

Making Buildings Safe

*Buildings could serve as a first line of defense
against biological attacks.*

Many US workers spend a great deal of their lives inside temperature controlled commercial buildings, breathing circulated and filtered air. Circulating air improves indoor air quality and makes the environment more comfortable for building occupants, but if that circulation allowed biological agents to spread throughout a building, it could also make the occupants more vulnerable to the effects of a biological attack. Air circulation may have contributed to the spread of anthrax spores in 2001 when an envelope containing anthrax spores was opened in the Hart Senate Office Building and people on several floors and in adjacent office suites were exposed. If the heating, ventilation, and air conditioning (HVAC) systems of large commercial buildings were

manipulated to intentionally expose occupants to a biological attack, mass casualties could result.

In a 2002 *Washington Post* op ed piece, Ralph Gomory, Richard Garwin, and Matthew Meselson asserted that HVAC systems, if properly configured, might be able to protect building occupants instead of facilitating the spread of dangerous pathogens. They argued that HVAC systems configured to filter pathogens from the air could become “not a conduit for, but a defense against, bioterrorist attack.”²⁶⁸ If exposure to dangerous pathogens could be reduced, then illness and possibly deaths could also be averted or decreased.

INVESTING IN BETTER AIR IN
COMMERCIAL BUILDINGS WOULD
PROVIDE BENEFITS EVEN IN THE
ABSENCE OF AN ATTACK.

Investing in better air in commercial buildings would provide benefits even in the absence of an attack, because enhanced air filtration standards could boost energy efficiency, lower maintenance costs, improve indoor air quality, and, presumably, improve occupants’ general health. Some studies have suggested that as many as 15 million office workers in the United States suffer from “sick building syndrome,” a series of nonspecific symptoms that include headache, fatigue, and upper respiratory complaints that “appear to be linked to time spent in a building, but no specific illness or cause can be identified.”^{269,270} Although the causes of sick building syndrome are varied and often unknown, it has been attributed to improper air ventilation and to chemical and biological contaminants.²⁷⁰

The Sloan Foundation continues to focus on protecting health and examining the role of biological contaminants in the indoor environments in homes, hospitals, and public buildings, and shaping the emerging field

of “indoor ecology.”²⁷¹ Reducing natural threats like sick building syndrome will help many on a routine basis, and reducing exposure to pathogens could diminish the consequences of exposure to a biological weapon. As there would be less need to treat victims of a biological attack if building filtration were successful, these engineering methods are an important complement to medical preparedness. As Gomory said, “The threat is here, the threat is only going to get worse as our knowledge of how to construct DNA improves, and the cheapness of doing it improves. And yet, the stuff is filterable. And it’s bound to be, because it’s that big. So you can defend against it, but not by traditional medical methods.”¹



Using Air Filtration to Make Buildings More Secure

Updated Guidelines and Training for Building Owners and Managers

Better filtered air could theoretically reduce the consequences of a bioterrorist attack and curb the spread of ordinary infections. However, the practicality and feasibility of augmenting the HVAC systems of existing buildings had to be examined. In 2002, the Sloan Foundation launched a major collaboration with the American Society of Heating, Refrigerating

and Air Conditioning Engineers (ASHRAE), a 50,000 member professional organization that provides influential guidance to the industry. Sloan's direct involvement began when Gomory contacted John L. Tishman, then chairman of the board and chief executive officer of Tishman Realty & Construction Company, based in Manhattan. The company's senior vice president, Harvey Brickman (now retired), was asked to investigate the efficiency of filters in averting the effects of a biological attack to determine whether filtration devices were effective and readily available.

A mechanical engineer by training, Brickman found that such filters were effective, readily available, and might even be cost effective for some buildings. "ASHRAE looked into all aspects of this problem, including filtration, arrangement of systems, where the vulnerable points were, when you should run your system, when you shouldn't run your system," Brickman recalled. "The problem is more than just filtration. It's how you operate your systems, how you design your systems and how you assess risk."²⁷²

This research helped establish pragmatic guidance for upgrading air filtration. Air filters are rated with a minimum efficiency reporting value (MERV). MERV ratings range from 1 to 20; filters rated 17 or higher are known as HEPA filters (HEPA stands for high efficiency particulate arresting). HEPA filters, which are expensive, are used in hospital operating rooms, clean rooms of silicon chip manufacturers, and other environments with strict air quality control requirements. Yet in conventional settings, filters with MERV ratings of 13 to 16 can remove most pathogens, often without major changes to a building's air handling system or significant extra costs.²⁷³

Brickman worked with ASHRAE to translate the findings into practical advice that was disseminated through a 2004 Sloan supported satellite

A White-Knuckle Ride to the 27th Floor

To understand the issue better herself, Paula Olsiewski arranged to see an HVAC system up close. Brickman took her to an office building under construction in Times Square. She donned a hardhat, stepped into an outside hoist, and was lifted to the twenty-seventh floor in a white-knuckle ride.

Later that day, Olsiewski and Brickman spoke with the building's operations manager. "He asked us, 'If I install more efficient air filters everywhere, what will my cost be?'" Brickman said. "We did a quick calculation and told him it would be in the range of \$30,000 a year."

"He said, 'This is an 800,000 square foot building. I spend millions of dollars a year maintaining and cleaning it, and \$30,000 is a drop in the bucket.'"

Ultimately, the management company retrofitted all its buildings in New York City with upgraded filters. As one of its officials later told Olsiewski, "It was a no-brainer."

broadcast, "Homeland Security for Buildings."²⁷⁴ Sloan also funded a 2006 satellite broadcast and simultaneous webcast on "Multiple Benefits Solutions for Enhanced Building Security." That program reached approximately 20,000 building professionals, "one of the largest audiences ever for an ASHRAE webcast,"²⁷² according to Brickman.

With Sloan support, Brickman also convened a luncheon at which building engineers and managers were invited to meet with members of the NYPD so the two groups could exchange information. The goals were to provide NYPD with expertise on buildings and get building engineers to think more about security. "The supervisors in charge of the homeland security division of the police department were interested and engaged," Brickman explained. "They wanted to know what an air-conditioning system really does. What are its components? How can attacks affect it? How can building operators mitigate the effects of a terrorist attack or accidental spill?"²⁷²

Brickman believes that making buildings safe will require more research and training. "Right now, the best thing any group can do is to educate and advise builders who are contemplating construction or are trying to retrofit a building. It

means updating information and making sure, either through ASHRAE or through the Building Owners and Managers Association [BOMA], that it gets to the people who make these critical decisions.”²⁷² To that end, Sloan funded ASHRAE’s 2009 white paper, “Guideline for the Risk Management of Public Health and Safety in Buildings,”²⁷³ which offers guidance for evaluating, designing, and implementing measures to reduce risks in new and existing structures.

According to Brickman, much remains to be done to strengthen buildings against bioterrorism. “One of the major deficiencies today is the location of outside air inlets in buildings, which is very hard to correct once a building is constructed. If the outside air intake is at ground level, someone can come up and throw something in it and contaminate the whole building.”²⁷² In some structures, the problem is the ventilation system itself.

Today, it is difficult to gauge the long term effect of these efforts, partly because building owners are reluctant to publicize information about security for fear that doing so would help criminals circumvent the measures. “I do know that new buildings most likely have MERV 14 16 filters,” said Brickman. “Disseminating the information with Sloan’s assistance did a lot to publicize the problem and persuade people to take action. But unfortunately, retrofitting older buildings lags behind. The problem is money. We can’t force people to do things that are in their own best interests. But we can tell them what the benefits are and hope that they comply.”²⁷²



Expert Consensus on Practical Steps to Make Buildings Safer

The Working Group on Reduction of Exposure to Infectious Agents During a Covert Bioterrorism Attack

The Sloan Foundation enlisted the Center for Biosecurity of UPMC to establish expert consensus on ways to protect building occupants from a terrorist attack with an aerosolized biological agent.

In 2005, after completing an extensive review of reports on air filtration published in the forty years prior, the center convened the Working Group on Reduction of Exposure to Infectious Agents During a Covert Bioterrorism Attack.²⁷⁵ Participants included experts in an array of specialties—air filtration, building ventilation and pressurization, air conditioning and air distribution, biosecurity, building design and operation, building decontamination and restoration, economics, medicine, public health, and public policy—who represented private industry and academic institutions, the US General Services Administration, the US Postal Service, the Environmental Protection Agency (EPA), the National Institute of Standards and Technology, and the CDC.

The working group focused on identifying and agreeing on a set of actions that commercial building owners and operators could take to improve building safety using “currently available off the shelf technologies” that could be implemented immediately for modest expense.²⁷⁵ The 2006 report “Improving Performance of HVAC Systems to Reduce Exposure to Aerosolized Infectious Agents in Buildings: Recommendations to Reduce Risks Posed by Biological Attacks”²⁷⁵ included the group’s recommendations.

The most straightforward and important of the recommendations was that commercial HVAC systems be fitted with filters that have higher MERV ratings. ASHRAE recommends a minimum MERV rating of 6 for filters used in commercial buildings. That size will remove less than 20 percent of particles in the same size range as anthrax spores. Alternatively, a MERV 13 filter could remove more than 95 percent of those particles for only slightly greater operating cost.²⁷⁵

Because inadequate installation and maintenance renders the air filtration systems in many buildings considerably less effective than design specifications call for, the working group also recommended that commercial HVAC systems be configured and operated to work as intended. To that end, the group advised that building operators seal, caulk, and replace gaskets in air handling systems and change filters according to manufacturer recommendations. The group also noted the importance of regular commissioning and recommissioning of buildings to test and repair HVAC systems and ensure proper functioning. All of these actions should improve air quality and HVAC functioning, but they are not always taken. In fact, most commercial buildings have never been

IF THERE WERE A BIOTERRORIST
ATTACK, WHICH SIDE OF THE FILTER
WOULD YOU WANT TO BE ON?

commissioned. The working group attributed this to a lack of standardized training programs and continuing education for building operators.

Directly applicable to the goal of mitigating the consequences of a biological attack was the working group's commonsense recommendation that filters be installed on outdoor air intakes to limit the damage from a release of a biological weapon directly into an air handling system.

The group's final recommendation called for establishment of "[a] lead government agency for indoor air quality, to include biological hazards."²⁷⁵ Various government efforts have been made to protect building occupants from a biological attack, including the Immune Building Program (started at DARPA—the Defense Advanced Research Projects Agency—and moved to DTRA—the Defense Threat Reduction Agency)²⁷⁶ and guidance for building owners from HHS.²⁷⁷ Many government agencies have research programs and responsibilities related to the indoor environment—DOD, DOE, DHS, EPA, HHS—but none has the clear lead or primary responsibility.

Generating consensus among experts was just the first step, though. People who build commercial buildings or operate them needed to be informed of these inexpensive preventive measures that could save many lives. In September 2007, Tom Inglesby (now CEO of the Center for Biosecurity) met with the Real Estate Roundtable (RER) to inform its members about the working group's conclusions. He was accompanied by a White House representative who briefed the group about the bioterrorism threat. RER members collectively hold portfolios of "5 billion square feet of office, retail and industrial properties valued at more than \$1 trillion; over 1.5 million apartment units; and in excess of 1.3 million hotel rooms."²⁷⁸

In 2008, the center launched the website *Protecting Building Occupants from Biological Attacks* (<http://www.upmc-biosecurity.org/buildings>) to provide practical recommendations for building owners and information about the costs and benefits of implementing HVAC improvements. The site also points end users to numerous sources of additional information.

In addition to improving biosecurity, the measures recommended by the working group could save energy and reduce costs for building owners, which could increase the likelihood of their adoption. Commissioning buildings, for example, can lead to considerable energy savings.²⁷⁹ Figures from Lawrence Berkeley National Laboratory indicate that if commissioning buildings were a national *requirement*, the following benefits could be realized: more than 20,000 new jobs for trained workers, up to \$30 billion annual savings from reduced energy costs by 2030, and annual reductions of greenhouse gas emissions of about 340 megatons of carbon dioxide.²⁸⁰

Although the economics and the energy savings are important, the Sloan Foundation is primarily focused on protecting health by finding ways to reduce the effects of biological contaminants in the indoor environments of homes, hospitals, and public buildings.²⁷¹ Natural threats, such as those thought to cause sick building syndrome, may affect many people, but given the modest cost of protection, the threat of bioterrorism should be prepared for as well. Owners have that responsibility to the people who work in their commercial buildings. After all, asked Gomory, “If there were a bioterrorist attack, which side of the filter would you want to be on?”²⁸¹

