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COVID-19 PANDEMIC: THE ENGINEERING CONTRIBUTION TO THE SOLUTION

In this most challenging time, it is imperative that everyone utilizes their respective skills to create new ideas, implement innovative designs, and provide real solutions to the benefit of everyone's health and wellbeing.

Ring & DuChateau's collective expertise and contribution to the solution is design engineering. As engineers by profession, we are pledged to hold paramount the safety, health and welfare of the public in the performance of our professional duties. This commitment has been and continues to be at the forefront of every idea we've shared and every design we have implemented for the past nearly 60 years of our company's existence.

We continue to be committed to working towards new recommendations and solutions to battle the current COVID-19 crisis we are living in. Ring & DuChateau, since its inception, has been a leader in healthcare systems design. In addition, over the past 20 years we have become leaders in the application of new innovative ideas and approaches to enhance the protection of patients and staff inside their work environment. In many cases, these ideas have been implemented in anticipation of the need to assist our healthcare clients in managing a pandemic outbreak such as what we are now experiencing. Because it is certain to happen again, preparedness will be key to maximizing everyone's health and safety.

HVAC DESIGN FEATURES AND SOLUTIONS

HVAC design features can assist in the management of abnormally high influx of infectious patient census beyond the intended capacity, or “surge”. These design features are intended to give healthcare facilities the ability to be flexible and accommodate more patients with an infectious virus than under normal modes of operation while also offering a higher level of protection to the healthcare workers and staff. These features and how they operate are included here.

SURGE AREAS AND SYSTEMS

These are areas of a hospital and their respective Air Handling Units that are capable of surge capacity with large percentages of outside air and exhaust air, and the ability to maintain a pressure differential to adjacent areas.

Intention: The basic intention is be able to house a large census of infectious/infected patients in a controlled Surge area on a dedicated floor or wing of a hospital. This area will be isolated physically and by the HVAC systems to prevent the spread of the infectious organisms to other areas of the hospital and other healthcare workers in the hospital.

Description of operation: The entire wing or area of the hospital is physically isolated, likely in its own smoke compartment, and isolated and under a negative pressure to adjacent areas achieved by indexing the entire area to a negative pressure with the respective dedicated AHU indexed to 100% outside air and 100% exhaust. Each patient room would be negative to the corridor within this negative wing, whether in the Surge mode of operation or not.

Code required: This is currently not a code requirement, but an AHU systems enhancement installed to manage a pandemic disease outbreak. All Patient Rooms within this wing or floor would need to remain negative whether in the Surge mode of operation or not, as patient rooms are not allowed by code to be switchable (change pressure relationship to surrounding spaces).

Other considerations: A further enhancement is to include the option of all the rooms being either Universal or Acuity Adaptable, such that they are designed capable of functioning as an ICU if needed, and now they can support other functions such as Ventilators, Dialysis, etc.

NEGATIVE PRESSURE ROOMS

These are rooms that can be operated at a negative pressure.

Intention: The goal is really the same in terms of maintaining a negative air pressure relationship (for infected or infectious patients), but in this case just to the corridor and not the remainder of the building. In function it is very similar to Surge, just done on a much smaller scale. Unlike the case of a Surge wing where the entire wing or floor is under a negative pressure, in this case it might be a room or a number of rooms.



NEGATIVE PRESSURE ROOMS, continued

Description of operation: A room or number of rooms are kept at a negative pressure in relation to the adjacent corridor. Good practice requires that these rooms are exhausted directly to the outdoors by a dedicated exhaust fan served by emergency power.

Code required: Like Surge, this is not a code classification nor a code requirement and therefore does not appear in the ventilation table for air changes, but offers an operational mode that satisfies a clinical need or desire to keep infectious patients of any type under a negative pressure relationship to adjacent areas. What is of code concern (DHS) is that no rooms can be switchable in terms of pressure relationship, so if there are rooms that are functionally designated negative in air pressure to adjacent rooms, they must be designed that way and stay that way.

Other considerations: The ability to maintain the desired pressure differential must be tested by a certified air balancer. The benefit over doing a Surge wing or floor is that it allows for a few more rooms under a negative pressure to offer some additional capacity, while it does not impose unmanageable capacity penalties on heating and cooling infrastructure or AHU heating and cooling coils and the related piping.

UNIVERSAL AND ACUITY ADAPTABLE ROOMS

Intention: The goal is to develop a certain number of rooms available, by design, that are capable of providing much more intensive architectural and MEP capacities on demand, and in essence use them for virtually any Patient Nursing application—even ICU/CCU, if so designated. They can function as sort of an acuity surge and are built at a minimum additional cost. Given the normal accepted design intentions for these rooms, they would have been adequate to function as an ICU with ventilators in the current COVID-19 applications.

Description of operation: These are strictly designed for the flexibility to house more intensive equipment and functions on occasion, but not under normal applications. They are more of a robust Med./Surg. or General Patient Room.

Code required: Like Surge and Negative pressure, they are not a code classification, and therefore there are no specific MEP systems requirements as there are for other patient or nursing unit requirements.

Other considerations: How robust they are designed to become is subjective, as there is no category or definition. In most cases where, they are normally identical to an ICU from the MEP perspective.

AIRBORNE INFECTIOUS ISOLATION (A.I.I.) ROOMS and TB/MDRTB ISOLATION ROOMS

Intention: These rooms are intended to house a patient census that must be contained due to the fact that they are infectious to the surrounding patients and healthcare workers. They are contained physically and via a negative pressure HVAC system that is direct exhausted directly to the outdoors.



Description of operation: The rooms must have a minimum air change rate of 12 ACH and all this air is ducted directly to the outdoors via a dedicated exhaust system that is served by emergency power. The pressure differential must be monitored continuously locally and at the building automation system.

Code required: This designation is an official designation in the FGI guidelines, and subject to all the requirements found within it.

Other considerations: By code, there are required to be a certain number of these rooms in a given facility, however the number is low enough that it is of no real use in a pandemic or outbreak situation. The capabilities of these rooms would allow them to be very effective in an infectious outbreak with infected patients, however their numbers are insignificantly low.

PROTECTIVE ENVIRONMENT (P.E.) ROOMS

Intention: These rooms are intended to house a patient census that must be protected from other patients and healthcare workers due to the fact that they are immunosuppressed and vulnerable. They are contained physically and protected by a positive pressure HVAC system in relation to surrounding areas.

Description of operation: The rooms must have a minimum air change rate of 12 ACH and under a constant positive pressure relationship to all surrounding areas. The pressure differential must be monitored continuously locally and at the building automation system.

Code required: This designation is an official designation in the FGI guidelines, and subject to all the requirements found within it.

Other considerations: By code, there are required to be a certain number of these rooms in a given facility. They are of no real use in a pandemic or outbreak situation. The capabilities of these rooms would not allow them to be part of an infectious outbreak management plan.

RECIRCULATING SELF-CONTAINED UV/HEPA UNITS

Intention: This is a self-contained recirculating device that is intended for purposes of a high level of local air purification to reduce the level of particle contaminants in the environment and to a high degree.

Description of operation: The device is placed directly in the space. There is a fan that runs air past a UV light array to accomplish the destruction of biological organisms, and then a HEPA filter that collects the particles to a level of 99.99% for particles in of .3 microns and larger, which would include COVID-19. This device, or multiples of this device, could provide air change rates that disinfect the air to high degree in a short amount of time.

Other considerations: This could be particularly useful in a surge event in space where a large number of patients and healthcare workers reside, as it could significantly reduce the number of COVID-19 particles present in the space.



ENGINEERING SOLUTIONS FOR YOUR FACILITY

All of the design approaches discussed here are adaptable to the majority of existing code compliant healthcare HVAC systems, with reasonable implementation costs when applied to existing systems. A brief assessment of a facility's existing system can quickly determine the costs and implications to implement.

To our clients who have facilities where some of these systems were implemented in the design, we offer our thanks for the opportunity to be part of a team led by a visionary client that spent dedicated the resources needed to be prepared for flexibility and responsiveness to crisis situations. We offer our knowledge and experience with your systems to advise or assist you in the use and application of these system features. We understand that over the years staff and experience may have changed, so please contact us to review what you have and how to best apply it. We will also review your other current HVAC systems to suggest what conversions can be made to better accommodate future needs. We would anticipate our work efforts to include the following:

- Review the existing Air Handling Units (AHU) and areas of service that were intended to be able to be used at any given time as Surge systems and make recommendations.
- A review of your remaining Nursing Unit, ICU/CCU, and Emergency Department AHU zoning and layout to determine opportunities to convert areas/systems to address Surge capacity for an infectious patient census.
- A review of AHU system features (serving Nursing, ICU/CCU, and ED) for their ability to be converted to a high percentage of Outside Air for use in a Surge or Purge application. Features include heating and cooling coil capacity, outside air percentages, filtration rates and humidification characteristics
- A brief review of the heating and cooling infrastructure to support the additional outside air loads in a Surge or Purge mode of operation.
- A review of your typical Med./Surg. or General Patient rooms to consider what might be involved in transforming them to Universal or Acuity Adaptable rooms. This will allow the rooms to be used in ICU/CCU application for critical patients, that require additional clinical devices for their necessary care (such as ventilators, or dialysis machines). This allows additional ICU/CCU rooms at the flip of a switch.
- A review of spaces which could benefit from the use of UV/HEPA recirculating devices that are used to purify air to a very high degree in smaller, higher traffic areas such as Waiting Rooms.
- A review of areas that could be used as swing space to house patients, such as abandoned patient rooms, laundries, kitchen/dietary areas.

To those of you who we have not worked with, please consider us to help you address these issues. We would be happy to tailor our services to meet your needs.

**We can help you be prepared for the next time.
Give us a call to find out how.**



Ring & DuChateau has the systems design experience healthcare facilities need to meet the challenge of patient surge resulting from pandemic or other emergency situations. We continue to work with current clients to proactively review installed systems features and provide guidance on future readiness. Some of our experience includes:

Children's Wisconsin / Milwaukee, WI

- West Tower includes capability to control each floor independently and provide surge for 10 floors for a total of 240 patients
- Ventilation Upgrades in progress

St. Agnes Hospital / Fond Du Lac, WI

- South Tower has 3 floors with 51 standard patient rooms and 6 isolation rooms

Monroe Hospital / Monroe, WI

- 1st Floor East Wing surge capacity of 19 patient rooms
- Emergency Department—11 standard patient, 2 isolation, 2 trauma rooms

Beaver Dam Community Hospital /

Beaver Dam, WI

- Emergency, Radiology, Surgery and Pharmacy Departments - AHU capable of 100% OA for surge operations
- ED: 13 standard patient rooms, 2 isolation rooms
- Surgery Department - 25 post/pre OP Patient rooms, 6 operating rooms and 2 procedure rooms

Wausau Hospital / Wausau, WI

- South Building Nursing Unit 3 Floors, ~60 Patient Rooms

Luther Midelfort Hospital / Eau Claire, WI

Infrastructure for surge includes:

- North Wing: 20 Standard Patient Rooms
- South Wing: 21 Standard Patient Rooms

St Luke's Medical Center / Milwaukee, WI

- Center Building 8th Floor – 30 standard patient rooms designed to be used in pandemic. A Pandemic Sequence was included in sequence of operation
- Knisley building – 2nd and 3rd floor ICUs ~30 rooms, 3 isolation rooms with 100% outside air for AHU serving these units. Supply air volumes to patient rooms can be modified so all rooms go to negative pressure.

St Michael's Hospital / Stevens Point

- Emergency Department – AHU capable of ~50% OA for partial surge operation.
- Post /pre operations patient rooms - AHU capable of ~50% OA for partial surge Operation

St. Joseph's Hospital / Milwaukee, WI

- Emergency Department – 100% OA AHU

Grand Itasca / Grand Rapids, MN

- Emergency Department: 11 universal patient rooms, 8 treatment rooms, 1 negative pressure room, 1 triage, ambulance garage decontamination
- Surgery Department: 19 post/pre op rooms convertible to negative pressure

Froedtert Pleasant Prairie / Pleasant Prairie, WI

- Surgery AHU sized for 100% OA
- OR AHU have smoke purge setup to be used for a pandemic mode
- Emergency Department - 45% OA with HC sized for 100% OA
- Two units serving each of 2 patient floors with capacity to increase OA
- AHU-10/11 sized for 100% OA supporting ~1/3 of the floor plus remaining shell space with the units twinned together
- AHU-12/13 sized for 33-45% OA for partial surge mode with units twinned together

Froedtert Pleasant Prairie –Surgery Center /

Pleasant Prairie, WI

- Surgery Center supported by Heating system with for 100% OA Heating Capacity allowing Surge Capacity for the majority portion of the year

Martha Jefferson Hospital / Charlottesville, VA

- Emergency Department AHU sized for 100% outside air operation in emergency situation
- Surgery AHU sized for 100% outside air operation in emergency situation

Sauk Prairie Memorial Hospital / Prairie du Sac, WI

- Emergency Department AHU sized for 100% outside air operation in emergency situation
- Surgery AHU sized for 100% outside air operation in emergency situation
- Patient Wing AHU sized for 100% outside air operation in emergency situation

St. Elizabeth Hospital / O'Fallon, IL

- Emergency Department AHU sized for 100% outside air operation in emergency situation
- Surgery AHU sized for 100% outside air operation in emergency situation

