http://dx.doi.org/10.5588/ijtld.21.0704

LETTER

Air conditioners, airborne infection prevention and air pollution in buildings in New Delhi

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Running Head: Assessing air quality systems in buildings

Article submitted 21 November 2021. Final version accepted 10 December 2021.

Dear Editor,

The focus on airborne spread of SARS CoV-2 started even before WHO declared it to be through airborne mode of transmission.[1] A critical method of airborne infection control for both TB and COVID-19 is dilution ventilation.[2,3] This means the flushing out of aerosolised droplets of exhaled breath or cough or sneeze that would otherwise linger in the interior air of built spaces. Air conditioners, such as split air conditioners,[4] simply recirculate the indoor air, thereby increasing the duration and concentration of pathogen-containing aerosols when an infected person is present. The proposed solution is to use operable windows and doors to allow outdoor air to enter and replace the indoor air.[5,6] This process of dilution can happen through diffusion (when windows are open) or be accelerated using mechanical ventilation methods such as exhaust fans and air handling units with fresh air dampers. However, open windows have disadvantages with regard to thermal comfort, increase in noise, entry of insects (when used without wire meshes) and entry of ambient pollutants. This last problem, especially the entry of suspended particulate matter, leads to a double paradox for most urban dwellers. In India, New Delhi has a severe air quality crisis due to the presence of high concentrations of particulate matter of 2.5 μm diameter ($PM_{2.5}$) in the ambient air.[7] The inhalation of $PM_{2.5}$, when

present at high concentrations, is a cause of lung diseases.[8] Opening windows for dilution ventilation to occur is therefore a choice between preventing the spread of airborne infections and the possible risk of lung damage due to high levels of $PM_{2.5}$. There is therefore a reliance on mechanical ventilation, as it ensures thermal comfort in New Delhi's climate and is also perceived to act as an air filter, making the supplied air free from $PM_{2.5}$. Heating, ventilation and air conditioning (HVAC) systems also have the advantage of being able to integrate ultraviolet (UV) germicidal irradiation or UVGI systems for sterilisation,[9] as well as carbon dioxide monitoring for ventilation feedback. Conversely, HVAC systems may cause harm in cases where (due to energy efficiency constraints) there is recirculation of indoor air.[10] The HVAC system may also lack appropriate filters capable of separating a significant portion of $PM_{2.5}$ in the supplied ambient air.

To appraise the airborne control features of air conditioners, a series of applications were filed under the Right to Information Act, 2005,[11]for various important buildings in India. These buildings include the Indian Parliament, the Supreme Court of India, the venue for the G20 intergovernmental forum meeting in 2023,[12] the Assembly Hall of Delhi, the Rashtrapati Bhawan (President's House) and other such buildings. These buildings should set the tone and serve as role models for other buildings in the country. The aim was to discover the current level of air conditioning and airborne infection control measures in these buildings. We also assessed the filtration capacity of fresh air intake by HVAC systems.

Of all the buildings studied, the Indian International Convention and Expo Centre, the building likely to host the G20 in 2023, had exceptional results (Table). All other symbolically important buildings lacked adequate HVAC systems. For example, the Assembly Chamber in the Parliament building did not have UVGI installed in the HVAC. Fresh air accounted for a maximum of only 10% of the total supply. The Darbar Hall and the Ashoka Hall in the Rashtrapati Bhawan did have 100% fresh air provision, but only had filters capable of filtering particles with a diameter of 10 μm, not 2.5 μm. The Chanakya Hall in the Hotel Samrat (used for important government functions) had a provision for 79.89 cubic feet per minute (CFM) of fresh air per person, but was only using 50 μm filters. These buildings are at the heart of the Indian Government and the health of users of these buildings affects that of the entire country. The use of the Right to Information Act, 2005, is also worth noting, as it is an indispensable tool for researchers to obtain information from government departments in a timely manner, bypassing bureaucracy and making data available transparently.[13]

This study highlights the importance of appropriate HVAC systems in public buildings, as these play a key role in preventing the spread of airborne diseases, as well as other particulate

matter. We suggest that there should be information about the HVAC system at the entrance to every building to increase awareness among visitors. The current focus on ventilation due to COVID-19 could benefit the global fight against TB, as the mode of transmission is similar for both and adoption of HVAC systems is a priority in many settings. Our observations in India may also be true for urban buildings in other countries, which are dealing with a similar air pollution crisis and require dilution ventilation.

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Table Government buildings in New Delhi: air conditioning systems with respect to filtration, fresh air supply and other factors.

Building	Air conditioning	Fresh air provision	Filter provided	UVGI present	CO_2 monitoring	Remarks
Darbar Hall, Rashtrapati Bhawan, New Delhi (events hosted by the President of India)	HVAC with 9 AHUs of 3,300 CFM each	Fresh air provided; 100% fresh air intake 29,700 CFM (according to facility manager)	Yes; only pre-filter (least count: 10 μm)	No	CO_2 monitoring not done	Although fresh air intake is good for air borne infection control, the filter may be ineffective against $PM_{2.5}$
Ashoka Hall, Rashtrapati Bhawan	HVAC with AHUs 17,000 CFM x 2	Fresh air provided; 100% fresh air 34,000 CFM	Yes; only pre-filter (least count: 10 μm)	No	CO_2 monitoring not done	Although fresh air intake is good for air borne infection control, the filter may be ineffective against $PM_{2.5}$
Chanakya Hall, Hotel Samrat (used for government events)	HVAC with AHUs 12,000 CFM	Fresh air provided; 79.89 CFM/person	Yes; only pre-filter (least count: 50 μm)	No	CO_2 monitoring not done	The filter may be ineffective against $PM_{2.5}$ despite fresh air intake
Lok Sabha and Rajya Sabha chambers, Parliament of India	HVAC system	Fresh air provided; ~10% fresh air by design	Details not provided	No.	Details not provided	There is a scope for increasing fresh air intake; UVGI not available.
Delhi Legislative Assembly Chamber	HVAC with 2 AHUs 12,000 CFM	Fresh air provided by AHU; quantity not known	Yes; MERV 8 (least count: ~10 μm)[14]	No	CO_2 monitoring not done	The filter may be ineffective against $PM_{2.5}$ despite fresh air intake
Chief Justice's Court, Supreme Court of India	VRV system; tower split air conditioners in other rooms	Fresh air 10–15%; advised to open windows	Yes; but details not provided (probably in-built OEM filters)	Yes	Not provided	In the absence of a treated fresh air unit, VRV systems will only recirculate indoor air
Planery Hall, IICC (venue for G20 in 2023)	Centralised district air conditioning system	Quantity not provided; declared compliance	EU 3 and EU 8 provided (equivalen	Advanced oxidation technology instead	CO_2 monitoring done	The system has sanitisation and filtration

	with ASHRAE 62.1 and NBC 2016[15]	t to MERV 6 and MERV 14; ~10 μm and 1 μm respectively)[14]	that may be appropriate

UVGI = ultra violet germicidial irradiation; HVAC = heating, ventilation and air conditioning; AHU = air handling unit; CFM = cubic feet per minute; $PM_{2.5}$ = particulate matter of 2.5 μm diameter; MERV = minimum efficiency reporting value; VRV = variable refrigerant volume; OEM = original equipment manufacturers; IICC = India International Convention and Expo Centre, New Delhi; ASHRAE = The American Society of Heating, Refrigerating and Air-Conditioning Engineers; NBC = National Building Code, 2016