommended to ensure the economizer operates as intended.

There are numerous manufacturers and control schemes for economizers. Finding effective workarounds to temporarily limit the economizer damper operation in response to wildfire smoke is challenging. It is recommended to plan and investigate what actions are needed to limit operations; this may include adding switches and control relays. Other workarounds may also be required.

Ensure that the system can be restored to its normal operating conditions after the smoke event. For example, a simple solution is to place the outdoor air damper in manual control and set the position to allow the minimum air required for ventilation. A building automation system may have this ability. Another technique is to disconnect the damper actuator and manually set the damper position, then physically hold the damper position in place with blocking, wire, or a clamping tool.

Regardless of the method, installing filters on the air intake is recommended. These temporary economizer bypass measures are to limit the amount of outdoor air and $PM_{2.5}$ brought into the building. Having the ability to quickly respond to changing conditions is needed to minimize adverse health outcomes.

7.6 Considerations for SARS and COVID

HVAC filtration and air cleaning recommendations for smoke and SARS/COVID are similar due to similar respirable particle sizes. The difference is the outdoor air ventilation rate: a low outdoor air rate is desirable for smoke control and a high rate is desirable for removal of virus particles. Additionally, improved HVAC filtration must be in the recirculation air to facilitate infection control. The facility engineer’s challenge is to monitor system components and indoor conditions and change system settings as outdoor air quality changes to balance potential tradeoffs between smoke and exposure to infectious agents. Portable air cleaners with a HEPA filter (or other high efficiency filters) may be helpful in removing virus particles, as well as smoke particles without increasing the amount of outdoor air.

7.7 Activated Carbon Air Filters

As previously stated, smoke infiltration in healthcare facilities is much more problematic than all other commercial and residential buildings. Much information is available on the value of HEPA filters which are extremely efficient at removing the fine particulates in wildfire smoke from entering the HVAC system and recirculating it throughout the building. However, HEPA filters do not remove the gasses and odors found in wildfire smoke and additional filtering may be warranted for certain areas or facilities. Carbon filters are designed to filter organic compounds found in wildfire smoke much more thoroughly.

Activated carbon is a highly porous substance that attracts and holds organic chemicals inside it. The media is created by first burning a carbonaceous substance without oxygen which makes a carbon “char”. Next, the “char” is treated chemically or physically to develop an interconnected series of “holes” or pores inside the carbon. The great surface area of this internal pore network results in an extremely large surface area that can attract and hold organic chemicals.

Activated carbon attracts and holds organic chemicals from vapor and liquid streams cleaning them of unwanted chemicals. Organic chemicals are attracted to carbon the best and very few inorganic chemicals will be removed by carbon. The molecular weight, polarity, solubility in water, temperature of the fluid stream and concentration in the stream are all factors that affect the capacity of the carbon for the material to be removed. Volatile Organic Compounds such as Benzene, Toluene, Xylene, oils, and some chlorinated compounds are common target chemicals removed through use of carbon. Other large uses for activated carbon are the removal of odors and odor contamination.

Rigid cell odor removal air filters can withstand fluctuations in airflow, making these filters ideal for variable-volume HVAC systems. These vapor phase adsorber filters remove molecular contaminants and ozone from the air stream at low concentration levels. Rigid cell odor removal air filters are commonly used to improve indoor air quality in commercial or industrial applications such as museums, archive storage facilities, and semiconductor fabrication facilities and can be instrumental in keeping smoke and odors from affecting patients and staff in healthcare facilities.

Like the finer particulate HEPA filters (or MERV 14 or greater), carbon filters can impact air distribution and pressures, so it is critically important that your HVAC system be designed with enough fan power to support their use. This may not be an option for existing installations, but new buildings and HVAC replacement projects should consider sizing the air handling unit to accommodate these needs; an option to consider would be the installation of filter racks in air handlers that would not be used during normal operations but could be immediately put into operation in a wildfire (or pandemic situation or airborne pathogen) event. This would alleviate concerns about operations and maintenance costs related to carbon filters.

7.8 Use of Portable Air Cleaners

If the HVAC system is not able to reduce the smoke particulate concentrations sufficiently throughout the building, a cleaner air space can be created using one or more portable air cleaners with a HEPA filter (or other high efficiency filter) in a closed room. It is important to have a correctly sized air cleaner(s) for the space. Multiple devices may be needed for larger rooms. The Association of Home Appliance Manufacturers (AHAM) has developed a rating system and room size recommendations for portable air cleaners. The smoke clean air delivery rate (CADR) is the rating for 0.09- to 1.0-micron particles and represents the amount of clean air delivered on the high-speed setting. Units with a sufficient Smoke CADR, recommended room size for the application, and low noise ratings are recommended. For wildfire smoke, AHAM recently updated their sizing recommendation to a Smoke CADR equal to the size of the room in square feet. EPA also provides additional information on the selection and use of portable air cleaners. Do-it-yourself room air cleaners can be used consisting of a box fan and a MERV 13 filter to provide air cleaning like a small room (100 sq. ft.) air cleaner but with more noise, which may limit their usefulness.

7.9 Test HVAC in Smoke Ready Mode

When the Smoke Readiness Plan is prepared and before the start of wildfire season, test the HVAC system with the additional filtration and adjusted flow settings. There may be several non-functioning items that will take more time to fix than emergency conditions allow. Tips for the trial run:

- If there is a building automation system, make a list of controller settings and changes that need to be made. It will speed up and simplify implementing the plan during a smoke emergency. Install the filters and test the system.
- When adding filters, adjusting dampers and exhaust settings, position a person with a cell phone/walkie talkie at an exterior door to observe and confirm that the building pressure remains slightly positive to the outside. To check that the building pressure is positive, use a flutter strip (flagging tape or toilet paper) taped to the outside edge of the door. If the pressure is positive, the strip should be flowing outward (indicating that air flow is moving out of the door).

7.10 Implement the Smoke Readiness Plan

Be ready to implement the plan when smoke mitigation is needed. Use the operations checklist that is in your plan. Some examples include:

1. Are windows and doors closed and sealed, and building envelope weatherized?
2. If limiting door use, is signage posted on the closed entrances?
3. Are the outdoor air economizers disabled and minimum damper settings adjusted?
4. Are upgraded filters installed?
5. Are exhaust airflows minimized and balanced to maintain positive air pressure?
6. Is the system fan set to run continuously to maximize the air filtration benefits?
7. Is there a plan to monitor the ambient air $PM_{2.5}$ and to frequently check filters and replace as needed?
8. Are the portable room air cleaners ready for service with fresh filters?
9. Is the building engineer or HVAC technician ready to change back to normal operations when the smoke clears?
10. If part of your Smoke Readiness Plan, create your cleaner air space.
11. After the smoke event, return system to normal operation and determine the need to clean or change filters.

7.11 Monitor Effectiveness of Plan and Adjust

Once the plan is implemented, use the data from the indoor $PM_{2.5}$ monitor to determine whether the actions taken have reduced the smoke particulate levels. If an upward trend in $PM_{2.5}$ levels is observed or the smell of smoke inside the building is increasing, check filters and replace as needed, look for cracks in the building envelope and seal them, and reduce indoor particulate matter sources. If levels are still not decreasing after these adjustments, create temporary cleaner air spaces using portable air cleaners or consider relocating to another facility.

In sudden, relative short duration fire events, temporarily reducing the amount of ventilation air or shutting air off altogether may be considered but will almost always create unexpected conditions. In healthcare facilities, positive and negative air pressure relationships are of critical importance for infection control; these areas within the facility and the impacts on patients must be taken into consideration before making any changes to HVAC systems. Track important information with handheld devices or a Building Automation System. Knowing the levels of $PM_{2.5}$, temperature, relative humidity, carbon dioxide concentration, and number of occupants will allow problems to be addressed as they arise.

7.12 In-duct Smoke Detectors

In-duct smoke detectors are required to be installed within the airstream or in a manner that samples the air being supplied to the building. When smoke is detected in the airstream, the smoke detector will send an alarm or supervisory signal to the building fire alarm system and will automatically shut down the HVAC unit. This safety feature is intended to prevent smoke from a fire inside the building being conveyed to other parts of the building by the HVAC system. These detectors were not intended to shut down HVAC equipment from smoke entering the airstream through outside air intake grilles, but it is obviously beneficial from that standpoint as well. Can the in-duct smoke detectors be bypassed?

Duct smoke detectors operate on either a photoelectric principle or an ionization principle, both of which need smoke to trigger an alarm. Photoelectric detectors are generally considered less sensitive since they require visible smoke to obscure an internal light source to trigger an alarm. If filters have been provided in the outside air intake airstream, it is unlikely that the amount of smoke that makes it through the filters would be sufficient to actuate a photoelectric-principle smoke sensor. If there is sufficient smoke, the building will become unhabitable after a short period of time if the air handler remains operational.

Typically, commercial projects use dual detection – ionization and photoelectric detection for enhanced safety and fewer unwanted alarms. Ionization chamber smoke detectors rely on radiation to "ionize" the air inside the chamber. A radioactive source "decays," or sheds particles and photons from unstable atoms. The particles interact with neutral air molecules flowing through the chamber and triggers when smoke breaks the constant flow of ions. Any air contaminant or product of combustion that will attract free electrons in the sensor will interrupt the flow of current and trigger an alarm. Therefore, it is recommended that only photoelectric sensors be used in air handlers that need to be configured to handle outside air during wildfires.

Generally, the amount of dilution of smoke in the airstream is so great, the in-duct detectors and sampling tube detectors do not register the smoke until the quantity is significant. When the amount of smoke entering the building from outside air intake ducts is significant the HVAC system should shut down to protect the occupants. Prior to restarting the shutdown HVAC unit, the outside air needs to be filtered or blocked as described in this chapter. Bypassing the in-duct smoke detectors should therefore not be needed.

Another newer technology that could be used for smoke entering outside air intakes is Video Image Smoke and Fire Detection (VISD). VISD consists of a digital video camera coupled with a computer running video analytic software which can recognize smoke and fire in the image. VISD systems can monitor outside the building and look for visible indications of a fire or smoke to determine if the smoke is from outside the building or inside the building and provide early warning to facilities engineers to take an immediate action.

7.13 Adjust the Plan

After implementing the plan, incorporate any adjustments and lessons learned into your Smoke Readiness Plan prior to the next wildfire season.

7.14 Implementation

Solutions that involve modifications to existing systems that are intended to be permanent that changes air flows, pressure differentials, equipment, adding filter banks, other changes to filtration, adding or relocating ducting, etc., requires the submittal of a project to OSHPD. For emergency related projects refer to PIN 72 Emergency Work Authorization.

7.15 References

1. California Air Resources Board; California Office of Environmental Health Hazard Assessment; U.S. Centers for Disease Control and Prevention; U.S. Forest Service; and U.S. Environmental Protection Agency. [2021] *Wildfire Smoke: A Guide for Public Health Officials.* Retrieved from *Wildfire Smoke Guide and Factsheets Publications* | AirNow.gov

2. U.S. Environmental Protection Agency. [2020] *AirNow website.* Retrieved from https://www.airnow.gov/

3. U.S. Environmental Protection Agency. [2020] *State Smoke Advisory Websites.* Retrieved from *Smoke Advisories* | AirNow.gov

4. U.S. Environmental Protection Agency. [2003] *Air Quality Guide for Particle Pollution.* Retrieved from *Air Quality Guide for Particle Pollution* (epa.gov)

5. Berkeley Lab. [2020] *Low-Cost Home Air Quality Monitors Prove Useful for Wildfire Smoke [news article with links to relevant publications].* Retrieved from *Low-Cost Home Air Quality Monitors Prove Useful for Wildfire Smoke | Indoor Environment Group* (lbl.gov)

6. California Air Resources Board. [2020] *Hazardous Ozone-Generating Air Purifiers.* Retrieved from *Hazardous Ozone-Generating Air Purifiers* | California Air Resources Board

7. U.S. Environmental Protection Agency. [2018] *Residential Air Cleaners: A Technical Summary.* Retrieved from *Residential Air Cleaners - A Technical Summary* (epa.gov)

8. ASHRAE Epidemic Task Force. [2022] *ASHRAE Building Readiness Guide.* Retrieved from ASHRA Epidemic Task Force Building Readiness

9. U.S. Environmental Protection Agency [2024] *Wildfires and Indoor Air Quality.* Retrieved from *Wildfires and Indoor Air Quality (IAQ) | Indoor Air Quality (IAQ) |* US EPA

10. U.S. Centers for Disease Control and Prevention. [2021] *COVID-19 Considerations for Cleaner Air Shelters and Cleaner Air Spaces to Protect the Public from Wildfire Smoke.* Retrieved from *COVID-19 Considerations for Cleaner Air Shelters and Cleaner Air Spaces to Protect the Public from Wildfire Smoke* | CDC

11. Association of Home Appliance Manufacturers [2020] *Frequently Asked Questions about Testing of Portable Air Cleaners.* Retrieved from AHAM Frequently Asked Questions about Testing of Portable Air Cleaners

12. Association of Home Appliance Manufacturers [2019] *Find* a *Certified Room Air Cleaner.* Retrieved from *Find a Certified Room Air Cleaner* – AHAM Verified

13. Association of Home Appliance Manufacturers [2022] Using an Air Cleaner to Manage Wildfire Smoke. Retrieved from *Using an Air Cleaner to Manage Wildfire Smoke* - AHAM Consumer Blog

14. U.S. Environmental Protection Agency. [2018] *Guide to Air Cleaners in the Home.* Retrieved from *Guide to Air Cleaners in the Home* (epa.gov)

15. Puget Sound Clean Air Agency. [2020] *DIY Air Filter.* *DIY Air Filter | Puget Sound Clean Air Agency, WA* (pscleanair.gov)

16. U.S. Environmental Protection Agency. [2019] *Wildfire Smoke: A Guide for Public Health Officials.* Retrieved from *WILDFIRE SMOKE: A GUIDE FOR PUBLIC HEALTH OFFICIALS* (airnow.gov)

17. Health Canada. [2020] *Guidance for Cleaner Air Spaces during Wildfire Smoke Events.* Retrieved from *Guidance for Cleaner Air Spaces during Wildfire Smoke Events* - Canada.ca

7.16 Additional Resources

A. Wildfire Smoke

1. U.S. EPA Smoke-Ready Toolbox for Wildfires: *Smoke-Ready Toolbox for Wildfires* | US EPA

2. U.S. CDC Wildfires Website: *Wildfires*|CDC

3. BCCDC Wildfire Smoke Website: *Wildfire Smoke* (bccdc.ca)

B. Filter Upgrades for Buildings

1. ASHRAE guidance for Reopening Schools and Universities, Filtration Upgrade Section: ASHRAE Introduces Updated Reopening Guide for Schools and Universities | ashrae.org

2. ASHRAE Building Readiness Guide: Building Readiness (ashrae.org)

C. Box Fan Filters

1. Climate Smart Missoula, How to build a Do-It-Yourself Fan/Filter Air Cleaner, DIY fan filter - MONTANA WILDFIRE SMOKE

2. New York Times, Wirecutter: How to Make a DIY Air Purifier: How to Make a DIY Air Purifier - YouTube

3. Oregon Health Authority: Fact Sheet: Do It Yourself (DIY) air filter: Do It Yourself (DIY) Air Filter (oregon.gov)

4. Puget Sound Clean Air Agency: DIY Air Filter: DIY Air Filter | Puget Sound Clean Air Agency, WA (pscleanair.gov)

5. The Confederated Tribes of the Colville Reservation, Air Quality Program: Box Fan Filter, A DIY Users Guide: Box Fan Filter A DIY Users Guide Colville Tribes Air Quality Program - YouTube

6. Washington State Department of Ecology, Instructional Video for Building Your Own Air Cleaner, (259) How to make your own clean air fan - YouTube

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SECTION 8
UPGRADING AIR FILTERS

8.0 Introduction

How can I tell If my system can safely use MERV 13 filters? When upgrading filters to ones with higher efficiency, there is concern that the additional pressure drop will stress or harm the fan motor or other HVAC components. Monitoring the fan motor operation and checking temperatures at a few key locations will provide information to determine safe operation or the inability to use higher MERV rated filters.

8.1 Overview

Air handlers and roof top package units are designed with a fan sized to provide air flow for adequate heating and cooling of the areas they serve. To do this, the supply air fan provides static pressure to move the air though dampers, filters, and heat exchangers, as well as ductwork, registers, and the conditioned space. The amount of air must be adequate to transfer heat in and out of the conditioned space within the design parameters of the equipment.

Supply fans should be evaluated and sized to ensure they can provide the design airflow through a loaded MERV 13 filter. The operating point at the design airflow and the required total static pressure, plus the pressure drop from a dirty MERV 13 filter, should not be in the fan surge or 'do not select' zone and the fan motor horsepower rating should be selected to handle the brake horsepower increase due to the added pressure drop from a dirty MERV 13 filter. The fans' motor starters or variable frequency drives should be selected so their rated current (amperage) is not below the required current (amperage) draw to handle the added pressure drop from a dirty MERV 13 filter. With oversized fans and motors to account for the pressure drop of dirty MERV 13 filters, the designer or contractor must confirm that, during normal operation, the fans can still satisfactorily throttle down to the design minimum airflow (or the airflow required by the Energy Code).

Cleaning the ducts, fan and finned air coils will provide additional capacity for air filtration. These systems are dynamic: as filters load with dust and heat exchangers become fouled with dirt, the performance is affected and the potential for failure increases. To gain an understanding of important benchmark temperatures and pressures, reference the manufacturer's literature. Rule of thumb guidance is presented as a starting point.

8.2 Centrifugal Fan Surge

Surge is a natural phenomenon that occurs when the maximum head pressure and minimum flow is reached by a centrifugal fan. When the head pressure is greater than the outlet pressure, the air will reverse and try to flow back into the fan inlet. This unstable pressure cycling creates pulsing noises and vibrations known as surge. If surge is created by the addition of MERV 13 filters, the fan design has been exceeded. Another method should be used to clean the indoor air.

8.3 ECM Fans

Electronically Commutated Motors (ECM) used to drive fans are electronically speed controlled for constant torque. These motors will increase in speed and power usage to maintain a constant air flow. Up to a point this is a good thing. These motors should be monitored for amperage to verify they do not overload when upgraded filters are installed and whenever the filter loading is checked. Do this until there is adequate history that demonstrates the motors do not exceed their rated electrical capacity (full-load amperage) during a wildfire smoke event. As the static pressure increases, ECM fans may become noisy.

8.4 VFD Controlled Fans

Fan motors on a Variable Frequency Drive (VFD), also known as a variable speed drive, typically are controlled to maintain a duct static pressure set point. These motors need to be monitored as well for overloading. Check the drive parameters to verify they match the motor name plate information. Most VFDs will provide adequate motor protection if these parameters are correct. If the drive display shows the motor operating continuously at 100% speed, the unit or filters may need additional corrective actions.

8.5 Other AC Induction Motors

Constant speed induction motors typically used with fans will decrease the power usage as the filters load with dirt and the air flow decreases. These motors will not overload with a greater pressure drop but lower air flow may harm other parts of the system. When increasing the fan speed do not exceed the maximum tip speed or the maximum motor power.

8.6 Direct Expansion Cooling

Low air flow can lead to loss of cooling and compressor failure. Air temperature measurements are a simple way to verify safe operation. The manufacturer's literature or the startup records will have a recommended air temperature difference across the evaporator coil. The rule of thumb is 20°F air temperature difference with a minimum discharge temperature of 55°F measured after 20 minutes of continuous running. If the discharge temperature is below 55°F, visually check for frost or ice on the evaporator coil. Frost is an indication that there is inadequate air flow and the filters, or the level of dust loading are too restrictive. Some fan motors may have the ability to increase speed by changing electrical connections or VFD settings. After adjusting the fan speed, re-check the temperatures. As the filters load with dust, the air flow may fall below the acceptable rate. Piston (reciprocating) compressors are most likely to be damaged by low air flow; scroll compressors are a little more resilient. Units with compressor staging may require additional observation and testing. It is up to the operator to determine that conditions for safe operation are in place.

8.7 Heat Pumps

While cooling, follow the guidelines above. While heating, low air flow may cause the unit to shut down when the high-pressure safety device trips. Review the manufacturer's instructions to determine the appropriate limits for the maximum discharge temperature and air temperature difference.

8.8 Electric Resistance Heating

Electric heating elements must have sufficient air flow to operate. Review the manufacturer's instructions to determine the appropriate discharge temperature limit.

8.9 Combustion Appliances

Roof top units and air handlers with natural gas or propane heat need adequate supply air flow for heat transfer and to prevent damage to the heat exchanger. The unit label or manufacturer's literature will list a maximum discharge air temperature and a range of temperature differences that indicate acceptable operation. Rule of thumb is 160°F maximum discharge temperature and 40° to 60°F air temperature difference across the heat exchanger. Direct-fired units and oil-fired units have similar parameters. Always use the manufacturers recommended settings to determine that safe operations are being met.

8.10 Implementation

Solutions that involve modifications to existing systems that are intended to be permanent that changes air flows, pressure differentials, equipment, adding filter banks, other changes to filtration, adding or relocating ducting, etc., requires the submittal of a project to OSHPD. For emergency related projects refer to PIN 72 Emergency Work Authorization.

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SECTION 9
HOW TO EXPEDITE EMERGENCY PROJECTS

9.0 Introduction

Emergency work may be necessary due to permanent equipment failure, natural disaster, or other occurrences that require immediate repair or replacement to ensure jobsite or building occupant health or safety. During pandemics or unusual occurrences, emergency work may be necessary to provide safe environments for patients or to provide temporary patient care inside the facility.

OSHPD recognizes that emergency temporary construction and installation of temporary equipment is sometimes required to accommodate construction or to provide transitional solutions. An emergency does not generally include maintenance to prevent something from failing; a true emergency is the actual disaster, event, or failure of equipment that creates the situation requiring immediate action.

9.1 Background

While certain work in healthcare facilities is exempt from the requirements for a permit, most construction work in a hospital requires a building permit. This includes construction for alterations or remodels and includes the replacement of equipment. OSHPD recognizes there are situations where an emergency exists that require immediate corrections to be made quickly to keep the hospital operational and occupants safe.

A general overview of OSHPD's policy related to emergency projects is provided herein. Refer to PIN 72 Emergency Work Authorization for the specific requirements for emergency authorization. This will help to understand expectations so that the regulatory requirements are known prior to an emergency.

OSHPD will consider and may issue an Emergency Authorization to Proceed (EAP) with emergency work prior to plan approval and building permit based on emergency conditions and necessity. Even where an EAP is granted, the design for permanently repairing or replacing building systems, components, or equipment must be reviewed, approved, and permitted as soon as practical to comply with the California Administrative Code, Chapter 7, Article 3, APPROVAL OF CONSTRUCTION DOCUMENTS. All emergency work that is intended to remain must adhere to the requirements for permanent equipment and building components. For emergency work that is intended to be temporary equipment and building components see CAN 2-108 Temporary Systems, Utilities and Equipment.

9.2 Procedure

When an emergency arises, the facility must take the following actions:

A. Immediate Action

The facility may take the necessary emergency actions to abate and make safe the emergency condition that poses an imminent danger to life, injury, or property damage. Such emergency actions may proceed prior to contacting OSHPD; however, the OSHPD Regional Compliance Officer (RCO) must be contacted immediately after.

B. Notification to OSHPD and Request for EAP

Immediate written notification shall be provided to the RCO for determination and issuance of EAP with repairs, replacement, or installation of temporary equipment prior to required plan approval and building permit (refer to California Administrative Code, Chapter 7, Article 20, REPAIR OF DAMAGE AFTER AN EMERGENCY). The "Request for Information to Authorize Emergency Work" (HCAI-FD-101) should be included in the notification to the OSHPD RCO. See Appendix A for the form and instructions. For all emergency projects, the Permit Application and complete Testing Inspection Observation (TIO) Program shall be submitted within the next working business day as required by California Building Code, Section [A] 105.2.1, Emergency repairs.

It is the facility's responsibility to notify the California Department of Public Health (CDPH) Licensing and Certification of the emergency condition, any affects to the facility's operations, and their request to OSHPD to approve the emergency repair, replacement, or temporary equipment project.

Because each emergency condition is unique, the RCO will review each EAP request on an individual basis and decide if it can be granted.

C. If EAP is Denied

If the RCO determines the request does not meet the requirements for EAP, the request will be denied. If the approval for emergency authorization is denied, the project will proceed as a traditional submittal and construction work may not proceed until the plans have been reviewed and approved and a building permit has been issued.

D. If EAP is Approved

1. A Letter of Emergency Authorization to Proceed will be issued by the RCO for the specific work that may be performed with conditions and restrictions noted.
2. The Design Professional(s) of Record [DPORs]) provides all necessary direction to perform the work of construction and inspection of the work in the form of plans, notes, sketches, installation instructions and/or drawings, Testing, Inspection and Observation (TIO) program, etc., to the Contractor and the IOR.
3. Complete construction plans for emergency work, involving permanent equipment replacement or building area revisions must be submitted to OSHPD within 10 days of the emergency work authorization issued by the RCO.

4. The construction work on the emergency project must be carried to completion without undue delay.
5. The DPOR is responsible for submitting the TIO program with the construction document submittal and maintaining the TIO with all required tests and inspections for field approval during performance of the emergency work.
6. All emergency authorized work must be continuously inspected by an IOR approved by the Office. The IOR shall coordinate required field observation with all necessary Field Staff. The IOR shall submit their daily field records of construction progress for this Emergency Authorization project to the Compliance Officer, Fire Life Safety Officer, and Regional Compliance Officer for each day or any portion of a day that they are present at the project site.
7. A Certificate of Substantial Compliance milestone must be included in the TIO program for any work, equipment, or area that will be placed into temporary or permanent use or service.
8. Additional repairs or corrections may be required if the authorized emergency work does not comply with the conditional approval and the final OSHPD approved construction documents.

Special consideration must be given to additional electrical load on the emergency power supply system (see CAN 2-108 Temporary Systems, Utilities and Equipment).

All emergency temporary equipment is required to be removed prior to project closure.

9.3 Returning to Pre-Disaster/Emergency State

Once an emergency is deemed over or the risk has subsided to a level where a facility can return to “close to normal” operations, the facility needs to document what changes were made during the emergency and plan to return systems to their previous state. To do this it may be as simple as notifying their Compliance Officer, or it may require a project with an associated building permit. Forethought should be given to the amount of time it will take to prepare drawings, submit, and have a permit approved, as well as construction required to bring the facility back into compliance.

If a facility wishes to make temporary changes permanent, a project must be submitted so that the installation will be code compliant. Many temporary conditions were allowed by way of an executive order or a waiver by CDPH. Due to there being very little, if any, oversight of what was being installed, many applications are a temporary solution and not compliant with any regulations or building standards. Examples of this are running extension cords down corridors or across floors, adding medical gas outlets in non-patient care areas with no supervising physician, and cutting holes in windows or walls to provide direct exhaust from patient care areas. These conditions were never intended to be left in place permanently, but the results of the changes were beneficial. Unsafe, non-complying work and/or conditions are not permitted to remain in place after the emergency that made them necessary has ceased to exist.

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SECTION 10
OSHPD'S RESPONSE FOR DISASTERS

10.0 Introduction

OSHPD has authority granted it by the Hospital Facilities Seismic Safety Act that in the event of a seismic event, or other natural or manmade disaster that OSHPD believes is of such a magnitude that it may have compromised the structural integrity of a hospital building, or any major system of a hospital building, OSHPD shall send one or more authorized representatives to examine the structure or system. "System" for these purposes shall include, but not be limited to, the electrical, mechanical, plumbing, and fire and life safety system of the hospital building. If, in the opinion of the OSHPD, the structural integrity of the hospital building or any system has been compromised and damaged to a degree that the hospital building has been made unsafe to occupy, OSHPD may cause to be placed on the hospital building either a red placard or a yellow placard. If the building is still safe to occupy OSHPD may place a green placard on the building.

10.1 Activation of Emergency Operation Center

The Emergency Response Plan and the Emergency Operation Center (EOC) are activated by the HCAI Director or other authorized staff in concert with California Department of Public Health (CDPH), Emergency Medical Services Authority (EMSA) and Office of Emergency Services (OES) when a significant disaster occurs. In such an event, OSHPD is mandated to respond as follows:

- Provide emergency structural, critical nonstructural and fire and life safety assessment of Acute Care Hospitals and Skilled Nursing Facilities.
- Ensure rapid inspection postings of facilities in OSHPD jurisdiction in a disaster area.
- Provide information on OSHPD's emergency assessment status of facilities to CDPH, EMSA, OES and others as necessary.
- Arrange priority review, approval and permitting of hospital repair and reconstruction of those affected facilities for a limited time following an earthquake.
- Upon activation, OSHPD′s Emergency Operations Center (EOC) will be set up in OSHPD's Sacramento or Los Angeles offices in accordance with the Standardized Emergency Management System to manage and coordinate the emergency response. A Forward Staging Area may be established. Priorities for inspection will be established by HCAI in cooperation with CDPH, EMSA, OES and the affected facilities. Direct requests for safety assessment of structures may be sent to the EOC through the main OSHPD telephone number, (916) 440 8300.

10.2 OSHPD's Emergency Response

The OSHPD Emergency Response Plan is based on the following:

- OSHPD is tasked in the California State Emergency Plan to aid in two emergency response areas: the Medical and Health Services Function and the Construction and Engineering Function. OSHPD′s priority will be to assist CDPH and EMSA with implementation of the Medical and Health Function response. Assistance to the Construction and Engineering Function will be secondary and provided only if personnel and resources are available.
- OSHPD's primary directive is to maintain occupancy for hospitals and skilled nursing facilities as long it is safe to do so. Consideration will be given to potential damage in aftershocks after an earthquake.
- OSHPD response teams will not interfere with local efforts to keep hospitals and skilled nursing facilities open and providing service to the community if there is no threat to health, such as ventilation, sanitary facilities, etc., and life safety at the site. It is OSHPD′s intent to allow hospitals and skilled nursing facilities to provide services to the public under emergency conditions without interference.
- OSHPD will identify only hazards related to structural, critical nonstructural, or fire and life safety building damage. Other inspections for licensing and health-related issues, such as staffing, supplies, etc., may result in closure of a hospital or skilled nursing facility regardless of OSHPD's assessment. OSHPD personnel will conduct initial damage assessments. If necessary, OSHPD will request mutual aid through CDPH, EMSA, or OES to obtain additional technical assistance.
- Severely damaged hospitals and skilled nursing facilities may be posted and evacuated before OSHPD officials arrive. This action could be taken by local response officials or local structural engineers. OSHPD will encourage local officials or deputized engineers to use the ATC-20-2 methodology for immediate on-site assessments. OSHPD response teams will re-inspect and re-post hospitals and skilled nursing facilities which have been posted by others.
- OSHPD damage inspection reports are not intended for use by local jurisdictions, hospitals, or other parties for the purpose of obtaining disaster relief funds from the State or Federal government.
- OSHPD will not participate in emergency repair decisions by hospital or skilled nursing facility officials. For a specified and limited time following an earthquake, unobserved repair of hospitals and skilled nursing facilities will be allowed by OSHPD. (The time will be determined by the severity of the earthquake and dictated by the length of the emergency period.) Review, approval, and permitting of hospital and skilled nursing facility repair and reconstruction projects will be given priority by OSHPD for a specified and limited time following an earthquake.

10.3 Inspection and Tagging of Buildings

The OSHPD inspection usually consists of a Compliance Office, a Fire Life Safety Officer, and a District Structural Engineer. Each is tasked with inspecting certain aspects and systems of the building. The final posting of the building is determined by the determination based on the combined inspections. For example, a building or portion of a building may be safe structurally, however, there may be flooding caused by broken utility lines and systems to the extent that it is unsafe to occupy. Buildings will be tagged with one of three placards after the inspections are completed.

INSPECTED

<u>LAWFUL OCCUPANCY PERMITTED</u>

This facility was inspected under emergency conditions in accordance with <u>California Health & Safety Code 130025</u> by the California Department of Health Care Access and Information (HCAI), OSHPD, Emergency Operations Center (EOC).

<u>CAUTION</u>: Post-disaster incidents or aftershocks since posting may increase damage and risk. Immediately report any unsafe changes to HCAI EOC at (916) 319-8013. Re-inspection may be required.

Date: ________ Time: ________	**This structure has been inspected and no apparent hazard has been found, Safety Evaluation Team Comments below:**
Facility ID: ________ Building #: ________	
Facility Name and Address:	
Safety Evaluation Team:	
CO: Phone No:	
DSE: Phone No:	Facility is required to contact California Department of Public Health,
FLSO: Phone No:	Licensing and Certification for patient/resident-repopulation clearance.
Other:	**Notes:**

Do Not Remove, Alter, or Cover this Placard for 90 Days Unless Authorized by HCAI
(916) 319-8013, eoc@hcai.ca.gov
(A photograph of this notice has been filed with the HCAI EOC)

Rev 10/2022

ABOUT YOUR POSTING:

Your facility has been evaluated and is now posted with a green INSPECTED placard. This placard indicates the Safety Evaluation Team has determined that damage, if any, does not pose a significant safety hazard. This posting is intended only to inform occupants that the building may be safely occupied; it does not imply that damage should be ignored or that repairs are not necessary.

In an earthquake, it is possible that subsequent aftershocks could create new damage or increase the initial damage, causing the need for the INSPECTED posting to be changed to a more restricted level of use. If you have evidence that an aftershock has substantially increased damage to your building, you should contact HCAI to schedule a re-inspection. It is likely HCAI will re-inspect posted buildings after a major aftershock even if re-inspections are not requested by the owner.

WHAT TO DO NEXT:

You will need to assess your minor damage to determine what efforts are necessary for repair. You may need the services of design and construction professionals and building permits from HCAI.

If you are attempting to make repairs on your own without the help of contractors, be aware that you will still need a building permit or similar authorization and you must use an approved inspector of record for the work. Certain minor work (e.g., re-anchoring equipment or repairing any damaged structural members) requires a permit. Building permits are required by law and will help prevent challenges to the adequacy of the work performed when a property is sold or when insurance claims are made.

Your GREEN INSPECTED placard shall remain in place for 90 days after posting unless removal is authorized by HCAI. If you have additional questions regarding our assessment, call our Sacramento Office at (916) 319-8013, eoc@hcai.ca.gov.

Rev 10/2022

A green placard indicates that the building is safe for occupancy. However, there may be other considerations by CDPH, other jurisdictional agencies, or the hospital or skilled nursing facility that may make the building unsafe for operations.

RESTRICTED USE

This facility was inspected under emergency conditions in accordance with California Health & Safety Code 130025 by the California Department of Health Care Access and Information (HCAI), OSHPD, Emergency Operations Center (EOC).

CAUTION: Post-disaster incidents or aftershocks since posting may increase damage and risk. Immediately report any unsafe changes to HCAI EOC at (916) 319-8013. Re-inspection may be required.

Date: ___________ Time: ___________ Facility ID: ___________ Building #: ___________	**Caution: This structure has been inspected and found to be damaged as described below:**
Facility Name and Address:	
	Entry, occupancy, and lawful use are restricted as indicated below:
Safety Evaluation Team:	
CO: Phone No:	
DSE: Phone No:	Facility is required to contact California Department of Public Health,
FLSO: Phone No:	Licensing and Certification for patient/resident-repopulation clearance.
Other:	**Notes:**

Do Not Remove, Alter, or Cover this Placard for 90 Days Unless Authorized by HCAI (916) 319-8013, eoc@hcai.ca.gov

(A photograph of this notice has been filed with the HCAI EOC)

Rev 10/2022

ABOUT YOUR POSTING:

Your facility has been evaluated and is now posted with a YELLOW Placard. This placard indicates the Safety Evaluation Team has determined that the observed damage precludes unrestricted occupancy. The RESTRICTED USE posting does not require the owner to obtain a permit to allow entry.

Localized structural damage may also place a portion of a building in an unsafe condition while other areas remain usable. Overall damage may be such that entry is appropriate for occupants to remove belongings and for contractors to make repairs but is not appropriate for normal occupancy. A description of the limits or conditions for continued use is listed on the RESTRICTED USE placard.

In addition to posting the entire building, posting may be necessary at specific locations outside a building. In situations where a potential falling hazard exists, the immediate area below that part of the building may be marked or otherwise barricaded with yellow tape having a message that reads *Do Not Cross Line, Restricted Area - Keep Out*, or similar cautionary wording. Damaged masonry, parapets, or veneers above outside spaces are examples of falling hazards requiring such barricading.

WHAT TO DO NEXT:

Since your building appears repairable, you will need to assess the damage, determine what efforts are necessary for re-occupancy, and begin these efforts. You will need the services of design and construction professionals and permits from the HCAI.

You may begin the engagement of design and construction professionals at any time. HCAI will usually allow the entry and occupancy of a building to be determined by a design professional engaged by the owner if their written and signed occupancy recommendations appear reasonable and are posted on the building.

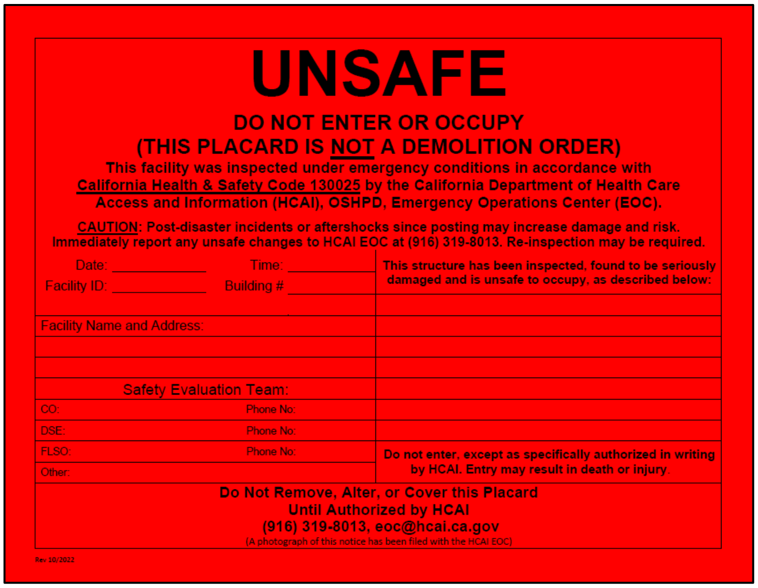
Permits will be needed from HCAI to begin work. The specific rules applying to the reconstruction or repair of your building may be somewhat different than those used in non-disaster conditions. There may be situations, which require an older structure to be repaired using current standards for earthquake resistance rather than those used in the original construction. Use of the current standards can substantially reduce the damage caused by future earthquakes, but this will also usually raise the cost of the repair work.

If you are attempting to make repairs on your own without the help of contractors, be aware that you will still need a building permit or similar authorization and you must use an approved inspector of record for the work. Certain minor work (e.g., re-anchoring equipment or repairing any damaged structural members) requires a permit. Building permits are required by law and will help prevent challenges to the adequacy of the work performed when a property is sold or when insurance claims are made.

Your YELLOW RESTRICTED USE placard shall remain in place until removed by HCAI. If you have additional questions regarding our assessment, call our Sacramento Office at (916) 319-8013, eoc@hcai.ca.gov.

Rev 10/2022

A yellow placard means the building has restricted use. This could be a portion of a building or limitations on who may occupy the building or portions of the building. The restrictions will be noted on the placard. Re-entry or re-use of the restricted area may not occur until whatever had caused the building to become unsafe has been repaired or mitigated and the building is reinspected and posted with a green placard by OSHPD.



UNSAFE

DO NOT ENTER OR OCCUPY

(THIS PLACARD IS NOT A DEMOLITION ORDER)

This facility was inspected under emergency conditions in accordance with California Health & Safety Code 130025 by the California Department of Health Care Access and Information (HCAI), OSHPD, Emergency Operations Center (EOC).

CAUTION: Post-disaster incidents or aftershocks since posting may increase damage and risk. Immediately report any unsafe changes to HCAI EOC at (916) 319-8013. Re-inspection may be required.

Date: ______ Time: ______ Facility ID: ______ Building # ______	This structure has been inspected, found to be seriously damaged and is unsafe to occupy, as described below:
Facility Name and Address:	
Safety Evaluation Team:	
CO: Phone No:	
DSE: Phone No:	
FLSO: Phone No:	Do not enter, except as specifically authorized in writing by HCAI. Entry may result in death or injury
Other:	

Do Not Remove, Alter, or Cover this Placard
Until Authorized by HCAI
(916) 319-8013, eoc@hcai.ca.gov
(A photograph of this notice has been filed with the HCAI EOC)

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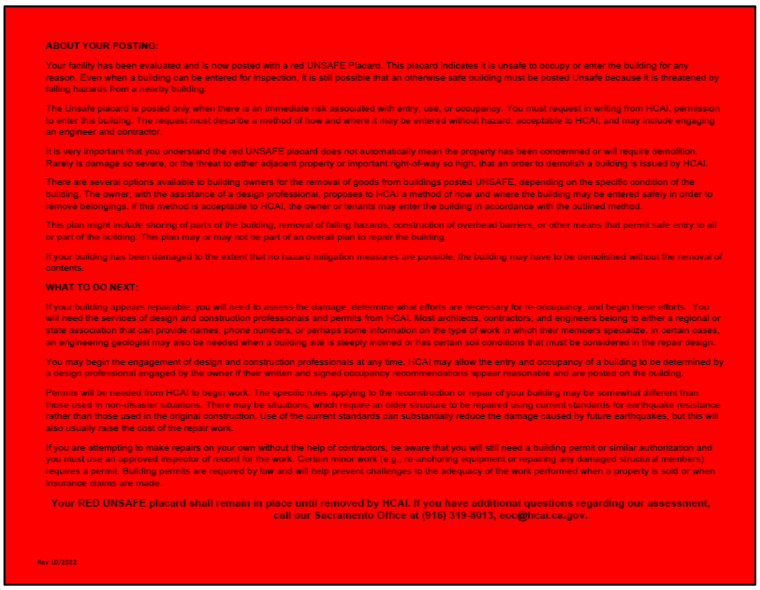

ABOUT YOUR POSTING:

Your facility has been evaluated and is now posted with a red UNSAFE Placard. This placard indicates it is unsafe to occupy or enter the building for any reason. Even when a building can be entered for inspection, it is still possible that an otherwise safe building must be posted Unsafe because it is threatened by falling hazards from a nearby building.

The Unsafe placard is posted only when there is an immediate risk associated with entry, use, or occupancy. You must request in writing from HCAI, permission to enter this building. The request must describe a method of how and where it may be entered without hazard, acceptable to HCAI, and may include engaging an engineer and contractor.

It is very important that you understand the red UNSAFE placard does not automatically mean the property has been condemned or will require demolition. Rarely is damage so severe, or the threat to either adjacent property or important right-of-way so high, that an order to demolish a building is issued by HCAI.

There are several options available to building owners for the removal of goods from buildings posted UNSAFE, depending on the specific condition of the building. The owner, with the assistance of a design professional, proposes to HCAI a method of how and where the building may be entered safely in order to remove belongings. If this method is acceptable to HCAI, the owner or tenants may enter the building in accordance with the outlined method.

This plan might include shoring of parts of the building, removal of falling hazards, construction of overhead barriers, or other means that permit safe entry to all or part of the building. This plan may or may not be part of an overall plan to repair the building.

If your building has been damaged to the extent that no hazard mitigation measures are possible, the building may have to be demolished without the removal of contents.

WHAT TO DO NEXT:

If your building appears repairable, you will need to assess the damage, determine what efforts are necessary for re-occupancy, and begin these efforts. You will need the services of design and construction professionals and permits from HCAI. Most architects, contractors, and engineers belong to either a regional or state association that can provide names, phone numbers, or perhaps some information on the type of work in which their members specialize. In certain cases, an engineering geologist may also be needed when a building site is steeply inclined or has certain soil conditions that must be considered in the repair design.

You may begin the engagement of design and construction professionals at any time. HCAI may allow the entry and occupancy of a building to be determined by a design professional engaged by the owner if their written and signed occupancy recommendations appear reasonable and are posted on the building.

Permits will be needed from HCAI to begin work. The specific rules applying to the reconstruction or repair of your building may be somewhat different than those used in non-disaster situations. There may be situations, which require an older structure to be repaired using current standards for earthquake resistance rather than those used in the original construction. Use of the current standards can substantially reduce the damage caused by future earthquakes, but this will also usually raise the cost of the repair work.

If you are attempting to make repairs on your own without the help of contractors, be aware that you will still need a building permit or similar authorization and you must use an approved inspector of record for the work. Certain minor work (e.g., re-anchoring equipment or repairing any damaged structural members) requires a permit. Building permits are required by law and will help prevent challenges to the adequacy of the work performed when a property is sold or when insurance claims are made.

Your RED UNSAFE placard shall remain in place until removed by HCAI. If you have additional questions regarding our assessment, call our Sacramento Office at (916) 319-8013, eoc@hcai.ca.gov.

Rev 10/2022

A red placard means that a building is unsafe to occupy and must be evacuated, if that has not already occurred. Re-entry or re-use of the building may not occur until whatever had caused the building to become unsafe has been repaired or mitigated and the building is reinspected and posted with a yellow placard for Restricted Use or a green placard by OSHPD.

10.4 What if Emergency Repairs or Construction are Needed

Refer to Section 9, How to Expedite Emergency Projects, if damage occurs because of the disaster that requires immediate repairs or construction work. The facility may take the necessary emergency actions to abate and make safe the emergency condition that poses an imminent danger to life, injury, or property damage. Such emergency actions may proceed prior to contacting OSHPD; however, the OSHPD Regional Compliance Officer (RCO) must be contacted immediately after.

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SECTION 11
COORDINATION FOR TEMPORARY SURGE FACILITIES AND ALTERNATE CARE SITES

11.0 Introduction

Hospitals serve their communities when a disaster happens. Be it an earthquake, pandemic, wildfire, or other disaster, community residents know where their hospitals are and that they are there to help. But depending on the disaster, hospitals can be overwhelmed with people trying to gain access, or it can be impacted by the disaster making it unsafe to provide healthcare in the facility. When hospitals start to reach capacity to provide safe treatment of patients, alternative locations need to be looked at to provide other on-site or off-site options. If there are neighboring hospitals, they may be available but are likely at capacity as well. And nearby communities may be too far to be of any real support. So, there may be a need to seek other locations or venues in which emergency care may be provided. Sports stadiums, convention centers, hotels and other large-scale facilities have all been considered for temporary or surge spaces for over-populated hospitals or hospitals that have had to close because of a disaster.

Most healthcare providers have found that keeping their patients onsite is the best option as that is where their equipment and their staff is. Many alternative sites have been considered and configured as standby facilities. Remote sites have been set up with emergency cots, portable screens, and even increased ventilation but they have proven to be difficult to staff as the facilities need their staff at their home locations. This does not mean to rule these options out, but they should not be the first plan of action.

Converting these types of spaces require careful planning and tremendous resources to provide a safe environment to provide patient care under various temporary conditions. Even the best planning efforts may be inadequate when outside assistance comes in with their own equipment and attempt to fit everything into the available space. Proper distancing between beds, privacy, and adequate ventilation for the conditions need to be identified and made a priority.

11.1 Locations and/or Buildings to Consider

There are considerable types of locations that may be considered. The primary decision factors should be space, availability, adequate infrastructure and utilities, and proximity to the healthcare facilities. One of the first considerations is volume. What are the specific needs to be addressed? Can the facility or building accommodate those demands? With small scale emergencies, tents or even hotels can accommodate a minor surge. But in large scale emergencies the anticipated patient load can be very high so venues such as sport arenas and conference centers may need to be considered. These venues often host large scale events and are likely to have the infrastructure in place to readily adapt to more critical needs.

Sports arenas and convention or conference centers are good examples of buildings or areas that can be converted for large scale uses. They were originally designed for large scale and various functions such as sporting events, concerts, conventions, etc., and provide large open spaces to facilitate patient care beds/gurneys and support functions needed. They are also designed to provide the needed utilities for these varied events but may fall short of capacity required for healthcare services. This needs to be part of the evaluation for anticipated future use of these facilities. If the capacities are not present, temporary, or mobile utilities can be brought in to meet needed demands. The infrastructure will also need to be evaluated for these utilities for placement of generators or equipment, routing of cabling and ducts through the facility, and maintaining egress with these obstructions in place.

These types of facilities are not under OSHPD jurisdiction, and the agencies, facilities and venues should work closely together so that plans are coordinated and expedient. Many local jurisdictions do not have the experience handling emergencies and OSHPD remains a good resource to assist with implementation of use for temporary facilities.

An example of using a sports arena is the Sleep Train Arena in Sacramento, California. The facility was surveyed for potential use, and it was determined that not only could the main floor be used, but several of the upper levels surrounding the main arena could be set up for patient care.

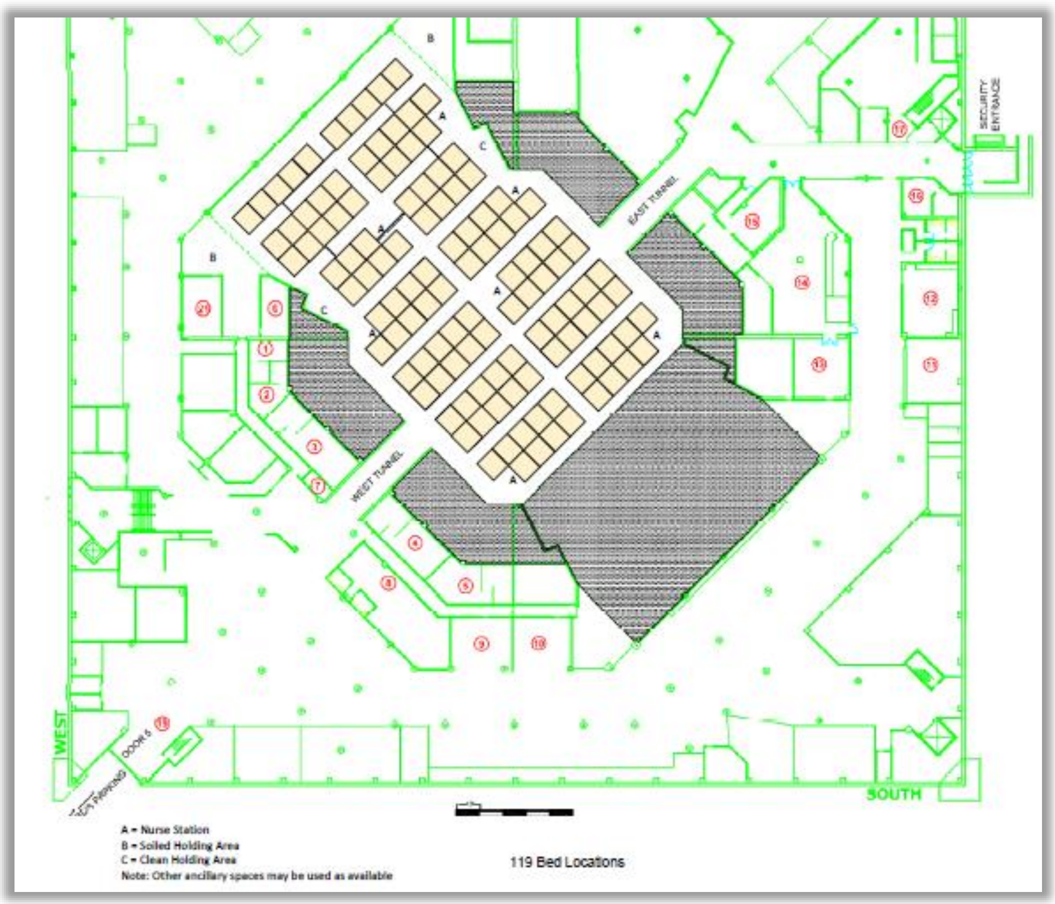

Figure 11.1 – Sports Arena Main Floor Proposed Layout for Patient Beds

Surrounding upper-level corridors were also used for bed placement.

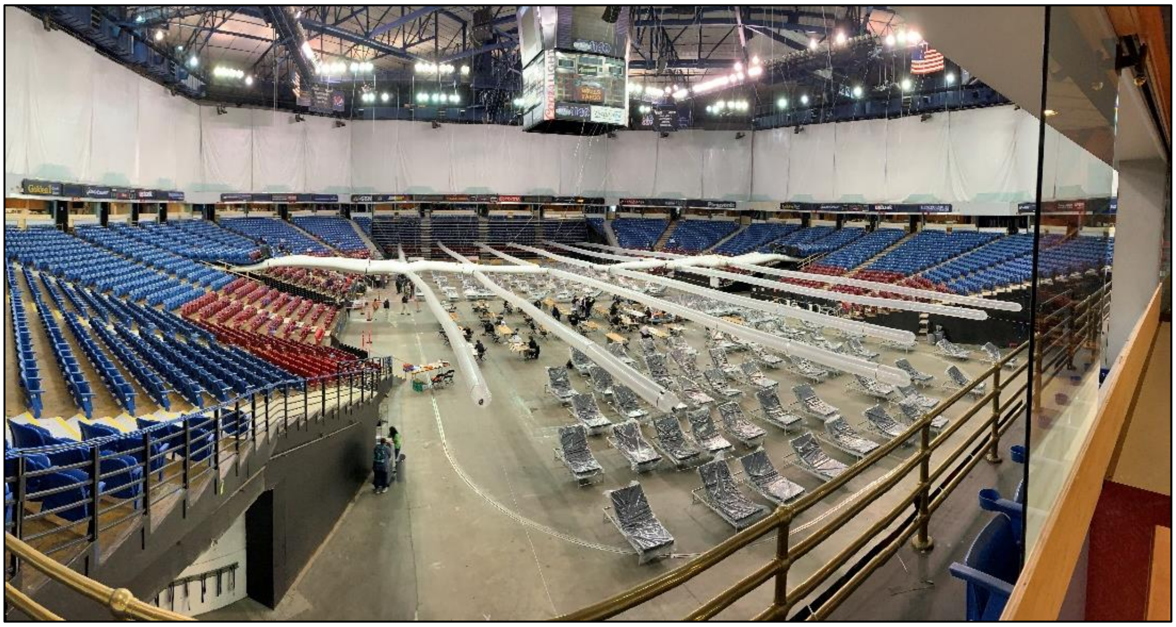

Figure 11.2 – Overview of Bed Layout on Main Floor

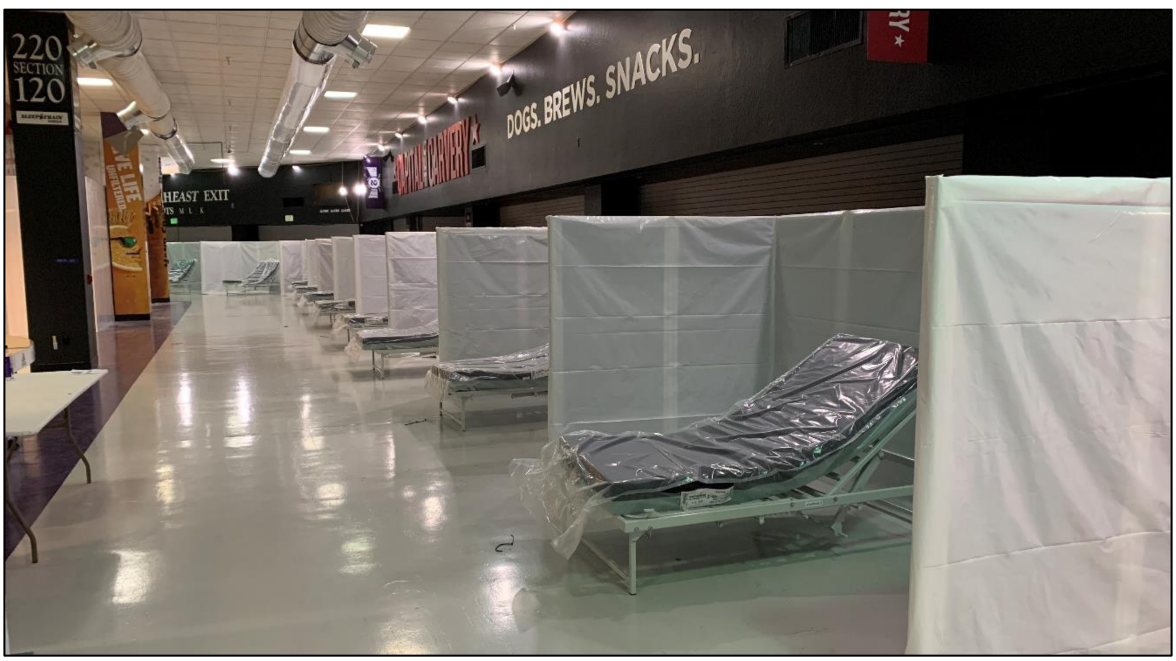

Figure 11.3 – Alternate Locations for Additional Patient Care Stations

Although there is a lot of flexibility built into the arena, the demands on existing utilities, services, and equipment for patient care could not be provided, so additional mobile units and temporary equipment had to be brought in to provide the needed power and services.

Special attention must be given to how the cables are routed so they are not damaged and do not block egress paths.

Figure 11.4 – Temporary Service Yard

Figure 11.5 – Routing of Temporary Electrical Utilities

Figure 11.6 – Routing of Temporary Ventilation and Exhaust Ducts

Convention Center: The Santa Clara Convention Center was also a site studied for temporary patient care at the beginning of the COVID pandemic in early 2020. The large event and exhibit spaces allowed for a lot of flexibility in layout and support functions.

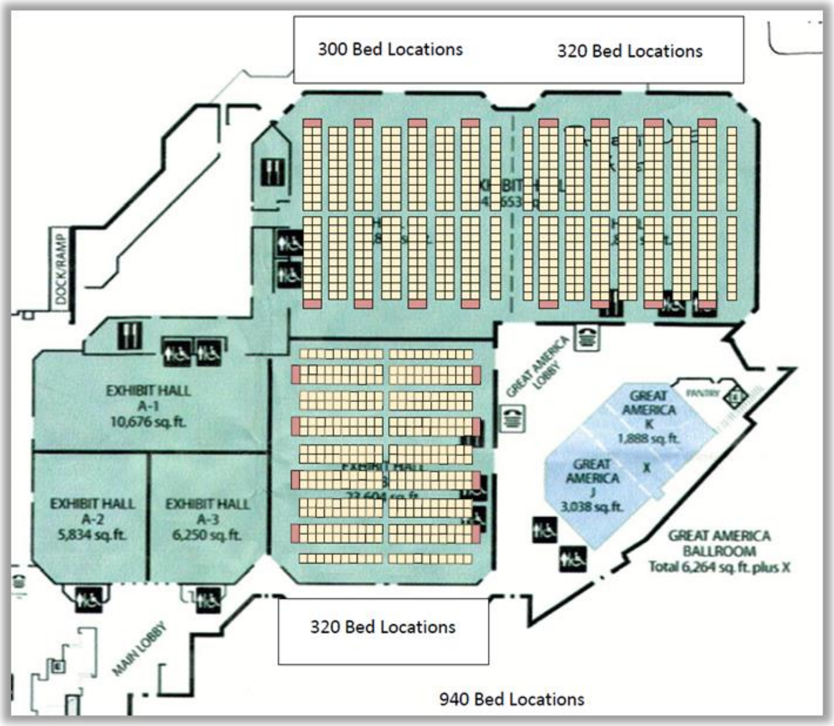

Figure 11.7 – Bed Layouts for a Convention Center

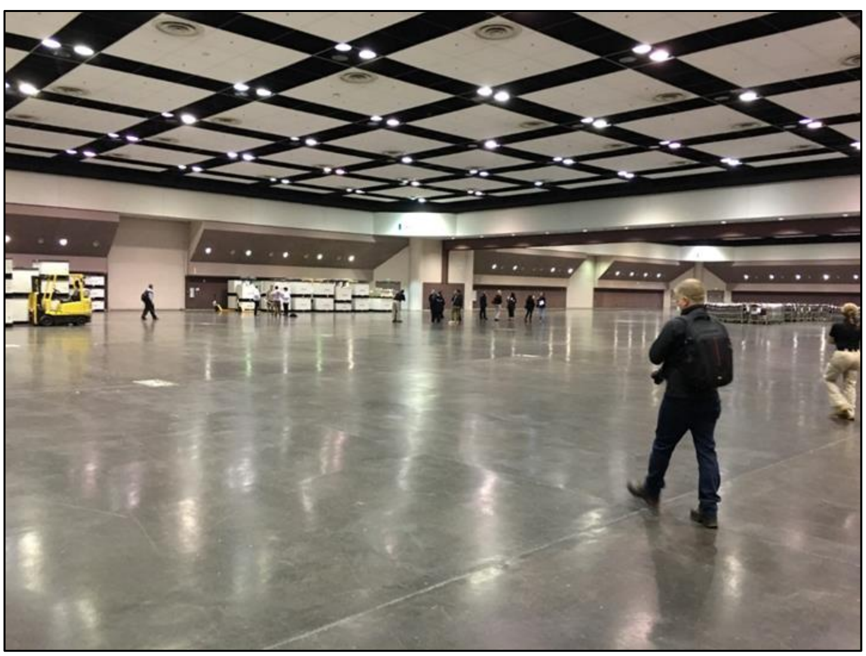

Figure 11.8 – Convention Center Space Offers Flexibility

To provide services in differing types of facilities such as those mentioned above it is critical to have a plan. Plans should be coordinated with healthcare facilities, governments, agencies, and the venues themselves to better understand needs and options depending on the type of emergency. There are many logistical considerations that need to be coordinated including access to the site, what emergency provisions will be provided, what support functions will those require, and are there adequate utility services available or will temporary services need to be procured. Site logistics should include parking, triage areas, access to the service being provided and routing of utilities to the areas of service. Electrical cables may have to be routed from temporary utility yards to the internal spaces providing care. Providing for proper ventilation for pandemics, as well as wildfires will take logistical planning as the cabling and duct runs can be very large and block access.

It was found that with the last pandemic, many agencies did not know who they could contact to receive support or guidance, although there are many sources that are available:

- The Department of Public Health (CDPH) website provides direction and guidance through All Facility Letters and other public information.
- The Department of Health Care Access and Information (HCAI) provides many resources on the Building Safety & Finance page. In case of emergency and for who to contact, information can be found at Facility Detail.
- Other web sites that provide resources:
  - Centers for Disease Control and Prevention (CDC)
  - CalFire
  - The Joint Commission