R&D TO SUPPORT HEALTHY AIR TRAVEL IN THE COVID–19 ERA AND BEYOND

HEARING

BEFORE THE

SUBCOMMITTEE ON SPACE AND AERONAUTICS

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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C O N T E N T S

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Appendix II: Additional Material for the Record

R&D TO SUPPORT HEALTHY AIR TRAVEL IN THE COVID–19 ERA AND BEYOND

TUESDAY, JUNE 23, 2020

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON SPACE AND AERONAUTICS,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to notice, at 11:32 a.m., via Webex, Hon. Kendra Horn [Chairwoman of the Subcommittee] presiding.

SUBCOMMITTEE ON SPACE AND AERONAUTICS
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING CHARTER

R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond

June 23, 2020
11:30 a.m.
Cisco WebEx

PURPOSE

The purpose of this hearing is to examine the status of R&D related to supporting healthy air travel during COVID-19 and future pandemics, and other issues.

WITNESSES

- **Ms. Heather Krause,** Director, Physical Infrastructure Issues, Government Accountability Office
- **Dr. Byron Jones P.E.**, Professor, Alan Levin Department of Mechanical and Nuclear Engineering; Director, National Gas Machinery Laboratory, Kansas State University
- **Dr. Vicki Hertzberg,** Professor and Director, Center for Data Science, Nell Hodgson Woodruff School of Nursing, Emory University

OVERARCHING QUESTIONS

- What is the current scientific understanding of the spread of coronavirus and other communicable diseases in the unique environment of aircraft cabins?
- What, if any, gaps exist in the scientific understanding of the potential risks of coronavirus transmission on aircraft, and what is needed to address them?
- What is the federal government's role, in particular the FAA's, in research and development activities related to understanding and mitigating the spread of COVID-19 and other communicable diseases in aircraft environments and through air travel?
- What planning and actions can be taken to improve the resiliency of the U.S. aviation system and the safety of air travel during the COVID-19 era and for future pandemics, and how can relevant R&D activities best inform those efforts?

BACKGROUND

Until 2020, the number of global air travel passengers was increasing annually; in 2018, more than 4.3 billion people used scheduled air transportation to travel more than 8.2 million kilometers internationally and domestically, according the United Nations' International Civil

Aviation Organization (ICAO).[1] U.S. airlines alone carried an estimated 925.5 million passengers in 2019, the highest total ever recorded.[2] Prior to the onset of the COVID-19 pandemic, the International Air Transportation Association (IATA) predicted that the global number of air travel passengers would nearly double by 2035 from 3.8 billion per year in 2016 to 7.2 billion per year in 2035.[3] As air travel continues to play an increasing role in modern life, the role of the aviation system in the spread of communicable disease is an important global public health concern. Aviation presents a unique confluence of potential risk factors for the spread of communicable diseases, as airport, and especially aircraft, environments feature high densities of people interacting frequently in confined indoor spaces and traveling to and from geographically diverse regions.[4]

In the era of the ongoing COVID-19 pandemic, passenger air travel has drastically decreased. As of June 15, 2020 ICAO is forecasting, "An overall reduction of air passengers (both international and domestic) ranging from 46% to 62% in 2020 compared to 2019."[5] As a result, ICAO estimates airlines are facing a potential loss of revenue of up to $314 Billion.[6] At the peak of the pandemic in the U.S., the Transportation Security Administration (TSA) screened as few as 100,000 people a day nationwide on April 7th, a 96 decrease from the same time a year ago.[7]

The role of commercial aviation in the U.S. economy is significant, and such a decline in passenger air travel could have far-reaching economic implications. The U.S. is the leading aerospace manufacturer in the world, generating over $130 billion in exports, resulting in a $89.5 billion trade surplus, and over 2.5 million jobs in the United States.[8] [9] The decline of air travel has reduced recent airline and aerospace manufacturer revenues, resulting in decreased capacity and employee layoffs.[10] As portions of the U.S. economy begin to reopen, the aerospace industry

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[1] ICAO, "The World of Air Transport in 2018," available at: https://www.icao.int/annual-report-2018/Pages/the-world-of-air-transport-in-2018-statistical-results.aspx

[2] Bureau of Transportation Statistics, "Preliminary estimate Full Year 2019 and December 2019 US Airline Traffic Data." January 17, 2020. https://www.bts.gov/newsroom/preliminary-estimated-full-year-2019-and-december-2019-us-airline-traffic-data

[3] International Air Transport Association, "Forecasts Passenger Demand to Double Over 20 Years." October 18, 2016. https://www.iata.org/en/pressroom/pr/2016-10-18-02

[4] National Academies of Sciences, Engineering, and Medicine. 2013. *Infectious Disease Mitigation in Airports and on Aircraft*. Washington, DC: The National Academies Press. Available at: https://doi.org/10.17226/22512.

[5] https://www.icao.int/sustainability/Pages/Economic-Impacts-of-COVID-19.aspx

[6] https://www.icao.int/covid/cart/Pages/CART-Take-off.aspx

[7] Statement by Transportation Security Administration
https://twitter.com/TSAmedia_LisaF/status/1247877932917362689

[8] Aerospace Industry Association, Workforce, "The Facts." https://www.aia-aerospace.org/research-center/statistics/industry-data/workforce/

[9] Aerospace Industry Association, "The Facts on Trade." https://www.aia-aerospace.org/research-center/statistics/industry-data/foreign-trade/

[10] Voytko, Lisette. Coronavirus Layoffs: Boeing Lays off 6,770 Workers Amid Pandemic, *Forbes*, May 27, 2020. https://www.forbes.com/sites/lisettevoytko/2020/05/27/coronavirus-layoffs-boeing-lays-off-6770-workers-amid-pandemic/#24c7103645bd

has seen an uptick in demand.[11] Airlines are taking preventative measures to reduce the risk of COVID-19 transmission, though policies and practices among airlines are inconsistent.[12]

Communicable Disease Transmission in Aircraft Environments

Communicable diseases are caused by viruses or bacteria that can be spread through one or more routes, such as direct, person-to-person transmission, indirect transmission via surfaces (fomites), or airborne transmission. Respiratory viruses like the novel coronavirus that causes COVID-19 can be spread by droplets released by an infected person (when, e.g., coughing, sneezing, or talking), but aerosols capable of traveling much farther than droplets ("airborne" transmission) may also play a role.[13] In aircraft cabins, risks of transmission by many of the typical routes may be heightened due to the high occupancy, at a high density, of passengers and crew in an enclosed environment.[14]

Research activities focused on disease transmission risks and mitigation strategies on aircraft have been somewhat limited, but they have often increased in response to historical public health crises and associated concerns over transmission via the aviation system. For example, during the severe acute respiratory syndrome (SARS) outbreak of the early 2000s—caused by a coronavirus strain closely related to the SARS-CoV-2 strain of today—Air China flight 112 from Hong Kong to Beijing carried an infected passenger who ended up infecting 18 other passengers and 2 flight attendants, bringing the virus to multiple locations that previously had no cases. Research found that a majority of the infected passengers were sitting more than two rows away from the originally infected passenger, which raised concerns that distancing passengers during flights may not be enough to prevent disease transmissions.[15]

Research into this case and others explore concerns about airplanes' closed, indoor environments. Most modern plane circulation systems use high-efficiency particulate air (HEPA) filters that can remove over 99 percent of airborne particles and contribute to lowering the threat of the virus once the air passes through the filter.[16] [17] The filtered air is blended in with clean air

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[11] LeBeau, Phil. "American Airlines and Other Carries are Adding Summer Flights as Passengers Slowly Return." *CNBC,* June 4, 2020. Available at: https://www.cnbc.com/2020/06/04/american-airlines-and-other-carriers-are-adding-summer-flights-as-passengers-slowly-return.html

[12] Pallini, Thomas. "11 major US airlines have new pandemic rules for keeping passengers safe, but some are doing more than others. Here's how they compare.", *Business Insider*, June 15, 2020. Available at: https://www.businessinsider.com/us-airline-new-coronavirus-travel-rules-comparison-american-united-delta-2020-6

[13] Prateek Bahl, Con Doolan, Charitha de Silva, Abrar Ahmad Chughtai, Lydia Bourouiba, C Raina MacIntyre, "Airborne or Droplet Precautions for Health Workers Treating Coronavirus Disease 2019?," *The Journal of Infectious Diseases*, April 16, 2020. Available at: https://doi.org/10.1093/infdis/jiaa189

[14] Sevilla, Nereyda L. "Germs on a Plane: The Transmission and Risks of Airplane-Borne Diseases." *Transportation Research Record,* October 15, 2018, Vol. 2672(29) 93–102. Available at: https://journals.sagepub.com/doi/full/10.1177/0361198118799709.

[15] Hertzberg, Vicki Stover et al. "On the 2-Row Rule for Infectious Disease Transmission on Aircraft." *Annals of Global Health* vol. 82,5 (2016): 819-823. Doi:10.1016/j.aogh.2016.06.003

[16] Heffernan, Tim. "Can HEPA Air Purifiers Capture the Coronavirus?" *New York Times,* April 7, 2020. Available at: https://www.nytimes.com/wirecutter/blog/can-hepa-air-purifiers-capture-coronavirus/

[17] Aleksandrova, Dayana. "What are airplane HEPA Filters and do they make cabin air safe?" *Matadornetwork,* May 5, 2020. Available at: https://matadornetwork.com/read/airplane-hepa-filters-make-cabin-air-safe/

pulled in through the engines, in most cases creating a roughly a 50-50 mix with a very high exchange rate, which is better airflow than is generally found in many restaurants and other indoor spaces.[18] Other research into the transmission of diseases on aircraft found that the highest risk of infection in an aircraft cabin comes from droplets being passed from passenger to passenger or through surfaces.[19] If small aerosol particles are associated with a given virus, then a further consideration is that such particles have been shown to linger in the cabin air and could transmit the virus before entering into the HEPA filters.[20]

Many airlines have adopted one or more new health safety protocols and policies, such as: screening passengers for COVID-19 symptoms and preventing those with symptoms from flying, requiring passengers and crew to wear masks, leaving seats open to limit the density during flight, and increasing cleaning regimens.[21] Preventing symptomatic customers from boarding flights can reduce some risk of COVID-19 transmission, but presymptomatic and asymptomatic carriers could also present transmission risks.

FAA Research

From 2004 to 2015, FAA supported the National Center of Excellence (COE) Center of Excellence for Research in the Intermodal Transport Environment (RITE) Airliner Cabin Environment Research (ACER), with leadership from Purdue University, Auburn University, and Kansas State University. The ACER COE brought together aircraft cabin environment expertise from academia, industry, and government organizations. The Center's research encompassed health and safety effects of the airline cabin environment on passengers and crewmembers, the efficiency and effectiveness of aircraft environmental control systems, and the study of emerging technologies with the potential to eliminate bleed air contaminants and purify aircraft air supplies. An area of focused research was in understanding the complex physics of the flow of air and contaminants within the cabin, particularly the bleeding of toxic fumes and chemicals from the aircraft engine.

The ACER COE also studied the transmission of disease in aircraft. In 2007, FAA and ACER researchers published a report on disinfecting aircraft cabin contaminated with influenza viruses.[22] In 2012, FAA and ACER researchers reported the findings from a study of the airborne

[18] Laris, Michael. "Scientists know ways to help stop viruses from spreading on airplanes. They're too late for this pandemic." *Washington Post,* April 29, 2020, Available at: https://www.washingtonpost.com/local/trafficandcommuting/scientists-think-they-know-ways-to-combat-viruses-on-airplanes-theyre-too-late-for-this-pandemic/2020/04/20/83279318-76ab-11ea-87da-77a8136c1a6d_story.html

[19] Hertzberg, Vicki Stover et al. "Behaviors, movements, and transmission of droplet-mediated respiratory diseases during transcontinental airline flights." *Proceedings of the National Academy of Sciences of the United States of America* vol. 115,14 (2018): 3623-3627. doi:10.1073/pnas.1711611115

[20] *Ibid*

[21] Editorial Board, "Keep the Middle Seat Empty for Now, Please." *Bloomberg,* June 5, 2020. Available at: https://www.bloomberg.com/opinion/articles/2020-06-05/will-airlines-remove-the-middle-seat-to-prevent-covid-19

[22] Rudnick, Stephen et al. "Inactivating Influenza Viruses on Surfaces Using Hydrogen Peroxide or Triethylene Glycol at Low Vapor Concentration." *Air transportation Center of Excellence for Airliner Cabin Environmental Research,* April 2009.

and surface transport of respiratory virus droplets throughout the cabin.[23] The 2012 study found that the bulk airflow pattern in the cabin played the most important role in transport. The researchers further concluded that passenger and crew movements could have been the primary cause of the 2003 in-flight SARS transmission from an infected passenger to passengers seated as far as seven rows away.

GAO Assessment of Aviation Preparedness to Respond to Communicable Diseases

In 2015, the Government Accountability Office (GAO) reviewed the preparedness of the U.S. aviation system to respond to communicable diseases and released findings and recommendations in the report, "Air Travel and Communicable Diseases: Comprehensive Federal Plan Needed for U.S. Aviation System's Preparedness."[24] The report examined "(1) the extent to which selected U.S. airports and airlines have plans for responding to communicable disease threats from abroad and to which a national aviation-preparedness plan guides preparedness, and (2) the challenges that U.S. airports and airlines have faced when responding to threats and any actions taken to address them."

Through this assessment, GAO found that the U.S. does not have a comprehensive national aviation preparedness plan aimed at preventing and containing the spread of diseases through air travel. This is despite the fact that, according to GAO, the U.S. is obligated as a member state of ICAO to establish a national aviation-preparedness plan for communicable disease outbreaks that pose a public health risk or public health emergency of international concern.[25] Further, neither U.S. airports nor airlines are required to have individual preparedness plans, and no federal agency tracks which airports and airlines have them. GAO also learned from stakeholders of numerous challenges in communicating timely, accurate information—such as response guidance, status of training of workers, sanitation procedures, and information to help coordinate first responders—among and between airlines and airports during active communicable disease threats.

GAO recommended that the Department of Transportation (DOT) and FAA work with relevant stakeholders, such as the Department of Health and Human Services, to develop a national aviation-preparedness plan for communicable disease threats, which could enable the aviation system to respond more rapidly and effectively, potentially improving the health and safety of staff, crew, and the flying public. In responding to the report, DOT agreed that such a plan is needed, but suggested instead that public health agencies should lead the effort, while GAO maintained that "*DOT is in the best position to work with its relevant stakeholders, including those that have the needed public health expertise, to develop a national aviation-preparedness plan*" as DOT is responsible for the aviation sector and has the liaison role for U.S. obligations under ICAO to establish the plan.

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[23] FAA Technical Report RITE-ACER-CoE-2012-01, "Infectious Disease Transmission in Airliner Cabins," February 22, 2012. Available at: https://www.faa.gov/data_research/research/med_humanfacs/cer/media/InfectiousDiseaseTransmission.pdf

[24] GAO-16-127, "Air Travel and Communicable Diseases: Comprehensive Federal Plan Needed for U.S. Aviation System's Preparedness," December 16, 2005. Available at: https://www.gao.gov/products/GAO-16-127

[25] ACI and ICAO, Airport Preparedness Guidelines for Outbreaks of Communicable Disease, Revised (April 2009)

Chairwoman HORN. I'll go ahead and get started. So, this hearing will come to order. Without objection, the Chair is authorized to declare a recess at any time.

And before I deliver my opening remarks, I want to make note that, today, the Committee is meeting virtually, and in this virtual format, I want to begin with a couple of reminders to the Members and participants about the conduct of this hearing. First, the Members should keep their video feed on as long as they are present in the hearing to be counted, and Members are responsible for your own microphones, so please keep your microphones muted unless you are speaking.

And finally, if Members have documents they wish to submit for the record, please email them to the Committee Clerk, whose email address was circulated prior to the hearing. And thank you all for joining us.

So, good morning, everyone, and welcome to today's remote hearing on R&D (research and development) support healthy air travel—to support healthy air travel in the COVID–19 era and beyond. I'd like to welcome our witnesses and thank you all for being here.

Commercial air travel is an essential part of the fabric of our society and economy. It plays a critical role in business, commerce, education, travel, and tourism. We take for granted that we can now easily travel vast distances by air and reach destinations that were once reserved for imagination. In just over a century, air travel moved from our imagination to a reality that has changed the way we interact with each other and connect with the world. Our dependence on air travel will only continue to grow.

In 2018, the International Air Transport Association projected that global air travel will nearly double in 20 years, from 4 billion to more than 7 billion annual passengers. As with many other industries, the COVID–19 pandemic has dramatically impacted commercial air travel. In the United States alone, passenger air travel was down an estimated 96 percent in April 2020 from April 2019 nearly a year before. Worldwide, the air travel industry is projected to lose more than $300 billion in gross operating revenues this year. And the ripple effects of this shift extend well beyond the airlines, to travel and tourism, business, supply chains, and much more.

While Congress has provided financial support to the airline industry through loan guarantees, workforce support, and tax relief in the *CARES Act*, full recovery also requires ensuring safety and re-establishing public confidence as we continue to face the risks of COVID–19. To that end, airlines are taking concrete and proactive steps to protect crew and passengers through increased cleaning, modified boarding procedures, and requiring the use of masks by passenger and crew. These are positive steps, but are they enough to ensure safety and reestablish trust?

Additionally, with each airline determining its own approach, individuals are left on their own about what is safe, and that's a confusing place to be. That's why today's discussion is so important. It's about understanding what we know, what we don't know, and what we need to know to reduce confusion and provide clear, science-based guidance on ensuring the safety of passengers and crew during this and any future pandemic.

Because of the silent threat of asymptomatic or presymptomatic individuals remains, Federal public health agencies such as the CDC (Centers for Disease Control and Prevention) provide guidance and recommendations about precautions and actions to reduce the spread of COVID–19. However, agency roles and responsibilities for determining the risk of virus transmission on aircraft and issuing guidance about specific mitigation measures are unclear. The FAA (Federal Aviation Administration) has conducted research on cabin airflow and aircraft environmental control systems in the cabin. What does that research tell us about mitigating any risk of COVID transmission?

As a lifelong Girl Scout, I know the importance of being prepared. The threat of COVID–19 demands a national response. That's why we also need to examine the status of planning—for the Federal Government, for the airlines, and for the traveling public—so that we and the industry aren't caught off guard with the threat of any future pandemics. Further, we need to examine our aeronautics and aviation R&D plans, the extent to which they include relevant research priorities and unique experiences such as healthcare specialists and scientists to deal with the mitigating—mitigating the risks of novel viruses, and how R&D can inform our national plans.

In June 2016—June 16, 2020, article, the President of the National Academy of Sciences wrote about the coronavirus pandemic. She noted the need for "actionable science to inform rapid decision-making," "strategic science to inform long-term planning," and "irreplaceable science to understand what works." Today's conversation will consider what research has been done, what research needs to be done, and what further actions need to be taken to understand and mitigate the risks of virus transmission through air travel. I can't think of a better way to frame our discussion on R&D to help ensure the resiliency of our air travel system during the COVID–19 era and beyond. Thank you.

[The prepared statement of Chairwoman Horn follows:]

Good morning, and welcome to today's remote hearing on "R&D to Support Healthy Air Travel in the COVID–19 Era and Beyond." I'd like to welcome our witnesses and thank you for being here.

Commercial air travel is an essential part of the fabric of our society and economy. It plays a critical role in business, commerce, education, travel, and tourism. We take for granted that we can now easily travel vast distances by air and reach destinations that were once beyond imagination. In just over a century, air travel moved from our imagination to reality that has changed the way we interact with each other and connect with the world. Our dependence on air travel will only continue to grow. In 2018, the International Air Transport Association projected that global air travel will nearly double in 20 years, from 4 billion to more than 7 billion annual passengers.

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enough to ensure safety and reestablish trust? Additionally, with each airline determining its own approach, individuals are on their own about what is safe. That's a confusing place to be.

That's why today's discussion is so important. It's about understanding what we know, what we don't know, and what we need to know to reduce confusion and provide clear and science-based guidance on ensuring the safety of passengers and crew during this and any future pandemic. Because the silent threat of asymptomatic or presymptomatic individuals remains.

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And as a lifelong Girl Scout, I know the importance of being prepared. The threat of COVID–19 demands a national response. That's why we also need to examine the status of planning—for the Federal government, for the airlines, and for the traveling public—so that we and the industry aren't caught off guard with the threat of any future pandemics. Further, we need to examine our aeronautics and aviation R&D plans, the extent to which they include relevant research priorities and unique experience such as health care specialists and scientists to deal with mitigating the risks of novel viruses, and how that R&D can inform national plans.

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Thank you.

Chairwoman HORN. And the Chair now recognizes Ranking Member Mr. Babin for an opening statement. Mr. Babin?

Mr. BABIN. Thank you, Madam Chair. I appreciate you and glad to be with you virtually this afternoon.

The COVID–19 pandemic has touched virtually every aspect of our lives. Families are self-isolating and limiting in-person contact with friends and family. Many workplaces have fundamentally restructured in response to this virus. Our economy and employment levels are challenged as we attempt to protect our public health.

While industries like restaurants and entertainment were asked to sacrifice profits and solvency for the greater good, other sectors like health care and grocers were asked to accept greater risks. The aerospace industry was asked to span these two different paradigms. On the one hand, air travel was significantly curtailed in order to prevent the spread of the disease. On the other hand, transportation, including air travel, is considered an essential function to our society. This places passengers, airlines, and the country in a precarious position of continuing operations in the face of not only health risks, but also risks to the overall viability of the companies who are operating at a fraction of their normal operating capacity.

According to recent press reports, airlines are operating at between 15 and 17 percent capacity compared to last year. At the same time, private jet flights have surged 70 percent, but this doesn't do anything to help most Americans. Polling done recently by the International Air Transportation Association indicated that only 45 percent of the population was willing to fly within one or

two months of restrictions being lifted. This does not bode well for an industry that our Nation depends upon so heavily.

For this reason, it is crucial to understand the health risks posed by airline travel as accurately as possible. Research into how the virus propagates in an aircraft cabin via airborne or surface transmission is the start. Characterizing that environment will then allow airlines, aircraft manufacturers, airports, government agencies, and the public to develop technologies and processes to mitigate those risks. HEPA (high-efficiency particulate airfilters), ultraviolet (UV) lights, antimicrobial surface coating and treatments, increased cleaning protocols, passenger screenings, masks, social distancing, and limited movement in the cabin for restroom access and service carts are all options that are being considered.

But all of these options are traded against other considerations such as power, weight, maintenance, cabin pressure, comfort, certification, and, not least, cost. They must also demonstrate efficacy. At the end of the day, the best way to stay safe is to stay home. Any option to fly comes with some element of risk. One could make the argument that the risk of driving to and from the airport, walking through the airport, and traveling on buses, tram cars, and so on are far riskier than the actual flight. This may not be true, depending on whether you have a preexisting condition or being a member of a vulnerable population. Still, it does illustrate that the aircraft is just one of the elements that we have to address.

It is the responsibility of our agencies, our legislature, our industry, and our public to find the right balance of risk. That balance may change as time goes by. Strict controls put in place initially to "flatten the curve" may not be appropriate in the long term. Conversely, controls may need to be reinstated over time if new information is presented. Science will characterize and inform these risks and decisions.

While other factors will undoubtedly play a role in final decisions, understanding the air travel environment is the very first step. This will require an assessment of a variety of disciplines such as computational fluid dynamics, statistics and modeling, epidemiology, sociology and psychology, chemistry, biology, and many more. This is certainly not an easy task, but it is not unachievable.

It is often said that these are unprecedented times, but we have faced similar health challenges before. I am very confident we can come through this stronger and more resilient than ever. The aerospace industry and our scientific, technical, and healthcare systems are absolutely second-to-none.

I look forward to hearing from our witnesses today, and I yield back.

[The prepared statement of Mr. Babin follows:]

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According to recent press reports, airlines are operating at between 15 and 17 percent capacity compared to last year. At the same time, private jet flights have surged 70 percent, but this doesn't do anything to help most Americans. Polling done recently by the International Air Transportation Association indicated that only 45 percent of the population was willing to fly within one or two months of restrictions being lifted. This does not bode well for an industry that our nation depends upon so heavily.

For this reason, it is crucial to understand the health risks posed by airline travel as accurately as possible. Research into how the virus propagates in an aircraft cabin via airborne or surface transmission is the start. Characterizing that environment will then allow airlines, aircraft manufacturers, airports, government agencies, and the public to develop technologies and processes to mitigate those risks. HEPA filters, ultraviolet lights, antimicrobial surface coating and treatments, increased cleaning protocols, passenger screenings, masks, social distancing, and limited movement in the cabin for restroom access and service carts are all options being considered.

But all of these options are traded against other considerations such as power, weight, maintenance, cabin pressure, comfort, certification, and cost. They must also demonstrate efficacy. At the end of the day, the best way to stay safe is to stay home. Any option to fly comes with some element of risk. One could make the argument that the risk of driving to and from the airport, walking through the airport, and traveling on buses and tram cars are far riskier than the actual flight. This may not be true, depending on whether you have a preexisting condition or are a member of a vulnerable population. Still, it does illustrate that the aircraft is just one of the elements that we have to address.

It is the responsibility of our agencies, our legislature, our industry, and our public to find the right balance of risk. That balance may change as time goes by. Strict controls put in place initially to "flatten the curve" may not be appropriate in the long term. Conversely, controls may need to be reinstated over time if new information is presented. Science will characterize and inform these risks and decisions. While other factors will undoubtedly play a role in final decisions, understanding the air travel environment is the first step. This will require an assessment of a variety of disciplines such as computational fluid dynamics, statistics and modeling, epidemiology, sociology and psychology, chemistry, biology, and many more. This is certainly not an easy task, but it is not unachievable.

It is often said that these are unprecedented times, but we have faced similar health challenges before. I am confident we can come through this stronger and more resilient than ever. The aerospace industry and our scientific, technical, and health care systems are second-to-none.

I look forward to hearing from our witnesses today and yield back.

Mr. BABIN. But I would also ask for unanimous consent, Madam Chair, that a letter from the Airlines for America (A4A) be added to the record. I yield back.

Chairwoman HORN. Without objection, it'll be added to the record. Thank you. Thank you, Mr. Babin.

The Chair now recognizes the Chairwoman of the Full Committee, Ms. Johnson, for an opening statement.

Chairwoman JOHNSON. I want to express my appreciation to Chairwoman Horn for holding this hearing and really make a special thank you for the witnesses for appearing before the Subcommittee today.

The aviation system is both an important contributor to the U.S. economy and an important factor in the national and global response to a communicable disease outbreak. At the threat of—as the threat of COVID–19 continues, it is critical for the health and safety of flight crews, airport employees, and the flying public that science-based policies, practices, and regulations are put in place to reduce the risk of further spread of the virus. Research and development must be part of the solution.

Congress has been attentive to public health concerns on aircraft, paying particular attention to the issue of cabin air quality. While researchers have learned about the airplane cabin air circulation and the spread of communicable disease in aircraft, many questions remain. Today's hearing will inform us on the role of R&D in understanding and mitigating the risk of virus transmission through air travel. I also look forward to hearing from our witnesses about how the research is being translated to operational solutions because the airlines, crew, and the flying public really need clear information.

The coronavirus is a national and global crisis. Yet, despite international obligations and recommendations from GAO (Government Accountability Office), we continue to lack a national preparedness plan to address the threat of communicable disease transmission through travel. That is troubling, given the devastating toll that the coronavirus has taken on airlines and so many other industries. We need to be prepared to avoid repeating the same mistakes with our future pandemics.

I continue to be proud of how the research community and our frontline workers like those in the aviation community continue to rise to the ongoing challenge of COVID–19. I look forward to the—hearing from our witnesses about how R&D can be part of the solution to healthy air travel during this COVID–19 and into the future. I thank you and yield back.

[The prepared statement of Chairwoman Johnson follows:]

Good morning. Thank you, Chairwoman Horn, for holding this hearing, and thank you to our witnesses for appearing before the Subcommittee today. The aviation system is both an important contributor to the U.S. economy and an important factor in the national and global response to a communicable disease outbreak. As the threat of COVID–19 continues, it is critical for the health and safety of flight crews, airport employees, and the flying public that science based policies, practices, and regulations are put in place to reduce the risk of further spread of the virus. Research and development must be part of the solution.

Congress has been attentive to public health concerns on aircraft, paying particular attention to the issue of cabin air quality. While researchers have learned about airplane cabin air circulation and the spread of communicable disease in aircraft, many questions remain.

Today's hearing will inform us on the role of R&D in understanding and mitigating the risk of virus transmission through air travel. I also look forward to hearing from our witnesses about how the research is being translated to operational solutions, because the airlines, crew, and the flying public need clear information.

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I continue to be proud of how the research community and our frontline workers like those in the aviation community continue to rise to the ongoing challenge of COVID–19. I look forward to hearing from our witnesses about how R&D can be part of the solution to healthy air travel during COVID–19 and into the future.

Thank you, and I yield back.

Chairwoman HORN. Thank you, Chairwoman Johnson.

The Chair now recognizes Ranking Member Lucas of the Full Committee for an opening statement. Mr. Lucas?

Mr. LUCAS. Thank you, Madam Chair and Ranking Member of the Subcommittee and Chairwoman Eddie Bernice Johnson.

I can think of no more timely or important hearing than the topics and subject matter we're covering today, examining the status of R&D as it relates to supporting healthy air travel.

As we heard in the hearing earlier this year, and addition to COVID–19, there are potentially one million-plus pathogens that exist in the wild, so the efforts that we apply to address and deal with the struggles we have right now, whether it's COVID–19 or other things, are more important to the future of air travel than I think we could even possibly imagine.

Whether it is the health of our—each of us individually, our families, or has COVID–19 has demonstrated, the world, the issues discussed today have to be addressed in a thoughtful manner that will help move everything forward. We didn't just have trouble starting with this plague, but it is a reflection of struggles we've had for decades.

I very much appreciate the Chair and the Ranking Member for holding this hearing. I look forward to the witness's comments, and let's work together to make sure the lives of our constituents are safer and more productive as a result of this. Yield back, Madam Chair.

Chairwoman HORN. Thank you, Mr. Lucas. And thank you again to the witnesses.

At this point if there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

At this time, I'd like to introduce our witnesses for this important hearing today. Our first witness is Ms. Heather Krause, Director of the Government Accountability Office Physical Infrastructure Team. The Physical Infrastructure Team assists Congress and Federal agencies to address challenges within the U.S. infrastructure, including transportation systems. Since joining GAO in 2003, Ms. Krause has been an expert on the safety and operations of the National Airspace System. Ms. Krause received a bachelor of arts degree in political science from the University of Minnesota Duluth and a master's degree in public policy from the University of Minnesota. Welcome, Ms. Krause.

Our second witness today is Dr. Byron Jones. At this time, I would like to recognize Congressman Marshall for an introduction of Dr. Jones. Mr. Marshall, you are recognized.

Mr. MARSHALL. All right. Good morning, Chairwoman Horn and my good friend Ranking Member Babin. Hopefully, you got a good connection with me. I'm running around the State of Kansas right now, but I did not want to miss a chance to introduce a fellow wildcat from the K State University.

Dr. Byron Jones is the Director of the National Gas Machinery Laboratory at the Kansas State University located in beautiful Manhattan, Kansas. He's a long-standing member of K State's faculty. He served as the Associate Dean for Research at K State's College of Engineering—by the way, I might add, one of the top engineering programs in the country—and serves as the Head of Mechanical and Nuclear Engineering and is Director of the Institute for Environmental Research.

His current research areas include aircraft cabin air quality, aircraft environmental control systems, turbomachinery, and aircraft

bleed air contamination. Wow. He serves as Technical Director of the FAA Air Transportation Center of Excellence for Airliner Cabin Environment Research and has chaired the development of the original ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) standard 161 air quality and commercial aircraft.

He has a bachelor's degree, of course, from Kansas State University. Somehow we let him slip down to Oklahoma State University (OSU) for his M.S. and Ph.D. from Oklahoma State University and all in mechanical engineering. He's a licensed professional engineer, of course, and a licensed commercial pilot, wow, so that brings some substance to the discussion today.

He brings a wealth of knowledge on this topic and, again, welcome to Dr. Byron Jones from Kansas State University, the home of the fighting wildcats.

Chairwoman HORN. Thank you, Mr. Marshall. And of course I would be remiss—Ranking Member Lucas and I always have to celebrate all of the amazing Oklahomans that we have and spending time at OSU absolutely is included in that. I would venture to guess the Ranking Member agrees with me there.

So, our third witness today is Dr. Vicki Hertzberg, Professor of the Nell Hodgson Woodruff School of Nursing and Director of—at the Center for Nursing Data Science at both Emory—both at Emory University. Professor Hertzberg is an internationally recognized expert on big data and its impact on health care. She has led research efforts in social contact and disease transmission in densely populated indoor spaces, including emergency rooms and aircraft cabins. Professor Hertzberg received a bachelor of science degree in mathematics and statistics and a doctoral degree in biomathematics, health statistics track, from Miami University in Ohio. Welcome, Dr. Hertzberg.

As our witnesses—each of you should know that you will each have five minutes for your spoken testimony. Your written testimony will be included for the record in the hearing. When you've completed your spoken testimony, we will begin with questions, and each Member will have five minutes to question the panel. We have a timer here that you should be able to see on your screen, and I will notify you as time is up. We will begin today with Ms. Krause.

Ms. Krause, you're recognized.

TESTIMONY OF MS. HEATHER KRAUSE, DIRECTOR, PHYSICAL INFRASTRUCTURE ISSUES, GOVERNMENT ACCOUNTABILITY OFFICE

Ms. KRAUSE. Thank you. Chairwoman Horn, Chairwoman Johnson, Ranking Member Babin, and Ranking Member Lucas and Members of the Subcommittee, thank you for the opportunity to discuss our work on reducing the risk of transmitting communicable disease through the aviation sector.

Air travel more than any other mode of transportation creates the potential for infected persons to move quickly from one part of the world to another. Air travel greatly aided and accelerated the global transmission of COVID–19, which is having profound effects around the world. In light of the resulting pandemic and warnings

about the risk of air travel, as noted earlier, U.S. passenger airline traffic fell dramatically, dropping 96 percent in April 2020 as compared to a year ago.

COVID–19 is only the latest communicable disease to raise concerns about the spread of contagion through air travel. Since 2002, there have been six major public health threats with global ramifications, including SARS (severe acute respiratory syndrome) in 2003 and the Ebola virus in 2014. Ensuring that the United States is prepared to respond to disease threats from air travel and conducting the necessary research to reduce the risks of a contagion are two vital responsibilities of the Federal Government.

My testimony today focuses on, one, the U.S. aviation system's preparedness to respond to communicable disease threats; and, two, the extent to which disease transmission on aircraft and in airports has been a focus of FAA research.

Starting with our work on preparedness, the United States still lacks a comprehensive national aviation preparedness plan to limit the spread of communicable diseases through air travel. In December 2015 during the Ebola pandemic we recommended that DOT (Department of Transportation) work with relevant stakeholders such as the Departments of Health and Human Services (HHS) and Homeland Security (DHS) to develop a national aviation preparedness plan for communicable disease outbreaks. We concluded that the absence of a national plan undermined the ability of public health in and transportation sectors to coordinate on a response or to provide consistent guidance to airlines and airports.

More than 4 years later, DOT is confronting an even more widespread public health crisis with COVID–19 without having taken steps to implement our recommendation. DOT and HHS officials agree that a national aviation preparedness plan could add value. However, DOT maintains that HHS and DHS have both the legal authority and expertise for public health and emergency response respectively and that these agencies should lead any efforts to address planning for communicable disease outbreaks, including for transportation.

We continue to believe that DOT would be in the best position to lead this effort because DOT and FAA have stronger and deeper ties to, and oversight responsibility for, the relevant stakeholders that would be most involved in such a broad effort, namely, airlines, airports, and other aviation stakeholders. A national aviation preparedness plan can not only provide a way for the public health and aviation sectors to coordinate and more effectively prevent and control a threat, it could also help minimize unnecessary disruptions to the national aviation system, which to date have been significant.

In addition, Annex 9 to an international aviation treaty, to which the United States is a signatory, contains a standard that obligates member States to establish such a plan.

Now turning to FAA's research and development, FAA has sponsored limited Federal research into disease transmission onboard aircraft and in airports. Instead, FAA's research has focused on areas like reducing accidents, improving airport operations and airspace management, and developing new technologies. Such re-

search is consistent with DOT's strategic goals related to safety, infrastructure, and innovation.

Even so, FAA has funded some programs relevant to mitigating communicable disease transmission in airports and on aircraft. For example, in 2018 the Airports Cooperative Research Program or ACRP, which is funded by FAA's Airport Improvement Program, held a workshop on airports' roles in reducing the transmission of communicable diseases. ACRP has issued several reports, including guidance to airports and airlines on infectious disease, mitigation onboard aircraft, and for ways to reduce the spread of communicable disease in airports.

The Centers for Disease Control within HHS, which is responsible for the Nation's public health, also sponsors health-related research involving air transportation. Such research, along with developing and maintaining a national aviation preparedness plan, is critical to ensuring the United States is sufficiently prepared to respond to any future communicable disease threat.

This concludes my statement. I look forward to answering your questions.

[The prepared statement of Ms. Krause follows:]

United States Government Accountability Office

Testimony

Before the Subcommittee on Space and Aeronautics, Committee on Science, Space, and Technology, House of Representatives

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AIR TRAVEL AND COMMUNICABLE DISEASES

Status of Research Efforts and Action Still Needed to Develop Federal Preparedness Plan

Statement of Heather Krause, Director,
Physical Infrastructure

GAO Highlights

Highlights of GAO-20-655T, a testimony before the Subcommittee on Space and Aeronautics, Committee on Science, Space, and Technology, House of Representatives

Why GAO Did This Study

The transmission of COVID-19 has been greatly aided by air travel. In light of the pandemic and warnings about the risks of air travel, U.S. passenger airline traffic fell by 96 percent in April 2020 as compared to April 2019. COVID-19 is only the latest communicable disease threat to raise public health concerns regarding the spread of contagion through air travel. Ensuring that the United States is prepared to respond to disease threats from air travel, as well as conducting the necessary research to reduce the risks of contagion, are two vital responsibilities of the federal government.

This statement provides information on (1) the U.S. aviation system's preparedness to respond to communicable disease threats and (2) FAA's management of its R&D portfolio, including the extent to which disease transmission on aircraft and at airports has been the focus of FAA research. This statement is based on GAO-16-127 issued in December 2015 and GAO-17-372 issued in April 2017. GAO conducted updates to obtain information on the actions agencies have taken to address these reports' recommendations.

What GAO Recommends

GAO made several recommendations in its prior work, including that DOT develop a comprehensive national aviation-preparedness plan, and that FAA identify long-term R&D priorities, among other things. Progress has been made in addressing some of the recommendations. Continued attention is needed to ensure that the remainder of these recommendations are addressed.

View GAO-20-655T For more information, contact Heather Krause, 202-512-2834, krausen@gao.gov

June 23, 2020

AIR TRAVEL AND COMMUNICABLE DISEASES

Status of Research Efforts and Action Still Needed to Develop Federal Preparedness Plan

What GAO Found

The United States still lacks a comprehensive plan for national aviation preparedness to limit the spread of communicable diseases through air travel. In December 2015 during the Ebola epidemic, GAO recommended that the Department of Transportation (DOT) work with relevant stakeholders, such as the Department of Health and Human Services (HHS), to develop a national aviation-preparedness plan for communicable disease outbreaks. GAO concluded that the absence of a national plan undermined the ability of the public-health and aviation sectors to coordinate on a response or to provide consistent guidance to airlines and airports. Moreover, Annex 9 to an international aviation treaty to which the United States is a signatory contains a standard that obligates member states to develop such a plan. DOT is now confronting an even more widespread public health crisis—the Coronavirus Disease (COVID-19) global pandemic—without having taken steps to implement this recommendation. Not only could such a plan provide a mechanism for the public-health and aviation sectors to coordinate to more effectively prevent and control a communicable disease threat, it could also help minimize unnecessary disruptions to the national aviation system, disruptions that to date have been significant. Some aviation stakeholders have publicly highlighted the resulting piecemeal approach to adopting standards during the response to COVID-19, such as various airline and airport policies regarding facemasks, as demonstrating the need for a more coordinated response. The existence of a national plan might have reduced some of the confusion among aviation stakeholders and passengers. While DOT agrees that a national aviation preparedness plan is needed, the agency continues to suggest that HHS and the Department of Homeland Security have responsibility for communicable disease response and preparedness planning. GAO continues to believe that DOT is in the best position to lead this effort given its oversight responsibilities and ties with relevant aviation stakeholders.

The Federal Aviation Administration (FAA) has sponsored limited federal research into disease transmission onboard aircraft and in airports. FAA's research goals focus on areas like improving airport operations and air space management, and developing new technologies, which FAA has aligned to DOT's strategic goals related to safety, infrastructure, and innovation. Based on prior work and interviews with FAA officials, GAO found that FAA's research in cabin safety for crew and passengers does not focus on disease transmission. For example, according to FAA officials, ongoing research that most closely relates to disease contamination is research related to monitoring the quality of "bleed air," which is outside air that is drawn through jet engines into an aircraft cabin. In 2017, GAO found that FAA could be more strategic in how it develops its research and development (R&D) portfolio, chiefly in identifying long-term research needs and explaining how FAA selects projects. Of the three recommendations GAO made in that report to improve FAA's management of its R&D portfolio, FAA fully addressed one, issuing guidance in 2018 on prioritizing and selecting R&D projects. While FAA has made some progress addressing GAO's recommendations on research portfolio development and reporting, further attention to these recommendations could help ensure that FAA strategically identifies research priorities across the agency.

Chairwoman Horn, Ranking Member Babin, and Members of the Subcommittee:

Thank you for the opportunity to discuss our body of work relating to reducing the risk of communicable disease transmission in the aviation sector and the status of the Department of Transportation's (DOT) aviation research and development on this topic. The outbreak of Coronavirus Disease 2019 (COVID-19) is having profound effects around the world. Its global transmission was greatly aided and accelerated by air travel, which totaled more than 4.5 billion passengers in 2019, mostly before the widespread outbreak. In light of the resulting pandemic and warnings about the risks of air travel, U.S. passenger airline traffic fell by 96 percent in April 2020, as compared to April 2019. COVID-19 is only the latest communicable disease to raise concerns about the spread of contagion through air travel. Since 2002, there have been six major public health epidemic threats with global ramifications, including the severe acute respiratory syndrome (SARS) in 2003 and the Ebola virus disease in 2014. More than any other mode of transportation, air travel creates the potential for infection to move quickly from one part of the world to another. In December 2015, we recommended that the Secretary of Transportation should work with relevant federal stakeholders to develop a national aviation-preparedness plan for communicable disease outbreaks.[1]

In order to identify technologies and solutions to improve the safety of the civil aviation system, the federal government conducts research and development (R&D) to advance U.S. technological leadership and foster a dynamic aerospace industry. The Federal Aviation Administration (FAA) within DOT, along with the National Aeronautics and Space Administration (NASA), is responsible for the management of the federal government's civil aviation R&D. The Centers for Disease Control (CDC) within the Department of Health and Human Services (HHS) also sponsors health-related research involving air transportation.

My testimony today is based largely on reports we issued in 2015 on air travel and communicable disease and in 2017 on FAA's management of

[1]GAO, *Air Travel and Communicable Diseases: Comprehensive Federal Plan Needed for U.S. Aviation System's Preparedness*, GAO-16-127 (Washington, D.C.: Dec. 16, 2015).

commercial aviation R&D.[2] Specifically, this testimony describes: (1) the U.S. aviation system's preparedness to respond to communicable disease threats from abroad and (2) FAA's management of its R&D portfolio, including the extent to which disease transmission on aircraft and at airports has been the focus of FAA research.

To conduct our prior work, we reviewed available documents and interviewed officials from the key federal departments with responsibilities for conducting aviation research and for preparing for communicable disease threats from abroad and responding to them. In addition, we interviewed a range of stakeholders to discuss aviation preparedness and research, and potential opportunities to improve those areas. More detailed information on our objectives, scope, and methodology can be found in each of the reports.

For this statement, we contacted DOT, Department of Homeland Security (DHS), and HHS officials to determine the status of a national aviation-preparedness plan for the aviation system as recommended in our 2015 report. In addition, we interviewed FAA officials to learn about actions FAA has taken to address the recommendations we made in our 2017 report to improve the development, tracking, and reporting of the federal government's civil-aviation research and development portfolio. We also reviewed aviation-related research on communicable disease from the past 10 years, selected based on key word searches.

We conducted the work on which this testimony is based in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on audit objectives. We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

Background

In the United States, the roles and responsibilities related to preparing for, assessing, and responding to communicable disease threats in the civil aviation system require immense coordination among a number of federal agencies and aviation stakeholders. Each federal agency has a different mission, which affects its responsibilities for protecting against communicable disease threats. The DHS and HHS are the lead agencies

[2]GAO-16-127and GAO, *Aviation Research and Development: FAA Could Improve How It Develops Its Portfolio and Reports Its Activities*, GAO-17-372 (Washington, D.C.: Apr. 24, 2017).

for responding to a communicable disease threat. They focus on protecting our borders at ports of entry, including airports, from threats from abroad and protecting the nation from domestic and foreign health, safety, and security threats, respectively. FAA is responsible for civil aviation and commercial space transportation flight safety in the United States and the safe and efficient movement of air traffic in the national airspace system, as well as for the safety of U.S. airlines, other U.S. operators, and FAA-certificated aircrews worldwide. As part of this responsibility, FAA regulates and certificates airports, airlines, and airmen and provides guidance.[3]

In the case of a communicable disease threat, numerous federal, state, and local entities may be called upon to respond, depending on their legal authority and whether the threat is identified before, during, or after the flight. For example, before boarding, HHS and DHS may identify travelers who are not allowed travel, based on public health threats.[4] The CDC can prohibit the introduction of nonresident foreign nationals into the United States from designated countries or places, but only for such time as the CDC deems necessary for public health. During a flight, CDC regulations require pilots to immediately report to CDC any deaths or the occurrence of any travelers with signs or symptoms that may indicate a communicable disease infection during international flights coming to the United States. And, once an aircraft with a suspected ill passenger approaches an airport, federal or local public health officials, first responders (e.g., fire or emergency medical technicians), airport authorities, air traffic control personnel, or a combination of these stakeholders may make decisions about and lead certain aspects of the response based on the situation and available response protocols or preparedness plans. In addition, some response-related roles and responsibilities are established in law or by interagency agreements, and others may be defined in FAA-required airport-emergency plans, although those plans are not required to address communicable disease threats.

In addition, FAA supports and coordinates a range of R&D activities for the civil aviation system. The inventory of FAA's R&D activities is

[3]Within the Department of Labor (DOL), the Occupational Safety and Health Administration (OSHA) aims to assure safe and healthful working conditions, including for airline crews and the contract employees who clean aircraft.

[4]When HHS requests DHS assistance, HHS notifies DHS's Transportation Security Administration of individuals it has identified as public health threats who should be designated "Do Not Board."

expressed in the *National Aviation Research Plan (NARP) and in FAA's Fiscal Year R&D Annual Review*.[5] FAA is required to submit both of these documents annually to Congress.[6] According to FAA's most recent *NARP*, FAA's research budget from all accounts in FY 2017 was $422.3 million.[7] FAA's research budget supports activities conducted by FAA as well as a range of partners, including other government agencies, universities, and private sector organizations.

FAA's process for developing its commercial aviation research portfolio spans the agency. To develop the NARP and its R&D portfolio, FAA's program planning teams, which focus on specific research program areas, identify R&D projects to meet one of DOT's three strategic goals and FAA's five R&D goals.[8] Further, an executive board in FAA provides guidance and oversight over the agency's portfolio development process, and a statutorily created advisory committee—consisting of individuals that represent corporations, universities, associations, and others—conducts external reviews of FAA's R&D programs for relevance, quality, and performance. This advisory committee also makes recommendations to FAA on the proposed R&D portfolios and budgets.

[5]FAA uses the *NARP* to present budget requirements for its R&D programs to Congress. The NARP identifies FAA's R&D goals and research programs that the agency has prioritized. The FAA's Fiscal Year *R&D Annual Review* provides summaries of R&D accomplishments.

[6]49 U.S.C. § 44501(c).

[7]Three appropriation accounts contribute to FAA's overall research budget, including Research, Engineering and Development (RE&D), Facilities & Equipment (F&E), and Grants-In-Aid for Airports (AIP).

[8]DOT's three strategic goals focus on safety, infrastructure, and innovation. FAA's R&D goals focus on, among other things, airport and air space management, infrastructure durability, new technologies, system-wide analysis, and improving the human component of the system.

In the Continued Absence of a Comprehensive National Plan, the U.S. Aviation System Remains Insufficiently Prepared to Respond to Communicable Disease Threats

In 2015, we found that the United States lacked a comprehensive national aviation-preparedness plan to limit the spread of communicable diseases through air travel, though some individual airport and airline preparedness plans did exist.[9] Accordingly, we recommended that DOT work with relevant stakeholders, such as HHS, to develop a national aviation-preparedness plan for communicable disease outbreaks. We emphasized that a comprehensive national plan would provide a coordination mechanism for the public-health and aviation sectors to more effectively prevent and control a communicable disease threat while also minimizing unnecessary disruptions to the national aviation system. Additionally, U.S. airports and airlines are not required to have individual preparedness plans for communicable disease threats and no federal agency tracks which airports and airlines have them. As such, the extent to which U.S. airports and airlines have such plans is unknown. However, all 14 airports and 3 airlines we reviewed in 2015 had independently developed preparedness plans for responding to communicable disease threats from abroad. These plans generally addressed the high-level components that we identified as common among applicable federal and international guidance for emergency preparedness, such as establishment of an incident command center and activation triggers for a response. While the 14 airports and 3 airlines had plans that address communicable diseases, representatives from these airports and airlines reported facing multiple challenges in responding to threats. Identified challenges that included obtaining guidance; communication and coordination among responders; and assuring employees have appropriate training, equipment, and sanitary workplaces. As we stated in our 2015 report, a national aviation preparedness plan to respond to communicable disease outbreaks could help address these challenges.

As of June 2020, DOT, DHS, and HHS stated that the federal government still has not developed a national aviation-preparedness plan to respond to communicable disease outbreaks. In making our recommendation in 2015, we pointed to Annex 9 to the Chicago Convention—an international aviation treaty to which the United States is a signatory—which contains a standard that obligates International Civil Aviation Organization (ICAO) member states to develop a national aviation-preparedness plan for

[9]GAO-16-127.

communicable disease outbreaks.[10] DOT and CDC officials in 2015 stated that some elements of a national aviation-preparedness plan already exist, including plans at individual airports. However, as we discussed in our 2015 report, individual airport plans are often contained in multiple documents, and FAA reported that the plans are intended to handle communicable disease threats posed by passengers on one or two flights, rather than an epidemic—which may require involvement from multiple airports on a national level. Most importantly, a national aviation-preparedness plan would provide airports and airlines with an adaptable and scalable framework with which to align their individual plans, to help ensure that individual airport and airline plans work in concert with one another.

DOT and CDC officials agreed in 2015 and continue to agree today that a national aviation-preparedness plan could add value. DOT, however, maintains that those agencies that have both legal authority and expertise for emergency response and public health—namely DHS and HHS—are best positioned to take the lead role in developing such a plan within the existing interagency framework for national-level all-hazards emergency preparedness planning. We continue to believe that DOT would be in the best position to lead the effort because FAA and DOT have stronger and deeper ties to, as well as oversight responsibility for, the relevant stakeholders that would be most involved in such a broad effort, namely airlines, airports, and other aviation stakeholders. In addition, DOT's Office of the Secretary is the liaison to ICAO for Annex 9 to the Chicago Convention, in which the relevant ICAO standard is contained.

In response to the current COVID-19 pandemic and in the absence of a national aviation-preparedness plan, DOT officials pointed to ongoing efforts to engage with interagency partners at DHS and HHS, as well as industry stakeholders, to better collaborate on the aviation sector's communicable disease response and preparedness. For example, DOT told us that it has facilitated conference calls between federal and private sector stakeholders and has collaborated with CDC to update interim

[10]Chicago Convention on International Civil Aviation, Section F of Annex 9, subparagraph 8.16. ICAO is a United Nations specialized agency created in 1944 by the Convention on International Civil Aviation (Chicago Convention), under which ICAO Member States agreed, among other things, "to take effective measures to prevent the spread by means of air navigation of cholera, typhus (epidemic), smallpox, yellow fever, plague and such other communicable diseases as the [ICAO Member] States shall from time to time decide to designate." Chicago Convention on International Civil Aviation art. 14, Apr. 4, 1944, 61 Stat 1180, T.I.A.S. No. 1,591.

guidance for airline crews related to communicable diseases, specifically COVID-19.[11] While these actions are helpful, some aviation stakeholders have publicly highlighted piecemeal response efforts that may have led to some of the confusion among stakeholders and chaos at certain airports that occurred earlier this year following the COVID-19 travel bans and increased screening efforts. For example, stakeholders described actions taken by individual airlines in the absence of FAA guidance, such as to cease operations to certain countries, and a piecemeal approach to establishing standards for safely continuing or expanding service, such as various airline and airport policies regarding facemasks. This piecemeal approach points to the continued need for DOT to implement our 2015 recommendation to develop a coordinated effort to plan for and respond to communicable disease threats. We have included this open recommendation as one of 16 high priority recommendations to DOT.[12]

[11]CDC, *Updated Interim Guidance for Airlines and Airline Crew: Coronavirus Disease 2019 (COVID-19)* (Updated Mar. 11, 2020).

[12]GAO, *Priority Open Recommendations: U.S. Department of Transportation* GAO-20-513PR (Washington, D.C.: April 23, 2020).

FAA Has Taken Steps to Improve Its R&D Portfolio Management, but Has Conducted Limited Research on Disease Transmission in Aircraft and Airports

FAA is Taking Steps to Improve the Formulation and Management of its R&D Portfolio Based on GAO Recommendations

While a national aviation-preparedness plan can help better manage the response to the next aviation pandemic, other efforts such as research and development are also key. In 2017, we found that FAA's actions related to the management of its R&D portfolio were not fully consistent with statutory requirements, agency guidance, and leading practices.[13] As part of that work, we assessed FAA's actions to manage its R&D portfolio in three key areas: (1) developing its portfolio of R&D projects, (2) tracking and evaluating those projects, and (3) reporting on its portfolio. We found that FAA could be more strategic in how it develops its R&D portfolio, chiefly in identifying long-term research needs and in improving disclosure of how projects are selected. As a result of these deficiencies, we found that FAA management could not be assured that the highest priority R&D was being conducted. We also found that while FAA tracks and evaluates its research projects consistent with leading practices, it did not fully address all statutory reporting requirements, such as identifying long-term research resources in the *National Aviation Research Plan (NARP)* or preparing the *R&D Annual Review* in accordance with government performance-reporting requirements. These reporting deficiencies can limit the usefulness of the reports to internal and outside stakeholders. Accordingly, in 2017, we recommended that DOT direct FAA to (1) take a more strategic approach to identifying long-term R&D research priorities across the agency, (2) disclose how research projects are prioritized and selected, and (3) ensure that the NARP and *R&D Annual Reviews* meet statutory requirements for content. DOT agreed with all three recommendations.

As of June 2020, FAA has fully addressed one of our recommendations and taken partial action on two other recommendations. Specifically, FAA

[13]GAO-17-372.

fully responded to our recommendation that FAA disclose the process it uses for prioritizing and selecting research projects by updating in 2018 its internal guidance documents to allow better transparency over project selection. In partially responding to our recommendation to take a more strategic approach to identifying research priorities across the agency, in June 2019, FAA issued a redesigned *National Aviation Research Plan (NARP)* for 2017-2018. The redesigned plan is a good first step. Also as part of an effort to be more strategic, FAA is beginning to take actions to understand emerging aviation issues requiring FAA's research attention. This recommendation has not been fully addressed as, according to FAA officials, the agency is still developing guidance to ensure that future NARPs take a strategic approach and incorporate emerging issues into future plans. FAA officials told us they plan to finalize the guidance by the end of 2020. Similarly, with respect to our recommendation aimed at achieving compliance with statutory reporting requirements, the redesigned 2017-2018 NARP included a list of agreements with federal and nonfederal entities on research activities, resource allocation decisions, and a description of technology transfer to government, industry, and academia, among other items. Officials told us that they are finalizing the 2019 *R&D Annual Review*, which has been redesigned to address other statutory reporting requirements, and will develop guidance to ensure that future documents meet those requirements.

Disease Transmission Research Has Received Limited FAA Focus in Recent Years

FAA has sponsored limited federal research into disease transmission onboard aircraft and in airports. FAA's research goals focus on areas like improving airport operations and air space management, and developing new technologies, which FAA has aligned to DOT's strategic goals related to safety, infrastructure, and innovation. Based on our prior work and interviews with FAA officials, we found that FAA's research in cabin safety for crew and passengers does not focus on disease transmission. For example, according to FAA officials, as of June 2020, ongoing research that most closely relates to disease contamination is research related to monitoring the quality of "bleed air," which is outside air that is

drawn through jet engines into an aircraft cabin.[14] FAA officials said that its Civil Aerospace Medical Institute is participating in this research.

Even so, FAA has funded some programs that are relevant to mitigating communicable disease transmission at airports and on aircraft. For example, in 2015 the Transportation Research Board's Airports Cooperative Research Program (ACRP), which is funded by FAA's Airport Improvement Program (AIP), decided to hold a series of workshops on topics that are of significance to airports and that are not being addressed by other federal research programs.[15] The decision to hold the first ACRP workshop on communicable disease occurred toward the end of the Ebola virus outbreak. ACRP has also issued reports on reducing communicable disease transmission at airports and aircraft.[16] These reports have provided information and guidance to airports and airlines on infectious disease mitigation onboard aircraft and ways to respond to a communicable disease in airports. For example, a 2013 ACRP report recommends reducing the amount of time aircraft ventilation systems are shutdown at the gate, so that an aircraft's high efficiency particulate air (HEPA) systems, which can capture more than 99 percent of the airborne microbes, continue to operate. ACRP also has a research project currently under way for publication early next year on effective collaboration to prevent, respond to, and mitigate disease threats.[17]

Prior to 2014, FAA also funded some research on disease transmission on aircraft through its Centers of Excellence research consortium. Specifically, in 2004, FAA established the Airliner Cabin Environment Research (ACER) Center of Excellence, which conducts research on,

[14]Air supplied to a pressurized aircraft cabin occurs via an environmental control system. Fresh air from outside the aircraft enters the environmental control system in most large commercial airplanes via the aircraft engines. The compressed air is then "bled" through ports and is cooled before being mixed with recirculated air, ultimately becoming distributed throughout the cabin. See FAA, Civil Aerospace Medical Institute, *Aircraft Cabin Bleed Air Contaminants: A Review* (Oklahoma City, OK: November 2015).

[15]Transportation Research Board, *Airport Roles in Reducing Transmission of Communicable Diseases: Summary of a Workshop of the Airport Cooperative Research Program's 2018 Insight Event* (Washington, D.C.: 2019).

[16]Transportation Research Board, *Infectious Disease Mitigation in Airports and on Aircraft*, (Washington, D.C.: 2013); Transportation Research Board, *Preparing Airports for Communicable Diseases on Arriving Flights: A Synthesis of Airport Practice* (Washington, D.C.:2017).

[17]Transportation Research Board, *Effective Collaboration to Plan and Respond to Communicable Disease Threats* (03-49). Expected publication January 2021.

among other things, the safety and health of passengers and crew inside the cabin. In 2010 and 2012, ACER published research on air quality in airline cabins and disease transmission in aircraft.[18] A researcher we interviewed who is affiliated with ACER said that the Center established a laboratory in 2006, called ACERL, which is currently conducting research on the dispersion of airborne particles (including viruses) in the aircraft cabin for CDC's National Institute of Occupational Safety and Health. As of 2014, ACER began operating independently as a consortium academia, government, and others and is no longer being funded solely by FAA.

FAA and DOT principally look to HHS and the CDC for guidance on passenger health issues. HHS has statutory responsibility for preventing the introduction, transmission, and spread of communicable diseases into the United States and among the states.[19] Within HHS, CDC has defined its mission as protecting America from health, safety and security threats, both foreign and domestic. CDC alerts travelers about disease outbreaks and steps they can take to protect themselves. CDC also has the authority to quarantine passengers traveling from foreign countries, if necessary, to prevent the introduction, transmission, or spread of communicable disease. CDC's National Institute for Occupational Safety and Health has conducted research and issued guidance in the past on disease transmission in aircraft and cabin crew health and, as previously noted, is funding current research through the ACER Center. CDC has also issued COVID-19 guidance for cabin crew safety.

[18]National Air Transportation Center of Excellence for Research in the Intermodal Transport Environment (RITE), Airliner Cabin Environment Research (ACER) Program, *Report to the FAA on the Airliner Cabin Environment* (Report No. RITE-ACER-CoE-2010-1) (Aug. 16, 2010); National Air Transportation Center of Excellence for Research in the Intermodal Transport Environment (RITE), Airliner Cabin Environment Research (ACER) Program, *Infectious Disease Transmission in Airliner Cabins* (Report No. RITE-ACER-CoE-2012-01) (Feb. 22, 2012).

[19]Under section 361 of the Public Health Service Act (codified at 42 U.S.C. § 264), HHS is authorized to make and enforce regulations to prevent the entry and spread of communicable diseases from foreign countries into the United States and among states. The authority for carrying out these functions on a daily basis has been delegated to CDC, an agency in HHS.

Some Technologies Could Be Useful to Reduce the Risks of Communicable Disease in Air Travel

There are a variety of technologies that could help address infectious disease transmission associated with air travel, but these technologies are at various stages of maturity. For example, the initial screening of passengers for fevers is typically done with handheld infrared thermometers and has been reportedly discussed for use by Transportation Security Agents. Reports also state that the mass screening of crowds using thermal cameras has been used in some airports in Asia, but such scanners are still being tested for standalone use in the United States, with some concerns reported about the accuracy of the results. Aircraft disinfection has traditionally been done by cleaning crews, but a number of methods are being developed using heat, chemicals, and UV light, and are under examination by researchers.

Chairwoman Horn, Ranking Member Babin, and Members of the Subcommittee, this completes my prepared remarks. I would be pleased to respond to any questions that you or other Members of the Subcommittee may have at this time.

GAO Contact and Staff Acknowledgments

If you or your staff have any questions about this statement, please contact me at (202) 512-2834 or krauseh@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this statement.

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Heather Krause

Heather Krause is a Director in GAO's Physical Infrastructure team. She is one of GAO's experts on the safety and operation of the national airspace system, including the integration of drones and commercial spaceflight into the national airspace.

Within GAO, Heather has worked in the Physical Infrastructure and Strategic Issues mission teams and previously led GAO's duplication and cost savings work.

Heather joined GAO in 2003. She holds a bachelor of arts in political science from the University of Minnesota Duluth and a master's degree in Public Policy from the University of Minnesota.

Chairwoman HORN. Thank you, Ms. Krause. The Chair now recognizes—oh, excuse me—Professor—Dr. Jones, you're recognized.

TESTIMONY OF DR. BYRON JONES, P.E., PROFESSOR, ALAN LEVIN DEPARTMENT OF MECHANICAL AND NUCLEAR ENGINEERING; DIRECTOR, NATIONAL GAS MACHINERY LABORATORY, KANSAS STATE UNIVERSITY

Dr. JONES. Good morning, Chairman Johnson—Chairwoman Johnson, Chairwoman Horn, Committee Members, guests, I am pleased to be able to offer my comments to this Committee today. I am a mechanical engineer. I do not claim to be a disease transmission expert. However, I have worked extensively with the aircraft environmental control systems, and I believe I understand how they function, how virus-containing droplets are carried by the air within the cabin, and how ventilation systems flush these droplets from the cabin. Sponsors of our research on these topics have included the FAA, CDC NIOSH (National Institute for Occupational Safety and Health), and Boeing.

Aircraft and air travel play two distinct roles with regard to disease spread during a pandemic. First, there is the transport of infected people throughout the world, which allows disease to spread across large distances. Second, there is transmission of disease between people within the aircraft. I will be addressing only the latter role, transmission within the aircraft cabin.

If I can get my thing to scroll up here, with regard to air travel, I believe the most critical research needed in the near-term is collection of the data and development of the tools needed to be able to quantitatively assess the risk of COVID–19 transmission on aircraft and to be able to quantitatively assess the effect of various mitigation measures on that risk. The key word here is quantitative. Expert opinions are plentiful, but reliable data are scarce. The air transportation industry and the flying public need sound quantitative information about risk and the impact of mitigations to be able to devise and deploy the appropriate mitigation strategies and to make informed decisions about air travel.

It is unrealistic to expect the risk of COVID–19 transmission in aircraft to be zero in the near future. However, it is realistic to expect that appropriate mitigation measures can be taken so as to ensure the risks are comparable to or lower than exposure risks we face in everyday life.

Unfortunately, we simply do not have the data nor the knowledge to confidently make that judgment today. We need these answers today, not in 2 years, not even in 6 months because we're not talking about a traditional research effort but rather an immediate, focused effort.

The scientific community is slowly learning about how COVID–19 is transmitted. However, when all is said and done, there's a lot more that we do not know than we do know. It is believed that a primary means of transmission is via respiratory droplets that are expelled when an infected person coughs, sneezes, talks, or even breathes. These droplets are then inhaled or otherwise transferred to the respiratory system of an uninfected person. The largest droplets do not travel far from the source. However, all but the largest

droplets can become partially or fully suspended in the air and be carried much further by air currents. The smaller ones can stay suspended more or less indefinitely and will stay in the cabin air until they are flushed out by the ventilation air or contact a surface.

High-risk environments are those environments with high-occupant density, extended exposure time, and poor ventilation. In this respect, aircraft cabins are both good and bad. Aircraft cabins are well-ventilated and—with a combination of outside air and HEPA-filtered recirculated air. One can be confident the air supplied to the cabin is virus-free.

Additionally, the amount of air supplied relative to the volume of the cabin is very high. This high ventilation rate results in an exponential decrease in droplet concentration with distance from the source as a ventilation air flushes the droplets from the cabin as they spread. This exponential decrease has been well-characterized through FAA and CDC NIOSH-funded research. Some small fraction of the smaller droplets will still be carried a number of seats from the source. Exposure risk presented by these droplets is not known.

The ventilation is good on aircraft, but that is not the whole story. The occupancy density is higher than just about any other space we routinely occupy and that occupancy can extend for several hours or more. Operating aircraft while maintaining 6 feet personal distancing is not economically feasible. Any realistic scenario for air travel in the COVID–19 environment will require other mitigation measures. We understand qualitatively how these mitigations work. However, as stated previously, we do not have the information needed to quantitatively assess the risk of transmission in aircraft and to assess the impact of mitigations on that risk. Ultimately, we need this information to be able to confidently say that air travel poses no greater risk of infection than other aspects of our daily life.

I thank you for your attention, and I thank Congressman Marshall for that wonderful introduction.

[The prepared statement of Dr. Jones follows:]

Testimony Provided by Byron W. Jones
June 23, 2020

Chairwoman Horn, committee members, staff, guests, I am pleased to be able to offer my comments to this committee today.

First a disclaimer. I speak today as a private citizen and not as an official representative of Kansas State University, the FAA, the CDC nor any other government agency or private institution with which I have worked.

Additionally, I am a mechanical engineer and do not claim to be a disease transmission expert. I have worked extensively with aircraft environmental control systems and I believe I understand how they function, how air contaminants, including virus containing droplets, are carried by the air within the cabin, and how ventilation systems flush these droplets from the cabin. Over the past 20 or so years, sponsors of research conducted by my colleagues and me on these topics have included the FAA through the Airliner Cabin Environment Research Center, CDC-NIOSH, and Boeing. CDC-NIOSH is currently funding some of our research.

Aircraft and air travel play two distinct roles with regard to disease spread during a pandemic. First there is the transport of infected people throughout the country and the world which allows the disease to spread rapidly across large distances. Second, there is transmission of disease between people within the aircraft. While the latter may amplify the spread during a pandemic, we mainly look at this transmission within the cabin from the perspective of the health of the passengers and crew on the aircraft. I will be addressing only the later role, transmission within the cabin.

I would like to address what I believe to be the most critical research needs in the near-term. The airlines, aircraft manufacturers, and flying public need the data and the tools to be able to quantitatively assess the risk of COVID-19 transmission on aircraft to be able to quantitatively assess the effect of various mitigation measures on that risk. Easy to say, challenging to accomplish.

It is unrealistic to expect the risk of COVID-19 transmission in aircraft to be zero in the near future. However, it is realistic to expect that appropriate mitigation measures can be taken so as to ensure the risks are comparable to or lower than exposure risks we face in everyday life. When it is clear what mitigation measures are needed and they are in place, the public can once again fly with confidence regarding their safety. Unfortunately, we simply do not have the data nor the knowledge to confidently make that judgement today. We need these answers today, not in two years or even in six months. Thus, we are not talking about a traditional research project but rather an immediate focused effort. Whether this research should be pursued and funded by industry or government is not for me to say but it would greatly benefit both the flying public as well as the air transportation industry.

The scientific community is slowly learning about how COVID-19 is transmitted and the details of how the virus travels from the host to infect another person. However, when all is said and done, there is a lot more that we do not know than we do know. It is believed that a primary means of transmission is via respiratory droplets that are expelled when an infected person coughs, sneezes, yells, sings, talks, or

even breathes. These droplets are then inhaled or otherwise transferred to the respiratory system of an uninfected person. These droplets span a wide range of sizes, from 1 micron, about 1/100 the diameter of a human hair to about 500 micron, the diameter of a small rain drop. The largest droplets will either strike a surface as a projectile upon being expelled or fall out of the air within a few seconds. They do not travel far from the source. However, all but the largest droplets can become partially or fully suspended in the air and can be carried much further by air currents. The smaller ones can stay suspended more-or-less indefinitely and will stay in the air until they are flushed out by the ventilation air or contact a surface and stick to it.

Qualitatively, we can identify the high risk environments, given the droplet nature of the transmission. Those are environments with high occupant density, extended exposure time, and poor ventilation. If an infectious person is present in such an environment, and expelling droplets, the droplet concentration in the air will continue to build and spread due to the poor ventilation; the high occupant density will result in many people being exposed; and the extended time proportionately increases that exposure. In this respect, aircraft cabins are both good and bad. Aircraft cabins are very well ventilated with a combination of outside air and recirculated air. HEPA filtration is nearly universal on the recirculated air which effectively removes viral material. Thus, one can be assured the air supplied to the cabin is virus free. Additionally, the amount of air supplied relative to the volume of the cabin is very high, a number of times higher than typical building environments. This high ventilation rate results in a rapid, exponential decrease in droplet concentration with distance from the source as the ventilation air rapidly flushes the droplets from the cabin as they spread. This exponential decrease has been well characterized through the ACER and CDC funded research. Some small fraction of the smaller droplets will still be carried a number of seats from the source. The exposure risk represented by these droplets is not known.

Additionally, the ventilation system is highly engineered and must meet stringent certification requirements and operational regulatory requirements. When in a commercial airliner, you can be assured that a carefully designed and functional ventilation system is supplying the cabin. Such is not true of many other spaces we occupy where it is difficult to determine if the ventilation is good or even functioning.

The ventilation is good on aircraft but that is not the whole story. The occupancy density is higher than just about any other space we routinely occupy and the occupancy can extend for several hours or more. Operating aircraft while maintaining six feet personal distancing is not economically feasible. Additionally, there is nothing magic about six feet. Given the high ventilation rate, it may be overkill and given the extended exposure times, it may not be adequate. Any realistic scenario for air travel in the COVID-19 environment will require mitigations other than the standard personal distancing. These mitigations may include universal use of face masks, use of high grade face masks, between the seat barriers, individual enclosures, etc. We understand, qualitatively, how these mitigations work. However, as stated previously, we do not have the information needed to quantitatively assess the risk of transmission in aircraft and assess of the impact of these mitigations. Ultimately, we need this information to be able to confidently say that air travel poses no greater risk of infection than other aspects of our daily life.

One final comment, I have focused on droplet transmission as that appears to be the dominant mode of transmission and it is what I know. However, there are certainly other modes that could be important, for example contact with contaminated surfaces or person-to-person contact. Ultimately we need to be able to quantitatively assess the risk for all likely modes.

Thank you for your attention.

Brief Bio
Byron W. Jones

Byron W. Jones is a Professor in the Alan Levin Department of Mechanical and Nuclear Engineering at Kansas State University and is the Director of the Kansas State University National Gas Machinery Laboratory. He has been a member of the KSU Faculty since 1978. He received his BS degree from KSU and his MS and PhD degrees from Oklahoma State University, all in mechanical engineering. Prior to his current position, he served as the Associate Dean for Research for the KSU College of Engineering. He has also held positions of Head of Mechanical and Nuclear Engineering and Director of the Institute for Environmental Research at KSU. Prior to joining KSU, he was a Sr. Systems Analyst at the Montana Energy and MHD Research and Development Institute.

His current research areas include, aircraft cabin air quality, aircraft environmental control systems, turbomachinery, and aircraft bleed air contamination. Dr. Jones serves as the technical director of the FAA Air Transportation Center of Excellence for Airliner Cabin Environment Research (ACER), a graduated center. He chaired the development of the original ASHRAE Standard 161, Air Quality in Commercial Aircraft. Dr. Jones is a licensed professional engineer and licensed commercial pilot, single engine land. He is a Fellow and Life Member of the American Society of Heating Refrigerating and Air-Conditioning Engineers, a Life Member of the American Society of Mechanical Engineers, and a Member of SAE International.

Chairwoman HORN. Thank you very much, Dr. Jones.
Dr. Hertzberg?

TESTIMONY OF DR. VICKI HERTZBERG, PROFESSOR AND DIRECTOR, CENTER FOR DATA SCIENCE, NELL HODGSON WOODRUFF SCHOOL OF NURSING, EMORY UNIVERSITY

Dr. HERTZBERG. Ladies and gentlemen of the Committee, good afternoon. First, a disclaimer. The contents of my testimony represent my opinion and are not the official opinion of the Emory University.

Second, I'm Vicki Stover Hertzberg. I earned a Ph.D. in biomathematics from the University of Washington in Seattle, Washington, in 1980. I was on the faculty at the University of Cincinnati from then until 1995, and I have been on the faculty of Emory University since 1995. I'm Professor and I direct the Center for Data Science at the Nell Hodgson Woodruff School of Nursing of Emory University.

Next, I review how I developed particular expertise that qualifies me to testify before you today. After the SARS pandemic in 2002 to 2004, many organizations became concerned about how a novel infectious agent might spread in their environments. There were two papers published in the medical literature documenting such spread for SARS or severe acute respiratory syndrome. One publication described how SARS spread in an emergency department or an E.D.

This particular publication led to my collaboration with Dr. Doug Lowery-North, an emergency medicine physician. We studied movements of patients and staff in the E.D. at Emory University Hospital Midtown to determine how frequently and for how long patients and staff came into contact with one another, that being within 3 feet or a meter, in order to understand better how an infectious disease could spread in an E.D.

Another publication documented SARS transmission on a 3-hour flight from Hong Kong to Beijing because airplane cabin environments were of concern. Dr. Sharon Norris, the Chief Physician of the Boeing Company at the time, was interested in supporting studies of how a novel infectious agent transmitted by large respiratory droplets might spread among passengers and flight attendants or what I call the crew on an airplane.

She approached my colleague at Georgia Institute of Technology, Professor Howard Weiss, an applied mathematician and an expert in modeling infectious disease outbreaks, who was also aware of our work in the E.D. Professor Weiss and I were funded by the Boeing Company to determine how a novel infectious disease might spread on an airplane, which we have since called the "Fly Healthy Study." We quantified behavior and movements by passengers and crew during 10 flights across the country so that we could determine which pairs of individuals were coming into close contact as to enable infection transmission.

A second goal was to document what infectious agents were present on airplanes. There were three major findings from our study. First, based on our simulations of movement, one to two passengers or crew member will become infected as a result of contact

with an infectious individual on a cross-country flight at the probability of infection that we tested. Two, tests for respiratory viruses were negative for all air samples and all 18 respiratory viruses that were tested. Three, microbial communities present on an airplane—on airplanes are highly variable from flight to flight with the vast majority of airplane-associated microbes being human commensals or otherwise nonpathogenic entities. Our findings set a baseline for non-crisis-level airplane cabin conditions.

What are the implications of our findings for air travel in this pandemic? Our results state that if the SARS-CoV–2 virus is as contagious as the novel agent with the transmission rate used in our simulations, one can expect one to two passengers or crew to become infected on a full flight of similar duration.

Implications of this finding is significant. Unless airlines are willing to mandate that passengers and crew show up at least 4 hours in advance of a flight for nasal pharyngeal swabbing of all passengers and crew followed by PCR (polymerise chain reaction) testing for presence of the virus and to prevent anybody with a positive test from boarding, and if flights continue to be at or near capacity, there is no way to absolutely guarantee that SARS-CoV–2 virus will not be transmitted during the flight.

What are the knowledge gaps? What are the unknown unknowns regarding safety of air travel and live transmission of novel infectious agent? First, I am not aware of good data that would allow us to determine an infectious rate to use in simulations.

Two, the inverse problem needs to be solved, that is, given a passenger who subsequently develops disease, where was the infectious person likely seated?

Three, our results are only applicable to large respiratory droplet transmission. We do not know about transmission from aerosol—that is the smaller droplets that are generated—or fomites—that is the physical objects that facilitate infection transfer between people.

Four, our results are only applicable to time and flight between 10,000 feet on ascent to 12,000 feet on descent. There are other places along the way to traveling by air in which infection can be transmitted, and we know little about those places. These include transportation to and from the airport, areas traversed from check-in to the gate, passenger mingling in the gatehouse area, as well as at baggage claim.

Fifth, we do not know anything about passenger behaviors and movements on double-aisle planes, long-haul flights, or flights outside the United States.

This concludes my remarks. Thank you for the opportunity to testify.

[The prepared statement of Dr. Hertzberg follows:]

Testimony of Dr. Vicki Hertzberg
House Committee of Science, Space & Technology
Subcommittee on Space & Aeronautics
"R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond"
June 23, 2020

Ladies and Gentlemen of the Committee,

Good morning.

(1) Disclaimer. Contents of my testimony represent my opinion and are not the official opinion of Emory University.

(2) Biographical Information. My name is Vicki Stover Hertzberg. I hold a B.S. in Mathematics & Statistics from Miami University in Oxford, Ohio, class of 1976, and a Ph.D. in Biomathematics – Health Statistics track from the University of Washington in Seattle, Washington, granted in 1980. I was on the faculty of the University of Cincinnati, Division of Epidemiology and Biostatistics, 1980 – 1995. I have been on the faculty of Emory University since 1995. I served as chair of the Department of Biostatistics 1995-2001 in the Rollins School of Public Health. In 2015 I moved to the Nell Hodgson Woodruff School of Nursing where I am Professor and direct the Center for Data Science. I have published over 130 articles in the peer-reviewed literature. I am a Fellow of the American Statistical Association, and I have also held that association's P.Stat. accreditation since 2010 when it was first offered.

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(3) Next, I review how I developed particular expertise that qualifies me to testify before you today. As a result of the SARS epidemic in 2002-2004, many organizations became concerned about how a novel infectious agent might spread in their environments. There were two papers published in the medical literature documenting such spread for SARS. One publication described how a SARS patient presented at the emergency department (ED) of a community hospital in Toronto during the course of the epidemic, and 126 subsequent hospital-acquired SARS infections among patients and staff were traced to direct or indirect exposure to this patient, of whom several died. This particular case gave rise to my collaboration with Dr. Douglas Lowery-North, who was at the time the vice-chair for operations in the Emory University Department of Emergency Medicine, beginning in 2005. In 2007 we were funded to do a pilot study in which we determined how a novel infectious agent transmitted by large respiratory droplets would spread among patients and staff in the ED. We studied patients and staff in the ED at Emory University Hospital Midtown in 81 12-hour shifts over the course of a year, July 1 2009 – June 30 2010. We used radiofrequency identification (RFID) to determine how frequently and for how long patients and staff came into "contact" with one another, where we defined contact as 1 meter of proximity, or approximately 3 feet. CDC and WHO guidance

at the time averred 1 meter as the distance over which large respiratory droplet transmission of diseases like SARS or influenza could occur. We collected these data, which became the source of 4 subsequent research publications. In one of these papers, we used the data to simulate how an infection might spread by randomly making one patient or one staff "infectious" with a novel agent and determining how many other staff and patients might become infected as a result of contact with this "infectious" individual. Over 10,000 such simulations, we found that cross-infection risk between ED health care workers was much higher than between health care workers and patients or between patients. On average, 11 patients who were infected in the ED would be admitted to the hospital over the course of an 8-week outbreak of such an infection, leading to further cross-infection risk once in the hospital.

Another publication documented SARS transmission on a 3 hours flight from Hong Kong to Beijing. There were 120 people on this flight, including one infectious passenger. Afterwards 16 people developed laboratory confirmed SARS, 2 were diagnosed with probable SARS, and 4 were reported to have SARS but could not be interviewed. Thus, airplane cabins are another environment of concern.

My colleague at Georgia Institute of Technology, Professor Howard (Howie) Weiss, an applied mathematician who models infectious disease outbreaks, was aware of our work in the ED. In 2011 he was approached by Dr. Sharon Norris, who was at that time the chief physician of The Boeing Company. Dr. Norris was interested in studying how a novel infectious agent transmitted by large respiratory droplets might spread among passengers and flight attendants ("crew") on an airplane. Professor Weiss and I prepared a proposal to The Boeing Company to do so, and this proposal was subsequently funded. Our first goal was to quantify behavior and movements by passengers and crew so that we could determine which pairs of individuals were coming into sufficiently close contact as to enable infection transmission. Our second goal was to understand what, if any, infectious agents were present on airplanes.

With additional assistance of experts from Delta Airlines, CDC, TSA, and NIOSH, we trained a team of graduate students in observation and recording. This team, along with Professor Weiss and three post-doctoral scholars made 5 round trips, that is, 10 flights, between Atlanta and various West Coast cities between November 2012 and May 2013. We could not

use RFID to determine contacts, so we resorted to using observation. Over the course of each flight a team of 10 graduate students observed and recorded the behaviors and movements of passengers and flight attendants in the economy cabin from the time that the plane had reached 10,000 feet altitude on ascent until the time that the plane had reached 10,000 feet altitude on descent, on average, about 4 hours per flight. The post-doctoral scholars took environmental samples of air and touch surfaces before and after each flight, and also took environmental samples of air during the flight. All flights were on Boeing aircraft of a single aisle 3 + 3 seat configuration, with one lavatory near the front and two in the rear. All flights were at or near full capacity, with 1-2 empty seats at most available on each flight, if any.

From the data collected by the graduate students we were able to reconstruct movements by passengers and crew on these 10 flights. In order to simulate how a novel infectious agent might spread on an airplane, we created 1000 “fantasy flights” in which we created a seat map of a single aisle, 3 + 3 seat economy cabin, and randomly selected passengers and crew to populate each fantasy flight from our dataset, with their empirical behaviors and movements becoming their simulated behaviors

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and movements on the fantasy flights. We determined all contacts over which a large respiratory droplet novel infectious agent could spread on all fantasy flights. Subsequently we made either a passenger or a crew member infectious, and simulated infection transmission 10,000 times, repeating for all 1000 simulated flights. For these simulations we used as the rate of infection an estimate we obtained from data given in a paper by Moser et al. that appeared in the American Journal of Epidemiology in 1979. This paper described transmission of influenza on an airplane that was grounded on a tarmac in Alaska for 3 hours with no air circulation. From that episode of confinement, 72 percent of the 54 passengers aboard became ill with symptoms of an influenza-like illness within 72 hours. We calculated the transmission rate from these data, then quadrupled ("super-sized") it for the transmission rate in our simulation. From these simulations we produced heat maps showing the median probability of infection over 1000 simulated flights from a given passenger or crew source.

Environmental samples were shipped to and processed by the Genomic Services Lab at HudsonAlpha Institute for Biotechnology (Huntsville, AL). Each of the 229 environmental samples was split into two, from which DNA and RNA were isolated. One aliquot from each air sample was tested using

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qPCR against a panel of 18 commonly circulating respiratory viruses, including the influenza A H1N1 2009 pandemic strain, as well as three coronavirus strains.

HudsonAlpha Institute for Biotechnology also performed DNA sequencing of the V4 hypervariable region of the 16S rRNA gene for each sample. Following bioinformatics processing of the sequences by world-class experts at the J. Craig Venter Institute we were able to determine the bacteria and archaeae present in the airplane cabin environment, effectively characterizing the airplane cabin microbiome.

The study resulted in two major publications. The first manuscript gave the characterization of behaviors and movements of passengers and crew, described results of our simulation studies, and recounted outcomes of the qPCR respiratory virus panel testing. This manuscript was published in *Proceedings of the National Academies of Sciences of the United States of America* (PMID: 29555754), first appearing on March 19, 2018. The second manuscript gave the results of the 16S rRNA gene sequencing. This manuscript was published the journal *Microbial Ecology* (PMID: 29876609), first appearing on June 6, 2018.

There are three major findings from our study.

1. Based on our simulations, 1-2 passengers or crew member will become infected as a result of contact with an infectious individual on a cross-country flight.
2. Our respiratory virus qPCR panels were all negative for all air samples and all viruses.
3. The microbial communities present on airplanes are highly variable from flight to flight, with the vast majority of airplane-associated microbes being human commensals or otherwise non-pathogenic.

Our findings set a baseline for non-crisis-level airplane cabin conditions.

Following our study, prospects for further funding from The Boeing Company evaporated. Although there was some discussion with Dr. Norris about other studies, including studies of long-haul flights to China or Japan, there was no funding forthcoming. Professor Weiss and I thought that the prospects of funding from the National Institutes of Health or the National Science Foundation were low and did not think that the significant time investment on our part to develop a proposal would result in funding. Dr.

Norris attempted to build a funding consortium with the CDC, FAA, ASHRAE, US Department of Health and Human Services, IATA, etc., but was unable to do so. Dr. Norris retired from The Boeing Company in February of this year. In September 2019, Professor Weiss accepted a new faculty position at Pennsylvania State University.

(4) Implications of Our Findings for Air Travel in This Pandemic. Our results demonstrate that if the SARS-CoV-2 virus is as contagious as the influenza virus with the transmission rate that we "super-sized" in our simulation, one can expect 1-2 passengers or crew to become infected on a full flight of 4 hours duration. The implication of this finding is significant. **Unless airlines are willing to mandate that passengers and crew show up at least 4 hours in advance of a flight for nasopharyngeal swabbing of all passengers and crew followed by PCR testing for presence of the virus and prevent anybody with a positive test from boarding, and if flights continue to be at or near capacity, there is no way to guarantee that SARS-CoV-2 virus will not be transmitted during flight.**

(5) Knowledge Gaps. What are the known unknowns regarding safety of air travel in light of transmission of a novel infectious agent?

1. I am not aware yet of good data that would allow us to determine an infection rate to use in simulations.
2. The inverse problem needs to be solved – that is, given a passenger that subsequently develops disease, where was the infectious person likely seated.
3. Our results are only applicable to large respiratory droplet transmission. We do not know about transmission from
    a. aerosol (smaller droplets) generation; or
    b. fomites, that is physical objects that facilitate infection transfer between people.
4. Our results are only applicable to time in flight, between 10,000 feet on ascent to 10,000 feet on descent. There are other places along the way to traveling by air in which infection can be transmitted, and we know little about those places. These include:
    a. Transportation to and from the airport
    b. Areas traversed from check-in to the gate
    c. Passenger mingling in the gate house
    d. Baggage claim

I will add here that a group of investigators led by Ashok Srinivasan at University of West Florida is examining how transmission can occur in the boarding and deplaning processes.

5. We do not know anything about passenger behaviors and movements on double aisle planes, long-haul flights, or flights outside the U.S.

This concludes my remarks. Thank you for the opportunity to testify.

Biographical Information. My name is Vicki Stover Hertzberg. I hold a B.S. in Mathematics & Statistics from Miami University in Oxford, Ohio, class of 1976, and a Ph.D. in Biomathematics – Health Statistics track from the University of Washington in Seattle, Washington, granted in 1980. I was on the faculty of the University of Cincinnati, Division of Epidemiology and Biostatistics, 1980 – 1995. I have been on the faculty of Emory University since 1995. I served as chair of the Department of Biostatistics 1995-2001 in the Rollins School of Public Health. In 2015 I moved to the Nell Hodgson Woodruff School of Nursing where I am Professor and direct the Center for Data Science. I have published over 130 articles in the peer-reviewed literature. I am a Fellow of the American Statistical Association, and I have also held that association's P.Stat. accreditation since 2010 when it was first offered.

Chairwoman HORN. Thank you, Dr. Hertzberg.

At this point we will begin with our first round of questions, and the Chair recognizes herself for five minutes.

Again, thank you for—to our witnesses for your testimony and to all of our Members for participating. As we can tell, this is a critically important and timely issue that we are addressing here.

And it's clear that while some research has been done on communicable disease and transmission in aircraft, we have work to do, and it hasn't risen to the priority that we need to have progress to a national plan.

So, I'd like to begin with Ms. Krause. Clearly, as you mentioned, this is not the first epidemic that our U.S. air transportation system has had to face, and the question becomes why we find ourselves ill-prepared in terms of a national plan. So, a couple of questions for you.

First, how can we improve the resiliency of our air systems—air travel systems in response to such outbreak?

And then, second, can you speak to the prioritization of—and the development of a national plan, how we can expedite that, especially given the circumstances we find ourselves in?

Ms. KRAUSE. Absolutely. I think in a—implementing our recommendation for DOT to develop a national aviation preparedness plan is the way that we can build our resilience for future communicable diseases. What that plan does is offer a scalable and adaptable framework for individual airports and airlines to align their efforts with and really bring some harmonization and a national approach to responding to future pandemics, so I think implementing our recommendation of DOT coordinating with HHS and DHS and other stakeholders is key to ensuring that we're prepared going forward.

On the second part was the priority of getting this done, I mean, I think this is important in the sense that what we're seeing is when we did our work back in 2015, you had 14 airports and three airlines with a number of different individual plans, and they had some good components, but given that it's fragmented, again, that sort of puts an emphasis on why it's important to develop a national aviation preparedness plan.

Chairwoman HORN. Thank you, Ms. Krause. It is clear that research and development is central to this. So, I'd like to turn to Drs. Jones and Hertzberg for the next question. You both noted there are unanswered questions about research and the implication of COVID–19 and other communicable diseases for air travel. And there's discussed both publicly and privately funded research. So, given the urgency, Dr. Jones, that you expressed in your testimony of prioritizing this research, I would—I'd like for you to speak to—from your experience your sense of who should be in charge of coordinating this research and where the Federal Government role might be, how that might interact with private research, and then the same question to you, Dr. Hertzberg.

Dr. JONES. OK. This is Byron Jones. I'm not sure I'm the one to make the decision on whether the government or private or who should fund the research or be in charge of the research. I mean, it benefits the flying public as well as the private industry, so I would hope to see some kind of a joint effort. And generally, the

FAA has been the one who is taking the lead with anything aviation, but, I mean, this is really outside my role as a researcher.

You know, in terms of the need, I think what you're—in the aircraft, we're going to have to have some kind of mitigation. We can't sit 6 feet apart, and we don't even know if that's far enough. So, we—you know, we really need to be looking at how effective—you know, a facemask is, for example, does it allow us to sit 3 feet apart, you know, 2 feet apart, 1 foot apart? We just don't know that, and that's the kind of information we need.

Chairwoman HORN. Thank you very much, Dr. Jones. Dr. Hertzberg?

Dr. HERTZBERG. You asked about who should be in charge and the funding, et cetera, I—having thought about this for a long time, I do think that it needs to be a true partnership with the public health agencies, as well as the DOT agencies that understand how airplanes work. We could not have done the work that we did without significant input from Boeing engineers, for instance. And we believe that that is really the ultimate collaborative model to engage in. We also had significant input from Delta Air Lines, from Homeland Security, et cetera.

As for funding, there's been talk over the years of getting this funded in the private sector that—that I believe has never taken off for reasons I don't want to get into right now. I could speculate, but that does nobody any good.

But in public health, it's always difficult to fund something that you prevented, that you've prevented, you know, and so that's really hard to fund something here to prevent this disease from happening on airplanes.

Chairwoman HORN. Thank you very much, Dr. Hertzberg. Thank you to our witnesses. The Chair—my time is expired. I now recognize Mr. Babin for 5 minutes.

Mr. BABIN. Thank you, Madam Chair. Very, very interesting, and I appreciate all the witnesses.

I would like to ask first to anyone who can answer this, how does airline travel compare to other modes of public transportation from a disease transmission standpoint? Some of these questions, I know, have already been hit on. But is it riskier than trains, ships, buses, or how does that healthcare risk compare to overall safety, including accidents, of each mode of transportation? Can any of you all answer that? I know it's quite an involved answer, but just do the best you can.

Dr. HERTZBERG. Can I take a stab at it first?

Mr. BABIN. Sure. Yes, ma'am. Thank you.

Dr. HERTZBERG. I don't think that we understand as much as we have actually come to understand about airplanes in the similar way about things like trains and buses and subways and boats, so we don't know—we don't understand how people move about on them necessarily, et cetera. I think that's there have been a lot of publications over the years about disease transmission on airplanes. SARS was not the first, and it won't be the last. I believe there's actually papers being considered right now about COVID–19 being transmitted on airplanes, so—but you don't quite see the same level of interest in, oh, I got it on the subway or I got it on a bus. That doesn't mean that it shouldn't happen.

I will say that in assessing the bacteria and viruses that were present on an airplane that we looked very much like—we were very comparable to places that people spend a lot of time in, so, for instance, office buildings, schools. We actually looked very closely at something called the Boston subway study, and we compared very comparable to that in terms of what is present.

Mr. BABIN. OK. Thank you. Anybody else want to take a stab at that?

Dr. JONES. Yes, this is Byron Jones. I'll take a stab at it as well.

Mr. BABIN. Yes, sir.

Dr. JONES. The one big difference between airplanes and other modes of transportation is that airplanes tend to be the same from one airplane to the next to the next. There's not a lot of difference in the environmental control systems in an airplane and not a lot of difference in the seating density. You go to other transportation modes, trains can be anywhere from, you know, a crowded subway where everybody's crammed in there to a railcar that's half-full. And so it's very hard to generalize the comparison between aircraft and other modes of transportation because there's a lot of dissimilarities.

But I guess the main thing is if you work with an aircraft, you know what you're working with, you know what the situation is, and in transportation—other transportation vehicle, it could be anywhere all over the map. You just don't know. But given this—if you have the same occupancy density, you have the same ventilation rate, you would expect similar results.

And the other factor would be, you know, the duration of exposure. It's one thing to be on the subway for 5 minutes. It's another thing to be in an aircraft for 3 hours next to somebody.

Mr. BABIN. Right. OK, thank you. I've got another question I want to try to sneak in first, Dr. Krause, and this is something people have been thinking about. The seat size and proximity are ways that airlines manage costs. Everyone understands that. If airlines reversed the recent trend of smaller seats that are closer together, should we expect higher prices? You know, when they have us spaced out on those airplanes, they're about 2/3 full, and that's the max, that's something to think about because these airlines have to make a profit.

So, I'll start with you, Ms. Krause, if you don't mind.

Ms. KRAUSE. No worries, thank you. No, I mean, I think that there is certainly—you know, airlines generate profits and revenues by having people in seats, so that certainly is a factor that comes into play in terms of reducing the number of seats that might be filled or adding more seats and not filling them, so that's certainly a factor that plays in.

Mr. BABIN. OK, thank you. I've got about 20 seconds left if somebody else wants to take a stab at that.

OK. Well, with that, Madam Chair, I'll yield back. Thank you so much.

Chairwoman HORN. Thank you, Mr. Babin.

The Chair recognizes Chairwoman Johnson for 5 minutes of questions.

Chairwoman JOHNSON [continuing]. Because, first of all, I don't know who is leading the effort to determine how the spacing and

what have you should be on our airlines. Of course, that's where many of us in Congress have very personal questions because that is the method of which we travel to get back and forth to work. So, who right now is in charge of working with the airlines to determine what is safe and not safe?

Ms. KRAUSE. I can jump in there, Chairwoman Johnson. This is Heather. I mean, I would offer that DOT and FAA generally defer to the CDC when it comes to passenger safety and crew safety. The airlines have taken a number of steps. I know that was mentioned earlier in terms of aligning some of their practices with the CDC guidance and have talked about upping enforcement of some of those provisions like the use of masks on airlines. But I think we would sort of offer that if passengers start to find that the experience—their experiences are inconsistent or confusing, that may impact their confidence in the system, and so that may lead to the Administration and Congress having to determine whether further action might be needed.

I know the Administrator was at a hearing last week and spoke about some of the efforts that they're getting underway to come up with more specific recommendations and guidelines so that that effort is also being done, but again, I would sort of say it—as things start to play out, it will be up to the Administration and Congress to determine whether further action or clarification of those rules and responsibilities is needed.

Chairwoman JOHNSON. Thank you. Now, Dr. Jones and Dr. Hertzberg, what in your opinion are the primary research gaps regarding the risk of communicable disease transmission in airline cabins in that environment of air traffic overall?

Dr. JONES. This is Byron Jones. I'll take a shot at that first. I think the biggest thing I see in working with people in the airline—in the air travel industry is we just don't know the effect we have on that transmission when we take a given mitigation. So, if, for example, we put a barrier between the seats, we don't have the information—does that reduce the risk by 5 percent or 95 percent? We just don't know that. My question, if we require everybody to wear a mask, does that reduce it by 10 percent or 99 percent? We just don't know those. It's very difficult to get those data, and it's not an easy thing to do.

We know how, once it becomes airborne, how it moves around the cabin, but there's just a lot of—a lot that goes on in that very near environment close to the person, that interaction. We just don't know how that goes on, and that's where we would expect most of the disease transmission to occur.

Chairwoman JOHNSON. Thank you. Dr. Hertzberg.

Dr. HERTZBERG. I would also say that we don't know what role that physical objects play for transfer, so I cough into my hands, I get up, I walk to the back to the lavatory, and on the way I'm gripping the seatbacks to keep my balance. And on the way back to my seat I do the same thing. And then you get up 30 minutes later, you do the same thing on the way back to the back lav, and you come into contact with germs that I've transferred to those seatbacks. And then you touch your face, OK, and we don't really understand what the role of that kind of transmission could be in this disease. We don't understand too much about whether it's

aerosols or large droplets, so there's just a lot that we don't know that's somewhat disease-specific as well.

Chairwoman JOHNSON. Thank you very much. I think my time's expired. I yield back.

Chairwoman HORN. Thank you, Chairwoman Johnson.

Mr. Lucas, you're recognized. Mr. Lucas, I think you may be muted.

Mr. LUCAS. You would be correct as always, Madam Chair.

Chairwoman HORN. There you are.

Mr. LUCAS. Thank you for helping me. Let's touch for a moment back on that size and seat proximity issue. As the Full Chairwoman noted, it's an issue very important to Members who travel a lot. When I first came to Congress, I was 6-4 1/2. Now, time and Congress has ground the half inch off of me, but I'm still 6-4 in those seats, and it's still a matter of togetherness even before the public health and safety issues.

But isn't this an example that if we do the research, we make determinations about spacing, setting comfort aside, health issues, is this a situation where industry will expect Congress to set standards so that they will be implemented? Because, after all, it is a matter of cost control, seat spacing, and proximity now. And the farther we're apart, if we determine that's important, and I question the whole panel about this, won't that add to cost even though it very well may add to the quality of safety and certainly the quality of my knees?

Dr. JONES. This is Byron Jones. I'll jump in. I mean, obviously, if you reduce the seating density, you increase the cost. I mean, there's no getting around that. That's why it costs more to fly in first-class for those that have that opportunity. Most of us don't. In—and I think the thing to realize is is that it is—it will reduce the probability of exposure if you reduce the seating density, but to reduce it down to a very low level, you would have to make this seating density so low that it would be impractical to operate an aircraft in that mode economically.

The—now, when I say—I mean, let me back up. That's assuming no mitigation, nobody wearing a mask, nobody's doing anything else at all. Just—or just in there going about your normal business. So, that's why I keep saying—emphasizing the fact that you've got to have mitigations in there to keep that spread from seat to seat, from person to person.

Mr. LUCAS. Absolutely. And being the competitive industry it is, whatever that combination of mitigations are, if it increased the cost of doing business in a competitive industry, and airline travel is incredibly competitive, it'll have to be a standard implemented from the Federal level so that everyone will respond the same.

Along that line, and I again ask everyone on the panel. You've been really impressive with your responses and insights, how much money in the industry as a whole are they spending on doing this basic research? Because, clearly, these questions are important to the viability of their staff. They're very important to the viability of their customer base. And I'm not asking for any particular airline, but the industry itself is making investments, correct? They are making those investments?

Dr. HERTZBERG. We did our study—we were funded from 2011 to 2014, and we got a lot of money from the Boeing Company. We got assistance but no money from Delta Air Lines. We continued to talk after our funding ended with Dr. Norris, who was the Chief Physician. She was thinking along the same lines about what about long-haul flights, et cetera? She was interested in studying long-haul flights, for instance, to China or to Japan. But the money was never forthcoming for reasons that I could only speculate about.

Mr. LUCAS. Absolutely.

Dr. JONES. This is Byron Jones again. My experience is similar. We have received substantial funding from Boeing over the years. The airlines, I think they see themselves more as implementers as opposed to the people who generate the information that's needed. That's just my opinion.

Ms. KRAUSE. And this is Heather. I would just add that my understanding is Boeing has talked about starting up some research, but I haven't seen any—an estimate of other investments made on research for private sector yet.

Mr. LUCAS. Absolutely. Well, in my final moments I'll just simply note the world has changed; it's never going to be the same. And as we had our hearing earlier this year in Committee with a million-plus other pathogens lurking out there in the environment, what we do now is just necessity for the rest of humanity's time on this planet.

And with that, I yield back, Madam Chair. Thank you very much.

Chairwoman HORN. Thank you very much, Mr. Lucas.

The Chair now recognizes Ms. Lofgren for 5 minutes of questions.

Ms. LOFGREN. Thank you so much, Madam Chairwoman.

You know, it strikes me that we are very unprepared for this pandemic in terms of air travel and all public transit, that we need to have some standards that are science-based and that probably we're going to have to have a regulatory role in order to make that happen because the private sector has simply not done it. They haven't done the research. And even things I understand that just changing where the airflow comes, whether it's from the bottom or the top, would have an impact in terms of dispersal of aerosols, and yet that hasn't been done.

When I look at not only in the aircraft themselves but in the airports, it's very inconsistent airport to airport where, clearly, disease is being transmitted. We know that for fact here in California. LAX had a huge incident at the very beginning of the pandemic.

So, Dr. Krause, it seems to me that we ought to vest the research—there ought to be some public research because the airlines are going down. I mean, they are going down financially, and your description of somebody going to the restroom, coughing, touching all the seats, I mean, that's a reason why nobody wants to get on an airplane today.

So, do you think that the university community with some basic research funding could quickly come up with implementation recommendations based on science to get at least a standard in place promptly before all the airlines go completely under?

Ms. KRAUSE. Dr.—this is Heather. Dr. Hertzberg might be able to add some more. I would just offer that, you know, there is a role for Federal research in this area in terms of understanding the risk and transmissions, also to develop mitigation strategies and develop—and kind of test technologies. So, I'd offer that there is a Federal role to evaluate different options to reduce the risk. Dr. Hertzberg might be able to speak a little bit more to the university's role.

I know that in our work that we've done in FAA R&D we found that, you know, there can be some opportunities for FAA to partner with the private sector to accelerate some research and do that, so that might be something to look into in terms of the Federal——

Ms. LOFGREN. Well, maybe Dr. Hertzberg could comment on that then.

Dr. HERTZBERG. I think that universities are full of very bright people and that they could, with the appropriate funding, come up with some answers. In terms of the science itself, science takes time.

Ms. LOFGREN. Yes.

Dr. HERTZBERG. And so it might be quickly, but quickly in the timeframe of science.

Ms. LOFGREN. OK.

Dr. HERTZBERG. That could be 2 or 3 years.

Ms. LOFGREN. Well, when I look at, for example, looking not just at the aircraft but the airports, if you go to foreign airports, there are measures in place to detect people with temperatures, for example. We don't have that anywhere. We could do an—and we don't have to do all the research ourselves. Is that effective in the airports that use it? Is it something that we ought to implement? It doesn't look like anybody is in charge of doing these assessments.

Dr. HERTZBERG. It's not a straightforward answer because people can be asymptomatic——

Ms. LOFGREN. Sure.

Ms. HERTZBERG [continuing]. And have the virus and shed it and transmit it that way, so just taking temperatures alone is no guarantee.

Ms. LOFGREN. My time is expired, Madam Chair. Thank you so much. I yield back.

Chairwoman HORN. Thank you very much, Ms. Lofgren.

The Chair recognizes Mr. Posey.

Mr. POSEY. Thank you very much, Madam Chair.

This is for Ms. Krause based on her expertise and reading your testimony. You mentioned that there are a variety of technologies that could help address infectious disease transmission associated with air travel, but they're at various stages of maturity. These technologies will help much-needed consumer confidence that will lead to an increased air travel obviously.

This is already being reflected in the travel data from the TSA (Transportation Security Administration). According to the TSA, checkpoint travel numbers for 2020 and 2019, the United States had its highest travel throughput of 590,456 passengers this past Sunday. It's the highest since the start of the pandemic. Some of the technologies that you mentioned include handheld infrared

thermometers by TSA agents, a mass screening of crowds using thermal cameras, and aircraft disinfection methods using heat, chemicals, and UV light. How promising do these screenings and disinfection methods appear to be to you at this point?

Ms. KRAUSE. I think that's still to be determined, but that, again, could be a role in terms of leveraging research that's already out there and have been done even by some of the research of the folks on the panel and looking for Federal leadership and understanding sort of options and identifying options and how to make it safer, so I'd say there's still work—more work to be done to understand what works to mitigate the risks.

Dr. HERTZBERG. The other area of concern is that if—you could have an airplane that's clean as a whistle, but you have one infected—infectious person on there and you put a lot more people at risk.

Mr. POSEY. Are there other technologies in the works that you think look promising?

Dr. HERTZBERG. Not that I'm acquainted with other than just doing rapid PCR—swabbing and doing rapid PCR on everybody.

Mr. POSEY. OK. Ms. Krause?

Ms. KRAUSE. At this time, no. I think it is—there's a number of ideas that are being floated out there and a number of actions that the airlines are taking, different disinfectant technologies. I think, again, it's all sort of research that needs to be further developed to understand what might best mitigate some of these risks.

Mr. POSEY. Right. You mentioned that NASA (National Aeronautics and Space Administration), along with the FAA, in your testimony on how it is responsible for management with the Federal Government's civil aviation research and development. How could NASA help with identifying these technologies and solutions?

Ms. KRAUSE. At this point we—it's not something we've looked into, but we'd be happy to work with you to get a better sense of that.

Mr. POSEY. Yes, with NASA's expertise on spacecraft air quality issues—and they are working with the CDC and other Federal agencies—it seems like it would just really be a great synergy to bring them together.

Ms. KRAUSE. Yes. I think it is. You're right. I think it's important that the aviation—the different Federal aviation industries—or agencies come together, as well as public health, that really is going to need multiple Federal agencies to coordinate and come up with solutions.

Mr. POSEY. And who do you see as being the lead agency to kind of get this moving and get it coordinated?

Ms. KRAUSE. I mean, I think at this point FAA and DOT have largely deferred to CDC when it comes to passenger health issues. Again, they're—you know, they're looking to take some different steps to establish some guidelines, but largely, they've been leaving the research—we do think that the FAA has a role in understanding how this research—what's out there and being aware of the research and figuring out how to apply it on aircraft, but there is a role for FAA there.

Mr. POSEY. Thank you. I see my time is about to expire. I yield back, Madam Chair. Thank you.

Chairwoman HORN. Thank you, Mr. Posey.

Mr. Bera, you're recognized.

Mr. BERA. Yes, thank you. This obviously is quite interesting I think to many of us in Congress because a lot of us are going to get on an airplane today or tomorrow to fly back to Washington, DC. And obviously, as a physician, I think a lot of us, you know, rightfully, should be concerned about our own health because we're all coming from, you know, 435 districts all around the country, and then we're all going to fly back to our districts. And, you know, it is certainly of concern.

You know, just thinking about it from a healthcare perspective, you know, we know a lot more about this virus than we did previously, right? We know that transmission is certainly a component of exposure to virus load, as well as a function of time as well and, you know, so it does give us some cause for concern if you're on a—you know, for me coming in from California, I'm going to be on long flights with that.

There are things we can do to certainly mitigate things. Certainly, the science is pretty strong on face coverings, facemasks, reducing the spread if I'm infected, you know, to infecting others. We're still learning a lot about fomites and, you know, the transferability off of inanimate objects like solid surfaces, and we know different surfaces the virus survives for a longer period of time.

You know, Dr. Hertzberg, your example of, you know, touching the seats, we do know constant handwashing and constant use of hand sanitizer, you know, as we—you know, certainly will reduce the spread of the virus to ourselves—I guess the question is for any of the panelists. There is some suggestion that for those that are traveling more frequently like Members of Congress, instead of just wearing the usual face covering or facemask, that it may be appropriate for us to wear N95 masks now that, you know, there's a better supply, and I'd just be curious if, you know, any of the panelists have a thought on that, whether we should suggest that Members of Congress actually get N95 masks that they can use on those travels or if we suggest that to passengers, if any of—maybe Dr. Hertzberg.

Dr. HERTZBERG. N95s need to be fit-tested, and so they should not be worn just buying one off of Amazon and putting it on.

Having said that, masks work in two ways. So, they—with an N95, you're filtering out particles that you're breathing in. But even, you know, surgical masks and cloth masks, they prevent you from transmitting the large droplets even as you're talking. And so I would—I think that masks in general are a great idea.

Mr. BERA. So, we—you know—the——

Dr. HERTZBERG. The N95 that I'm wearing protects me——

Mr. BERA. Right.

Ms. HERTZBERG [continuing]. But it also protects you. The cloth mask I'm wearing doesn't protect me, but it protects you.

Mr. BERA. And, you know, again, this may have been touched on earlier, but it's my understanding that over recent years the airlines have improved their ventilation systems and the filters in those ventilation systems. Is that correct, any of the panelists?

Dr. JONES. This is Byron Jones. Almost universally, the recirculation air in the aircraft is HEPA-filtered, so you're not spreading

disease around through the aircraft by the recirculation of the air. The basic functioning of the environmental control system is pretty much the same as it's been for, you know, the last 20 years or so, and the regulations on that haven't changed dramatically in recent times.

And the thing to keep in mind is the aircraft are in service for a long time, so even if you start changing the way they're made now, for example, the Boeing 787 has a different system, but you're still going to have aircraft in service for many years.

Mr. BERA. Right. And just a quick last question for Ms. Krause. Most airlines if not all airlines are now mandating the wearing of face coverings. Is that correct?

Ms. KRAUSE. That's—yes, that's what's been reported. I know that the airlines associated with the A4A in particular are working to use—or have masks as part of their policies.

Mr. BERA. Right. And it looks like I'm out of time, so I'll yield back.

Chairwoman HORN. Thank you, Mr. Bera.

Mr. Beyer, you're recognized.

Mr. BEYER. Thank you, Madam Chair. I had to find my unmute button. And thanks so much for holding this hearing. It's really interesting.

One of the major issues I was concerned with at the start of the pandemic was the inability of the airlines to effectively contact-trace passengers. And I learned that the U.S. Government had been pressuring airlines for years to collect contact information for passengers just in the case of this kind of contagious virus, and yet the airlines allegedly repeatedly refused, so we're just now coordinating a digital app to do this across the industry. But as the coronavirus spread across the United States, public health officials were not able to effectively contact trace.

So, a question, Ms. Krause, in the 2015 GAO study that you referred to a number of times, you found that DOT would be the most effective in organizing a national aviation preparedness strategy. First question is why no progress? I saw the pushback that they thought maybe HHS or DHS would be better, but we are now 5 years later with a strong GAO study that says they should have putting together an aviation preparedness plan.

Ms. KRAUSE. I think you hit on the reason why it is—we haven't seen implementation or movement on it is because DOT doesn't believe that they should be taking the lead. They see HHS and DHS as the ones that should lead and based on their public health and emergency preparedness responsibilities. They do point to some of the actions they've taken as it relates to COVID, things where they've facilitated calls with aviation stakeholders, airlines, and Federal agencies, coordinating with CDC on guidance from airline crew, but they don't see it as something that they should be taking the lead.

We—you know, we reiterate that we feel it's important for them to take the lead and that they should be taking the lead given their long-standing relationships and deep ties to the aviation industry, as well as their oversight responsibilities, so we are looking for them to take the lead on it.

Mr. BEYER. It certainly makes sense. I'm always fascinated because you don't usually see people say, oh, I don't want responsibility for that. Most of us are empire-builders. We pull things into ourselves. And certainly having them take the lead doesn't mean that you exclude HHS or DHS from the conversation or the construction.

Ms. KRAUSE. Absolutely. I think that that's what makes it really important. I mean, there really is a need for a multiagency coordination effort when it comes to responding to communicable disease threats. I mean, you really want to have that coordination so you avoid confusion, inconsistencies, duplication of resources, and really minimize the inconveniences to passengers, so it's important that there is coordination across these agencies responding.

Mr. BEYER. And, Ms. Krause, don't we have a constructive international obligation based on the Chicago Convention, the Annex 19 that you mentioned?

Ms. KRAUSE. Yeah, so that—as a signatory to that international aviation treaty, the U.S. is obligated to create such a plan.

Mr. BEYER. If I ever get a chance to meet the Chair of the Space Subcommittee, I'm going to recommend to her that we have Science Committee legislation that mandates that DOT do this national aviation plan, not just a GAO recommendation but a mandate from Congress.

Ms. KRAUSE. And that—oh, sorry. I would just add that is something that GAO is looking to elevate to a potential matter to Congress is to look to Congress to direct DOT to implement this plan because we think it is very important.

Mr. BEYER. Well, you've—this hearing has been worthwhile in many ways but especially what you've just presented.

So, a follow-up question, too, I opened saying we couldn't contact-trace airline passengers. Wouldn't that have been much easier if we had had this plan in place?

Ms. KRAUSE. Yes, I think that we definitely see that the plan would have provided some opportunity to outline some of the coordination and roles and responsibility, as well as communication mechanisms. When you have a preparedness plan, one aspect of it that could be a benefit is testing out some of those communication mechanisms, as well as identifying the roles and responsibilities so when you get into situations where you need to quickly respond, you have some agreement on who's doing what.

Mr. BEYER. That's great. Thank you very much, Ms. Krause.

Dr. Jones, I'm almost out of time, but your notion of showing up 4 hours ahead of time may become more plausible as we develop tests in the near term that will give us a result in 30 minutes or less where you can do it with saliva or with blood. And I hear those are coming in the coming weeks.

And with that, Madam Chair, I yield back.

Chairwoman HORN. Thank you very much, Mr. Beyer.

Ms. Wexton, you're recognized for 5 minutes of questions.

Ms. WEXTON. Thank you, Madam Chairwoman. And thank you to the witnesses for being with us today.

I appreciate my colleague from northern Virginia anticipating some of my questions actually about preparedness and DOT's reluctance to get involved in developing these plans because, as luck

would have it—now, I represent Dulles International Airport in my district, Virginia 10 here in northern Virginia.

And as luck would have it, I had a Zoom call with a number of representatives of various worker groups at Dulles Airport yesterday, and they all were expressing concern about DOT's reluctance or inability or unwillingness to engage in this kind of comprehensive planning for aviation industry. So, it's—I'm glad that we're looking at ways to require them to do that and to mandate them to do that, but unless and until that happens, we need to look at what the other options are.

And I'm very proud of Dulles Airport because they're one of 14 airports reviewed by GAO in 2015 when you looked at the preparedness of the U.S. aviation system in responding to Ebola and to communicable disease threats from abroad. And Dulles had independently developed a preparedness plan of their own despite not being required to by U.S. law.

Ms. Krause, can you discuss what goes into an airport developing a plan like that, a preparedness plan, and how heavy of a lift is it?

Ms. KRAUSE. I mean, what we found is when we looked at the 14 airports, including Dulles, is we assessed it against sort of high-level components that were—or many of them had the high-level components that would be outlined in Federal guidance and international guidance related to preparedness. I think that we found that the plans had varying levels of detail but that they were good, they had good elements in them.

I think that they—the big piece of it is that the FAA has often said the some of those individual airport plans are focused on situations where you're dealing with one or two flights, you know, with infected passengers and it doesn't sort of support that national-level response, so I think that's where we feel like the national aviation preparedness plan would really help take those various efforts from the different airports and even airlines that also put together plans and sort of get them working harmonized in support of a national response.

Ms. WEXTON. So, it's safe to say that there are differences between the plans that the airports have, right? I mean, those that even have them or had them going into this pandemic. But absent a national preparedness plan, how can we ensure that there will be adequate health and safety standards across all airports as they develop plans related to COVID–19?

Ms. KRAUSE. I think that's really where a plan comes in is sort of identifying what are the things that you're looking to coordinate and communicate on at a national level, and then that can help the individual airports and airlines really align their plans to those efforts.

Ms. WEXTON. Well, I hope that we come up with a national strategy because, you know, airports shouldn't have to—they shouldn't have to reinvent the wheel every single local airport, so—well, thank you very much. I will yield back with that.

Chairwoman HORN. Thank you, Ms. Wexton.

And I now recognize our honorary Subcommittee Member and Full Committee Member Mr. Weber for 5 minutes.

Mr. WEBER. Thank you, Madam Chair. This is a great hearing by the way. What a great hearing.

Dr. Jones, I want to go to you first if I can. You said you're a mechanical engineer by trade, and I was an air-conditioning contractor for 35 years. Do you know of any studies or any information about relative humidity in air cabins? In other words, the heavier the air, the more humidity, we call it particulate matter droplets. Do you know? Does it affect that?

Dr. JONES. It definitely has some effect on it. Two things. One is obviously the low relative humidity, which is typical in the aircraft cabin. The droplets evaporate more quickly, so that means they become smaller. The viral material and other material that's non-water-based in them would not evaporate, so that material stays, so they—the lighter—the smaller they are, the more easily they are to move about the cabin.

The other thing is is that humidity has a pretty significant impact on the viability of the viruses, and they become active much more quickly in a moderate humidity range.

On the flipside of that is is that the air turnover is so fast in the aircraft that we haven't seen much evidence that there's loss of viability once they're airborne.

Mr. WEBER. Well, thank you for that. I want to open up the question for the panel. We've talked about SARS, Ebola. I didn't hear H1N1 in there. Was there tracing that went on back during those epidemics, pandemics, whatever you want to call them? Was there tracing back then? Dr. Hertzberg, start with you maybe.

Dr. HERTZBERG. Yes, there was. There have been publications where they have attempted to contact passengers. We used a study of influenza infection on an aircraft that was set on a tarmac and the air system was turned off and it sat on that tarmac for 3 hours or something like that. And out of the passengers, like 75 percent of them became later infected with influenza. This was back in the 1970's.

There have been other reports of H1N1 being transmitted on aircraft, and those have been traced. The classic study is one of SARS that was reported in the *New England Journal of Medicine*, a 3-hour flight from Hong Kong to Beijing, and again, they did contact tracing for those individuals. Of course, that's China, so it's a little bit different.

Mr. WEBER. All right. How about you, Ms. Krause? Would you like to weigh in on that?

Ms. KRAUSE. Contract tracing is an area that we're looking into a little bit more to understand some of the challenges around developing that kind of a system when it comes to the aviation system. I mean, I think there are requirements for pilots if they're seeing infected passengers to report it, so there is multiple agencies involved when you're dealing with tracing and understanding contact.

Mr. WEBER. OK. And, Dr. Hertzberg, I'm going to come back to you. You talked earlier about being in contact with Boeing, and of course Boeing is obviously the largest airplane manufacturer in this country, I'm sure, but there's other airplane manufacturers, especially Airbus over in France, for example. Any input from any of those other manufacturers?

Dr. HERTZBERG. No.
Mr. WEBER. Not at all?
Dr. HERTZBERG. No.
Mr. WEBER. Have we reached out to them?
Dr. HERTZBERG. Not to my understanding.
Mr. WEBER. OK.
Dr. HERTZBERG. But I'm just a little old faculty member here doing my job.
Mr. WEBER. Well, I thank you for that. And then the last thing I want to say is I like Bill Posey's line of questioning about NASA. Obviously, NASA is very, very good at quarantining and for a lot of reasons, but any plans that anybody knows of to actually get NASA maybe, Chairwoman Horn, we might want to get some NASA people in here and talk to us, but does any of our panelists witnesses had conversation with NASA directly about that? No? Dr. Jones?
Dr. JONES. No.
Mr. WEBER. And I guess, Ms. Krause, no?
Ms. KRAUSE. No, but, I mean, I think that's—you know, to leverage whatever Federal knowledge and research is out there is important.
Mr. WEBER. Yes, well, I appreciate that. All right. Thank you, Madam Chairwoman, for letting me ride on your coattails. I yield back.
Chairwoman HORN. Well, thank you very much, Mr. Weber. It's always a pleasure to have you with us on this Subcommittee.
And I want—we have gone through all of the Members that are with us. Oh, wait, I stand corrected. I think we have one that has returned. Mr. Lipinski, are you here? Oh, Mr. Lipinski.
Mr. LIPINSKI. I was just put in. Thank you very much, Madam Chair, for letting me join the Subcommittee here today for this hearing. It's something that is critically important right now for us, as the Chairwoman of the Full Committee, Eddie Bernice Johnson, mentioned, for all of us that travel a lot back and forth to D.C. and other places, so the safety of air travel is really important.
And, like Ms. Johnson, I'm also on the Transportation and Infrastructure Committee, and so this is something that we have been going back and forth with the FAA on in terms of the FAA putting requirements on for air travel, which has not really been—FAA has not stepped up in that. The airlines have done some of that voluntarily.
But I wanted to ask on the research side here today, I want to ask Ms. Krause, do you believe that FAA and NIH (National Institutes of Health) are adequately coordinating on the research problems that we are discussing here today?
Ms. KRAUSE. At this point, I mean, we've only had some really initial conversations on that topic. I'm aware of informal coordination that's happening but not a formal coordination that's happening on this topic.
Mr. LIPINSKI. And how do you think that Congress could better facilitate this coordination?
Ms. KRAUSE. I think asking the question is important and sort of encouraging that that coordination occur. I mean, I think really leveraging all the knowledge that these different agencies have,

and it's important in this particular instance to have public health as well as the aviation sector coordinating in terms of figuring out the risks associated and sort of what mitigation can occur for aviation and travel.

Mr. LIPINSKI. I wanted to ask all the panelists. Are there ways the Federal Government can incentivize additional public-private partnerships in research efforts about cabin safety?

Ms. KRAUSE. I mean, I can start. I can start with some perspectives. I mean, I think when we have looked at FAA's R&D, they do have a number of mechanisms that they can use to—and that they do use to coordinate with the private sector on addressing R&D issues. It can also provide them an opportunity to collaboratively work with industry and the private sector in accelerating needed research, so there are some opportunities there.

Dr. JONES. Speaking from a researcher point of view, money always talks, and, you know, if there's some money there, the research will be done.

Dr. HERTZBERG. From my experience, especially with the Federal agencies, when there are specific calls put out, that usually gets a good response to that. It takes a scientist a long time to prepare a proposal for something that's unsolicited, so I can write a proposal to the NIH or to the NSF (National Science Foundation), and it would take me hundreds of hours to do that. And based upon my discussions with the CDC, when we were at the end of our Fly Healthy Study and trying to kind of drum up more business, they were very unenthusiastic. I could not imagine that we could have gotten similar enthusiasm from the NIH or NSF, and therefore, in my own little cost-benefit analysis I decided it wasn't—it was not going to pay off to submit such a proposal at that time. I might do it again. I might do it differently today.

Mr. LIPINSKI. Thank you. And in the little time I have left, Dr. Hertzberg, on a different—kind of different subject here in terms of not in the cabin but the safety of ground crew, I have Midway Airport in Chicago in my district, and, you know, a lot of airport workers are in my district from bag handlers to maintenance techs. So, Dr. Hertzberg, do you have any thoughts on how airport ground crew can best protect themselves, be protected if travelers, maybe exposed, pass through their workplace? So, what can we do for the ground crew in terms of safety?

Dr. HERTZBERG. They should be observing physical distancing. They should be wearing masks. They should be staying well-hydrated. They should be constantly washing their hands and keeping their hands away from their face.

Mr. LIPINSKI. Thank you. And I want to thank all the witnesses for their testimony today, especially—Dr. Jones is a fellow mechanical engineer. I especially appreciate your work. But I thank all—thank you, all of our witnesses, and I thank the Chairwoman for allowing me to join with the Subcommittee today. Thank you. I yield back.

Chairwoman HORN. Thank you very much, Mr. Lipinski.

And before we bring this hearing to a close, I want to echo my gratitude to our witnesses and all of the Members for this incredibly insightful and important hearing. I think that we have touched on and are just beginning in this critical place and needed action.

And, Mr. Beyer, yes, I agree we should take some action, and I think more needs to be done. We've raised important issues.

And I'm coming away with a few takeaways. Just to echo Mr. Lucas, that these threats will continue. There are millions and billions of potential threats to our health and safety, and from our witnesses, that we simply don't know enough right now about how to mitigate the spread in a quantitative way, Dr. Jones, that we don't have a plan, and that we don't have clear responsibilities, that more research is needed, interagency coordination is absolutely required, that the need is incredibly urgent and that Congress needs to act.

I know there are number of ways that we can direct this research and move forward, but the timeliness and the criticality of addressing these issues seems to me very present, so I am—appreciate everyone and look forward to working with my fellow Committee Members on this issue to take action to address this and find a way forward, to incentivize research, R&D, to keep it going, and then make sure that there is a plan to increase public safety.

And thank you again to all of our witnesses here today. The record will remain open for two weeks for additional statements from Members and for any additional questions the Committee may ask of the witnesses. Thank you again for your participation, everyone today, and the witnesses are excused, and we are now adjourned.

[Whereupon, at 1:05 p.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Ms. Heather Krause

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE AND AERONAUTICS

R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond

Questions for the Record to: Ms. Heather Krause

Submitted by Chairwoman Horn

1. **During the question and answer period of the hearing, you said that, when looking into FAA R&D, GAO has found that the FAA has opportunities to partner with private research entities to accelerate research. Could you please expand on the opportunities and research areas you have found that are or could be available to the FAA?**
    a. **What, in your view, are models for effective public-private partnerships that could be considered for such research?**

While we are not in a position to recommend specific research areas for FAA, our 2017 report did note that the FAA needs to be both more strategic in identifying long-term research needs (specifically needs beyond 5 years) as well as emerging issues.[1] For example, our report pointed to issues such as the increased demand for unmanned aerial systems (UAS) and cybersecurity as among those that the Research, Engineering and Development Advisory Committee (REDAC) concluded FAA was initially slow to address.

Key structural features to facilitate FAA partnerships with private research entities are already in place. To date, FAA has leveraged its research and development (R&D) budget, which supports both federal and private sector research, to cooperate formally and informally with private research entities. For example, FAA receives private sector advice in developing its research plans from REDAC, among others, and tracks private sector R&D activities through various advisory committees and more informal relationships. FAA also uses two formal mechanisms, funding agreements with private sector companies (among others), to perform R&D and technology-transfer partnerships to share facilities, equipment, and staff. These agreements and partnerships extend FAA's capabilities and resources and expand the U.S. technology base. For example, the Centers of Excellence (COE) program are collaborative efforts between FAA,

[1] GAO, *Aviation Research and Development: FAA Could Improve How It Develops Its Portfolio and Reports Its Activities*, GAO-17-372 (Washington, D.C.: Apr. 24, 2017).

universities, and industry to advance aviation technologies and expand FAA research capabilities. Half of COEs' funding for FAA research projects comes from FAA and the other half comes through the COEs' cost sharing program. These COEs have been successful in producing necessary research to support FAA's activities and the aviation industry. For example, as we noted in our prepared statement, FAA funded some research on disease transmission on aircraft through its Airliner Cabin Environment Research (ACER) Center of Excellence. However, COEs generally only have a ten-year life span and this COE ended in 2014.

2. **COVID-19 is an immediate challenge, with unique considerations for response and mitigation strategies. What considerations should go into the development of a national aviation preparedness plan for communicable disease threats to ensure that such a plan can be flexible and effective against the range of potential communicable disease threats?**

The International Civil Aviation Organization (ICAO), a United Nations organization of which the United States is a member, provides extensive guidance as well as a template for member states to follow in developing their national aviation public health preparedness plan. This guidance is not specific to any one public health emergency, but adaptable and scalable to any public health threats. The guidance provides necessary elements of general preparedness, such as communications and command and control procedures, as well as specific response measures, such as passenger screening and aircraft disinfection.[2] As we noted in our statement, a plan could provide a mechanism for the public-health and aviation sectors to coordinate to more efficiently and effectively to prevent and control a communicable disease threat. It could also help minimize unnecessary disruptions to the national aviation system, which can be significant, as has been the case during the ongoing COVID-19 pandemic. Some aviation stakeholders have publicly highlighted the resulting piecemeal approach to adopting standards during the response to COVID-19, such as various airline and airport policies regarding facemasks, as demonstrating the need for a more coordinated response. The existence of a national plan might also have reduced some of the confusion among aviation stakeholders and passengers.

[2] ICAO, *Guidelines for States Concerning the Management of Communicable Disease Posing a Serious Public Health Risk* and ICAO, *International Civil Aviation Organization: Template for a National Aviation Public Health Emergency Preparedness Plan.*

3. **During the question and answer period of the hearing, you discussed the importance of multiagency coordination in responding to communicable disease threats. What are the key considerations for the FAA, in leading the development and implementation of a national aviation preparedness plan, to ensure effective coordination across agencies?**
    a. **Are there particular models for multiagency coordination that might be considered for the development and implementation of a national aviation preparedness plan?**
    b. **What other Federal agencies should be included in such a coordination activity, and to what extent should the development and implementation of a national plan include engagement with local, state, and international governments?**

There are a number of leading practices for effective coordination and some specific considerations to developing a national aviation preparedness plan. Generally, our broad work examining coordination has identified several practices, which if considered and addressed, help interagency groups and other coordinating mechanisms achieve coordination benefits. ICAO guidance to member states for developing a national aviation-preparedness plan for communicable disease outbreaks also states that implementation of any measures within a preparedness plan should be a well-coordinated multi-agency effort to avoid confusion, inconsistencies, and duplication of resources, as well as minimize inconvenience to travelers. Leading practices of coordination from our prior work include the following:[3]

- Outcomes and Accountability: Have short-term and long-term outcomes been clearly defined? Is there a way to track and monitor their progress?

- Bridging Organizational Cultures: What are the missions and organizational cultures of the participating agencies? Have agencies agreed on common terminology and definitions?

- Leadership: How will leadership be sustained over the long-term? If leadership is shared, have roles and responsibilities been clearly identified and agreed upon?

[3] GAO, *Managing for Results: Key Considerations for Implementing Interagency Collaborative Mechanisms*, GAO-12-1022 (Washington, D.C.: Sep 27, 2012) and GAO, *Managing for Results: Implementation Approaches Used to Enhance Collaboration in Interagency Groups*, GAO-14-220 (Washington, D.C.: Feb 14, 2014).

- Clarity of Roles and Responsibilities: Have participating agencies clarified roles and responsibilities?

- Participants: Have all relevant participants been included? Do they have the ability to commit resources for their agency?

- Resources: How will the collaborative mechanism be funded and staffed? Have online collaboration tools been developed?

- Written Guidance and Agreements: If appropriate, have participating agencies documented their agreement regarding how they will be collaborating? Have they developed ways to continually update and monitor these agreements?

The development of a national aviation preparedness plan would involve numerous federal, state, and local aviation, public health, and security agencies. Identifying all the relevant agencies and involving them in the implementation of the plan would be key to its effectiveness. Because public health is a shared responsibility of federal, state, and local agencies, any plan may need to involve state and local public health agencies, as well as local law enforcement. Therefore, effectively coordinating a national policy would require a framework that can be adapted and applied at the local level. For example, the 2006 National Strategy for Pandemic Influenza Implementation Plan identified actions and expectations for federal agencies to make effective international and domestic transportation decisions in order to maintain infrastructure services, mitigate adverse economic impacts, and sustain societal needs in the case of a pandemic influenza threat. The implementation plan focuses not only on transportation, but also on protecting human and animal health, law enforcement, and institutions, among other areas.[4]

Finally, all aviation stakeholders, such as airlines and airport sponsors, should be involved in the development and implementation of any plan. As we noted in our 2015 report, in 2006, DOT, in coordination with CDC, published the National Aviation Resource Manual for Quarantinable Diseases, which provides guidance for airports and airlines on how to

[4] This plan was developed in response to the avian influenza threat of H5N1 that began in 2003, the strategy has not been updated to address other types of communicable diseases.

develop a communicable-disease preparedness plan that can be adapted and implemented for a variety of sizes and types of communicable disease threats. Although that document has not been updated or distributed, it could provide a roadmap for developing a national plan, particularly with respect to the roles of aviation stakeholders.

4. **In your prepared statement, you commented that based on GAO's prior work, FAA could be more strategic in how it identifies long-term needs and research priorities. What did GAO learn about how FAA identifies emerging research issues?**
    a. **To what extent does FAA have the discretion to initiate and conduct this research?**
    b. **To what extent does FAA have discretion to act quickly and competitively-select research that can respond to emerging issues, including those that relate to near- term crises such as the COVID-19 global pandemic?**

In our 2017 report on aviation research and development, we found that FAA's process for identifying and prioritizing research involves multiple internal and external stakeholders and that the agency faces challenges in identifying research priorities that address emerging issue areas.[5] To identify and develop its research portfolio, program planning teams within FAA, which focus on specific research program areas, identify R&D projects to meet DOT and FAA's strategic or R&D goals. These program planning teams are composed of project sponsors from FAA, such as its aviation safety organization, that identify and demonstrate a need for research and use the results of the research as well as research performers that undertake the research. The research performers are FAA employees who possess scientific, engineering, and technical expertise. Further, a statutorily created advisory committee—consisting of individuals that represent corporations, universities, associations, and others—conducts external reviews of FAA's R&D programs for relevance, quality, and performance. This advisory committee also makes recommendations to FAA on research needs, including on emerging issue areas, and FAA's proposed R&D portfolios and budgets. We found certain instances where FAA's research portfolio had not readily adapted to change, including emerging issue areas. For example, we found in 2015 that while FAA has undertaken research in both UAS and cybersecurity, it took several years for that research to occur.[6]

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[5] GAO-17-372.

[6] GAO, *Unmanned Aerial Systems: FAA Continues Progress toward Integration into the National Airspace*, GAO-15-610 (Washington, D.C.: July 16, 2015) and GAO, *Air Traffic Control: FAA Needs a More Comprehensive Approach to Address Cybersecurity As Agency Transitions to NextGen*, GAO-15-370 (Washington, D.C: Apr. 14, 2015).

Two factors limit FAA's discretion to quickly prioritize, initiate, and perform research that responds to emerging issues areas, including those that relate to near-term crises such as the COVID-19 global pandemic.

- First, FAA begins planning for its R&D portfolio 3 years in advance of a budget submission. That means FAA began to plan for its fiscal-year 2021 R&D portfolio and budget in 2018. Because of FAA's R&D planning and budget process, FAA tends to keep working in existing research areas and can take several years to initiate research in emerging areas.

- Second, it is challenging for FAA to shift funds for research, engineering and development because its research programs are appropriated as individual line items and there are limits on FAA transfer authorities for those programs. For example, FAA generally cannot transfer more than 10 percent of the funding level specified for each program.[7] We reported that while FAA has transferred some funds within appropriations accounts or between programs in the past to meet emerging needs, FAA officials told us that given planned priorities, it is challenging to decide from which research areas within the agency's appropriations account to transfer funding. For example, officials from FAA's Civil Aerospace Medical Institute (CAMI) told us in June 2020 that, in light of COVID-19, they had submitted a proposal to study pathogen transport on aircraft; however, this research was not immediately funded given other research priorities. Officials said that they will submit the research proposal for inclusion in FAA's fiscal year 2022 or 2023 research portfolio and budget. This budgetary challenge highlights why it is important for FAA to implement the recommendations from our 2017 report to undertake a strategic and forward-looking approach to identifying emerging needs.

5. Based on GAO's work on FAA R&D, what entity within FAA's R&D enterprise is best suited to conduct and lead research on disease transmission within aircraft?

There are two facilities within FAA that can perform research on disease transmission within aircraft. These facilities are the Mike Monroney Aeronautical Center/Civil Aerospace Medical

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[7] Pub. L. No. 116-94 div. H tit. I,133 Sat. 2534, 2941-42 (Dec. 20, 2019).

Institute (CAMI) in Oklahoma City, Oklahoma, and the William J. Hughes Technical Center in Atlantic City, New Jersey. The institute focuses on the impact of flight operations on human health, while the technical center focuses on improvements in aircraft design, operation, and maintenance and inspection. For the institute or the technical center to conduct research on a project, an internal FAA requester, such as the aviation safety organization, must sponsor the project. Sponsors identify and demonstrate a need for research, and the sponsor will use the results of the research.

6. To what extent has FAA or CDC issued standards on the use of disinfectants on aircraft or other approaches being used by airlines to mitigate the risk of transmission? What more could be done to measure the effectiveness of such approaches?

Both FAA and CDC have issued guidance for airlines on air cabin disinfection and precautions to be taken to limit the transmission of COVID-19, but not any regulations. Specifically, on March 4, 2020, CDC issued updated guidance to airlines on responding to COVID-19, including new guidance on the cleaning of aircraft and the use and disposal of personal protective equipment (PPE).[8] In May 2020 and based on CDC guidance, FAA issued COVID-19 guidance for airline crews, including aircraft cleaning guidelines and how to minimize crewmember exposure.[9] In July 2020, the Departments of Transportation, Homeland Security, and Health and Human Services jointly published guidance entitled, Runway to Recovery. This document packaged existing and new guidance to mitigate the risks of COVID-19 to the aviation system, including guidance on aircraft and airport disinfection. The Environmental Protection Agency (EPA) has a recommended list of disinfectants that are effective in killing the coronavirus and attests that these disinfectants are effective in killing the coronavirus and safe to use if properly applied.

While global research is underway to reduce COVID-19 transmission in all venues, air travel creates a unique environment that warrants additional study. For example, research indicates that we are still learning how COVID-19 is transmitted through the air versus surfaces and the best means to mitigate transmission through either medium. Furthermore, research by Vicki

[8] CDC, *Updated Interim Guidance for Airlines and Airline Crew: Coronavirus Disease 2019 (COVID-19)*, (March 4, 2020).

[9] FAA, COVID-19: Updated Interim Occupational Health and Safety Guidance for Air Carriers and Crews, SAFO 20009, (May 11, 2020).

Hertzberg and others has shown that, similar to other built environments such as offices, aircraft cabins that have been cleaned and disinfected contain numerous bacteria.[10]

[10] Weiss, Hertzberg, Dupont, Espinoza, Levy, Nelson, Norris & The Fly Healthy Research Team, "The Airplane Cabin Microbiome," *Microbial Ecology,* vol. 77 (2019): pp. 87–95.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE AND AERONAUTICS

R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond

Questions for the Record to: Ms. Heather Krause

Submitted by Representative Foster

The FAA recognized in its Safety Alert For Operators (SAFO), issued on March 12, 2020, the World Health Organization's (WHO) declaration of COVID-19 as a Public Health Emergency of International Concern (PHEIC), which subsequently was declared a pandemic. However, in recent news, many of the airlines are beginning to rollback their efforts in protecting airline crewmembers, passengers, and support staff by making all seats available instead of restricting access to *only* window and aisle seats. In that regard, I would like to enter into the record a letter from the Air Line Pilots Association (ALPA) to the FAA administrator and a report from ALPA pilots on unsatisfactory COVID-19 precautions.

1. **According to the report entered into the record on the unsatisfactory COVID-19 precautions, each contracted cleaner on airline 1 was different from flight to flight. Do your models consider different types of disinfectants? Do you have recommendations as to what types of disinfectants should be used based on model results?**

CDC and FAA provide guidance to airlines and crew on aircraft disinfection. In addition, airlines may also have their own cleaning and disinfection protocols, so practices and use of specific disinfectants may vary. On March 4, 2020, CDC issued updated guidance to airlines on responding to COVID-19, including new guidance on the cleaning of aircraft and the use and disposal of personal protective equipment (PPE).[11] In May 2020, and based on CDC guidance, FAA issued COVID-19 guidance for airline crews, including aircraft cleaning guidelines and how to minimize crewmember exposure.[12] In July 2020, the Departments of Transportation, Homeland Security, and Health and Human Services published guidance entitled, Runway to Recovery. This document packaged existing and new guidance to mitigate the risks of COVID-19 to the aviation system, including guidance on aircraft and airport disinfection. While we are

[11] CDC, *Updated Interim Guidance for Airlines and Airline Crew: Coronavirus Disease 2019 (COVID-19)*, (March 4, 2020).

[12] FAA, *COVID-19: Updated Interim Occupational Health and Safety Guidance for Air Carriers and Crews*, SAFO 20009, (May 11, 2020).

not in the position to recommend one type of disinfectant over another, the various guidance issued by the federal government refers airlines and aircrews to various disinfectants tested and approved by EPA as safe and effective in killing the coronavirus. Research by Vicki Hertzberg and others has shown that, similar to other built environments such as offices, aircraft cabins that have been cleaned and disinfected contain numerous bacteria.[13]

2. Are cabin air filters standardized in the industry and is it important these are changed out morefrequently during this pandemic?

According to the International Air Transport Association (IATA), cabin air filters in the majority of commercial aircraft are High Efficiency Particulate Air Filters (HEPA) that filter out more than 99 percent of airborne microbes, similar to those used in hospitals. Some older aircraft may still use less efficient filtration systems. According to the association, most airlines change their filters at regular intervals, within manufacturer guidelines. Furthermore, according to the association, an unchanged older filter may work less efficiently in moving air but still be as effective in removing viruses and bacteria in aircraft.

3. Are the FAA and other federal agencies taking the models produced in academia seriously? What can Congress and the Science committee do more to bring awareness to these important findings?

FAA funds considerable research conducted by non-federal entities and is required by statute to obtain the advice and recommendations of its outside advisory committee discussed below. As outlined in our 2017 report, FAA relies on its university partners and advisory committees for input on its research planning or to perform research.[14] FAA's NARP and other R&D planning documents identify both FAA's efforts to partner with private sector and academia to leverage resources and its capabilities to ensure that the agency can achieve its goals and objectives. The following are the mechanisms that FAA uses to partner with the private sector and academia:

- R&D funding agreements: FAA obligates funds to private sector companies, as well

[13] Weiss, Hertzberg, Dupont, Espinoza, Levy, Nelson, Norris & The Fly Healthy Research Team, "The Airplane Cabin Microbiome," *Microbial Ecology,* vol. 77 (2019): pp. 87–95.

[14] GAO-17-372.

as other federal agencies, universities, and non-profit organizations, to conduct R&D in support of FAA's R&D principles. FAA awards contracts, grants, and cooperative agreements with organizations to perform R&D activities.

- Technology transfer: FAA shares the scientific and technical knowledge and the technology developed from its R&D activities with the private sector and other organizations by promoting the transfer of FAA technologies to private sector commercial applications. FAA enters into cooperative research and development agreements (CRDA)—collaborative working agreements that allow FAA to share facilities, equipment, services, intellectual property, personnel, and other resources—with non-federal entities, including universities and private sector organizations.

- Air Transportation Centers of Excellence (COE) are collaborative efforts between FAA, universities, and industry to advance aviation technologies and expand FAA research capabilities. Each COE is a cooperative research organization with researchers from many universities. Half of COEs' funding for FAA research projects comes from FAA and the other half comes through the COEs' cost sharing program.

- Research, Engineering, & Development Advisory Committee (REDAC): This statutorily created advisory group includes representatives from academia on its full committee and subcommittees. REDAC provides advice and recommendations to the FAA Administrator on the needs, objectives, plans, approaches, content, and accomplishments of the aviation research portfolio.

- Radio Technical Commission for Aeronautics (RTCA): The commission is a non-profit organization that includes representatives from academia, airlines, airports, aviation service providers, government agencies, general aviation, labor unions, and manufacturers. The commission works in response to requests from FAA to develop recommendations on technical performance standards for key components for air transportation and to facilitate implementation of air traffic management system improvements.

Congress can help ensure that outside research and advice is included in FAA's National

Aviation Research Plan (NARP) by insisting that the NARP meets Congressional mandates and GAO recommendations. For example, we reported in 2017 that FAA had not adequately adapted its research plans to emerging issues, such as unmanned aerial vehicles and cybersecurity, concerns raised by advisors outside the FAA. FAA has partly addressed our recommendations and is working to implement those remaining.

Responses by Dr. Byron Jones

U.S. House of Representatives
Space & Aeronautics Subcommittee
Hearing
R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond
June 23, 2020

Questions for the Record
Responses from Byron W. Jones

Response to Chairwoman Horn, question 1:

For the most part, these features are not regulated by the FAA. The fact that they are similar across makes and models of aircraft is more the result of constraints associated with aircraft design, the need to maintain comfortable conditions in aircraft cabins, and economic considerations. Regulations do specify design minimums for the amount of outside air that the environmental control system is capable of providing the cabin (0.55 pound per minute per passenger when fully loaded). How that air is delivered to the cabin is not specified by regulation. Other regulations may impact these features indirectly but are directed at other considerations. For example, emergency egress requirements may impact maximum seating density.

Response to Chairwoman Horn, question 2:

To be clear, I do not want to imply that there have been no advances in aircraft environmental control systems in the past 20 years. For example, the air-conditioning packs that cool the air provided to the cabin are much more sophisticated and efficient than they were several decades ago. However, the way in which ventilation is provided to the cabin is pretty much tried and true, seems to work well, and there has not been a lot of reason to change it. Air is supplied to the cabin through air inlets more-or-less uniformly along the length of the cabin. The air for the entire aircraft comes from a single mix manifold. The air in the mix manifold is approximately 50% recirculated air from the cabin and approximately 50% compressed outside air obtained from the engine compressors (except for the B787 which uses electrically driven compressors). The outside air supplied to the mix manifold is cooled using air cycle machines in the air-conditioning packs. The recirculated air passes through HEPA filters before it is supplied to the mix manifold.

The ventilation parameters are important because they control how quickly aerosols containing viruses are flushed from the cabin after they are expelled from an infected persons and how widely they are spread before they are flushed from the cabin. The more quickly they are flushed from the cabin, the lower the exposure. The less widely they are spread, the fewer people are exposed. The proximity of people to one-an-other potentially impacts disease transmission in two ways. The closer people are to one-an-other, the more likely there is to be disease transmission through direct contact, including large droplets that may be expelled by an infected person. Additionally, the closer people are to one-an-other, the more people that are impacted by the aerosol suspended in the air from an infected person.

The concentration of these aerosols will be highest near the infected person and decrease with distance from that person. Thus, the more people in close proximity to the infected person, the greater the exposure to these aerosols.

The ventilation air supplied to the cabin relative to its size is high for aircraft cabins, much higher than most other spaces occupied by people which, of course, is good. On the other hand, the ventilation air supplied per person in aircraft cabins is lower than in most other spaces. These two parameters combined are consider in air quality standards such as ASHRAE Standard 161, Air Quality within Commercial Aircraft to determine what levels of ventilation are acceptable. One difference between aircraft and other occupied spaces is HEPA filtration of the recirculated air. With the HEPA filtration, the air supplied to the cabin is effectively free of COVID-19 viruses. HEPA filtration of recirculation air is not common in other types of transportation vehicles nor in buildings and, thus, there is at least the potential for the ventilation system to be spreading the virus in those other applications but not for aircraft. To be clear, just because the air supplied to the cabin is virus free does not mean that the air in the cabin is virus free. Obviously, if there is one or more people in the cabin expelling droplets containing viruses, there will be viruses in the cabin air somewhere.

Responses to parts a-c of this question follow.

a) There are a number of regulations related to aircraft environmental control systems but most of them relate to materials and equipment you can put on an aircraft and requirements for certification of these systems. These regulations also address how the equipment performs in emergency and failure modes, etc. With respect to regulations that would impact disease transmission, the regulations are limited. The primary regulation in this regard is the requirement for the environmental control system to provide a minimum of 0.55 pounds per minute of outside air per occupant. I guess you could say this requirement is based on "recent" research and is different from the previous requirement which only required an "adequate" amount but did not specify that value. The details of the design of the environmental control system and how it provides ventilation to the cabin are not specified.

   Whether or not these systems and the associated regulations are adequate is a complex of a question without a simple answer. What I will say is that ASHRAE Standard 161, Air Quality in Commercial Aircraft is much more detailed, was developed through consensus by a broad group of stake holders, and is a much more comprehensive guide to requirements for aircraft environmental control systems with regard to actual conditions in the cabin than are the current Federal Aviation Regulations. Most aircraft meet the key requirements of Standard 161. Thus, even though the regulations are not very specific, aircraft still meet a much more detailed standard in most cases. In general, I believe the systems are adequate during non-pandemic times. It is unrealistic to expect the environmental control system alone to prevent disease transmission. Just as in other enclosed environments, mitigation measures such as universal use of face masks, surface cleaning, physical barriers, etc. are needed as part of the disease transmission minimization program. What you do not want is an environmental control system that contributes to the transmission process. In this regard, aircraft environmental control systems appear to be adequate. Could aircraft environmental control systems be better? Probably. Could they be worse? Definitely.

b) There is a lot more we do not understand about COVID-19 transmission in aircraft than we do understand but COVID-19 and aircraft are not particularly unique in that regard. In my mind, the biggest question revolves around the role of aerosols, those virus containing droplets that are sufficiently small that they can be carried by air currents. The more we learn about COVID-19 transmission, the more it is being accepted that aerosols are important but it is far from a closed debate. While direct contact transmission, including droplets that are too large to be carried by the air, presents many challenges, we know how to address them through distancing, barriers, masks, and such. Similarly, transmission by fomites (virus contaminated surfaces) presents challenges but we also know how to address them through sanitizing, hand washing, etc. Aerosols present a very different challenge as you cannot isolate yourself from the air you breathe and we all have to breathe. While face masks certainly reduce the exposure from aerosols, especially if everyone is wearing them, many face masks do not provide a high degree of protection to the wearer against the smaller aerosols. Effective protection against aerosols, may require higher grade masks than are commonly worn by the public and possibly eye protection too.

c) I am not aware of any design changes to the environmental control systems that could be readily retrofitted in the near term and that would be likely to have a major impact on COVID-19. We have looked at different air delivery geometries and do not see a lot of difference in the resulting ventilation effectiveness. Some modeling work at other universities indicates that there may be some geometries that will reduce exposure but those results would need to be evaluated with full-scale experiments to validate the modeling work. Changes of this magnitude probably would only be applicable to new aircraft models and it is unlikely that retrofitting existing aircraft or changing designs that are already certified would be practical. Most of our research in this area has focused on understanding the nature of the transport and dispersion of aerosols and was not addressed at evaluating new designs. We did look at the impact of the individual air outlets that are on many aircraft. Their use does reduce the risk of exposure from aerosols but it is a small effect. We also did do some work with CDC-NIOSH on a passenger isolation system. It is a lightweight device that can be stowed in a small space on the aircraft and then deployed if there is need to isolate a person on board. For example, if a person develops COVID-19 symptoms in route on a long flight, the device could be deployed to isolate the sick person and minimize the exposure for the other passengers. It is very much a special case application and not something that would be used routinely.

Response to Chairwoman Horn, question 3:

An important question and I do not have as good of an answer as I wish I had. There is no one technology that is going to eliminate the potential for disease transmission in aircraft. There are multiple paths for disease transmission and it is important that all of the paths be addressed, not just one. That is, it can potentially be spread by physical contact with an infected person, by contact with large droplets expelled by an infected person, by contact with surfaces contaminated by an infected person, and by inhaling aerosols generated by an infected person. We do not fully understand the relative importance of the different methods of transmission but, for the most part, we know how prevent or minimize them. For example, boarding, deplaning, and seating can be devised to minimize physical contact between people, surfaces can be thoroughly cleaned between flights, passengers can be provided wipes to sanitize their surroundings during flight, passengers can be provided hand sanitizer

to use during flight all to prevent transmission from contaminated surfaces. Mask can be used to block droplets being expelled and inhaled and physical barriers can be placed between people to address the large droplet transmission. The use of physical barriers is limited on aircraft as they may hinder emergency egress and there are strict egress regulations that must be observed. Aerosol perhaps present the greatest challenge as they can spread from an infected person to many other people in high occupant density environments like an aircraft. Certainly, universal use of masks can play a useful role as does good ventilation and HEPA filtration of recirculation air. Thus, it is not so much a matter of coming up with some new technology that is needed but rather the methodical and thorough application of what we already know how to do. There may well be technology that will be very helpful but we are not dependent upon some technological breakthrough to minimize the risk. For the most part, I believe airlines are attempting to implement most of these practices. How well they are doing it, I am unable to determine.

Protection against aerosol is an area of concern as not all masks are effective in protecting against them. Masks are important and I am strong supporter of universal mask use in any environment where people are in close proximity and especially in aircraft. The prevailing attitude is that a mask is a mask is a mask. That is, the focus is on whether or not a person is wearing a mask and little attention is given to whether or not the masks being worn are effective. Something that is needed is a standardized method of evaluating the effectiveness of masks and then a rating method that can be applied to masks. We have that kind of rating system for high grade masks and respirators, e.g. N95 masks. We also have this these ratings for other types of air filters. We do not have any rating for the types of face masks that most of us are wearing every day. Some are many times better than others but there is no easy way for the wearer to make that determination. Masks serve as a two-way barrier, a barrier for droplets an infected person expels and a barrier to droplets another person would otherwise inhale. Masks need to be evaluated for effectiveness in both directions. If there were such an evaluation and rating capability, then the next step would be to require that passengers and crew not only wear a mask but also wear a mask that meets some minimum performance requirement.

With regard to the second part of your question, my response is as brief as it was long for the first part. I do not have any significant insight into what technologies to reduce the risk of disease transmission the FAA may be assessing at this time.

Response to Chairwoman Horn, question 4:

In my opinion, you have zeroed in on perhaps the most critical and urgent questions for air transportation today. The question of what is needed to improve public confidence in the safety of air travel during the COVID-19 pandemic is crucial to the viability of our air transportation system and the air transportation industry. I have given this question a lot of thought since the hearing and, if there is one recommendation that I have made that is followed, I hope it is the one I describe below.

The way to improve public confidence in air travel is to make certain it is indeed safe. Easy to say, not so easy to do. We could spend millions of dollars on studying and quantifying the different mechanisms of COVID-19 transmission in aircraft and, by the time we get all of the scientific studies needed completed,

it will be way too late to have a major impact on this question. However, the air transportation industry is conducting the necessary experiments to make this determination each and every day. We just are not collecting the data. That is, there are currently about 500,000 passenger embarkations daily in the US. With this many people flying we are conducting a huge experiment as to whether or not flying is safe but, unfortunately, no data are being collected. The airlines already have passenger information. They contact us to tell us when our flight changes; they contact us to tell us when it is time to check in; they follow up with us after a flight to get customer feedback; etc. What needs to be done is to follow up with each passenger, or at least a representative sample of passengers, about two weeks after each flight and ask them whether or not they have been diagnosed with COVID-19 since their flight. This information, in and of itself, will not determine the safety of air travel. Clearly, with this many people flying, there are infected people flying. What would need to be done is determine if there are clusters associated with a given flight, a given aircraft, a given gate, etc. If these clusters are no greater than can be attributed to random chance, then we can be assured air travel is safe, given the mitigation measures in place. If there are such clusters, then we can see where further mitigation measures are needed. Make no mistake, the data analysis will be daunting but it is certainly doable. The real beauty of such an endeavor is that there is no need for months and years of research to get the needed answers. Government and corporate bureaucracy aside, the necessary data could be collected in a matter of a few weeks, if not a few days. We could start answering this question almost immediately.

While at least some airlines would have to be full participants in any such endeavor, it is best that the oversight be provided by an independent entity. Who that should be, I am not prepared to say but it needs to be an organization that would not get bogged down in bureaucracy. Certainly, the airlines could conduct the study but the perceived validity will be much greater if there is independent oversight.

Response to Congressman Foster question 1:

The primary role of disinfectants is to inactivate the viruses on surfaces. Use of disinfectants between flights prevents someone on the next flight from being exposed to viruses deposited on surfaces during the previous flight. Similarly, using disinfectants during a flight, e.g. wiping down surfaces, is intended to inactivate virus on surfaces to prevent exposure of a person to viruses from an infected person deposited on those surfaces during the flight. These measures are important and part of a comprehensive approach to minimize disease transmission. The models with which I have worked or with which I am familiar address only airborne transmission, not surface transmission and, thus, do not address the impact of disinfectants. It is important to remember that there are multiple, parallel paths for COVID-19 transmission including physical contact with an infected person, exposure to large droplets expelled by an infected person, contact with surfaces contaminated by an infected person, and exposure to aerosols generated by an infected person. A comprehensive approach to understanding COVID-19 transmission risk requires addressing all of these modes and a comprehensive program to minimize risk requires addressing all modes, not just one. The work with which I am involved addresses only one piece of the puzzle which is a roundabout way of saying that I do not have any special expertise that would qualify me to recommend any specific disinfectant or disinfection method.

Response to Congressman Foster question 2:

To the best of my knowledge, there are no regulations that specify air filtration performance requirements in aircraft. ASHRAE Standard 161, Air Quality in Commercial Aircraft, specifies a minimum rating of MERV 17 (i.e. a HEPA filter) but that standard is voluntary, not regulatory. In reality, this grade of filter is the "standard of practice" in that essentially all airlines use this grade of filter on their aircraft. There are regulations addressed at filters, such as the G-loads they must be able to withstand and the testing that is required to certify them for aircraft applications. As a result of meeting these requirements, cabin air filters on aircraft are not inexpensive. The incremental cost of meeting a MERV 17 filtration performance standard as compared to a lower performance standard is not large compared to the cost of the filter so there really is no incentive for airlines to cut corners and use a lower grade filter. The exact size and shape of a filter will vary between makes and models of aircraft. However, they all pretty much use the same grade of filter media.

There is no pandemic specific reason to change out the filters more frequently. A filter does not become less effective at filtration just because it is loaded (dirty). As a filter becomes loaded with dust and other material it collects, the pressure required to drive the air through it increases. This increased pressure requirement is the basis for determining when the filters need to be changed. If the pressure requirement gets too large, the system will not be able to provide the required airflow and ventilation airflow will decrease. As long as the filters are changed before the airflow is reduced there is no benefit to changing the filters more frequently from the perspective of reducing disease transmission.

Response to Congressman Foster question 3:

The FAA funded development of models for airborne contaminant transport in aircraft cabins and related research through the Airliner Cabin Environment Research Center of Excellence. CDC-NIOSH continues to fund research to support this model development. I cannot speak for either agency but as far as I know, they take the models seriously. Perhaps it is worth noting that there are many different types of models. We hear a lot in the news about how models predict how COVID-19 will spread geographically, how many people will be infected, how different measures will impact the numbers, etc. That modeling is a completely different type of modeling than the type of modeling with which I have worked. The modeling with which I have worked is addressed at understanding and describing the physical processes whereby aerosols move about the aircraft cabin. This modeling work gives us insights as to how people may be exposed and how they may be protected but they do not predict infection rates.

With regard to what Congress and the Science Committee can do, in my response to question 4 posed to me by Chairwoman Horn, I recommended an investigation that potentially could be conducted quickly and that would provide definitive information about the COVID-19 transmission risk, or lack thereof, on aircraft. Anything that Congress and the Science committee could do to see that such an investigation is implemented promptly would be extremely valuable to the flying public and the air transportation industry.

Responses by Dr. Vicki Hertzberg

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE AND AERONAUTICS

R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond

Questions for the Record to:

Dr. Vicki Hertzberg

Submitted by Chairwoman Horn

1. You stated in your prepared testimony that we cannot guarantee that the SARS-Cov-2 virus will not be transmitted in flight if aircraft are flown at or near capacity and without mandated testing of all passenger and crew ahead of flights. Recently, airlines that had previously been flying at lowered capacities have announced plans to return to full flights. As a public health expert, given the current state of the outbreak and mitigations still in place within the aviation system, what impact to the containment of COVID-19 would you anticipate from this change back to full capacity flights?
    a. What is your assessment of the impact of the airlines' decision to mandate masks on reducing the transmission of COVID-19?
    b. Is it possible, through some combination of measures —such as mandating masks, extensive testing of passengers and crews, etc.—for the aviation system to minimize transmission aboard airlines while flying at full capacity? What other safety measures need to be put in place?

    RESPONSE: a) A universal mask mandate will cut down on disease transmission by way of large droplets. However, the mask mandate will not necessarily reduce transmission by way of aerosols unless the masks so mandated universally are fit-tested N95 masks. Universally mandated use of surgical masks or cloth masks will not prevent aerosol transmission unless coupled with physical distancing measures. Unfortunately, the minimum distance to ensure no aerosol transmission is not known. b) I do not foresee any combination of measures that would guarantee zero transmission while maintaining full capacity short of universal testing by rt-qPCR of all flight crew and passengers. One way to minimize transmission with full capacity could be a universal mandate of N95 mask use.
2. The nature of an organism that causes a future pandemic or infectious disease outbreak may have very different characteristics from the virus that causes COVID-19. What research questions about disease transmission in dense, enclosed environments such as aircraft cabins could help us be better prepared?

    RESPONSE: A better understanding of distribution of aerosols would help, as well as a better of understanding of how contamination of physical objects can facilitate disease transmission.

3. What information is needed to improve public confidence in air travel during the COVID-19 pandemic and what roles do the government and stakeholders have in that

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON SPACE AND AERONAUTICS

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1. According to the report entered into the record on the unsatisfactory COVID-19 precautions, each contracted cleaner on airline 1 was different from flight to flight. Do your models consider different types of disinfectants? Do you have recommendations as to what types of disinfectants should be used based on model results?
RESPONSE: In our PNAS paper we were careful to note that our results would only be applicable to the one airline on which we flew, that other airlines may have different clieaning protocols. I have no recommendations as to disinfectant as that is beyond my area of expertise.

2. Are cabin air filters standardized in the industry and is it important these are changed out more frequently during this pandemic? RESPONSE: Industry standardization of cabin air filters and optimal frequency of changing them are subjects beyond my area of expertise.

3. Are the FAA and other federal agencies taking the models produced in academia seriously? What can Congress and the Science committee do more to bring awareness to these important findings? RESPONSE: I would have no idea if the FAA and other federal agencies - unspecified - are taking the models produced in academia seriously. I do know that the NIH, NSF, CDC, and USDA do take these models seriously, as they are major funders of this type of research with respect to disease. I am not sure how Congress and the Science committee could bring more awareness to these important findings. However, Congressional appropriation of funding to support further research would allow some of the members' important questions to be addressed.

Response to first set of questions:

1. RESPONSE: a) A universal mask mandate will cut down on disease transmission by way of large droplets. However, the mask mandate will not necessarily reduce transmission by way of aerosols unless the masks so mandated universally are fit-tested N95 masks. Universally mandated use of surgical masks or cloth masks will not prevent aerosol transmission unless coupled with physical distancing measures. Unfortunately, the minimum distance to ensure no aerosol transmission is not known. b) I do not foresee any combination of measures that would guarantee zero transmission while maintaining full capacity short of universal testing by rt-qPCR of all flight crew and passengers. One way to minimize transmission with full capacity could be a universal mandate of N95 mask use.
2. RESPONSE: A better understanding of distribution of aerosols would help, as well as a better of understanding of how contamination of physical objects can facilitate disease transmission.
3. RESPONSE: Information needed include 1) data on aerosol distributions in aircraft cabins; and 2) data on potential for touch transfer of pathogens via physical objects. The government should be primary funder of the research necessary to obtain these data.

Response to second set of questions:

1. RESPONSE: In our PNAS paper we were careful to note that our results would only be applicable to the one airline on which we flew, that other airlines may have different clieaning protocols. I have no recommendations as to disinfectant as that is beyond my area of expertise.
2. RESPONSE: Industry standardization of cabin air filters and optimal frequency of changing them are subjects beyond my area of expertise.
3. RESPONSE: I would have no idea if the FAA and other federal agencies - unspecified - are taking the models produced in academia seriously. I do know that the NIH, NSF, CDC, and USDA do take these models seriously, as they are major funders of this type of research with respect to disease. I am not sure how Congress and the Science committee could bring more awareness to these important findings. However, Congressional appropriation of funding to support further research would allow some of the members' important questions to be addressed.

Appendix II

Additional Material for the Record

LETTER SUBMITTED BY REPRESENTATIVE BRIAN BABIN

Airlines for America®

We Connect the World

June 22, 2020

The Honorable Kendra Horn
Chairwoman
Subcommittee on Space and Aeronautics
2321 Rayburn HOB
Washington, D.C. 20515

The Honorable Brian Babin
Ranking Member
Subcommittee on Space and Aeronautics
2321 Rayburn HOB
Washington, D.C. 20515

Dear Chairwoman Horn and Ranking Member Babin:

On behalf of Airlines for America (A4A) and its member airlines, I would like to thank the Subcommittee on Space and Aeronautics for holding the hearing "R&D to Support Healthy Air Travel in the COVID-19 Era and Beyond." The coronavirus pandemic has had a devastating impact on the domestic commercial aviation industry, and the Subcommittee's leadership in examining how best to leverage emerging research and development to ensure the health of our returning passengers and employees is deeply appreciated. I would also like to take this opportunity to put the effects of the crisis into perspective for members of the Subcommittee and describe the monumental efforts currently underway to protect the health and wellbeing of Americans who rely on commercial aviation as well as the men and women working at U.S. airlines to make air travel possible.

Prior to this global health crisis, U.S. airlines were transporting a record 2.5 million passengers and 58,000 tons of cargo each day. As travel restrictions and stay-at-home orders were implemented, demand for air travel declined sharply and suddenly. At its lowest point in late April, passenger volumes were down 96 percent to a level not seen since before the dawn of the jet age (in the 1950s). As our country and communities are slowly reopening, more people are choosing to travel by airplane but the reality is that air travel remains down approximately 85 percent, U.S. carriers still have 44 percent of their fleet parked and airlines are continuing to burn approximately $6 billion in cash each month.

Since the onset of this health crisis, U.S. airlines have been taking substantial, proactive steps – in many instances exceeding Centers for Disease Control and Prevention (CDC) guidance – to protect passengers and employees. A4A's member airlines are all requiring passengers and customer-facing employees to wear a face covering over their nose and mouth. On June 15, 2020, A4A announced that that our "member carriers will be vigorously enforcing face covering policies, putting rigor around rules requiring passengers and customer-facing employees to wear facial coverings over their nose and mouth. This is one critical element of the multiple layers that A4A carriers are implementing to mitigate risk and protect passengers and crew."

That announcement is just one of many steps U.S. airlines are taking to help protect the wellbeing of all travelers. In May, A4A launched a public awareness campaign, "Fly Healthy, Fly Smart" which helps educate the traveling public on measures airlines are implementing as well

as reminding the traveling public of steps they can take to help mitigate transmission of COVID-19.

At check-in counters and gate areas, travelers will see agents sanitizing counters and kiosks. Some airlines have installed plexiglass shields over the counters to provide additional protection, and some have marked the floors to ensure appropriate distance is maintained. Carriers have also implemented a range of policies – including back-to-front boarding and adjusting food and beverage services.

U.S. airlines continue to carry out intensive cleaning protocols for aircraft, in some cases to include electrostatic cleaning and fogging procedures. Carriers are working around the clock to sanitize cockpits, cabins and key touchpoints – including tray tables, armrests, seatbelts, buttons, vents, handles and lavatories – with Environmental Protection Agency (EPA)-approved disinfectants. Airlines have also increased the frequency of deep cleaning procedures for all flights.

Additionally, A4A carriers have aircraft equipped with HEPA filters, which help generate hospital-grade air quality. The CDC has said, "because of how air circulates and is filtered on airplanes, most viruses and other germs do not spread easily on flights." Airlines are encouraging travelers to utilize mobile check-in, kiosks and to follow all CDC recommendations including wearing a face covering, frequently washing hands and staying home if ill.

The Transportation Security Administration (TSA) is also playing a critical role in adding extra layers of prevention to reduce the risk of transmission, including requiring their officers to wear face coverings and allowing travelers to keep possession of their boarding pass through check-in. We also support and encourage TSA to start conducting temperature screenings conducted as an additional mitigation layer and deterrent.

Again, thank you for your leadership and interest in this issue. I look forward to keeping you and the members of this Subcommittee informed as A4A and its member airlines continue to develop and implement policies for protecting the health of our passengers and employees.

Sincerely,

Christine M. Burgeson
Senior Vice President, Global Government Affairs

LETTER AND REPORT SUBMITTED BY REPRESENTATIVE BILL FOSTER

AIR LINE PILOTS ASSOCIATION, INTERNATIONAL
1625 Massachusetts Avenue, NW | Washington, DC 20036 | 703-689-2270 | 888-FLY-ALPA
THE WORLD'S LARGEST PILOTS UNION | WWW.ALPA.ORG

March 31, 2020

Via email transmission
and facsimile transmission

Administrator Steve Dickson
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, DC 20591

Re: Request for Immediately Effective Order, Directive or Regulatory Requirement Ordering Air Carrier Compliance with CDC Guidance

Dear Administrator Dickson:

I write on behalf of the over 63,000 pilots represented by the Air Line Pilots Association, International at 35 U.S. and Canadian air carriers. This is to request your immediate action to safeguard the health and safety of flight crewmembers, the public at large, and the airline transportation system. An urgent FAA order, directive or regulatory requirement is needed because "guidance" from the Center for Disease Control (CDC) is not mandatory and is not being consistently followed.

The FAA recognized in its Safety Alert For Operators (SAFO), issued on March 12, 2020, the World Health Organization's (WHO) declaration of COVID-19 as a Public Health Emergency of International Concern (PHEIC), which subsequently was declared a pandemic. It also acknowledged the Secretary of the Department of Health and Human Services' declaration of COVID-19 as a public health emergency. The situation continues to worsen as over 163,000 people now have the coronavirus in the United States, with cases in every state. "More than 3,000 people with the coronavirus have now died in the United States, according to a New York Times database, a figure that has tripled since Thursday morning and that now exceeds the number of people killed in the terrorist attacks on Sept. 11, 2001." N.Y. Times, *Coronavirus in the U.S.: Latest Map and Case Count* (updated Mar. 31, 2020 8:05 A.M. E.T.). Friday's reports of the death from COVID-19 of an American Airlines flight attendant is especially sobering, and highlights the exigency of taking all needed measures to avoid further contagion of airline crewmembers.

The FAA has the statutory authority and responsibility to promote the safe operations of civil aircraft by prescribing regulations, and minimum standards necessary for safety in air commerce and national security. 49 U.S.C. 44701(a). It has exercised its statutory authority "to fully occupy and exhaust the field of flight deck crew occupational safety and healthy while they are in aircraft in operation." *Memorandum of Understanding Between FAA/DOT and OSHA/DOL* (Aug. 2014), https://www.faa.gov/about/initiatives/ashp/media/FAA_OSHA_MOU_2014.pdf. The FAA can and must exercise this authority to issue a binding order, directive or regulatory requirement,

effective immediately, to assure adherence to stringent standards to prevent the spread of the coronavirus to crewmembers, those aboard aircraft, and the wider public.

An urgent order, directive or regulatory requirement is necessary to obtain unequivocal air carrier compliance with CDC guidance, specifically regarding notification of flight crew and other airline employees exposed to individuals who are confirmed positive for COVID-19.

CDC guidance tells employers: "If an employee is confirmed to have COVID-19 infection, employers should inform fellow employees of their possible exposure to COVID-19 in the workplace but maintain confidentiality as required by the Americans with Disabilities Act (ADA). The fellow employees should then self-monitor for symptoms (i.e., fever, cough, or shortness of breath)." *See* CDC, *Interim Guidance for Businesses and Employers to Plan and Respond to Coronavirus Disease 2019 (COVID-19)*, https://www.cdc.gov/coronavirus/2019-ncov/community/guidance-business-response.html?deliveryName=USCDC_2067-DM23558 (last visited Mar. 30, 2020).

This means notifying crewmembers who have been in direct contact with other individuals subsequently determined to be infected by the coronavirus, whether infection is determined by positive test or other medical confirmation. Such notification *must* include crewmembers exposed to the infected person 48 hours before the infected person became symptomatic. Current scientific research indicates that contagion is possible at least 48 hours before symptom onset. Significantly, ALPA has learned that this life-saving notification process is not being uniformly obeyed.

Of equal concern is the lack of consistent airline adherence to the industry specific CDC guidelines addressing aircraft cleaning and disinfection. *See* CDC, *Updated Interim Guidance for Airline Crew: Coronavirus Disease 2019 (COVID-19)*(Updated Mar. 4, 2020), https://www.cdc.gov/quarantine/air/managing-sick-travelers/ncov-airlines.html.

We are aware of airlines claiming to have cleaned aircraft with alcohol-based disinfectants that fail to comply with the minimum 70% alcohol-based solution. *See* CDC, *Cleaning and Disinfecting Your Facility*, https://www.cdc.gov/coronavirus/2019-ncov/prepare/disinfecting-building-facility.html (last visited Mar. 30, 2020). The FAA should make airlines aware of their obligation to stringently adhere to these standards. We suggest including a list of specific products recognized to disinfect for the virus causing COVID-19. *See* EPA, List N: Disinfectants for Use Against SARS-CoV-2, https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2 (last visited Mar. 30, 2020)

Like the CDC guidance, the FAA's SAFO is merely "recommended action" and does not have the force of law or regulation. Written directives with legal authority and the risk of FAA enforcement action, fine or penalty are necessary to assure full adherence to the CDC standards. Failures to follow these minimum standards risk greater spread of infection and increased loss of life. Accordingly, immediate Administrator action is warranted.

We urge the FAA to require by immediately effective order, directive or regulatory requirement that air carriers must comply with the CDC guidelines. Moreover, such written prescriptive should also specify that air carriers have an affirmative duty to notify airline employees who have been exposed to an individual confirmed to have the COVID-19 infection

(whether that individual is an employee, contractor, vendor, passenger or in another status). It should include notification to crewmembers in contact with infected individuals at least 48 hours before the ill person became symptomatic. It should also mandate rigorous adherence to COVID-19 disinfectant protocols for cleansing aircraft, simulators and other surrounding areas. Gaps in airline procedures in this realm risk far-reaching and life-threatening consequences.

Under these dire circumstances, immediate action with the force of regulation is required. Just as this crisis has led other agencies to issue final rules taking prompt effect with subsequent public comment, so too is such action warranted by the FAA. *See, e.g.*, *Control of Communicable Diseases; Foreign Quarantine*, 85 Fed. Reg. 7874 (Feb. 12, 2020) (CDC interim rule under 42 C.F.R. § 71, effective Feb. 7, 2020, comments due Mar. 13, 2020), https://www.federalregister.gov/documents/2020/02/12/2020-02731/control-of-communicable-diseases-foreign-quarantine.

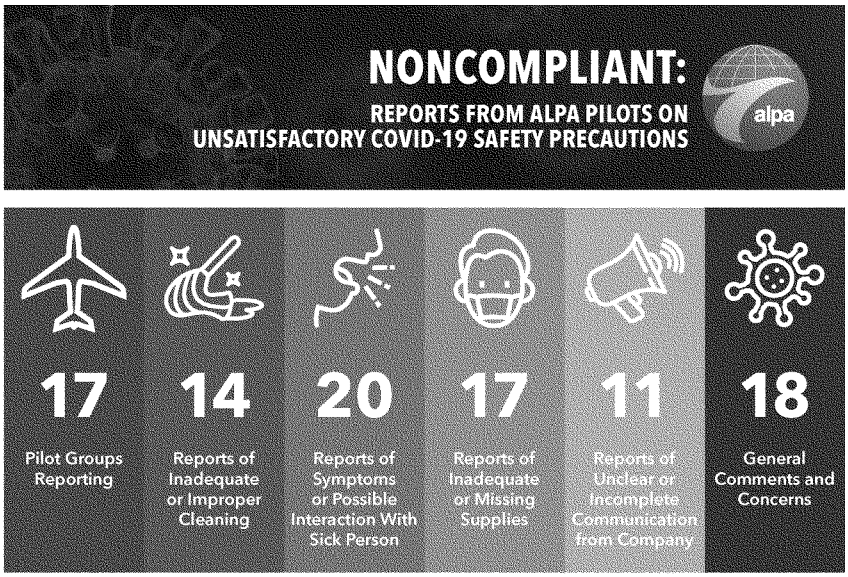
The Nation faces a grave threat with virus infection increasing exponentially, and the death toll rising hourly. We urge you to act at once by order, directive or regulatory requirement to ensure full air carrier compliance with needed health and safety standards to limit further spread of the coronavirus.

Sincerely,

Joseph G. DePete

Captain Joe DePete
President, Air Line Pilots Association, International
Email: Joe.DePete@alpa.org
Telephone: 202-797-4010

cc: Daniel K. Elwell, Deputy Administrator
Ali Bahrami, Associate Administrator for Aviation Safety



AIRLINE 1

- Each contracted cleaner is using a different disinfectant, not sure of everything that is being used at the moment.
- Supplies are hard to come by. While the company is trying to stock every aircraft with cleaning materials, they get raided by employees.
- The company is slow to adapt, if something needs to be fixed in the process it could easily take 3 weeks-2 months.

AIRLINE 2

- There are reports of Sani Coms still being used on aircraft.
- Report from 3/27/2020: Just tested positive for Covid19 yesterday. On day 8 of symptoms. Caught covid19 from captain I flew with on 27 March who texted me that he had tested positive too. Symptoms started 2 April.
- Report from 3/19/2020: Flight from LAX to XXX. Passenger one empty seat over coughing, sneezing and noticeably sweating. Felt onset of Coronavirus on March 22–EXTREME fatigue, occasional cough and slight fever. Checked with personal physician, ALPA Aeromedical physician and LEC Chairman who all recommended to self-quarantine for 14 days. Missed two trips–24 March and 1 April.

Key: *Inadequate Cleaning* *Symptoms / Possible Interaction with Sick Person* *Inadequate Supplies* *Missing / Unclear Communication from Company* *Questions / Comments*

June 22, 2020

- Report from 3/8/2020: Symptoms started on flight to CDG after layover in NYC. I was seen by a Dr. in my hotel room and called in sick delayed return home. Mild fever, body and heads ache, bad cough. No C19 test available. I returned home when fever broke. When are C19 antibody tests available to see if I had it?
- Report from 4/10/2020: Will wetting a surface with common hydrogen peroxide adequately kill Covid19?
- Report from 4/19/2020: Symptoms on 19 April. Tested on 20 April. Test result positive on 22 April.
- Report from 4/17/2020: There was no Matrix3 wipes onboard the aircraft so we could disinfect the flight deck. Flight Ops published a video saying that all of our aircraft would have them. We did not. We did have two small packets of Purell alcohol wipes for each pilot and gloves for each pilot. That was it.
- Report from 4/18/2020: There were no Matrix 3 wipes onboard the jet. Only Purell wipes (two small packets per pilot) to clean the flight deck. There were gloves as well. According to Flight Ops, there should have been Matrix 3 wipes onboard.
- Report from 4/27/2020: Matrix 3 wipes, the only product to kill the COVID-19 virus was not boarded on the aircraft. Flight Ops weeks ago, in their video, said that every let will have the Matrix 3 wipes onboard. The response from the company is, "we are out of them, and the supplier is having a hard time keeping up". Also, why isn't the union forcing the government and airlines to require each and every passenger to wear a mask? It doesn't make sense to me. ALPA is not doing enough to protect our lives and our family.
- Report from 4/27/2020: Was picked up by the Hotel Airport van at the XXX airport marked "CREW ONLY". The van was completely full of crews, most crews did not have a mask on. We were shoulder to shoulder. If someone had COVID-19, we all will get it. It's very unsafe to come to work every week. I certainly don't feel safe coming to work.
- Report from 4/28/2020: I was on a hotel van this morning from the XXX Airport hotel and the van was so full with crew members that 3 pilot were standing in the aisle of the small van. There were 18 people onboard the van including the driver. The pilots that were sitting were shoulder to shoulder. Most of the pilots were not wearing a mask. If one crewmember had COVID-19, we all will get it on the 10 min. van ride to the airport. I see this over and over. It's not safe to come to work anymore.
- Report from 5/10/2020: Upon arrival at the plane in XXX, there were no matrix 3 wipes and no flight kit cleaning bag. These were supposed to be a no-go item when the plane left XXX.
- Report from 5/09/2020: My observation was that about 50% of the LAS TSA agents were wearing a mask. I know it's not required yet by the TSA agents, but just an observation. It's no wonder that well over 500 TSA agents have COVID-19, because they don't care about their own health or others.
- Report from 5/10/2020: Upon exiting the secure area of the airport, I noticed several TSA workers at the passenger checkpoint were not wearing masks. I realize it's not required yet for TSA to wear masks. I think it's foolish that they are not wearing masks now. I guess they don't care about the passenger or crew's health.
- Report from 5/10/2020: I observed that 100% of the TSA agents were wearing masks including at KCM. The KCM agent said they are required to wear masks at LAX. It's still not required at LAS or DTW, as I observed yesterday and today.

- Report from 3/25/2020: I am reporting now because I And my family were tested for the antibody via a blood test on May 12 and just found out today May 14 that I was positive for the antibody. My family members were negative. I was never tested for the virus. Before it was revealed that loss of taste and smell was a symptom, I did lose my sense of taste and smell on the day of our return flight from XXX to XXX. I realized it when I got my crew meal in the cockpit, with no other real symptoms. In fact I had my temperature taken at the airport in XXX upon arrival and had no fever. I flew one more trip after that to XXX and back to XXX on April 1-2., thinking I was fine. Still with no other symptoms. I started to hear shortly after that trip that loss of taste and smell was an official symptom. I lost sense of taste for approx 12 days (starting March 25) and lost sense of smell for approx 3 1/2 to 4 weeks. I have been completely back to normal since approx April 22. I did self quarantine at home after returning from XXX for about 3 weeks around my family just to be safe, even though I had no other symptoms. The next time I went to work was May 14 for recurrent training, so I have not had any exposure to COMPANY personnel. I'm not sure if this is important to report at this time because it has been so long, but thought the data may be relevant.
- Report from 5/15/2020: How is it that we are not regularly tested for Covid since we are considered essential front line employees and are potentially exposed to the virus every day at work?
- Report from 06/03/2020: I went into the XXX pilot lounge at 4pm. I was the only person in the place with a mask. I even saw a Chief pilot talking by the computer s with no mask. The pilots are careless!
- Report from 06/05/2020: I have a medical background. Masks do not prevent the spread of airborne viruses. If people want to voluntarily wear masks, fine, but it should not be mandatory. Trying to social distance on aircraft by capping the seats is just stupid. There's another flu season coming and if we continue on this path, all the airlines will be bankrupt, again.

AIRLINE 3

- There is poor communication regarding the cleaning of aircraft. There was a potential case on a JFK to XXX flight but since the case was never confirmed positive we are unsure if the aircraft was ever cleaned.

AIRLINE 4

- Airline 4 is unable to answer any questions regarding the cleaning process or materials provided to crews. We are unsure if there is communication problems with the company or if they are still working on a plan of action.
- Report from 4/17/2020: I was tested for Covid-19 on Friday, April 3rd and confirmed positive on Tuesday April 7th. Feel free to call me any time.

- Report from 3/19/2020: As requested by recent email, I am submitting this DART relating to SAFO 20009. I contacted the company scheduling department in the evening of March 19 by telephone that I was ill & headed to the ER and would not be available for work the next day. The ER diagnoses me as having COVID-19 (later proven correct when a POSITIVE result occurred on my test kit from the ER). I called scheduling again in the early morning of March 20th and advised them that the hospital as well as the local Health Department had advised me the entire crew should be considered infected. Scheduling did not remove the rest of my crew from their flights and they continued the rest of the 4-day trip. The company did not advise anyone I had flown with of my diagnosis and their probable infection. I was forced to try and reach out through friends of friends and other non-standard sources to contact the multiple pilots and flightcrew members I had flown with to advise them of my confirmed positive infection. The company refused to remove these pilots from work, and most of them continued to be scheduled for work by the company. I believe one or two utilized their sick time and own expense to not go to work. I tried to have the company advise my crew members by asking for it over telephone and by email several times. This never occurred. Attached is one of my emails I sent to the company advising them the health department had contacted me asking those crew members to be quarantined or at least advised of their possible infection.
- Report from 4/23/2020: No sanitizing wipes of any kind were available prior to our flight today. I have been off and away from airports since 3/25 so I don't know if this is a recurring problem. The flight attendant implied they almost never can acquire the wipes. My first officer mentioned that she had not seen any coming from the company but had gotten some from her previous captain, who had brought his own from home. This is why we need the FAA to enforce having the necessary cleaning supplies and/or cleaning the cockpit between crews. Without enforcement we will be unlikely to get the supplies we desire.
- Report from 5/1/2020: Flew Flight XXXX into Buffalo and deadheaded out on the a/c as it returned to ORD. No specialized cleaning was done in the cabin nor was there any cleaning of the flight deck. Crew PPE has improved. Each segment is provided with four masks, rubber gloves, and four alcohol wipes.
- Report from 5/03/2020: Company did not enact enhanced cleaning procedures promised during an aircraft turn from airport XXX to airport YYY. Observed as a deadheading passenger and the inbound operating captain. Company is supposed to be providing PPE per segment (masks, sanitizer wipes, sanitizer gel), but it was not provided on this flight segment and appears to be provided inconsistently. Company adherence to enhanced cleaning procedures is in need of improvement.
- Report from 5/09/2020: At the out station the cleaning crew came on and "wiped" down the plane before the customers boarded. It seemed to be Clorox or at least in a Clorox bottle which seems like a good start. The problem was the only part of the passenger seats that was wiped down was the seat itself. Not the area that passengers touch constantly, such as seatbelts, window shades, arm rest etc. Also the entire plane was supposedly wiped down in less than 10 minutes which I find impossible since it takes me over 10 minutes to wipe down the things I touch in the flightdeck.
- Report from 5/09/2020: The company only continues to provide limited sanicoms to wipe down the cockpit and headsets for each day. With multiple aircraft changes the ability to disinfect the flight deck after another crew. My crew also went to the CPO to refill a company given bottle of hand sanitizer and we were told it is only for XXX crew members only. I find this incredulous since our flying brought us into XXX through out the day multiple times. Where we are based should have no effect on being about to obtain cleaning products for our health when our trip locates is in a different base for work.
- Report from 5/15/2020: In base the aircraft between passengers was not disinfected despite having over 70% capacity on the previous flight.

- Report from 5/15/2020: Today flying from an out station into base we ended up having a tight turn which lead to not enough time to obtain wipes. The company is still only distributing sanicoms and Ops has no supposed access to any of these wipes. So on this tight connection we had no option of walking to another terminal and obtaining wipes from the chief pilot. Therefore leaving no opportunity to have wipes to sanitize the headsets and flight deck.
- Report from 5/14/2020: Enhanced cleaning procedure not performed prior to boarding. Cleaning crew sent only one cleaner who wiped each seat with the same rag, did not clean tray tables, and did not clean flight deck.
- Report from 5/17/2020: Enhanced cleaning procedure was not initially performed. Requested cleaning procedure be performed in cabin and flight deck directly with cleaners on board who made a call from the jet bridge phone to their supervisor, then performed the procedure.

AIRLINE 5

- SaniComs are still being provided to pilots. SaniComs not on the approved list.
- The training center does not have a good process set up for instructors and there is a need for detailed cleaning guidance that matches the products being provided.
- Report from 4/20/2020: I flew the same airplane for two days. We arrived back from XXX around 1500L in YYY. After the passengers de-planed, two cleaners came on the plane wearing gloves only and had nothing else with them. They were on and about to get off the plane in less than 5 minutes. I asked the FA to ask if they were there to clean and she said yes. I asked the cleaners if they were going to disinfect the aircraft. They both looked at me with wide eyes and said they didn't do that and they thought someone else would. I asked the ramp agent if he knew who would come out to clean the plane. He said he wasn't sure and would follow up for us. I went back to the gate around 1830 to go to the plane. I was curious of the new procedures and wanted to make sure we had enough time to make sure the plane was properly cleaned for our passengers and other crew members. I asked the gate agent and they told me they didn't know if it was cleaned and I went downstairs to try and get on the plane early. I waited at the boarding door until 1920 for the gate agent to show up. I finally found someone to let me on the plane. After talking to Ops they told me the plane was cleaned at 1515, so it was the two cleaners who came out earlier with their gloves only and no cleaning material. I asked if they could verify if the plane had been cleaned and disinfected according to the new protocol, no one knew. The flight attendant found trash in the seat backs so we decided that it would be best to have the plane cleaned again to be safe. At one point Ops called us back while we were waiting and asked if the FA told the cleaners to leave because the plane was fine. We did not see any cleaners to tell them, they showed up around 1950. After talking with one of the supervisors, I was informed that the two agents that came out to the plane did not know the cleaning protocol so the plane was NOT cleaned or disinfected. We were told that they are only supposed to wipe down the tray tables on turn cleans. They told us the other cleaning machines were too big to fit on the plane so they never bring them on the aircraft. The cleaners wiped down the aircraft and followed the information that was provided to us via the company in my messages. They left us a virus kit. We boarded the aircraft and left for ZZZ 12 minutes late.

AIRLINE 6

- Cockpit cleaning is nonstandard and the contractor has been witnessed not cleaning the cockpit but reporting otherwise. There are multiple accounts of visibly dirty cockpits being reported as "cleaned."
- Adequate hand sanitizer is not available on aircraft despite no sink or soap onboard. When there is hand sanitizer, it is not an alcohol based solution.
- The government in China is using invasive procedures on crews when entering the country. They are being bussed to the passenger terminal to wait in crowds to be tested and on some bases they are being sprayed with unspecified chemical mixtures to ensure they are disinfected. Some of the chemicals used are eye irritants and the percentage of chemical used in these sprays is unknown. Crew members who are currently being isolated in hotels are being pressured to join the government's isolation camps. This directly contradicts the guidance provided by Airline 6 management and crews are left "on their own" while trying to navigate the process. Airline 6 security was not accessible during this process for some flight crews despite their commitment to oversee the health clearings.
- Report from 4/09/2020: Social distancing in the flight deck is not possible. Should it be mandated to wear cloth or mask protection to prevent the escape of particles from the mouth. Asymptotic crew members may unknowingly spread the virus. I recently purchased the enclosed items to wear next time I work, a suggestion made to me by my two daughters who are medical professionals. Website buffusa.com, known as multifunctional headwear. This headwear can easily be slipped down to the neck in case the O2 mask needs to be immediately used.

AIRLINE 7

- SaniHands are still being used to clean the cockpit and are not on EPA list N of approved items.
- Report from May 2020: Our training department resumed CQ ground school and the instructor attempted to lead the group in donning emergency equipment while we have an exemption to use alternate means to satisfy the requirement during the pandemic. The instructor was unaware of the exemption, and this is after the pilots were informed via email that alternate means would be in place for our safety. The MEC has addressed the company directly. Additionally, the company will provide face coverings for crew, but the hour at which [a pilot] was dispatched, there were no masks readily available, nor was anyone available to assist him. We will now be able to procure masks from Inflight supervisors, but communication on this has not been published yet. We are currently awaiting a response from the company on a myriad of safety concerns regarding their COVID-19 preparedness plans and policies, and we have grave concerns that our pilots will not be adequately protected or educated on how to protect themselves, based on the company's communications to date.
- Report from May 2020: Another point of concern is tracing and tracking crews with exposure to COVID-19 and ensuring CDC guidelines are interpreted to handle the way airline crews are scheduled and replaced. Two days ago, a Captain was replaced mid-pairing after he was identified as having exposure to a Flight Attendant who tested positive for COVID-19. Scheduling did not remove and replace the whole crew, just the Captain. The replacement Captain was not made aware of the reason why he was being called in, further placing the burden of his protection from the virus on him.

AIRLINE 8

- Flight Decks are being cleaned on RONs however there are complaints of visibly dirty cockpits after cleaning. There is no way to verify that this cleaning is happening or that it is effectively done.
- There are no 70% alcohol wipes available and the higher concentration wipes are being delivered in very small rounds.
- The Sani-Cide EX3 that is also being used directs that there is a 10 minute wait time prior to wiping the chemical off, however, Airline 8 task cards do not instruct to do this.
- Report from 3/25/2020: Flight attendant didn't call in sick out of fear of retaliation from the company. Ended up testing positive for COVID 19 days later.

AIRLINE 9

- Crewmembers are reporting that management is not being clear when informing that they have come in contact with a positive person. Management is not instructing crew members of the 48 hour self-monitoring period nor are they informing these crew members in a timely manner (within 48 hours of possible contact) or thfie day/time when they might have been in contact with a positive case of COVID19.
- Report from 5/09/2020: We asked for additional hand sanitizer from the agent passing out Safety kits and were told we only get the bottle we got in our first kit. Then we were given Sani-com.

AIRLINE 10

- Report from 4/09/2020: Departing IAD the flight crew requested catering and specifically additional water bottles. 6 Crew on board (all with late shows following day)--Catering responded stating they are no longer supplying water in the larger bottles, only small bottles are to be handed out. Personally drinking about 3 liters of water each day, I feel we still need to have water bottles supplied to each aircraft. Public water in hotels is generally found in the hotel gyms (closed) and if there is public a public water fountain, would that really the best place for us to get water from? Let's do what we can to ensure catering continues to supply our aircraft as needed by both crew and passengers.

AIRLINE 11

- Report from 4/08/2020: Airline 11 has started a marketing campaign regarding their steps to make the airline safer re: covid19. They have a video on their website (see above) where they use fogging technology. I would like to know what the name of the chemicals are that we will be exposed to, including the MSDS if possible. I would like to know what the side effects of these chemicals are regarding prolonged exposure. The company also claims that the Airbus 320 series aircraft completely cleans the cabin air every 3 minutes and I was wondering if the union has any information or proof to verify those claims?
- Report from 5/18/2020: Operated flight XXXX and XXXX on 5/18-19. Was not provided disinfecting wipes. None were available in the crew room and none were on board the aircraft. There were masks and a large bottle of hand sanitizer in the crew room, but nothing to wipe down the cockpit.

- Report from 5/27/2020: I feel like the company is doing a good job providing face masks. The health issue is not with the company but rather flight crew not wearing masks. Masks do not protect the wearer. They mostly protect those around the person wearing the mask. Therefore, if the captain chooses not to wear a mask even though the FO does, the FO is still at risk. I spoke with a fellow FO flying a line in May and he says masks come off as soon as cockpit door/cabin doors close. If I bring Covid home from work, I have members in my household who would be potentially hospitalized or worse by this virus. I am holding a reserve line in June. How am I to protect myself if crewmembers do not choose to wear a mask? I understand that the union's specialty is mediating with the company but what are we to do if the problem is within our own ranks because people don't research/understand how wearing masks is in effective mitigation tool for mitigating this virus?

AIRLINE 12

Report from 4/23/2020: RE 1st VP Fox's email:

- Airline 12 encourages the use of masks as described.
- Airline 12 is supplying all items listed. Additional supplies are thermometers available for each crew member and for FAs gowns and safety glasses.
- Airline 12 lavs are well equipped–in the aircraft which have a portable water system. More than half the fleet does not have running water. Those a/c are supplied with hand sanitizer in a pump bottle.
- Here's where they're falling down a bit. It his pretty well left up to the crews (both pilots & FAs) to clean as we see fit. They have said that there will be allowance made for any time required by an individual to clean. My opinion: with the amount of time the aircraft are sitting on the ground at major stations, most are sitting at least 7hrs between flights, there's no acceptable reason that the cleaning crews can't be the ones doing this.
- As for regulator merely recommending these practices–well that's not enough either. As the Government has designated airlines as essential they also need to require certain behaviors be completed with while off duty as well. Such as using protective items when doing necessary chores such as grocery shopping.

AIRLINE 13

- Report from 4/08/2020: While passengers were boarding the aircraft, the flight attendant discovered that there were no gloves or hand soap in the lav supply kit bag. I called Ops for a complete kit but there was no response. Are gloves and soap required for passenger flight or is it just on availability?
- Report from 4/09/2020: Just wondering how to clean hotel pillows.
- Report from 5/27/2020: I observed a Discrimination of airline personnel during temperature checks at XXX at terminal X at KCM access. There are airline crews with the option for "voluntary" temperature checks and others which are "required" temperature checks.
- Report from 06/18/2020: From company email. It is not clear if PIC or FO can refuse a passenger who refuses to wear a mask after boarding and before flight. Additional concern is if a passenger cannot wear a mask due to medical condition, then I doubt they are healthy enough to fly. OpSpec says we cannot board persons in need of supplemental O2 and cabin altitude will be lower than on the ground. We are not a medical flight.

AIRLINE 14

- Report from 4/09/2020: I'm a commuter, and the issue is about this recent change that crew members are not allowed to be assigned business/first class seats. My only concern is that this can put me around, and closer to most of the passengers in a given flight, and almost all the time on average. I was on a flight cltcut-off, where all of the seats except one in business were open, yet we (me and a couple other crew members) weren't allow to take seats in the front due to this new change. I'm completely against it, I still don't understand the benefit for this change, and don't understand how putting us essential crew members at higher risk by being around and closer to more people is something that is implemented for our travel.
- Report from 4/17/2020: XXX base is not staffed to receive masks all day and at XXX we do not pass through the base during a trip as we start and end there. I started my last trip 725 show time on a Thursday and no one was there. We either need to staff early to receive masks, be able to pick up in a different base or be able to receive masks at the end of a trip for our next trip.
- Report from 5/3/2020: Suggest that the company issue one extra Max at the end of a trip so that aircrew will have one to travel through the airport and pick up their allotted masks for their next trip/ reserve period.
- Report from 5/17/2020: My wife has been sick and after a trip to the ER, her along with the rest of the family have been directed to self quarantine for 14 days.

AIRLINE 15

- Report from 4/10/2020: I've contacted my MEC Vice Chair on April 7th 2020, and Base Chief Pilot on April 8th regarding the quantity and distribution of Airline 15 Pilots and Flight Attendants who've tested positive for C19. I've not received an explanation from either of these first points of contact. Nor have I seen any corporate communications detailing the extent to which C19 is effecting both groups. At this point I feel as though the pilot group is deliberately being left in the dark. The first, most obvious question is WHY? Is there a disproportionately high number of employees affected by the virus which management wish to conceal? Some might dismiss me as paranoid but I'm not the only member of this labor group asking the same questions. Therefore, I tend to think it's a fairly reasonable question given the circumstances. I know for a fact that this information is being collected and monitored closely. I think we deserve to know the truth about the extent of the viruses effect on our unique work environment, and co-workers heath, so we can make informed decisions moving forward.
- Report from 06/17/2020: This is just a general question, not particular to any single flight. FYI, I emailed the XXX Chief Pilot this suggestion back in March and while I think he forwarded it up the chain but I do not know of any further action, XX did not change any SOPs. COVID is spread through the air, and in an airliner cabin you have a lot of people in a confined space. For my airline, there has been no change in SOP regarding PACKS/airflow. I know that a lot of aircraft are equipped with HEPA filters, but from a risk standpoint, what is lowest risk: 1. Continue with current SOP regarding PACKS/ airflow 2. Always have PACK flow set to high in your aircraft regardless of occupancy to have max airflow circulating 3. Have PACK flow set to high and keep cabin recirculation fans off, so that cabin air isn't recycled at all, rather all air is new air coming in from the outside. If ALPA did an analysis and came up with a recommendation here, it would be beneficial to helping stymie the virus spread.

AIRLINE 16

- Report from 4/09/2020: Hotel desk is refusing to move me or other crewmembers to a hotel location that isn't downtown in one of the hardest hit covid cities right now. I don't find it safe to have our crewmembers downtown
- Report from 4/03/2020: Was exposed to another crew member in Shanghai that tested positive. Have been relieved from flight status for 14 days. No follow up from company or any medical personnel.
- Report from 4/08/2020: What is the FAA stance on pilot crewmembers wearing a facemask (such as N95) while at a duty station? Airline 16 is now providing masks at some domiciles. Are the pilots authorized to fly in seat while wearing the mask? Thank you.
- Report from 4/09/2020: A recent company communication indicated that some of our bases (with others soon to follow) are conducting temperature screening for COVID 19 upon arrival at the airport. If we are pulled off a trip for having a high temperature what will happen. Will be required to quarantine in place and if so who pays for our accommodations for the 14 days? Are we paid for the time away? Sick listed? Please provide dome clarifications.
- Report from 4/10/2020: What are practical guidelines for pilots returning home after flying to and staying at Covid epicenters such as Newark? In other words, what should we do to protect our families?
- Report from 4/14/2020: Being that we are regularly in a position to be exposed to COVID-19, and with Airline 16 system and crews large amount of China flying, is there any plan by the company to do antibody testing of aircraft crews as soon as these tests become available? It would seem to me that Airline 16 crews in particular, second only to medical personnel, have very likely already been exposed to/sickened by COVID-19. I and many others believe we have probably already had this. Will the union be pushing for this testing?
- Report from 4/14/2020: Worked flight AAA, XXX-YYY today. Upon boarding, my new routine consists of wiping down all cockpit touch areas with the company provided disinfectant wipes. There were none in the cockpit, I searched the locations provided by Airline 16, none could be found. I asked the FM if there was another location, he didn't seem to be interested in helping. I then called station operations and requested more wipes. There was a plastic bag of Purell hand wipes and some small alcohol wipes, both not suited to disinfect surfaces due to small size. I would have used them all. A follow up call to station operations for the Lysol wipes was met with what I would call disinterest. We were unable to secure additional company provided disinfectant wipes prior to departure. My CA and I used our personal supply, which are nearly impossible to replenish. No one seemed to think this was a problem.
- Report from 4/22/2020: Crew was not provided protection kit for cockpit flight AAA. Had to request it.
- Report from 4/24/2020: I was not a member of this crew but I wanted to make sure you are aware of this incident. Thanks.

AIRLINE 17

- 4/30/2020: A pilot who had recently been in the simulators had tested positive for COVID 19. Pilot in question was asymptomatic and tested positive after leaving the sims. Company indicated they have notified the appropriate personnel and have instructed them to self monitor. They claim that full CDC cleaning protocols were followed between sim periods and there is no risk to additional crews. ALPA is seeking formal clarity and challenging if the situation was dealt with adequately.