Aviation and Health

For National Academies of Science, Engineering and Medicine, 2021

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HEALTHY BUILDINGS FOR HEALTH

HARVARD T.H. CHAN SCHOOL OF PUBLIC HEALTH

As of 2015

6 Current and Emerging Issues

1. Infectious Disease

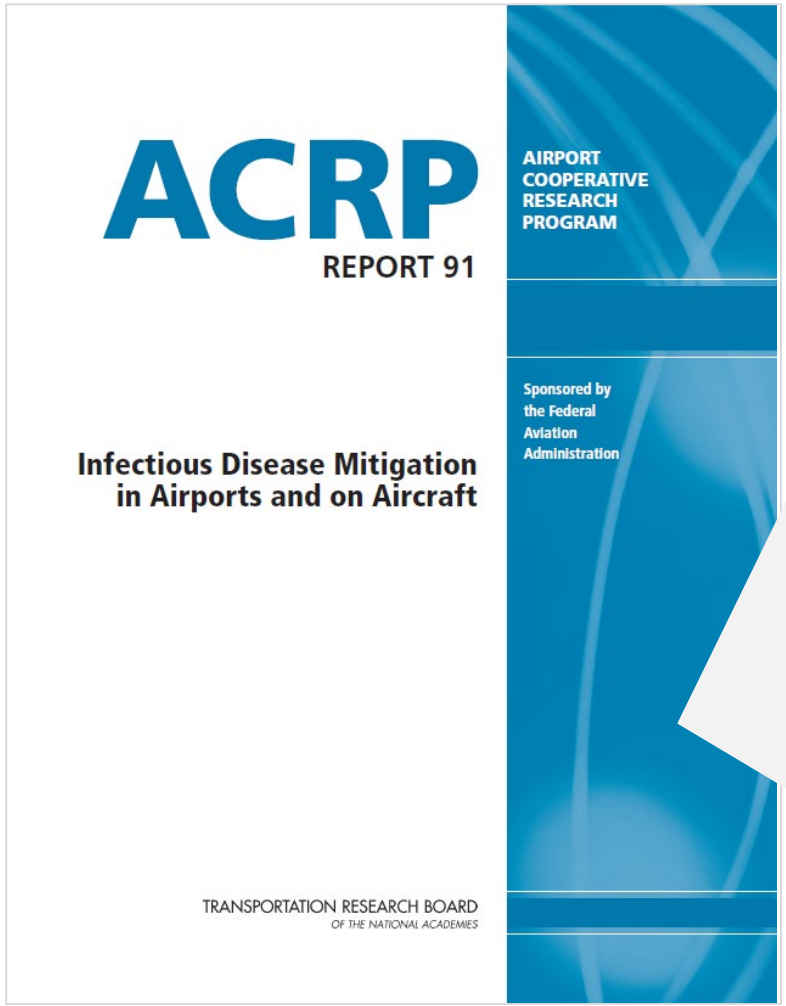
2. Mental Health

3. Ozone + Chemicals

4. Noise

5. Fuel Efficiency, Pressure and Ventilation

6. Bleed Air



CHAPTER 3

Airplanes

Airline Operators Should Consider Decreasing Ventilation Downtime on Aircraft Parked at the Gate

Highly Recommended

Rationale. The ventilation systems in operating aircraft are designed to bring in fresh air, filter the air, and circulate the air within the cabin. All of these actions reduce the potential transmission of infectious aerosols. However, once the aircraft is shut down, these systems are also shut down and the risk of transmission of infectious aerosols increases. Many airports have gate-based ventilation systems which are attached to the aircraft once the aircraft engines are shut down. As a result, air movement is maintained within the cabin. However, not all airports or gates are equipped with these gate based ventilation systems. In

Population(s) Targeted	Passengers	Flight Crew	Airport Ops (Public Contact)	Airport Ops (Limited Public Contact)	Guests
	✓	✓	○	✓	○
Area(s) Targeted	Pre-security	Security	Terminal	Airplane	Post-flight
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Exposure Route Targeted	Aerosol	Large Droplet	Fomite		
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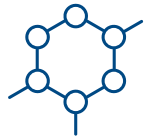

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Risk in Context

Environmental Control Systems

The Washington Post

Opinions

Airplanes don't make you sick. Really.

Joe Johnston wears a face mask at work at the Rocky Mountain Metro Airport in Broomfield, Colo., on May 14. (David Zalubowski/AP)

Opinion by **Joseph Allen**

MAY 18, 2020

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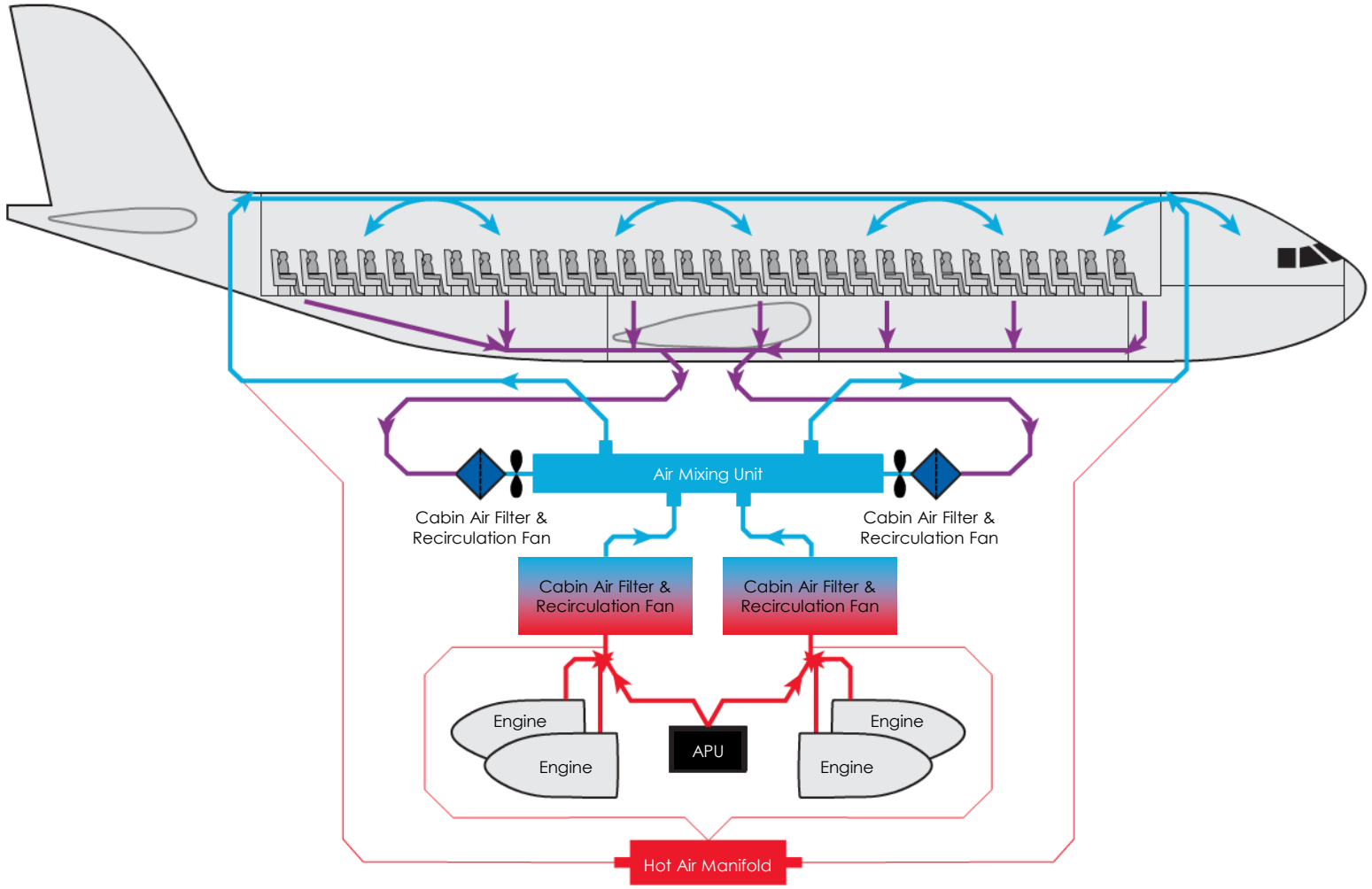
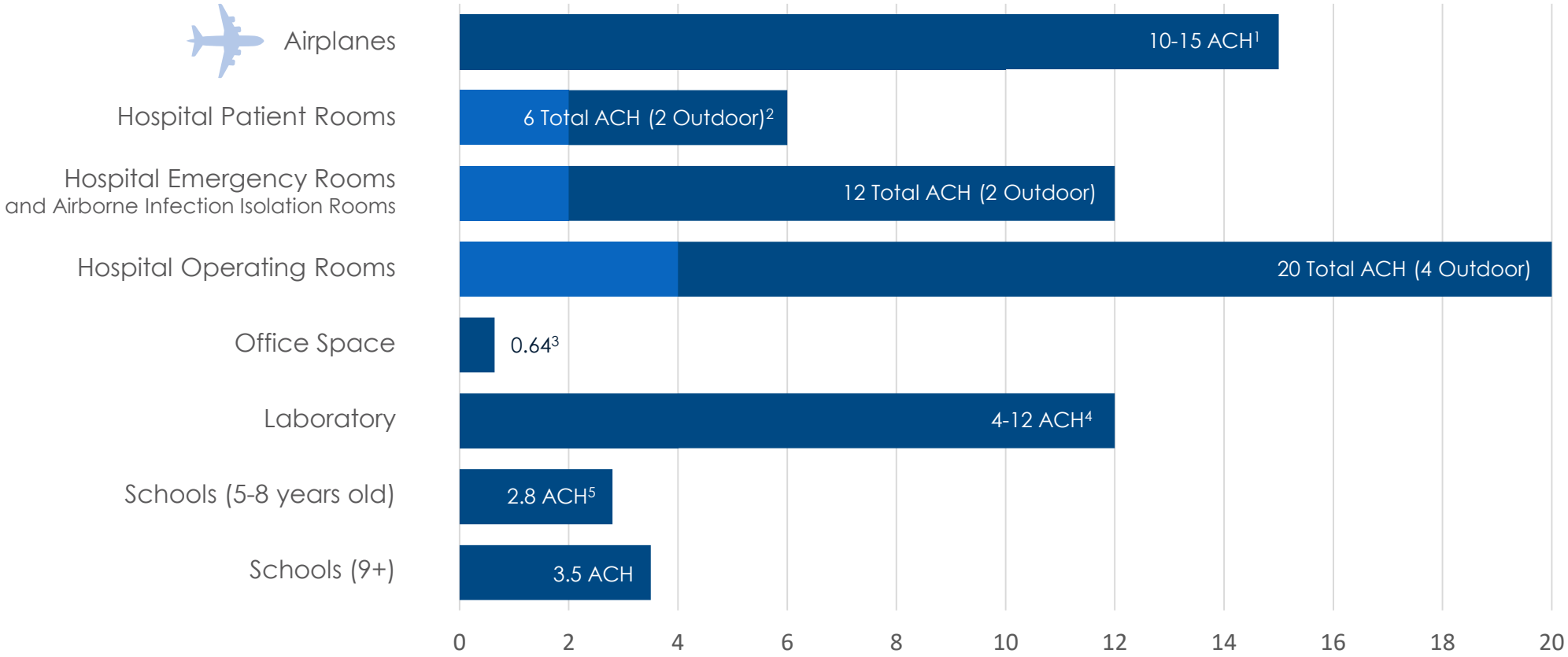


Hot air used for temperature control

Minimum required air changes per hour

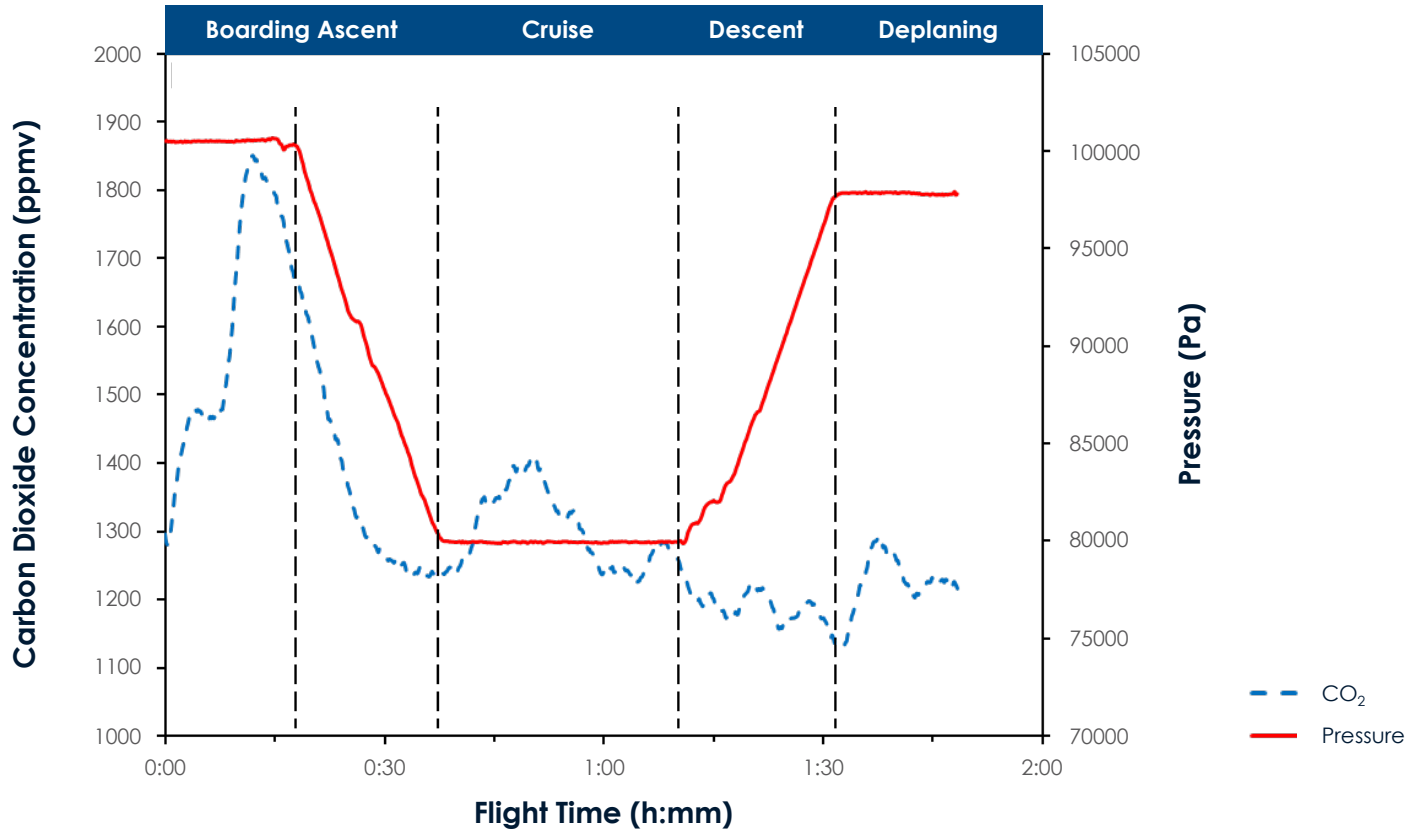


1. National Academies; Cao et al.
2. ASHRAE 170-2017
3. ASHRAE 62.1-2019
4. OSHA
5. ASHRAE 62.1-2019

A Warning from 2013…

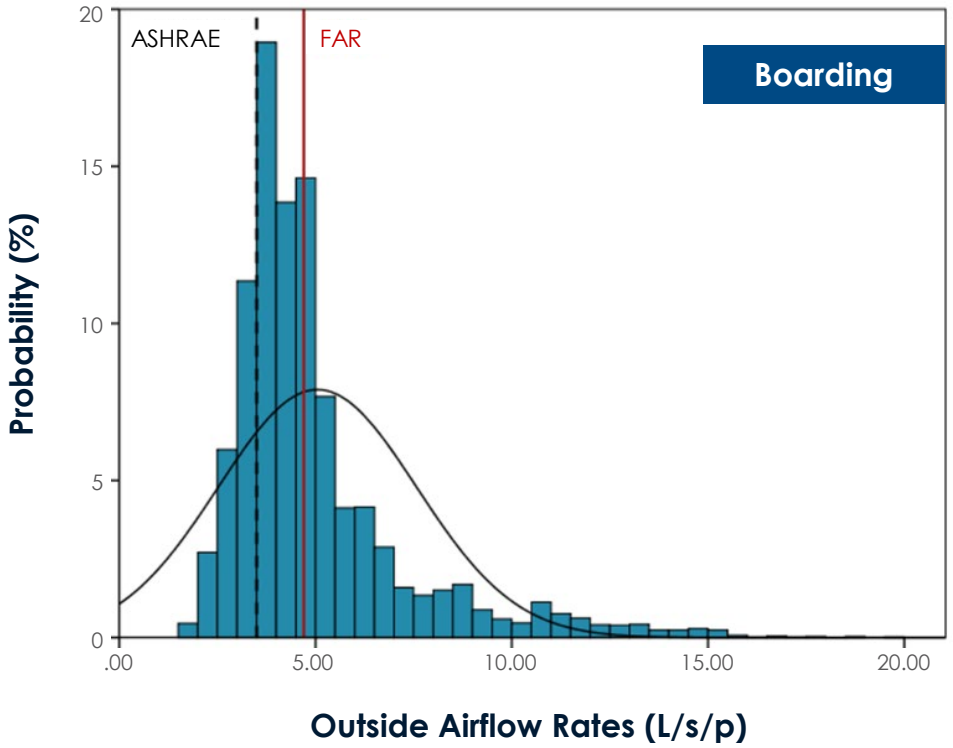
Low Ventilation at the Gate

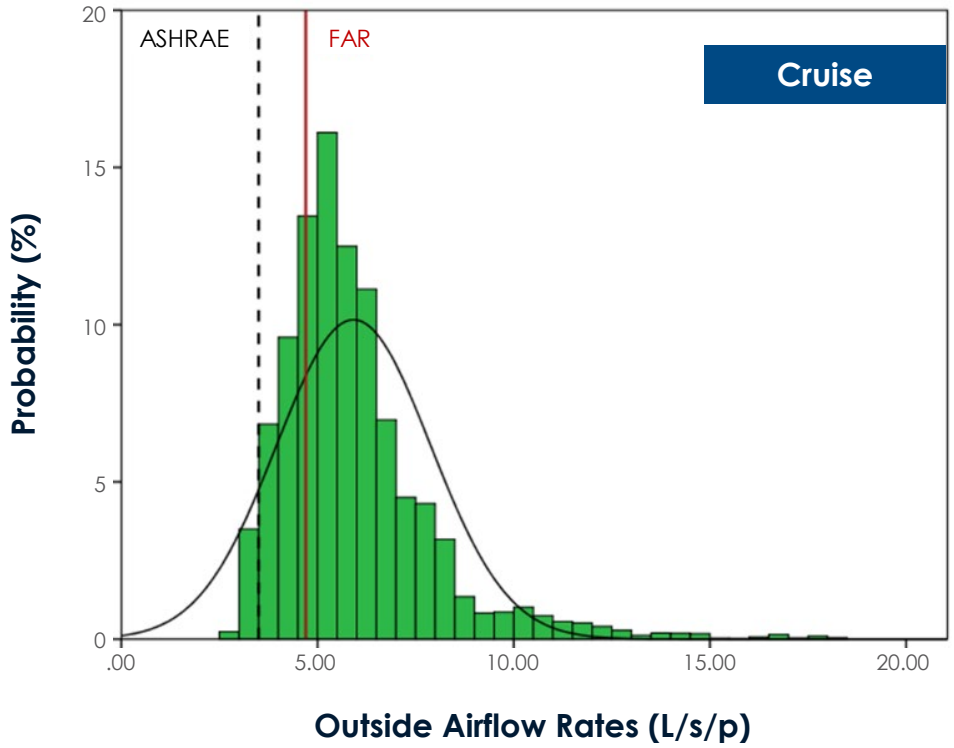
Measured CO_2 concentration and pressure during a typical flight



Cao, X., Zevitas, C.D., Spengler, J.D., Coull, B., McNeely, E., Jones, B., Loo, S.M., MacNaughton, P. and Allen, J.G., 2019. The on-board carbon dioxide concentrations and ventilation performance in passenger cabins of US domestic flights. *Indoor and Built Environment*, *28*(6), pp.761-771.

Probability distributions of outside airflow rates during boarding and cruise





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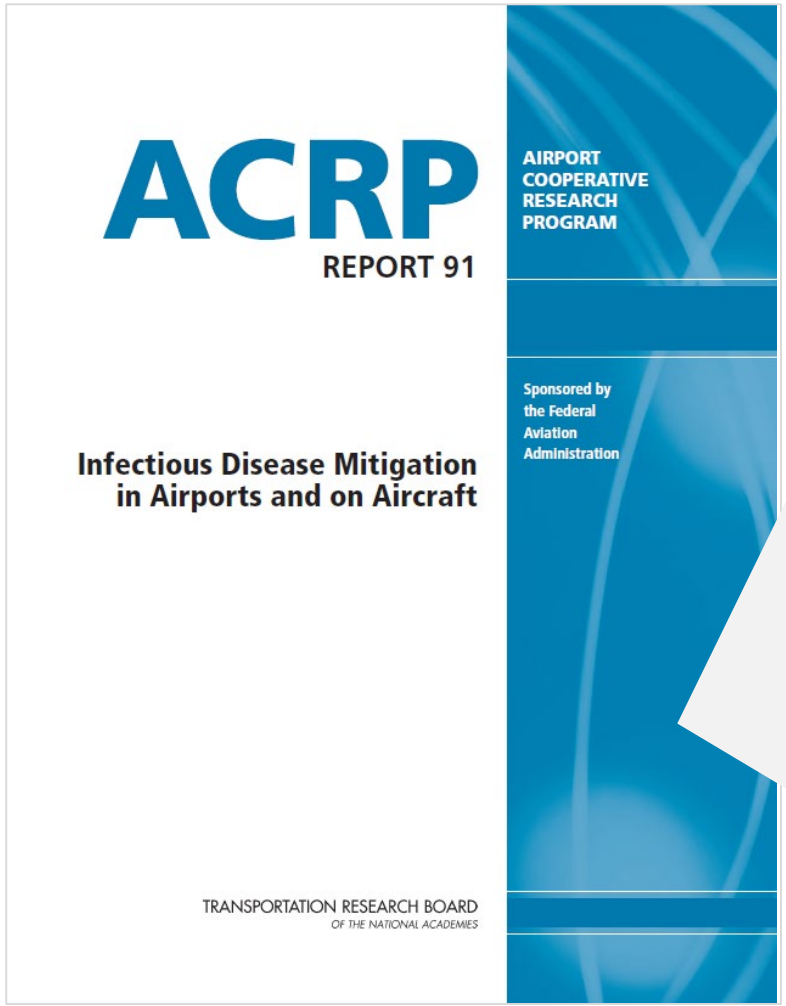

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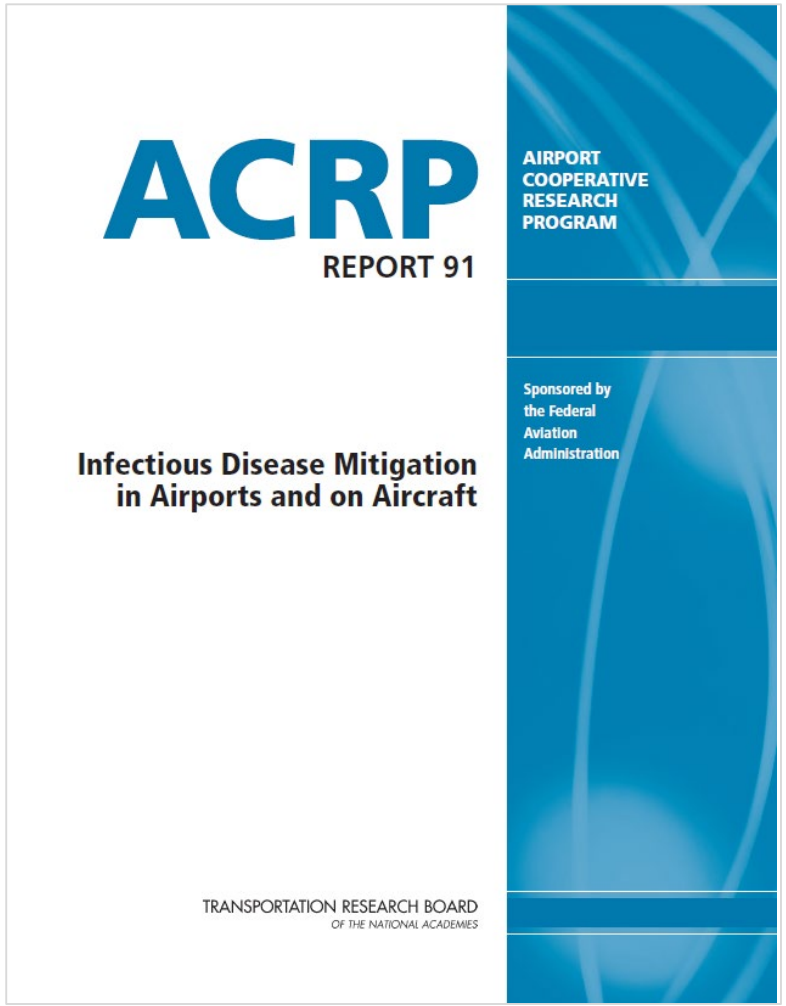


Points to Consider for Implementation

1. Install gate-based aircraft ventilation systems at all gates in an airport, when possible.

2. Attach gate-based ventilation systems to aircraft as soon as the aircraft is shut down.

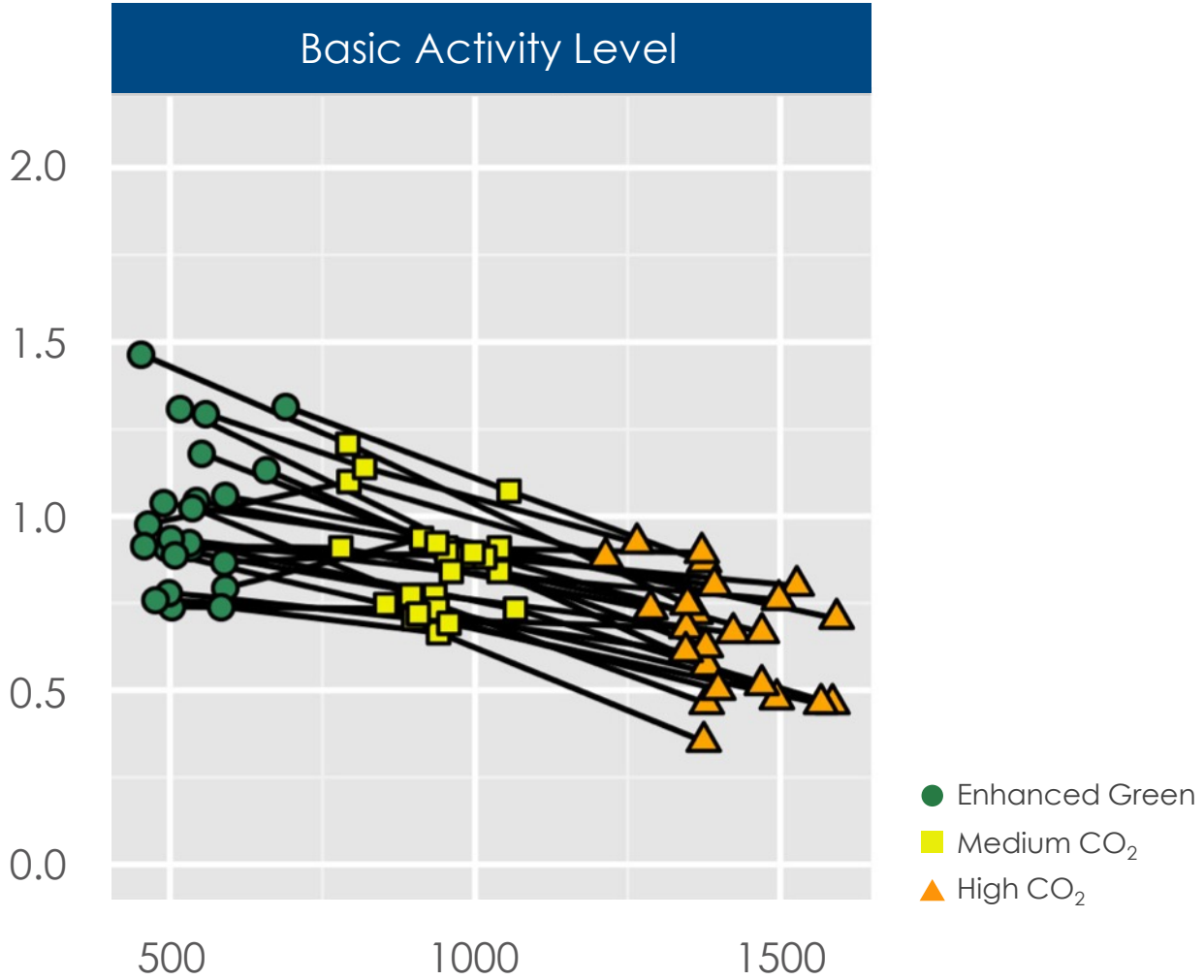
3. Do not detach gate-based ventilation systems until shortly before aircraft startup.

4. Installation of these systems, as well as their operation, may be expensive. Based on these costs, routine operation may not be warranted in all instances. **However, in the case of an emergency or a pandemic**, these costs would be justified. Airport operators and airlines should make preparations to provide gate-based ventilation to all parked aircraft in the event of an emergency or pandemic.

Ventilation Impacts Beyond COVID-19

Ventilation and Flight Performance

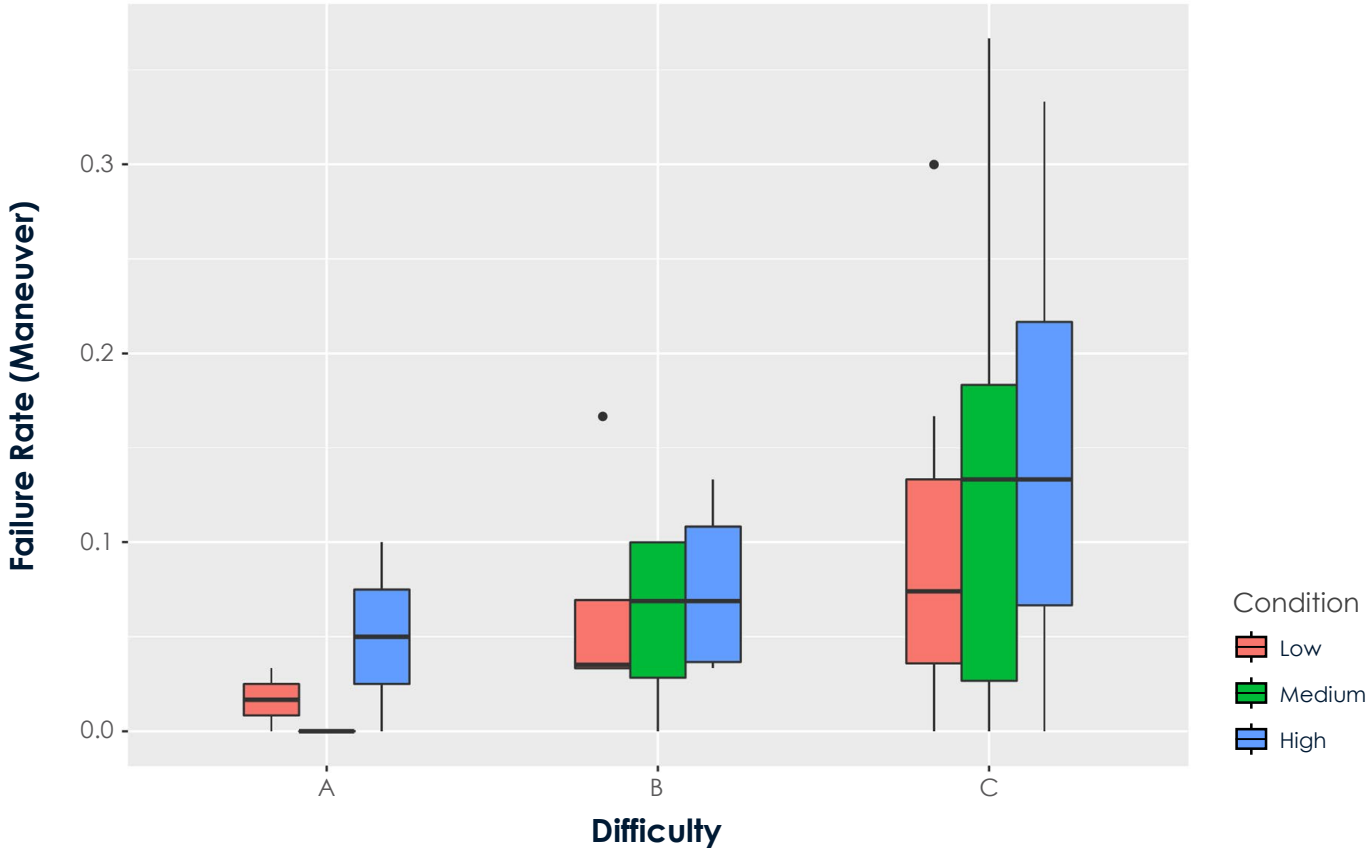
#THECOGFXSTUDY



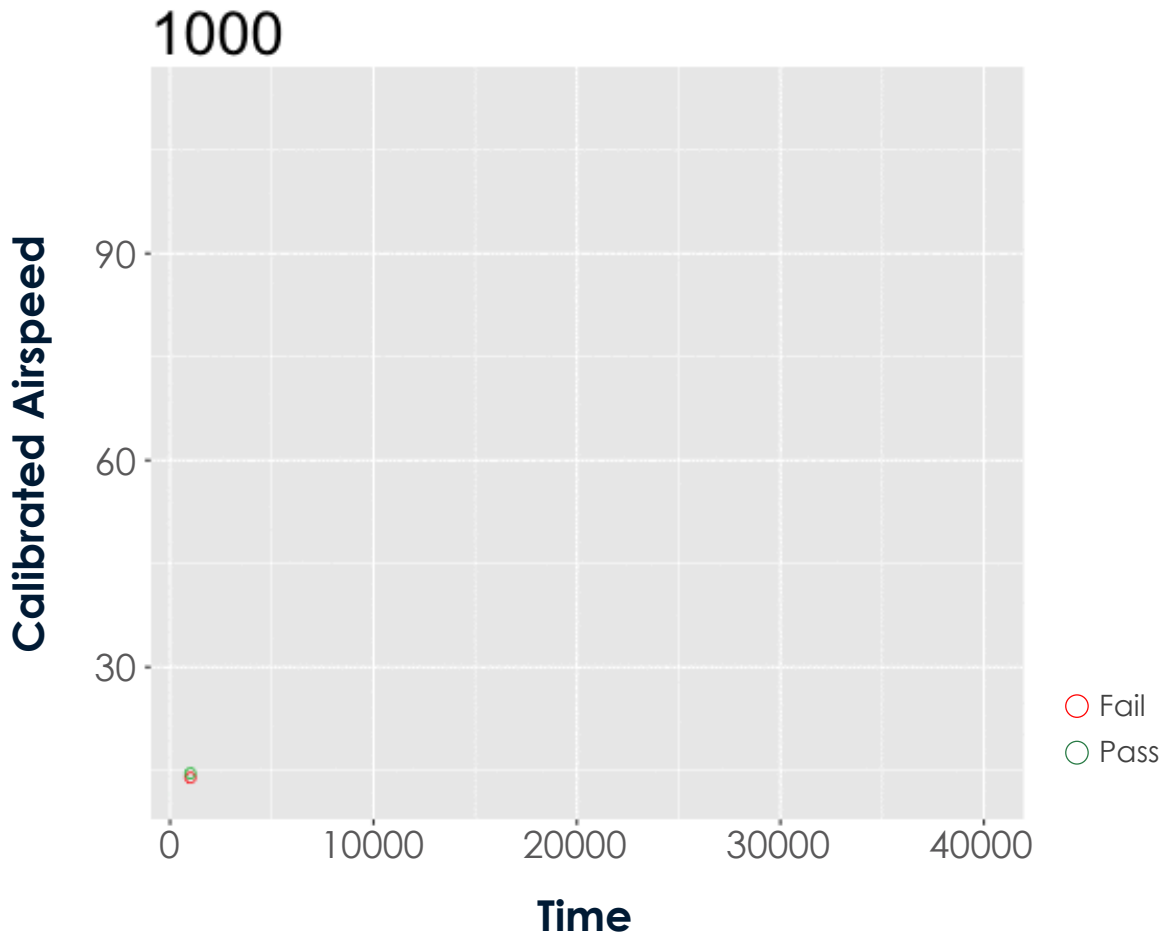
Allen, J.G., MacNaughton, P., Satish, U., Santanam, S., Vallarino, J. and Spengler, J.D., 2016. Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: a controlled exposure study of green and conventional office environments. *Environmental Health Perspectives, 124*(6), pp.805-812.

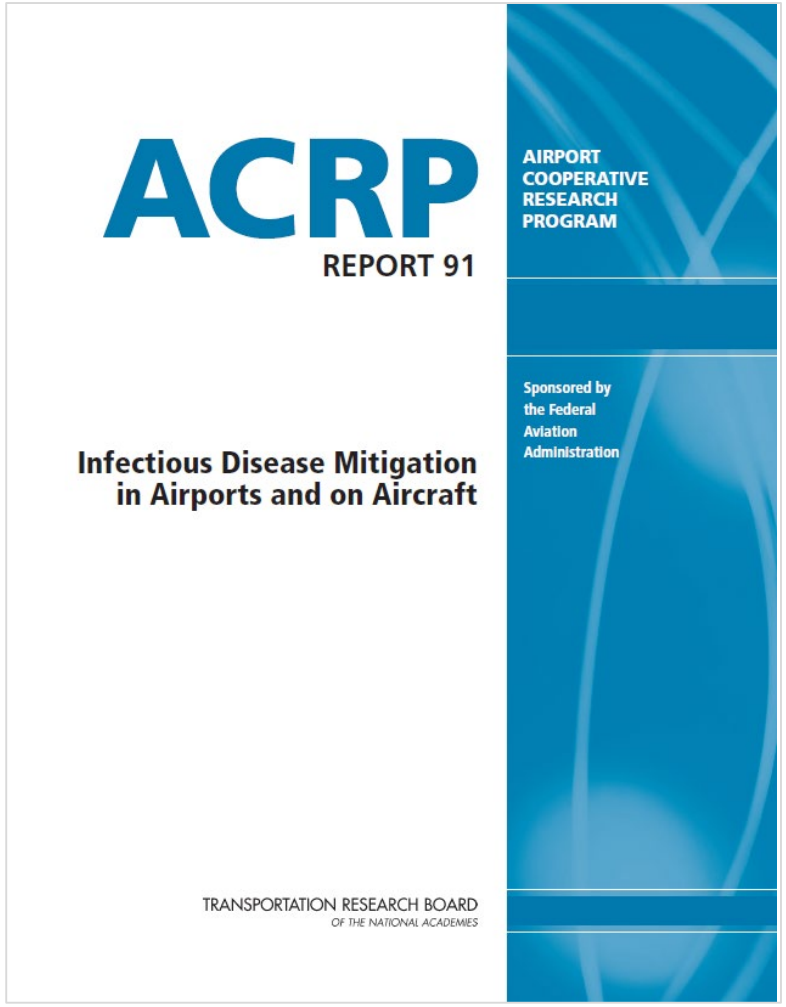
Failure rates of pilots on each maneuver

(by CO_2 condition and maneuver difficulty)



Rejected takeoff (1 engine inoperative)





SAGE journals

The on-board carbon dioxide concentrations and ventilation performance in passenger cabins of US domestic flights

X. Cao, Christopher D. Zevitas, J. Spengler, B. Coull, E. McNeely, B. Jones, S. M. Loo, P. Macnaughton, J. Allen less

Published 2019 · Environmental Science · Indoor and Built Environment

Journal of Exposure Science & Environmental Epidemiology

Airplane pilot flight performance on 21 maneuvers in a flight simulator under varying carbon dioxide concentrations

Joseph G. Allen, Piers MacNaughton, Jose Guillermo Cedeno-Laurent, Xiaodong Cao, Skye Flanigan, Jose Vallarino, Francisco Rueda, Deborah Donnelly-McLay & John D. Spengler

All resources available at: https://aviation.forhealth.org/

Thank you

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