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The following pages contain supplementary information for these articles in the December 2023 issue of ASHRAE Journal:

Coordinating ASHRAE Standards: How to Do a Combined Standard 62.1/170 Ventilation Calculation

By Abdel K. Darwich, P.E., C.Eng., HFDP

Example on use of the new 62.1-170 calculation method

Assume a hypothetical system in an outpatient healthcare facility is serving 6 exam rooms, one procedure room, 6 doctor offices and one conference room per the characteristic below. What is the required outdoor air for this system using the new method in Standard 170 Addendum f?

170 spaces				
	Area (sq.ft)	Ceiling Height (ft)	OA ACH	OA CFM
Exam 1	130	9	2	39
Exam 2	130	9	2	39
Exam 3	130	9	2	39
Exam 4	130	9	2	39
Exam 5	130	9	2	39
Exam 6	130	9	2	39
Procedure Room	260	9	3	117
Patient Corridor	500	9	0	0
				351
		170 Vou (cfm)		351
		170 System OA (cfm)		351

62.1 Spaces						
	Area (sq.ft)	Zone Population	Ra (cfm/sq.ft)	Rp (cfm/person)	Ra*A	Rp*P
Doctor Office 1	110	2	0.06	5	6.6	10
Doctor Office 2	110	2	0.06	5	6.6	10
Doctor Office 3	110	2	0.06	5	6.6	10
Doctor Office 4	110	2	0.06	5	6.6	10
Doctor Office 5	110	2	0.06	5	6.6	10
Doctor Office 6	110	2	0.06	5	6.6	10
Conference Room	400	15	0.06	5	24	75
					63.6	135
Sum of Zone Population	27					
System Population (62.1)	15					
Diversity	0.56					
62.1 Ev	0.71					
62.1 Vou (cfm)	138.6					
62.1 System OA (cfm)	195.5					

System Required OA = 546.5 cfm

For metric units, multiply :
1 ft by 0.3048 for m
1 sq.ft by 0.0929 fir sq.m
1 cfm by 0.4719 for L/s

Airborne Particulate Matter Filtration Using Non-Thermal Plasma Air Purification

By Timothy Lau, Ph.D.; Martin Belusko, Ph.D.

TABLE 1 Particulate filter classification according to EN 1822 and ISO 29463 standards. EPA = efficient particulate air filter, HEPA = high efficiency particulate air filter and ULPA = ultra low particulate air filter. Particle collection efficiencies are defined at the most penetrating particle size (MPPS).

	FILTER CLASSIFICATION		
PARTICLE COLLECTION EFFICIENCY	EN 1822	ISO 29463	
≥85%	E10	-	EPA
≥95%	E11	ISO15E	
≥99%		ISO20E	
≥99.5%	E12	ISO25E	
≥99.9%		ISO30E	
≥99.95%	H13	ISO35H	HEPA
≥99.99%		ISO40H	
≥99.995%	H14	ISO45H	
≥99.999%		ISO50U	ULPA
≥99.9995%	U15	ISO55U	
≥99.9999%		ISO60U	
≥99.99995%	U16	ISO65U	
≥99.99999%		ISO70U	
≥99.999995%	U17	ISO75U	

Zero Net Carbon-Ready Community Center

By Lee Harrelson, P.E., Associate Member ASHRAE; Tracy Steward, Member ASHRAE; Dennis Finn, P.E., Member ASHRAE; Brian Turner, P.E., Member ASHRAE

Environmental Impact

Lubber Run Community Center uses an underground parking garage to retain the cohesive park on-site without a significant loss of green space. The design seamlessly blends into the landscape, leaving patrons to feel more connected to nature. Eliminating the air-cooled chiller allows for a quiet site to connect with nature without HVAC equipment disruptions. The net zero energy design reduces the building's carbon footprint for the life of the building, and without considering renewable energy, the carbon savings from an ASHRAE Standard 90.1-2010 baseline building to the building performance is 223 metric tons of CO_2. Combustibles were eliminated, and the building uses battery storage instead of a gas generator. Stormwater retention was also improved on-site with bioretention basins, which lessened the burden of a storm on the community's overall infrastructure.

Indirect environmental benefits are achieved through improved electric grid harmonization due to the building's naturally low peak demand and selective dispatch of the battery energy storage system (BESS) for demand response and marginal emissions reductions. In addition, the heavy timber structure and much of the interior wood finishes were harvested from the existing site and are used throughout the project for significant embodied carbon reductions.

Optimizing Operation, Flexibility and Cost for Large Facility

BY MEHDI JALAYERIAN, P.E., LIFE MEMBER ASHRAE; SUZAN SUN-YUAN, P.E., MEMBER ASHRAE; KENNETH LECHNER

Indoor Air Quality (IAQ) and Thermal Comfort

The building occupancy has a large (code-mandated) amount of outdoor air requirement with demand control implemented to reduce energy consumption during low occupancy mode. Each air-handling unit includes airflow measuring stations at the outdoor air inlet, supply, and return ductwork connections. Multiple CO_2 sensors were installed at every high-density zone to accurately measure carbon dioxide at breathing zone level to control outdoor air quantities.

Within the cooling-dominated exhibition halls, each round diffuser delivers 4,350 cfm (2053 L/s). The round diffusers were selected based on their superior induction ratio accommodating ideal throw pattern for the 45 foot (14 m) installation height and discharge air temperature of 45ºF (7.2°C) serving the large volume space. The return air locations are found at both ends of the exhibition hall at an elevation of 58 ft, 0 in. (18 m). Addressing the requirements for noise criteria (NC) for the exhibition hall, circular jet diffuser velocities, discharge temperature for the non-isothermal turbulent flows, cold jet with room temperature difference, cold air draft with entrainment/induction ratio, and horizontal separation distance for diffuser selection are closely studied together. Within 6 ft, 0 in. (2 m) of the occupied or breathing zone, ASHRAE Standard 55-2017 identified the limits on temperature drifts and ramps of 2ºF (1°C) with a period of 15 minutes. The velocity within the occupied zone is around 43.6 fpm (0.2 m/s) and the calculated ΔT is 1.5ºF (0.8°C). Without traditional multiple levels of supply or return air for a 68 ft, 0 in. (21 m) tall space, using colder air with an analyzed arrangement achieved 25% improvement in the comfort temperature range for the occupied zone while providing for reduced sheet metal distribution, reduced AHU size, and ultimately reduced fan energy consumption.

Thermal comfort level is closely associated with ventilation effectiveness. This distribution arrangement enhances the ventilation effectiveness compared with multiple-level traditional air distribution patterns in a similar tall and large occupied space. The current Standard 62.1 (2019 or 2022) version has not recognized the cold air temperature credit that defines the outdoor air amount neither in zone level nor system level.

The reduced cooling air quantity and strategically configured and maximized spacing of supply diffusers provide for lower noise level within the exhibit hall, hence improving the occupant comfort.

Cost Effectiveness

As previously noted, the low-temperature chilled water approach results in a one-third system flow savings benefit against conventional systems, approximately 4,700 gal/min (297 L/s), equivalent to a reduction of 600 HP from chilled water pumps. The main chilled water header size was reduced from 28 in. to 20 in. (711 mm to 508 mm) with approximately 2,720 ft (829 m) of main schedule 40 carbon steel pipe. This provided substantial cost savings not only in piping material and support systems, but also in our selection and reduction of pumps, drive/VFD, and associated electrical feeder sizes.

Similar results in savings are reflected in the use of low-temperature air distribution on the building's air-handling systems in 68 ft, ’0 in. (21 m) high exhibition halls and 150 ft, 0 in. (46 m) high main lobby. In the exhibition halls, a total reduction of 537,500 cfm (253 672 L/s) provides an equivalent weight savings in sheet metal of approximately 116,986 lb (53 064 kg) or 24.25% versus a conventional air temperature system. It also creates savings on the total required AHU quantities, fan drive/VFDs, electrical feeders and wiring, associated control valves, dampers, louvers, and mechanical rooms, thereby providing substantial savings to the project.

The energy stored in the extensive chilled water piping network can be realized as thermal mass to support off-hours secondary cooling as mentioned previously. This design also reduces the need for emergency power backup to the main chiller plant including the chillers, pumps and cooling towers. Emergency power for mechanical equipment is provided only to critical 24/7 cooling units, associated backup tertiary pumps and code-mandated exhaust fans. This concept allowed for the reduced emergency power generator and associated distribution system.

With local authority approval, a 5 psi 34 (kPa) natural gas distribution network is delivered from the incoming service and distributed internally to each exhibition hall for exhibitor use. Benefiting from the higher operating pressure, a 4 in. (102 mm) pipe size serves approximately 3,100 ft (945 m) of welded schedule 40 carbon steel piping in lieu of a 6 in. (152 mm) pipe at standard operating pressure.

4,160V medium voltage power from the incoming west entrance serves the central plant over to substations located along the exhibition halls. Approximately 1,500 ft (457 m) at a reduced feeder size in lieu of a conventional larger 460V busway distribution provides substantial savings to the project.

Operation and Maintenance

With the construction of the new Convention Center addition, the operators now have an additional central plant to maintain. A variable primary and variable secondary chilled water distribution system allow for a stable and robust operation. The chillers and associated primary pumps operate more independently against the secondary distribution loop. In a large operating facility with complicated and varying load profiles, this arrangement streamlines the central plant maintenance and diagnoses potential problems quickly. The VFDs of the secondary distribution pumps and the minimum bypass control valve in the secondary distribution system adjust upon the differential pressure sensors in several critical loops. This designed arrangement greatly reduces a single point of failure of the control valve and reduces the potential downtime for the entire facility. The cost of a single 10 in. (254 mm) modulating pressure independent control valve does not contribute significantly to the maintenance operation budget, but the downtime for a facility like LVCCA would be intolerable.

Local atmospheric conditions drive the condenser water treatment system with three layers of filtration: the cooling tower spray pump package to rinse the cold-water basin at the roof level, the basket strainer before the condenser pump suction header and the centrifugal hydro cyclone air and dirt separator connecting the condenser water header back to the chiller condenser bundle. The air and dirt separator removes the smallest of particulate from the water distribution piping. The three processes help to prolong the life of chillers and reduce the maintenance required for the condenser systems.

Environmental Impact

R-1233zd is the refrigerant used on the four centrifugal chillers. Compared with R-514A and R-134a, R-1233zd has better performance on both refrigerant volatile decomposition measures and refrigerant thermal properties.

As part of providing minimal water use, low-flow water fixtures were selected and used on the project. In addition, cooling tower makeup water is metered and interfaced through the building automation system (BAS) for monitoring and recording water consumption.