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16 November 2015

Re: Review of Potential Impacts from the Proposed California Mechanical Code Change Allowing Plenum Return Air in Certain Areas of OSHPD 3 Clinics

As requested of the Joint Committee on Energy and Environmental Policy, this letter provides comments on the September 2015 Initial Study/Negative Declaration ("IS/ND") for the Proposed California Mechanical Code Change Allowing Plenum Return Air in Certain Areas of OSHPD 3 Clinics ("Project").

I. SUMMARY OF FINDINGS

As discussed below, I have reviewed the information contained in the IS/ND. The proposed change to § 407.4.1.4 of the California Mechanical Code would permit the installation and use of plenum return air in all *non*-surgery and *non*-critical-care patient-care areas that do not have specific pressure requirements in outpatient (OSHPD 3) clinics. I disagree with the conclusion in the IS/ND that no evidence exists of potentially adverse environmental or health impacts that could occur as a result of the proposed change.

To the contrary, substantial evidence exists that the use of plenum return air has resulted in adverse health and environmental impacts in facilities with susceptible occupants, including outpatient clinics. The proposed regulatory change will reduce protection against exposure to toxins, pathogens, and other harmful contaminants for the very population most at risk for deleterious effects from these exposures, including patients who are immune-compromised. The proposed regulatory change is also likely to increase energy use and reduce fire and smoke control in OSHPD 3 outpatient clinics. Because plenum return air systems can increase noise transmission from patient exam rooms and other areas were privacy is required, the proposed regulatory change is also likely to impact the privacy of patients and staff.

I. CREDENTIALS

During my 50+ year professional career, I have focused on advancing the designs and operations of indoor environmental control systems to enhance the health, safety, and well-being of occupants, energy efficiently and cost-effectively.

My early professional practice (1962-68) was in designing and servicing automatic control systems for existing buildings and developing applications of laminar flow cleanroom technologies for health care and industrial processes. This work led to my recruitment into the Bioenvironmental Engineering Traineeship Program at Kansas State University, which was sponsored by the National Institutes of Health.

My research at KSU (1968-1974) focused on the interactions of physiological responses of humans and laboratory animals to thermal, contaminant, lighting, and acoustic exposures. As Professor of Mechanical Engineering and Architecture at Iowa State University (1974-1983), I taught undergraduate and graduate courses in thermal, ventilation, lighting, and acoustic principles and design, and established the Building Energy Utilization Laboratory and the Center for Advancement of Building Technologies. My research during that period focused on the relationships between indoor environmental control for occupant needs and building energy utilization. From 1977-1983, I was Principle Investigator for an ASHRAE sponsored project: RP-202: Ventilation Requirements in Hospital Operating Rooms.

As Senior Staff Scientist and Senior Engineering Manager at Honeywell, where I was responsible for scientific development of a multi-divisional and international program in indoor air quality (1983-1989), I focused on the development and application of scientific methodologies for diagnosing building performance that had discomforting and deleterious effects on occupants, which became known as "*Sick Building Syndrome*" (SBS) and "*Building Related Illness*" (BRI). Many of the cases we investigated, including several health care facilities, resulted from over-aggressive energy conservation efforts. During the period (1983-1989) I was Principle Investigator on a project sponsored by the American Hospital Association: "Hospital Ventilation Requirements."

As Professor of Building Construction in the College of Architecture at Virginia Polytechnic Institute and State University (1989-1997), I was responsible for undergraduate and graduate instruction in mechanical and electrical systems and for research pertaining to human responses and control of indoor environments. During that time, I focused on research to improve the accuracy of building diagnostic procedures through adaptation of medical and other diagnostic paradigms.

Since I retired from Virginia Tech in 1997, I have focused on applying building diagnostic procedures for evaluating the interactions of human responses, indoor exposures, and building performance in terms of energy utilization (e.g., zero net energy mandates and goals) and protection during extraordinary conditions (e.g., resiliency) in federal buildings, other public buildings (e.g., schools and hospitals), and privately owned buildings.

This body of work has resulted in the publication of forty invited papers, fifty-five peer reviewed papers, fifty-one other articles and presentations, and six books that address the interactions between environmental control, system performance, and economic performance of buildings. This work has also resulted in five appearances before congressional committees, six testimonies at trial as an expert witness, and twenty-five depositions and administrative hearings that addressed the performance of buildings regarding their effects on health and safety.

ASHRAE

I became an Associate Member of ASHRAE in 1962 and a Full Member in 1967. I have served on Technical Committees since 1967, was elected an ASHRAE Fellow in 1992, became a Life Member in 2005 and received my Distinguished 50 year Life Membership in 2013. I served as a Member of the Board of Directors from 1997 – 2000. My first involvement with ASHRAE Standards was as a Graduate Student at Kansas State University, where I helped prepare drafts of ASHRAE Standards 55-74: *Thermal Environmental Conditions for Human Occupancy*, and ASHRAE Standard 62-73: *Standards for Natural and Mechanical Ventilation*. As Chairman of the ASHRAE Technical Committee 9.2 (1972-1975), I became involved in the development of

ASHRAE Standard 90-75: *Energy Conservation in New Building Design*. In 1978, I was appointed Chairman of the Committee that revised ASHRAE Standard 62-73 as ASHRAE Standard 62-1981: *Ventilation for Acceptable Indoor Air Quality*. In 1980-1981, I was appointed as Chairman of an *ASHRAE Presidential Ad Hoc Committee on Legionnaire's Disease* that prepared two seminal white papers on the sources, amplification sites, and energy and economic impacts of preventing future outbreaks of the disease in buildings. In October 2001, I was appointed as Chairman of an *ASHRAE Presidential Study Group and Ad Hoc Committee on Building Health and Safety Under Extraordinary Incidents* that prepared a white paper, which was accepted as a policy paper by the Board of Directors, and formed the basis of ASHRAE G29-2009: "*Guideline for Risk Management of Public Health and Safety in Buildings,"* of which I served as a member.

National Institute of Building Sciences (NIBS)

I have participated on NIBS projects for more than twelve years. From July 2002 – June 2003, I was principal investigator of a project co-sponsored by GSA and ASHRAE to "*Develop and Implement a* "*Continuous Accountability" Protocol for Implementation of GSA/ PBS P-100*." From July 2005 – June 2006, I was a team member that *provided physical security assessments for Department of Veteran Affairs Medical Centers*. From August 2004 – February 2007, I was a team member for the development of a "*Design Standard for Raised Floor Systems With and Without Underfloor Air Distribution," as a Supplement to the "PBS P100 Facility Standards for the Public Building Service*." From July 2007 – November 2014, I was a team member that provided *post-occupancy building performance evaluations* of four U.S. Courthouses for the GSA/PBS and seven health care facilities for US Department of Veterans Affairs. From September 2008 – January 2012, I served as a member of the Ad Hoc Subcommittee of the NIBS High Performance Building Council on the "*Development of requirements for providing higher performance of building operations in preparation and response to a disaster or catastrophic event than is presently provided by code*." Since May 2010, I have been a member, and chairman from September 2011 – July 2014, of, a committee to develop plans for the *improved design for persons with low vision*; these improvements have strong implications for effective use of energy within buildings.

- Facilities Guidelines Institute

As chairman of the NIBS Low Vision Design Committee, I was invited in 2012 to participate in the development of the new FGI Guidelines for Residential, Health, Care, and Support Facilities, which was published in 2014. In March 2014, I was invited to participate as a member of the FGI national Task Force to develop comprehensive design guidelines and code-level design criteria to control noise in residential health, care, and support facilities that serve elder Americans.

II. SUMMARY OF PROPOSAL

Currently, the 2013 California Mechanical Code § 407.4.1.4 prohibits outpatient healthcare clinics (OSHPD 3 Clinics) from using the space above a ceiling as an outside-air, relief-air, supply-air, exhaust-air, or return-air plenum.

OSHPD proposes amending the 2013 California Mechanical Code to exempt many areas within OSHPD 3 Outpatient Clinics from this prohibition. The proposed amendment would

allow plenum air returns in many *non*-surgery or *non*-critical-care outpatient areas that do not have pressure requirements (i.e., NR), including: patient examination, diagnostic, and treatment rooms; blood draw/phlebotomy rooms; blood bank and tissue storage rooms; bloodborne infection isolation rooms: patient holding rooms; labor/delivery/recovery rooms; birthing and patient rooms; observation/seclusion rooms; occupational therapy rooms; X-ray, CT Scan, MRI, ultrasound, and gamma camera rooms; pediatric play areas; recreation/activity areas; corridors; and administration areas.[1]

III. INCREASED HEALTH RISKS FROM USE OF PLENUM AIR RETURNS IN MEDICAL FACILITIES

HVAC systems in healthcare occupancies are more conservatively designed than other occupancies to protect against the spread of airborne contaminants and infectious diseases and to provide heightened protection to potentially immune-compromised patients. In its foreword to ANSI/ASHRAE/ASHE Standard 170-2013, *Ventilation of Health Care Facilities*, ASHRAE states:

> Ventilation systems and designs for health care facilities are intended to provide a comfortable environment for patients, health care workers, and visitors while diluting, capturing and exhausting airborne contaminants including potentially infectious airborne agents such as M. tuberculosis. Without high-quality ventilation in health care facilities, patients, health care workers, and visitors can become exposed to contaminants through normal respiration of particles in the air. Poorly ventilated health care facilities may increase the concentration of airborne contaminants including fungi or mold, which may cause allergic responses in even healthy workers and occupants. Some patients are profoundly immunosuppressed for prolonged periods and if exposed, are highly susceptible to infection from fungi. For such patients, fungal spores become invasive pathogens and lead to high rates of severe morbidity and mortality. For all these reasons, and considering the various occupancies and patient populations, great care must be taken in the design of health care ventilation systems.[2]

The IS/ND claims a "reasonable inference that the use of plenum return air as compared to fully ducted systems presents no greater risks of infection disease transmission."[3] This claim is not supported by evidence and is incorrect.

HVAC systems that rely on plenums rather than ducts have a higher risk of spreading pathogens and making occupants sick. Reliance on ceiling plenums rather than ductwork for return air can result in indoor air quality problems, increased risk of transmitting airborne pathogens and increased energy use. A fundamental difference between ducted and plenum return air is that the pressure across each return air inlet (i.e., grille) to the ductwork can be directly controlled (i.e., balanced) by return air grilles and the return or mixed air fan in the air handling unit (AHU), whereas pressure in the return air plenum tends to passively develop a

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[1] See Table 4, page 40, and Table 4-A in Appendix B, pages B-1 through B-3 of the IS/NA.
[2] ASHRAE Standing Standard Project Committee 170 (SSPC 170), Ventilation of Health Care Facilities, Foreword (Paragraph is essentially the same in 170-2008 and 170-2013).
[3] IS/ND at p. 42.

gradient from the most distal grilles in a zone to the most proximate grilles to the AHU.[4] This lack of direct pressure control of the return air increases the uncertainty of the return airflow rate to the AHU where filtration occurs. The unfiltered air in return plenums can, in fact, backflow from the ceiling plenum to the occupied spaces, especially when windows or other means of natural ventilation are also used,[5] or when the ceiling plenum air is used to supply fan-powered variable air volume (FPVAV) terminal units that are not filtered. In ASHRAE Standard 170-2013, Section 6.7.1 requires ducted return air for patient-care areas in "inpatient facilities," but is silent with regard to "outpatient facilities." Therefore, it cannot be assumed that Standard 170-2013 permits return air plenums in "outpatient facilities" (i.e., clinics). The U.S. Department of Veterans Affairs Design Guide for Outpatient Clinic – Satellite and Community Based (January 2009) states: "Use of space between the structural ceiling and the suspended ceiling is not permitted as an air plenum for air distribution or collection." [6] Of particular concern in the proposed change to § 407.4.1.4 is the combination of rooms and areas without pressure requirements that can be connected to the AHU through a common return air plenum from several different functional areas. I have personally observed problems with return air plenums in numerous of the over 250 buildings I have investigated, including serious plenum issues in outpatient clinics. I have also published peer-reviewed articles and testified in court trials on these issues.[7]

Evidence in the literature and my own investigations and testimony reveal that return air plenums and chases have been identified as sources of illness and infections to patients and other building occupants.[8] [9] While ductwork has a singular function of transporting supply, return, or exhaust air with minimum differences in thermal or contaminant conditions between their points of connection (e.g., between the HVAC equipment and the occupied spaces), plenums and chases (e.g., concealed building spaces) are often connected and have multiple functions: distribution of electrical services; electronic signals; domestic, hydronic and process water; condensate and wastewater; specialty gases; and supply and return air. As a result, unducted return air in plenums and chases is usually mixed with air from other pathways that contain extraneous thermal loads or contaminant sources.

Return air plenums are also more likely to cause pressure imbalances in the system and increase the risks of infection. Return air plenums adjacent to exterior walls or roofs are likely to incur moisture transfer and air leakage, which increases the risks of amplification of

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[4] See: Section 5.9, Air Distribution: Plenum and Ducted Return Air Distribution, in Facilities Standards for the Public Buildings Service, P100-2010, U.S General Services Administration;

[5] See FGI 2014, § 3.1-8.2.1.2 (2) Ventilation and Space Conditioning Requirements, allows windows for natural ventilation in non-critical care areas.

[6] The DVA Guideline for Outpatient Clinic refers to the DVA HVAC Design Manual PG18-10, March 2011. The restriction on return air plenums is given in Section 3.2.1.6.

[7] See e.g., Morey PR and Woods JE. 1987. Indoor Air Quality in Health Care Facilities. In Occupational Medicine: State of the Art Reviews, Vol. 2, Jul-Sep, pages 547-563; Woods testimony at trial. 1998. Weisfogel vs. Collard, et al. In Supreme Court of the State of New York, County of Nassau, Index #17605/94, (Case involved an outpatient clinic.); Woods testimony at trial. 1990. Call et al vs. Prudential Insurance et al. Torrence County Superior Court, California. (Case involved fitting out a space in an existing building).

[8] Woods testimony at trial. 1998. Weisfogel vs. Collard, et al. In Supreme Court of the State of New York, County of Nassau, Index #17605/94, (Case involved an outpatient clinic.)

[9] Woods testimony at trial. 1990. Call et al vs. Prudential Insurance et al. Torrence County Superior Court, California. (Case involved fitting out a space in an existing building.)

microorganisms and infection.[10] Room-side elements of exterior walls (e.g., drywall) and demising walls typically are not sealed to the deck above a return air plenum, and become "concealed spaces" and pathways through which moisture and microorganisms (e.g., Aspergillus sp.) can be transported to the return air plenums. These concealed pathways increase the risk of airborne pathogen exposure to patients and other occupants, especially in existing buildings.

The pathogens, which may be transported through a return air plenum system, include both (1) airborne infectious diseases from clinic patients and (2) dust, mold and other contaminants from the plenum space itself.

A. Airborne Infectious Diseases

Numerous airborne infectious particles have been shown to be transported between spaces by ventilation systems, including TB, measles, Varicella zoster, and some fungal spores.[11] The IS/ND attempts to dismiss the significance of the increased risk of airborne infectious disease by assuming that OSHPD 3 clinic patient exam rooms are unlikely to be an outbreak source for airborne infectious diseases. This assumption is not supported by any evidence and is contradicted by what is known about these diseases.[12]

"A primary source of pathogenic microorganisms in the health care environment is the patient with a contagious disease."[13] Infectious agents transmitted via the airborne pathway include, among others, tuberculosis, measles, chickenpox, SARS and influenza.[14] Airborne outbreaks of infectious diseases are a significant concern in clinic settings and do occur.[15] Outbreaks of TB and other airborne infectious diseases have been traced to physician offices or clinics. In one study of 53 infection clusters associated with outpatient settings, 10 clusters were associated with airborne or droplet transmission among patients and health care workers.[16]

Because the basic principles of disease transmission and prevention are the same regardless where a patient is seen, a patient with an airborne infectious disease will be just as infectious in an OSHPD 3 patient exam room as in a hospital or in an airborne infection isolation (AII) room.[17] However, the risk of spread of this infection through ventilation systems will be greater in the exam room setting because it has a less protective environment. The proposal to allow plenum air returns in patient exam rooms and other unpressurized outpatient clinic areas will increase the risk of airborne infection spread from these already less protected patient care areas.

The IS/ND argues that implementation of "recommended" (but not mandatory) administrative controls such as early detection, isolation and establishment of an infectious control infrastructure "should minimize" the potential for the transmission of chicken pox,

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[10] Patterson R, et al. 1993. Indoor Allergens: Assessing and Controlling Adverse Health Effects. Institute of Medicine, National Academy Press, Washington, DC, 220-221.
[11] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 130, § 12.2.3.
[12] This claim is also contradicted by the IS/ND itself, which states elsewhere that treatment rooms and examination rooms are "likely to have significant exposure to infectious patients." IS/ND at p. 43.
[13] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 28, § 4.2.1.
[14] See IS/ND at pp. 28-32.
[15] See also IS/ND at p. 33.
[16] IS/ND at pp. 32-33.
[17] Friedman & Petersen, Association for Professionals in Infection Control and Epidemiology (APIC), *Infection Control in Ambulatory Care* (2004) at p. 2.

measles, influenza and TB from OSHPD 3 clinic patient exam rooms.[18] While such controls may reduce risk of infection spread, they are not sufficient to offset the risk of contamination and infection by exposure through uncontrolled pressure in return air plenums.

Contrary to the IS/ND's assumption, early detection is often not possible. The Association for Professionals in Infection Control and Epidemiology ("APIC") warns that patients with unrecognized infectious diseases are often seen in clinics. APIC has found that "Infectious diseases account for 20-30% of physician office visits and there have been multiple outbreaks of measles, tuberculosis, and other infectious diseases traced to physician offices or clinics."[19] Acute infection of the respiratory tract is one of the most common reasons for consulting a physician.[20] [21] Early symptoms of highly infectious airborne diseases are identical to symptoms from many other sicknesses, including the common cold. Accordingly, carriers of airborne infectious diseases may be infectious before any identifying symptoms become evident.[22]

Increasingly, invasive procedures are being performed in imaging rooms, even though they have not been designed for sterile procedures, which would be exacerbated by the proposed allowance for return air plenums, or for cleaning and disinfecting after serving the infected patients. As a result, healthcare personnel often "make multiple contacts with undiagnosed patients before they are recognized as infectious."[23] APIC warns that there needs to be an *increased* focus on infection prevention and control programs in these settings – not a decreased emphasis as proposed by this regulation.[24]

Even if early diagnosis were possible, the IS/ND does not address the risk of spread of infection in clinics that do not have an airborne infection isolation (AII) room or other non-mandatory infectious disease control infrastructure. OSHPD 3 clinics are not required to have AII rooms. Clinics may solely consist of patient exam rooms and may rely on sending patients diagnosed with airborne infectious diseases to other facilities, once the diagnosis takes place. Even in clinics that do have infectious disease control infrastructure, the IS/ND provides no evidence that it is common practice to see patients with influenza in an AII room. Patients go to clinics with the flu almost every day and are rarely seen anywhere other than a patient exam room.

B. Contaminated Environments in Plenum Areas

Allowing plenum air returns in clinics will increase health risk to immune-compromised patients due to the fact that plenum areas are often contaminated with dusts, mold spores, rodent

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[18] IS/ND at pp. 36-37.

[19] Friedman & Petersen, Association for Professionals in Infection Control and Epidemiology (APIC), *Infection Control in Ambulatory Care* (2004) at pp. 1, 56.

[20] Friedman & Petersen, Association for Professionals in Infection Control and Epidemiology (APIC), *Infection Control in Ambulatory Care* (2004) at pp. 1, 56.

[21] See also IS/ND at p. 33.

[22] Friedman & Petersen, Association for Professionals in Infection Control and Epidemiology (APIC), *Infection Control in Ambulatory Care* (2004) at p. 7.

[23] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 218, § D.4 (healthcare personnel "make multiple contacts with undiagnosed patients before they are recognized as infectious").

[24] Friedman & Petersen, Association for Professionals in Infection Control and Epidemiology (APIC), *Infection Control in Ambulatory Care* (2004) at p. 1.

droppings and microorganisms from dead pests and other sources.[25] [26] These hazardous environmental conditions are commonly found in chases and plenums, particularly in older buildings that may be converted to clinic occupancies. When return air plenums are utilized instead of ducted returns, these contaminants are readily aerosolized from where that can either be directly emitted into the room through the return air grille or ceiling tiles removed for maintenance, or transported into the return air of the HVAC system, filtered, mixed with outdoor air, heated or cooled, and distributed into occupied spaces by the supply air diffusers.[27] Contaminated return air plenums and chases have been identified as sources of illness and infections to patients and building occupants.[28] [29] Above-ceiling plenums are also more prone to disturbance by maintenance activities that could release opportunistic fungi or allergens into a return airstream or directly into the room through the return air grilles or removed ceiling tiles, including opportunistic microbes such as *Aspergillus* that are a frequent component of building dust.[30] Dust or fungi within a ducted return is less likely be disturbed by such activities and thus poses less of a risk.

Aspergillus fungi, for example, are common health-care-acquired pathogens that are often traced to moisture-absorbent building materials such as ceiling tiles, false ceilings, or fireproofing materials, all of which are exposed in plenums.[31] "Numerous outbreaks of *Aspergillus* infections have been reported in hospital settings, most commonly associated with construction or renovation projects and infection to immune-compromised patients." [32]

A significant percentage of OSHPD 3 clinic patients are likely to be immune-compromised and at greater risk of contracting airborne infectious diseases through exposure to aeroallergens, aerosolized fungi and bacteria, toxins, and viruses within the clinic.[33] Immune-compromised patients have the greatest risk of infection by airborne microorganisms, including persons with diabetes and persons with respiratory illnesses such as asthma or emphysema. Diabetes rates in California are now at near epidemic levels, having risen more than 38% in the last decade. In Tulare County, over 12% of adults have diabetes.[34] Asthma rates in California are similarly concerning. Since 2001, the percent of Californians diagnosed with asthma has increased from 11.3% to 13%.[35] The percentages of children in California diagnosed with asthma range from a high of over 30% in rural Kings County to a low of approximately 8% in

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[25] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 97, § 9.5.2.;

[26] See also IS/ND at p. 42.

[27] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 97 § 9.5.2.

[28] Woods testimony at trial. 1998. Weisfogel vs. Collard, et al. In Supreme Court of the State of New York, County of Nassau, Index #17605/94, (Case involved an outpatient clinic.)

[29] Woods testimony at trial. 1990. Call et al vs. Prudential Insurance et al. Torrence County Superior Court, California. (Case involved fitting out a space in an existing building.)

[30] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at pp. 97-98, §§ 9.5.2, 9.5.3.

[31] U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, *Guidelines for Environmental Infection Control in Health-Care Facilities Recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC)*, (2003) at pp. 6-7 & Table 2.

[32] IS/ND at p. 34.

[33] Kowalski & Bahnfleth, *Airborne Respiratory Diseases and Mechanical Systems for Control of Microbes*, HPAC Journal (July 1998) at pp 34-48.

[34] Lin, California Watch, Californians Growing Heavier, More Obese and Diabetic (September 1, 2010), http://californiawatch.org/print/4405.

[35] Jewett, California Watch, *Asthma Hits State's Poor the Hardest* (Dec. 17, 2010) http://californiawatch.org/dailyreport/asthma-hits-states-poor-hardest-7539.

Orange County, with the statewide mean of nearly 15%.[36] Accordingly, the Proposed Amendment will reduce protection against the spread of airborne infectious pathogens in clinics that will regularly serve the very populations most at risk from these pathogens.

The IS/ND acknowledges that diseases such as Aspergillosis could occur during construction and renovation activities in clinic settings if immunocompromised patients are present.[37] But the IS/ND dismisses the significance of this risk, on the assumption that precautions could be taken by preparing a construction or demolition plan to minimize the dust generated and by preventing dust infiltration into patient care areas through the use of air tight plastic barriers and negative pressure ventilation.[38] I have testified that, in fact, this assumption is not valid. [39] [40]

In a ducted system, such construction and renovation activities are less likely to result in dust being drawn into the return air system. With a plenum system, on the other hand, contaminants from unprotected surface areas are drawn into the return air of the AHU. A return air plenum in the ceiling, and concealed spaces or chases that connect with the plenum can thus become sources or amplification sites for pathogens. If the return air plenum and chases or risers are common to other areas within an existing building, the risk of infection throughout the facility is likely to increase. This risk of transporting contaminants from the plenum directly into occupied areas of the building will be further increased if unfiltered fan-powered variable air volume (FPVAV) terminal units, of either the series or parallel type, are installed in the return air plenum: "Between heating and cooling operations, the fan only recirculates ceiling air." [41]

By removing the restriction on plenum return air ducts, OSHPD will increase the risk of plenum contaminants being transported through the building and harming occupants.

My conclusion is consistent with the analysis contained in the ASHRAE HVAC Design Manual for Hospitals and Clinics. The 2003 Design Manual[42] and its 2013 update[43] state that: "Ducted returns protect the airstream from direct exposure to such potential plenum conditions as accumulated dust, microbes or odors generated by wet materials (from piping leaks, roof leaks, or floor leaks in multi-story facilities[44]), rodent droppings, fibers from deteriorated flame proofing or equipment, and smoke from smoldering wiring insulation or other sources during a fire." The statement continues: "NFPA codes require that electrical cables installed in plenums used for air movement must be of plenum-rated type. ***Above-ceiling plenums, in particular, are prone to disturbance by maintenance activities that could release opportunistic fungi or allergens into a return airstream***."[45] My investigations have revealed that these conditions are not uncommon, especially for cases where occupant complaints persist.

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[36] California Health Interview Survey, Lifetime Childhood Asthma Prevalence (2009), http://www.centralcalasthma.org/index.php?id=58.
[37] IS/ND at p. 44.
[38] IS/ND at p. 39.
[39] Woods testimony at trial. 1998. Weisfogel vs. Collard, et al. In Supreme Court of the State of New York, County of Nassau, Index #17605/94, (Case involved an outpatient clinic.)
[40] Woods testimony at trial. 1990. Call et al vs. Prudential Insurance et al. Torrence County Superior Court, California. (Case involved fitting out a space in an existing building.)
[41] ASHRAE Handbook: Systems and Equipment, 2012, at page 4.16.
[42] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 97, § 9.5.2.
[43] See IS/NA at page 42.
[44] Parenthetical expression was deleted in the 2013 edition.
[45] Italicized for emphasis.

In discussing HVAC requirements for outpatient facilities, FGI's *2014 Guidelines for Design and Construction of Hospitals and Outpatient Facilities* bases the requirement for ducted return air on the use of the occupied space and incorporates by reference ASHRAE's *Standard 170-2013* for patient care areas. *Standard 170-2013* bases requirements for ducted return air on the need for differential pressure control and does not require ducted return air for all non-pressurized rooms.

The IS/ND claims that the FGI's *2014 Guidelines for Design and Construction of Hospitals and Outpatient Facilities* does not apply to non-pressurized areas of an outpatient clinic because it cites ASHRAE 170 for ventilation guidance.[46] While ASHRAE 170 requires ducted returns for some non-pressurized areas of inpatient facilities, it is silent with regard to outpatient clinics. However, ASHRAE 170 does state in § 6.7.1: "In inpatient facilities, patient-care areas shall utilize ducted systems for return and exhaust air." The quoted basis for the ASHRAE 170 guidance is the high cost of ducted return air systems in areas where pressurization requirements are not provided.[47] This assumed cost reduction for the plenum return air system implies no additional costs associated with deleterious exposures of the patients. Conversely, the statement in the ASHRAE HVAC Design Manual for Hospitals and Clinics[48] refers to the health risks from the exposure to contaminants in the plenum area, including dust, mold, rodent droppings or smoke from an electrical fire within the plenum area. These risks are not dependent on whether a room is required to maintain positive or negative air pressure. I disagree that the recommendation for ducted returns in the FGI Guidelines is only applicable to rooms requiring mandatory pressure differentials.

C. The IS/ND Lacks Substantial Evidence for Its Reliance on Air Filters to Reduce the Project's Pathogen Exposure Impacts Below a Level of Significance

The IS/ND dismisses the risk of airborne disease transmission based upon the requirement of ASHRAE Standard 170-2013 that return air from these rooms must be recirculated through one or two banks of filters with MERV 7 (approximately 30% small particulate removal efficiency), and/or with MERV 13 or 14 (approximately 90% small particulate removal efficiency).[49] If only one filter bank is installed, as allowed by Standard 170 for several outpatient clinic areas, the filters will be located upstream of the wet coils or humidifiers. In this configuration, the filtration will only partially protect against microbial penetration through the filter, but will not protect against microbial growth on the wet surfaces or subsequent emissions into the supply airstream. Only with the installation of the second filter bank, which is to be located downstream of these wet surfaces, will the risk of growth on these surfaces and subsequent emissions into the supply airstream be reduced. Additionally, the concentrations of contaminants upstream of the first filter bank are likely to be higher in a return air plenum than from ducted return air.

The IS/ND's reliance on filters to reduce the impact of airborne disease transmission below a level of significance is based upon a misunderstanding of how an HVAC system works. The filters are located in its air handling unit (AHU). The IS/ND assumes that all contaminants

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[46] See IS/ND at p. 41.
[47] See IS/ND at p. 41.
[48] See IS/ND at p. 42.
[49] See Paragraph 6.4 and Table 6.4 in ASHRAE Standard 170-2013.

emitted into the airflow pattern in the plenum return will be transported to the filters in the AHU. This assumption is false, because the pressure in the return air plenum is not actively controlled, as it would be in a ducted return, but is only passively controlled by the AHU. Where the air enters the plenum does not matter to the suction pressure at the fan in the AHU; only that sufficient airflow is received. As a result, pressure gradients develop in the plenum, with the most negative at the return air grilles located in rooms most proximate to the AHU, and the least negative at the return air grilles located in the rooms most distal to the AHU. In addition, airflow from adjacent return air plenums, which are interconnected, or maintenance activities within the plenums can perturb the plenum pressures to the extent that they can become positive with respect to the rooms and discharge air into them. Even then, the two banks of HVAC filters required for some of OSHPD 3 clinic areas are likely to be less than 90% effective, when the bypass losses due to the filter framing devices are also included, meaning that 10% or more of the pathogens upstream of the filters will penetrate them and recirculate through the system. Filters reduce exposure risk, but do not eliminate it. Filters are just part of the overall package of design requirements intended to reduce airborne disease transmission. They are not a substitute for restrictions on the use of plenum air returns in healthcare facilities.

IV. LOSS OF PRIVACY FROM USE OF PLENUM AIR RETURNS IN MEDICAL FACILITIES

The removal of the requirement for fully ducted HVAC systems may also result in the loss of patient privacy, because plenum return air systems will increase noise transmission between adjacent rooms compared to fully ducted return air systems.[50] "Noise control is of high importance in the health care environment because of the negative impact of high noise levels on patients and staff and because of the need to safeguard patient privacy." [51] The ASHRAE, HVAC Design Manual for Hospitals and Clinics recommends ducted returns to "minimize cross-talk wherein audible conversations are transmitted between rooms via open return connections, particularly when room partitions do not extend above the ceilings." [52]

Compared to ducted return air, return air plenums reduce noise attenuation and increase acoustic bridging between adjacent spaces. The proposed use of return air plenums is likely to result in an increased loss of patient privacy compared to that from ducted return air systems. Compliance with the requirements in Paragraphs 1.2-5.1.5 (Design Criteria for Performance of Indoor Wall & Floor/Ceiling Constructions), and 1.2.5.1.6 (Design Guidelines for Speech Privacy),[53] is needed to assure that the acoustic performance of the return air plenum system, which is in the proposed code change, is not less than for the ducted return air system required in the existing code.

V. INCREASED ENERGY IMPACTS FROM USE OF PLENUM AIR RETURNS IN MEDICAL FACILITIES

The removal of the requirement for fully ducted HVAC systems may result in greater energy demand and costs. Return air ductwork is typically insulated for noise control thereby also providing some thermal insulation. The heat transfer from exterior plenum walls and roofs

[50] See IS/ND at p. 85.
[51] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 42, § 4.8.2.
[52] ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 97, § 9.5.2.
[53] See FGI 2014, § 1.255.1 Acoustic Design.

typically imposes additional thermal loads, which require additional heating and cooling capacities of the HVAC system and demand larger rates of energy consumption, if the load is transferred by the return plenum to the AHU, rather than by natural radiation and convection, which allows for increased time constants due to absorption in the thermal mass of the facade. With the ducted return system, only some of the thermal load from the plenum is directly transferred into the duct and then to the AHU. As a result the heating and cooling coils may be larger with the plenum system and the fan power requirements may be larger with the return air duct system. There is no general principle that states one or the other system will require more annual energy consumption. In either case, the annual cost of infections is likely to outweigh the annual saving in the cost of energy.

The IS/ND dismisses this uncertainty on the basis of a literature review,[54] a proposed guideline[55] and one article[56] with the conclusion that the use of plenum return air in OSHPD 3 clinics would reduce energy consumption in both new construction and existing buildings.[57] This claim does not accurately describe the findings in the studies it cites. None of the studies directly related to outpatient clinic facilities, and none provided measured values of energy consumption rates or costs. The Taylor article was a general engineering study on return air systems, but did not provide any measured energy consumption data from actual buildings; the 2008 report by the National Center for Energy Management and Building Technologies (NCEMBT) was a literature review and survey that found varying opinions on the energy impact of plenum return ducts in various building types; and the Hydeman report was a guideline of variable air volume systems that incorporated the return air plenum in designs for fan-powered VAV systems.

D. INCREASED FIRE RISK FROM USE OF PLENUM AIR RETURNS IN MEDICAL FACILITIES

The proposed code change may also increase fire safety risks because un-ducted HVAC systems will transfer a continuous supply of oxygenated outside air into the plenum environment. Plenums contain substantially more flammable material than ducts. When combined with increased airflow from the HVAC system, the risk of fire and smoke spread is increased.[58]

Moreover, plenums in existing buildings are more likely to contain cables that do not meet the UL 910/NFPA 262 flame spread and smoke tests. Studies have shown that between 1988 and 1996, the percentage of cables failing the UL 910/NFPA 262 test increased from 10% to over 50%.[59]

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[54] W. Bahnfleth, D. McWhirter, and D. Novosel, "Impact of Air Return Strategy on Building Energy Consumption and Indoor Air Quality: Literature Review," Report NCEMBT-081010 (Alexandria, VA: National Center for Energy Management and Building Technologies, 2008) at p. 24

[55] M. Hydeman, S. Taylor, J. Stein, and K. Kolderup. (2003). "Advanced Variable Air Volume System Design Guide, #P500-03-082 (Attachment A-11 Product 3.6.2)": California Energy Commission.

[56] S. T. Taylor, 2015. "Return Air Systems," *ASHRAE Journal* (March 2015): 44-47.

[57] IS/ND at p. 100.

[58] See ASHRAE, HVAC Design Manual for Hospitals and Clinics (2003) at p. 97, § 9.5.2 (recommending ducted returns because plenums can spread smoke from smoldering wiring insulation or other sources during a fire).

[59] Stanitis & Dohmann, The Evolution of Plenum Cable Fire Standards and the Impact of those Standards on Material Specification, A History of Plenum Cable Fire Safety Issues, http://www.wireville.com/news/news01.html.

IV. CONCLUSION

Based on the available information and my experience, it is my opinion that removing the current restriction on plenum air returns in outpatient clinics would reduce protection against exposure to infectious disease and harmful contaminants, reduce patient speech privacy, increase energy use, and increase fire risks.

Respectfully Submitted,

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