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SYSTEM SOLUTIONS

This issue of Engineering System Solutions examines the use of air handling units for health care applications. Health care applications place special demands on the features and construction of air handling equipment. Hospitals are also some of the most expensive buildings to operate because they never close and they have very high air volume and ventilation rates.

In this article, we investigate a way to reduce air handler operating costs by as much as 11% with an excellent simple payback for any capital investment required. Assuming that a typical health care application will involve many air handlers, these savings can have a significant impact on the bottom line of a health care facility.

For more information on HVAC system design for health care applications, contact your local McQuay representative or visit www.mcquay.com.

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Health Care Air Handling Units – Bigger Is Better!

Modern health care facility design typically uses central air handling units as an integral part of the HVAC system. The units can be constant volume or variable air volume (VAV), although the minimum turndown for VAV units is kept much higher versus other building applications.

Central air handling systems are popular because most health care facilities are designed using the requirements set out in "Guidelines For Design and Construction of Health Care Facilities" published by the American Institute of Architects (AIA). Minimum air changes and ventilation rates for most health care area designations are provided in Table 2.1-2 of the guidelines. For example, an Intensive Care Unit (ICU) requires a minimum of 6 air changes per hour, two of which must be outdoor air. That works out to 1 cfm/ft^2 supply air and 33% outdoor air. These requirements make central air handling systems an excellent choice.

Air Handler Design For Health Care Applications

The strict requirements for health care applications put special demands on air handler design. Figure 1 shows a typical air handler configured for a health care application. Table 1 describes the components in direction of air flow.

Air handlers used in health care facilities typically operate at 5-inches static pressure or more. At this pressure, a properly designed and assembled unit is a must to avoid cabinet damage and leakage. Foam panel construction is becoming popular because it offers lightweight panels that are extremely rigid and have higher insulation values (Figure 2). Units shipped in sections should be sleeved so that a positive seal is formed when the sections are joined (Figure 3).

Many air handlers use steam for humidifiers and heating coils. For these applications, the proper trapping height must be established by using housekeeping pads, base rails, or trapping the unit below the floor. Variable height base rails offer the advantages of giving the designer flexibility in providing the proper trapping height and contributing to lower structure weight (Figure 4).

Figure 1 – Typical air handler configured for a health care application.

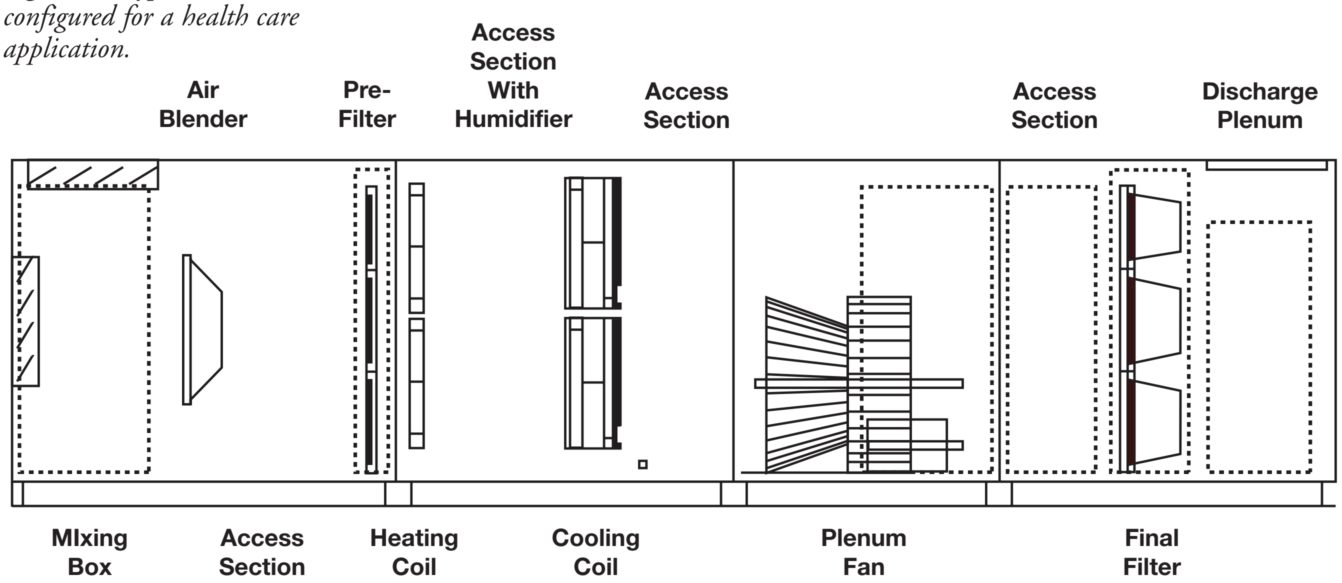

Figure 2 – Foam panel construction is extremely rigid and offers higher insulation values.

Figure 3 – A patented splice collar forms a positive seal when joining sections of McQuay Vision™ indoor air handlers.

Figure 4 – Variable height base rails provide flexibility in providing the proper trapping height.

Table 1 - Typical air handler configured for a health care application

Component Name	Purpose	Comment
Mixing Box	• Mix return and outdoor air • Provide economizer operation • Allow 100% purge in emergency situations	• Dampers should be high performance airfoil type • Low leakage • Promote good mixing
Air Blender	• Properly mix outdoor air in applications with large temperature differences	• Important where unit will see freezing air in winter months
Pre-filter	• 30% pre-filter to protect air handler and reduce the load on final filters	• Can be tight to heating coil to minimize space as filter can be removed for coil cleaning
Heating Coil	• Required to meet heating load (where climate requires heating) • May also need to meet 100% purge for dynamic smoke control systems	• Access for cleaning upstream and downstream must be provided • For steam, use integral face and bypass dampers (watch trapping height) • For hot water in freezing climates, use 50% P.G.
Humidifier	• Maintain humidity during dry periods	• Use steam grid engineered for air handler application
Access Section	• Allows access to coils and humidifier	• On units large enough to walk in, consider checker plate flooring
Cooling Coil	• Provide cooling and dehumidification	• Access for cleaning upstream and downstream must be provided • Include stainless steel IAQ drain pan
Access Section	• Allow access to fan and cooling coil	• On units large enough to walk in, consider checker plate flooring
Fan	• Provide required air volume at required total static pressure	• Should be draw through • Should be selected for high static application • Plenum fans are a good choice due to final filters • Consider perforated liner with Mylar® or Tetlar® liner for sound control
Final Filter	• Provide proper filtration (per Table 2.1-3 from the 2006 AIA Guidelines for Design and Construction of Health Care Facilities)	• Final filters must be last item in the air stream. • Filters over 75% efficiency require magnehelic gauge (per 2.1-10.2.5.5 from the 2006 AIA Guidelines for Design and Construction of Health Care Facilities)
Discharge Plenum	Allows supply duct connection	• On units large enough to walk in, consider checker plate flooring

Regional Health Care Applications

Smaller, regional health care centers often cannot justify using central chiller and heating plants, but these facilities must meet the requirements of the AIA guideline. One possibility is using rooftop air handlers, such as Skyline™ units from McQuay, with air-cooled chillers. The chillers can be provided with factory-installed pumping packages.

Another solution is to use applied rooftop units. Figure 5 shows a McQuay model RPS unit configured for health care applications. The difference between an RPS and a commercial packaged rooftop system is that it can be ordered with the required air stream components. In addition, the RPS offers flexibility in its DX cooling system (coil rows, fins and compressor horsepower) to meet the demanding ventilation load requirements. The RPS also offers streamlined commissioning as units are factory assembled, tested and shipped to site with complete controls. The controls can then be easily integrated into the BAS using LonWorks® or BACnet® communication.

The "Big" Opportunity

Many air handlers are designed for 500 fpm through the coils and filters. This meets the filter requirement and allows for flat filter banks. 500 fpm is also proven as an acceptable velocity to avoid condensate blow off from the cooling coil.

However, there is an opportunity to increase the air handler size and reduce the air velocity. Table 3 shows the component air pressure drops in an air handler at 500 fpm and 400 fpm.

Reducing the air velocity through the air handler will reduce the air pressure drop at several of the components. This, in turn, reduces the total static pressure required of the fan. This is very important in health care design because hospitals never close (8760 hour operation) and they are often constant volume with high static pressures. Figure 6 shows the annual energy use by components in a typical hospital in Minnesota. Fans are a dominant energy user.

Lowering the total static pressure by increasing the air handler size

Figure 5 – McQuay RPS applied packaged rooftop system configured for health care.

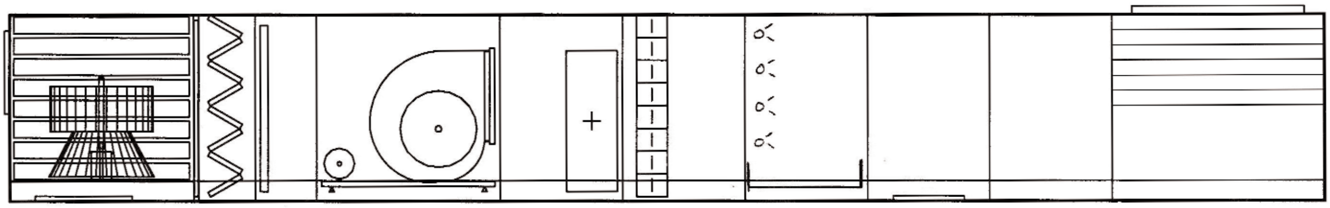

Table 3 – Component Air Pressure Drop (APD) At Different Velocities

Component	APD at 500 fpm	APD at 400 fpm
Return Dampers	0.08	0.08
Air Blender	0.25	0.25
Pre-Filter	0.22	0.17
Heating Coil	0.21	0.13
Humidifier	0.1	0.1
Cooling Coil	0.77	0.51
Final Filter	0.66	0.53
Cabinet	0.02	0.01
Internal Static Pressure	2.29	1.77
External Static Pressure	1.5	1.5
Total Static Pressure	3.81	3.28

Notes:

1. *Dampers and air blenders must be sized to provide proper mixing. There will not be any pressure drop savings at lower cabinet velocities.*
2. *Filter pressure drops are shown for clean filters. On average, the filter pressure drop will be lower for lower air velocities.*

reduces the fan work and results in annual operating cost savings. However, this requires a capital investment for the larger air handler. Table 4 shows the operating cost savings, capital cost and the simple payback for air handlers with an air velocity ranging from 500 down to 400 fpm in Minneapolis, MN and Dallas, TX.

As shown in Table 4 and Figure 7, approximately 450 fpm offers the best financial return for an additional $551 investment in a 20,000 cfm air handler. In fact, in both Minneapolis and Dallas, the operating cost savings resulted in a very favorable payback for the entire range of velocity reductions presented in Table 4. Thereafter, depending upon the size of the facility and the number of air handlers used, these savings can add up dramatically to improve the bottom line of the hospital.

In addition to the operating savings, the lower face velocity allows more filter area, which helps reduce the frequency of filter changes. Coils with fewer rows may also be used, which can help reduce the initial capital investment and make them easier to clean.

Conclusion

Health care applications place demands on air handlers that require flexible design and low leakage. Options for smaller hospitals include rooftop air handlers and chillers with pump packages, or applied rooftop units. Once the equipment type is chosen, consider designing around a 400 to 450 fpm air velocity to reduce operating costs. The payback is in the one-year range because hospitals never close. The savings can add up dramatically year over year depending upon the number of air handlers used.

To order a copy of the Guidelines for Design and Construction of Health Care Facilities, visit the AIA Bookstore at www.aia.org/books or the ASHRAE Bookstore at www.ashrae.org. For more information on HVAC system design for health care and the advantages offered by McQuay products, contact your local McQuay representative or visit www.mcquay.com.

Figure 6 – Annual energy by component in a typical hospital in Minneapolis, MN.

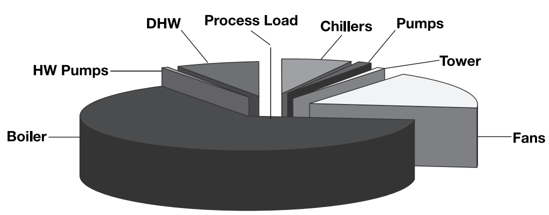

Figure 7 - Simple Payback Versus Face Velocity

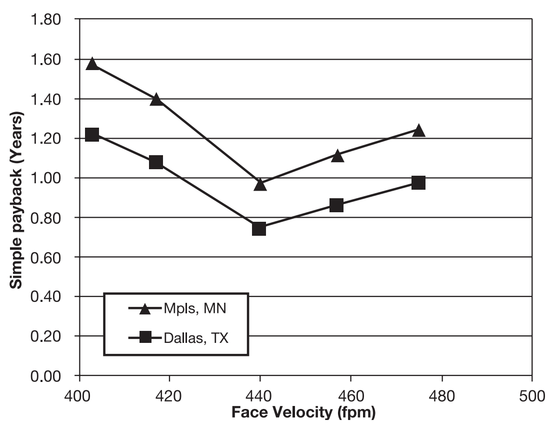

Table 4 – Simple Payback For Reducing Face Velocity

Face Velocity (fpm)		**403**	**417**	**440**	**457**	**475**	**495**
$/cfm		$2.16	$2.14	$2.10	$2.09	$2.07	$2.06
TSP (in. w.c.)		3.28	3.34	3.41	3.60	3.72	3.81
Fan BHP		15.19	15.42	15.73	16.59	17.14	17.56
Minneapolis, MN	Annual Energy Usage (kWh)	128274	129577	131858	137397	140981	143587
	Annual Operating Cost	$10,162	$10,265	$10,445	$10,884	$11,167	$11,377
	Simple Payback (years)	**1.58**	**1.40**	**0.97**	**1.12**	**1.25**	**Base**
Dallas, TX	Annual Energy Usage (kWh)	131606	132943	135283	140966	144643	147317
	Annual Operating Cost	$13,193	$13,327	$13,561	$14,131	$14,499	$14,770
	Simple Payback (years)	**1.22**	**1.08**	**0.75**	**0.86**	**0.97**	**Base**

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