Biosafety Tips

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Biosafety Tips brings you practical approaches to biosafety or "news you can use." If you are looking for a useful and sensible solution to a biocontainment problem or perhaps a reference to help convince a skeptical researcher about the need for caution, this is the place to look. In this column I share some biosafety insights for managing a variety of workplace situations. I welcome feedback or suggestions for future topics. Please e-mail any comments, suggestions, or insights to Karen Byers at karen_byers@dfci.harvard.edu.

Connection of a Class II/A2 Biosafety Cabinet to a Building Exhaust System

In 2010, the National Sanitation Foundation (NSF) and the American National Standards Institute (ANSI) issued a revision to *Standard 49:* Biosafety Cabinetry: Design, Construction, Performance, and Field Certification (NSF/ANSI, 2011). As a result of many discussions, the major revision was that Class II, Type A biosafety cabinets (BSCs) could no longer be directly connected to the building exhaust.

One incident described in the literature documents the importance of this change. In 1997, in a "Lessons Learned" column in the *Journal of the American Biological Safety Association* (First, 1997), Dr. Melvin First urged the NSF to require certification of the BSC ***as installed***. He cited the case of an experienced technician who had prepared sputum cultures in a Class II/A2 BSC for several years and who became seropositive for *M. tuberculosis*. The technician's contacts in the community were ruled out as possible sources, and no spills or laboratory incidents were reported. Examination of the BSC certification reports indicated that the test procedures were performed ***after removing the connection to the house exhaust***. The certifier considered maintaining proper exhaust to be the responsibility of the heating, ventilation, and air conditioning (HVAC) staff. At that time, only an exhaust duct airflow measurement could be used to assure the correct inflow velocity; however, certifiers today have a device to directly measure inflow velocity (Peters, 2005). Additional problems identified in this case include the fact that the exhaust fan was rated to pull 500 cubic feet per minute, the exact exhaust requirement of the BSC, and that supply to the room was minimal. Dr. First thought it was very unlikely that the exhaust requirements of the BSC were met (First, 1997).

In another incident, details from the certification report were not included, but direct connection of the Class II/A2 is a potential explanation for the exposures. Three clinical microbiology technicians simultaneously developed positive Mantoux purified protein derivative skin tests (PPD+) during a hospital's routine medical surveillance testing for tuberculosis. "The exposure was traced to a faulty microbiology safety hood. The hood was found to continuously circulate the contained and contaminated air rather than exhausting the air to the outside" (Shireman, 1992). No additional details about the BSC are available; however, there are data on the medical follow-up for the exposed technicians. The post-exposure prophylaxis for a PPD+ test is an isoniazid (INH) prescription for 6 months. In this case, one technician took the prescribed medication but had to stop after 3 months due to the side effects of the drug, one technician changed jobs and was not available for follow-up, and the third technician opted not to take the drug since she hoped to become pregnant within the next 6-month period. Unfortunately, the technician who did not take INH therapy later sought treatment for infertility and was diagnosed with endometrial tuberculosis from occupational exposure (Shireman, 1992).

Discussion

Exposures to *M. tuberculosis* in clinical settings are documented in a timely manner in the United States since monitoring for this agent is required by hospital medical surveillance programs and seroconversion to a positive PPD test triggers a root cause analysis. Proper functioning of the BSC to provide personnel protection requires consistent exhaust of 30% of the BSC inflow air. "Ganged" connections (connecting several biosafety cabinets and fume hoods to the same duct), fan belt failures, and preventive maintenance issues can all result in unexpected variations in the house exhaust. If the work conducted in the BSC involves only biological agents, the Class II/A2 BSC can be disconnected from the exhaust duct since the high efficiency particulate air (HEPA) filter will trap particulates, and exhausting the BSC into the room will not compromise the protection from particulates provided by a properly functioning BSC. However, since the plenums are under negative pressure, one type of connection of an A2 cabinet to exhaust is allowed and can be helpful for work with malodorous samples, minute quantities of volatile chemicals, or trace radioisotopes. The duct connection must include a gap of at least 1 inch between the exhaust filter and the duct transition to buffer the function of the biosafe-

ty cabinet from the variations in house exhaust (U.S. HHS, 2009). A schematic for a canopy connection, also called "thimble" or "air gap exhaust transition," is included in Figure 1 and the definition from the NSF/ANSI standard is as follows.

> "The external exhaust shall draw air sufficient to capture all exhaust from the BSC and to maintain a flow of air into the exhaust connection through the openings or gaps. The flow of air through the opening or gaps provides a buffer between the BSC exhaust and variation in the external exhaust system assuring consistent BSC performance and/or containment of volatile chemicals used in the BSC. Properly sized canopy openings or gaps also provide enough relief open area, so that if the cabinet exhaust system fails, the BSC will continue to function as if it was not connected to an exhaust system and **continue to provide biological and particulate containment only**" (NSF/ANSI 49, 2010).

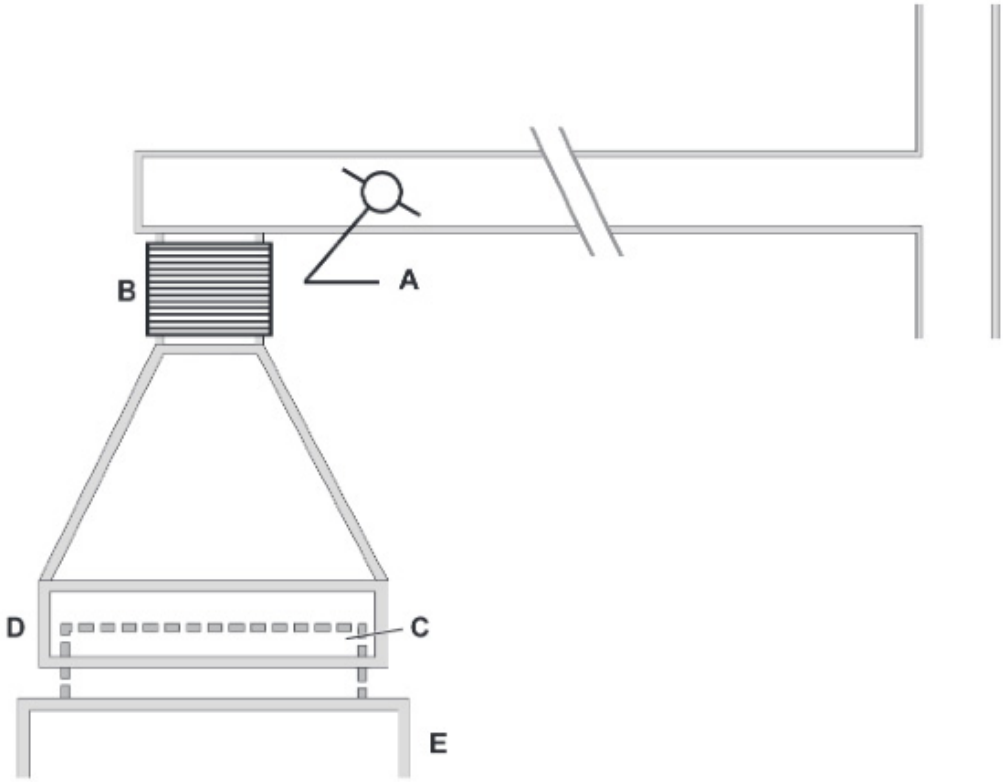
Note that approval of "minute chemical use" requires calculation of the actual quantity of chemicals to be used and potentially spilled. Caution must be used with flammables; the electrical system of the Class II/A2 is not sparkproof and the concentrations of volatile chemicals that may accumulate from recirculation must be considered. A discussion of chemical use in a biosafety cabinet is available in Appendix A of *Biosafety in Microbiological and Biomedical Laboratories* (U.S. HHS, 2009).

The concept of a canopy connection is simple enough. A gap is required so that the BSC operates independent of the exhaust system for the biological protection factors, and an integrated alarm warns the user when the volatile chemical protection fails. But engineering details need to be considered. If energy conservation is not a driving concern, a fixed-rate canopy appropriate for the size of the BSC, and the height of the front opening, can be installed. Dan Ghidoni explained the canopy design:

> "Original canopies simply spaced the hard duct up an inch over the cabinet—field developed or modified with no engineering. Now there are fixed and variable exhaust rate canopies. These are designed to maintain the biosafety cabinet intake and downflow within the NSF parameters of +/-5% despite fluctuation or complete failure of the building exhaust system. The variable exhaust rate canopies have a barometric valve that can increase or decrease the air gap as required. NSF requires smoke release inside the BSC to visually confirm that the

Figure 1

Canopy Connect Exhaust. Canopy (thimble) unit for ducting a Class II, Type A BSC: A) balancing damper; B) flexible connector to exhaust system; C) cabinet exhaust HEPA filter housing; D) canopy unit; E) BSC. Note: There is a 1" gap between the canopy unit (D) and the exhaust filter housing (C), through which room air is exhausted.



Reprinted from *Biosafety in Microbiological and Biomedical Laboratories* (*BMBL*), 5th edition, 2009; p. 316 (Figure 4).

smoke is captured by the canopy connection. Quantitative results with tracer gas have also been published; results may be requested at www.bakerco.com." (Dan Ghidoni, Baker, personal communication)

To communicate the changes in certification requirements, in 2011 NSF provided a memo to BSC certifiers, users, and biosafety officers, stating that non-compliant installations would be cited on the certification reports by NSF-certified technicians. The memo strongly advised a risk assessment of the work conducted in a program's BSC by a committee consisting of a health and safety program representative, a biosafety officer, and an NSF certifier. A focus on the work conducted in directly connected BSCs was recommended (NSF/ANSI, 2011). In 2012, NSF provided open access to Annex E of *Biosafety Cabinetry: Design, Construction, Performance, and Field Certification* to further facilitate communication among BSC certifiers and users and to support the role of biosafety officers in BSC selection and placement (NSF/ANSI, 2012).

Obtaining funds to change existing Class II/A2 installations is a challenge for biosafety professionals. Coordinating this activity with energy conservation and sustainability programs may be the best approach. If the laboratory ventilation plan does not require supplemental exhaust, a variable canopy exhaust connection can meet the BSC exhaust requirements with a small safety margin; this minimizes the exhaust of additional conditioned room air. But, for biosafety professionals, the most compelling reasons to bring all Class II/A2 installations into compliance with the NSF/ANSI 2010 standard are:

- **Personnel safety**. For laboratories handling pathogens, any Class II/A2 installations that are directly connected to the building exhaust should be evaluated immediately for disconnection or the installation of a canopy connection. In laboratories that are not deliberately handling pathogenic materials, consideration should be given to the fact that the BSC may be used with biological materials that have been inadvertently contaminated with pathogens or materials that are allergenic.
- **Product protection**. An improper installation may result in the waste of reagents and time due to culture contamination.

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Emerging Viral Diseases—The One Health Connection: Workshop Summary (2015)

In the past half century, deadly disease outbreaks caused by novel viruses of animal origin - Nipah virus in Malaysia, Hendra virus in Australia, Hantavirus in the United States, Ebola virus in Africa, along with HIV (human immunodeficiency virus), several influenza subtypes, and the SARS (sudden acute respiratory syndrome) and MERS (Middle East respiratory syndrome) coronaviruses - have underscored the urgency of understanding factors influencing viral disease emergence and spread.

Emerging Viral Diseases is the summary of a public workshop hosted in March 2014 to examine factors driving the appearance, establishment, and spread of emerging, re-emerging and novel viral diseases; the global health and economic impacts of recently emerging and novel viral diseases in humans; and the scientific and policy approaches to improving domestic and international capacity to detect and respond to global outbreaks of infectious disease. This report is a record of the presentations and discussion of the event.

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Available at: www.nap.edu/catalog/18975/emerging-viral-diseases-the-one-health-connection-workshop-summary