DUCTLESS FUME HOOD REVIEW

Division of Occupational Health and Safety,
Office of Research Services, Office of the Director, NIH

I. Introduction

In late December of 2004, a working group was formed to review the use of ductless fume hoods in the laboratories of the NIH. Members of the working group were LT Jason Barr, CIH; Mr. Alfred Ferruggiaro, CIH; Mr. Mark Gibson, CIH; Ms. Polly McCarty, CIH, CSP; Mr. Herb Jacobi; Mr. Rand Mortimer; and Dr. Randolph Larsen.

On January 6, 2005, the working group held its first meeting to begin the collection and review of information and policies on the use of ductless fume hoods. The final meeting was held March 9, 2005 to complete the review of materials and reach a consensus opinion.

II. Background

Ductless fume hoods are stand alone, bench top enclosures that use self-contained carbon and/or HEPA filters to remove fumes, vapors and particulates from air drawn into the device and then recirculated into the lab. The intent is to offer a replacement for a conventional chemical fume hood attached directly to the building exhaust system. For proper and effective use filters must be discarded and replaced when they near a chemical saturation point.

In 1989, the then Occupational Safety and Health Branch of the Division of Safety, conducted a study of ductless fume hoods. The ductless fume hoods were evaluated for face velocity, air flow patterns, spill control, noise levels, chemical breakthrough alarm response, and the solvent retentivity of the carbon filters. The results of the study indicated that the units would not adequately contain a 500 ml spill, the sensitivity of the chemical breakthrough alarm was not reliable and that filter breakthrough concentrations were seen within 12 to 24 hours depending on the solvent used and its concentration (0.9 ppm benzene, 44 ppm n-hexane and 24 ppm carbon tetrachloride). Based on these results, ductless fume hoods were not approved for use at the NIH.

In December 2004, NIAID requested the installation of two ductless fume hoods at the Twinbrook III facility. NIAID proposed to use one unit to store and use ethanol and xylene for slide processing (volume of chemicals stored ~2.5 liters). The second unit would be used to process tissue stored in formalin (volume of chemical stored ~0.5

liters). As a result of the request, The Division of Occupational Health and Safety (DOHS) agreed to review the policy on the use of ductless fume hoods at the NIH.

III. Information Review

For the policy review, the working group looked at information from several sources. The sources included manufacturer information and specifications, policies and procedures from other research institutions, and recommended standards and practices related to occupational safety and health.

IV. Manufacturer Information

The working group reviewed information from six manufacturers; Misonix, Inc., Sentry Air, Captair, NuAire, AirClean Systems, and Air Science USA.

In general, the manufacturers have products that are similar. The basic unit is a workstation where air, pulled through an adjustable front opening by an interior exhaust fan, picks up contaminants and is then cleaned by being pulled through a series of carbon and/or HEPA filters. The cleaned air is recirculated back into the room. All of the manufacturers offer monitors that alarm upon detection of decreased air flow below set points and vapor or gas emissions due to breakthrough. The alarm would indicate that the filters are approaching saturation.

The manufacturers include some selection criteria based on the amounts and types of chemicals and procedures to be used in the unit.

Ductless fume hoods are marketed as cost saving alternatives to standard laboratory chemical fume hoods. Advantages cited by the manufacturers are quicker installation time and lower installation costs by not having to install duct work and fans. Other cited advantages include energy savings due to not exhausting conditioned air to the outside, and portability of the units.

V. User Policies

The working group reviewed policies, procedures, and information from many research institutions including: The Centers for Disease Control and Prevention (CDC), the Environmental Protection Agency (EPA), NCI-Frederick, Auburn University, East Carolina University, Iowa State University, Michigan State University, Northwestern University, Princeton University, State University of New York, University of California, University of Hawaii, University of Kentucky, University of Massachusetts, University of Minnesota, University of Wisconsin-Madison, and University of Vermont. These institutions were looked at because they had a published policy on ductless fume hoods. Not all research facilities were found to have specific policies on ductless fume hoods.

Of the institutions reviewed, the CDC, EPA, NCI-Frederick, East Carolina University, John Hopkins University, University of California, University of Vermont, and University of Wisconsin-Madison specifically do not allow the use of ductless fume hoods at their facilities. The reasons for not allowing their use included; concerns with channeling in the carbon filters, concerns with handling filters contaminated with chemicals, costs related to disposal of the filters as hazardous waste, tracking and maintenance requirements for the changing of the filters, potential for contaminated air being recirculated into the lab, inadequate ability to contain and control chemical spills, and concerns about the appropriateness of their use in research labs because of the varied and unpredictable nature of research work.

Of the institutions that do allow the use of ductless fume hoods, their installation and use are discouraged and requires specific approval only after an extensive use review. There are also various typical restrictions that include; limiting use to chemicals with low toxicity, use where the hood is used only for the control of nuisance odors and dusts of procedures that would normally be conducted on the bench top, where very small amounts of chemicals are used, not for the storage of chemicals, and not for operations where there is continuous operation of the hood.

VI. Recommended Standards and Practices

The working group reviewed three standards that had sections pertaining to ductless fume hoods. These were: "Prudent Practices in the Laboratory", The National Academies Press; American National Standards Institute (ANSI), "Laboratory Ventilation, ANSI/AIHA Z9.5 – 2003"; and National Fire Protection Association (NFPA) Standard 45, "Standards on Fire Protection for Laboratories Using Chemicals".

In summary, the first two standards state that ductless fume hoods have very limited applications in research laboratories due to the wide variety of chemicals used in most labs and should only be used with chemicals of low hazard and where the access to the hoods and the chemicals used are carefully monitored. In the third standard, NFPA is more explicit. Section 6.4.1 States that "Air exhausted from laboratory hoods and other special exhaust systems shall not be recirculated." Following this Section is a reference to Appendix A (A6.4.1). This section states "Ductless laboratory hoods that pass air from the hood interior through an absorption filter and then discharge the air into the laboratory are only applicable for use with nuisance vapors and dusts that do not present a fire or toxicity hazard".

Under the ANSI/AIHA Z9.5 standard, a Hazard Evaluation and Analysis must be conducted for any ductless fume hood. Ductless fume hoods must have prominently posted signage informing operators and maintenance personnel on the allowable chemicals used in the hood, type and limitations of filters in place, filter change schedule, and a notice that the hood recirculates air in the room. Warnings are included that many chemicals of low molecular weight can be stripped from the filter and reenter the room

on the flow of air through the filter, resulting in a contaminant exposure to others in the room that is over a longer time span and at a lower concentration. Also, the collection efficiency and breakthrough properties of the filters may change where multiple air contaminants are used, resulting in earlier filter breakthrough.

VII. Working Group Summary

After review of the information collected, the working group expressed severe reservations about the use of ductless fume hoods at the NIH. These are:

1) There is a great variety of chemicals used in the research environment at the NIH. The filters for ductless fume hoods are specific for only a limited number of chemicals. As research directions change, the ductless fume hood may not offer adequate protection for researchers and facilities. A standard chemical fume hood that meets NIH specifications will accommodate almost any change in chemicals being used.

2) Chemicals used in a standard chemical fume hood are eliminated from the lab by the exhaust system. With a ductless fume hood, the chemicals adsorbed to the filter remain in the lab and the potential exists for their release back into the lab in an uncontrolled manner. Unless the filters are carefully packed, they are prone to "channeling" where voids form in the filter banks and hazardous chemicals can bypass the filter. When the filters near a saturation point, they exhibit breakthrough where the chemical vapors that should be trapped in the filter are released into the lab air. The charcoal filters can exhibit selectivity. Chemicals previously adsorbed onto the filter can be de-adsorbed and released into the lab air when the filter is exposed to other chemicals for which the charcoal has a greater affinity. The reliability of the hood sensors to detect and alert the user when the above conditions occur is questionable. We have first hand knowledge of the difficulties involved with maintaining different types of sensors.

3) In the event of chemical spills, the standard chemical fume hood will exhaust the vapor out of the lab. The ductless fume hood will have only a limited ability to trap high concentrations of vapor before breakthrough occurs.

4) Standard chemical fume hoods are very simple to use and require no operator intervention, unlike ductless fume hoods. With ductless fume hoods, someone must determine the proper filter medium, monitor the hood to be sure no one uses an improper chemical (one that is not filtered by the medium in use), be sure to turn the hood on and off before and after each use, determine when the filter needs to be changed and change it. Opportunities for improper use are great.

5) The appropriate use of ductless fume hoods require very controlled conditions. At the NIH we do not have highly controlled conditions. There are a great variety of hazardous chemicals in any one lab. There are regular staff changes and frequent

changes in research directions.

6) The NIH does not allow recirculation of air in lab buildings where, theoretically, the concentration of hazardous materials would be relatively low. It does not seem prudent to allow recirculation of air from containment equipment where there is potential for high concentrations of hazardous chemical material. NFPA 45 prohibits recirculation of laboratory chemical fume hood air.

7) To ensure that proper filter selection and maintenance occur, someone must be selected to be responsible. Since this would be a collateral duty to research, there is a real chance that this process will be over looked. Examples of this in the lab environment are common - ensuring gas cylinders are secured; completing waste tags for chemical waste containers; proper chemical storage; routine testing of eye wash stations.

8) Someone, again, collateral duty, must be responsible for ensuring no one uses a chemical for which the filter medium is ineffective.

9) Improper use of a ductless fume hood can lead to a false sense of safety. Again, assigning responsibility for control a of ductless hood would be a collateral duty and cannot be performed 24/7. Potential for misuse is greater than for a standard chemical fume hood.

10) Filter maintenance and disposal are hidden costs which must be budgeted for each year. There is also the disposal issue. The charcoal filters can weigh 35 to 45 lbs. The disposal method at institutes that do allow their use is via the chemical waste streams.

11) Personnel who are not conscientious may obtain this type of equipment. We have past experience with researchers/investigators using equipment for purposes other than that for which it was designed.

12) Designers/planners may see this as a reason NOT to put standard chemical fume hoods into labs (they will be value engineered out).

13) In benchmarking, we have determined that other comparable research agencies, both governmental and academic, do not permit the use of this type of equipment for the same reasons we do not.

14) It is the position of ANSI that ductless fume hoods have limited application in research laboratories due to the wide variety of chemicals used in most labs, and should only be used with chemicals of low hazard and where the access to the hoods and the chemicals used are carefully monitored. NFPA states, “Air from laboratory hoods should not be recirculated and ductless fume hoods in laboratories are only applicable for use with nuisance vapors and dusts that do not present a fire or toxicity hazard".

VIII. Conclusions

The working group has reached the conclusion that the overall safety of NIH personnel should not be dependent upon a system considered by several agencies to be undependable (breakthrough, channeling, chemical selectivity, sensor accuracy) and reliance on personnel action (selection of proper filters, use of inappropriate chemicals once filter medium is selected, regular maintenance and replacement of filters, turning equipment on and off before and after each use, not allowing equipment to be offered for surplus, etc.) should be avoided.

It is the conclusion of the working group that these devices are not appropriate for a research environment such as NIH. The current policy of not permitting ductless fume hoods in labs should be maintained.