Draft AIHA Position Paper:
Hazardous Exhaust Systems Are Unnecessary in Research Laboratories That Involve "Laboratory Scale" Use of Chemicals

Prepared by the Laboratory Health and Safety Committee

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Executive Summary

The AIHA welcomes the standardization of all codes, which will make our practice more efficient. We applaud the International Code Council's efforts to create a common mechanical code that may be used in as many jurisdictions as possible.

We have, however, noticed some inconsistencies between the IMC-2000 and recognized laboratory standards. (A copy of the relevant sections of the soon to be published revision of the ANSI/AIHA Z9.5 Standard for Laboratory Ventilation is table one of this document). The AIHA believes these inconsistencies can be easily resolved in a manner that is more protective of lab workers, more protective of emergency responders and more energy efficient.

The first inconsistency (Section I. in body of this letter) is in Sections 510.2 and 510.7. We believe it is possible to interpret these sections as requiring automatic fire suppression *within* laboratory hood exhaust ducts. It is the opinion of the AIHA that addition of fire suppression within the hood exhaust ducts will make them less effective and increase potential exposure to workers.

The second inconsistency (Section II. in body of this document) occurs in Section 510.4. We believe it is possible to interpret this section as prohibiting manifolded laboratory chemical exhausts if incompatible materials may be used. It is the opinion of the AIHA that this requirement would increase potential exposure to workers and first responders. Most laboratory ventilation systems are manifolded. Generally, a redundant motor is placed in parallel to the primary motor. This design allows for emergency back-up and uninterrupted service during maintenance. A redundant motor on every fume hood is not practical from a cost, space or maintenance perspective. The manifold prohibition requirement would lead to a lack of redundancy where it is most needed.

Both of these interpretations would be inconsistent with NFPA 45 and ANSI/AIHA Z9.5.

The AIHA is unaware of *any* fires or significant exposures, which would have been prevented by following the current Section 510 in place of the current NFPA 45. The AIHA believes following the current Section 510 in place of the current NFPA 45 will cause increased exposures to workers and emergency response personnel.

The AIHA understands the complex and time-consuming process involved in changing a code. **The AIHA has proposed adding the following exception to Section 510.1:**

510. 1 General – This section shall govern the design and construction of duct systems for hazardous exhaust and shall determine where such systems are required. Hazardous exhaust systems are systems designed to capture and control hazardous emissions generated from product handling or processes, and convey those emissions to the outdoors. Hazardous emissions include flammable vapors, gases, fumes, mists, or dusts, and volatile or airborne materials posing a health hazard, such as toxic or corrosive materials. For the purposes of this section, the health-hazard rating of materials shall be as specified in NFPA 704.

Exception: Laboratory ventilation systems in research laboratories that involve "laboratory scale" use. Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. These laboratory ventilation systems shall be provided in a manner compliant with 29 CFR 1910.1450 "Occupational Exposure to Hazardous Chemicals in Laboratories," and shall be constructed and operated in conformance with NFPA 45 Chapter 6, "Laboratory Ventilating Systems and Hood Requirements," and ANSI/AIHA Z9.5, "Standard for Laboratory Ventilation," provided:

A laboratory ventilation system, meeting the requirements of section 510.3 and segregated from other exhaust systems as listed in section 501.2, is present to control health hazard emissions as required by CFR 1910.1450 – Occupational Exposure to Hazardous Chemicals in Laboratories. This exhaust system shall be under negative pressure from the laboratory to the roof or penthouse, shall not recirculate air to other areas, and shall meet the other design and construction requirements of Chapter 6 of NFPA 45, "Laboratory Ventilating Systems and Hood Requirements," and ANSI/AIHA Z9.5 "Standard For Laboratory Ventilation.

Substantial supporting documentation and information are included in the body of this document. The specific sections of the IMC-2000 that are of concern to the AIHA are excerpted and italicized below. Also included are relevant sections of NFPA 45 - 2000 and the soon to be published revision of ANSI Z9.5– 1992 Standard for Laboratory Ventilation as well as AIHA's comments about each issue being addressed.

Discussion

I. Requirements For Hazardous Exhaust Systems which have automatic fire suppression systems

A. Relevant Excerpts from IMC-2000, ANSI/AIHA Z9.5 and NFPA 45-2000

IMC-2000

Section 510.2 Where required. A hazardous exhaust system shall be required wherever operations involving the handling or processing of hazardous materials, in the absence of such exhaust systems and under normal operating conditions, have the potential to create one of the following conditions:

1. A flammable vapor, gas, fume, mist or dust is present in concentrations exceeding 25 percent of the lower flammability limit of the substance for the expected room temperature.

2. A vapor, gas, fume, mist or dust with a health-hazard rating of 4 is present in any concentration.

3. A vapor, gas, fume, mist or dust with a health-hazard rating of 1, 2 or 3 is present in concentrations exceeding 1 percent of the median lethal concentration of the substance for acute inhalation toxicity.

Section 510.7 Suppression required. Ducts shall be protected with an approved automatic fire suppression system installed in accordance with the International Building Code.

Exception: An approved automatic fire suppression system shall not be required in ducts conveying materials, fumes, mists and vapors that are nonflammable and noncombustible.

2001 Supplement to the International Mechanical Code *Section 510.7 Change Exception to read as follows: (M24-00)*

Exception*: An approved automatic fire suppression system shall not be required in ducts conveying materials, fumes, mists and vapors that are nonflammable and noncombustible under all conditions and at any concentrations.*

ANSI/AIHA Z9.5 Standard for Laboratory Ventilation (soon to be published revision of 1992 Z9.5 standard) Sections Addressing Automatic Fire Protection in Laboratory Hood Ducts

Please note that the following sections of the soon to be published revision of

ANSI/AIHA Z9.5 –1992 standard as well as their commentary are included in Table 1 of this document.

5.3.2.8 System Classification. Laboratory hood exhaust systems shall not be classified as "Hazardous Exhaust Systems" as defined in Building Officials and Code Administrators International (BOCA), Uniform, or International Mechanical Codes.

5.3.2.10 Fire Supression. Fire sprinklers shall not be installed in chemical hood exhaust manifolds.

NFPA 45 – 2002 Sections Addressing Automatic Fire Protection in Laboratory Hood Ducts

6.10 Laboratory Hood Fire Protection.
6.10.1 Automatic fire protection systems shall not be required in laboratory hoods or exhaust systems.
Exception No. 1: Automatic fire protection shall be required for existing hoods having interiors with a flame spread index greater than 25 in which flammable liquids are handled.
Exception No. 2: If a hazard assessment shows that an automatic extinguishing system is required for the laboratory hood, then the applicable automatic fire protection system standard shall be followed.

B. AIHA Comments and Concerns Regarding Requiring Hazardous Exhaust Systems in Laboratories

Section 510.2 (2) of the 2000 IMC appears to require a hazardous exhaust system in laboratories that will use chemicals that have an NFPA health hazard rating of 4. Section 510.2 (3) appears to require a hazardous exhaust system in laboratories that will generate a vapor, gas, fume, mist or dust with a health hazard rating of 1, 2, or 3 in concentrations exceeding 1 percent of the median lethal concentration of the substance for acute inhalation toxicity.

Is it the opinion of the AIHA that Sections 510.2 and 510.7 of IMC-2000 should not apply to laboratories. For example, the current requirement would require a hazardous exhaust system for laboratories that use phenol. Phenol is a ubiquitous chemical used in small quantities in biomedical laboratories and is also an integral component in many synthesis and analytical operations. It has an NFPA health hazard rating of 4 and a fire hazard rating of 2. When phenol is handled in a research laboratory the container size is usually 1- liter. In the vast majority of situations where very hazardous chemicals are used the container size is usually 1 – liter and is almost never more than 4-liters. Seldom would more than 10-25 mLs be utilized at any time.

The AIHA has the following health/safety and practicality concerns regarding the IMC-2000

requirement for hazardous exhaust systems with automatic fire suppression in laboratory hood ductwork:

1. The requirement in IMC-2000 for hazardous exhaust systems with automatic fire suppression in laboratory hood ductwork is in direct conflict with other relevant guidelines (ANSI/AIHA Z9.5 and NFPA 45). Like NFPA 45, section 5 of the new UL 1805 standard, Laboratory Hoods and Cabinets, requires automatic fire suppression only if the hood materials have a flame spread index of 25 or greater.
2. An uncontrolled flow of water from sprinklers in chemical hood ductwork could push the contents of the hood onto the floor and create a very dangerous situation. This would especially be a problem if the hood contained water-reactive chemicals.
3. The ANSI Z9.5 commentary indicates that "Studies of actual exhaust systems have demonstrated that the spray cone produced by sprinkler heads can actually act as a damper and reduce or prevent airflow in the duct past the sprinkler head. Like a fire damper, this may produce a lack of flow at one or more fume hoods at the moment when it is needed most."
4. The wording of the IMC-2002 supplement is ambiguous. Does it mean that sprinklers are not required only for materials that have an NFPA fire rating of 0 (such as asbestos)?
5. Laboratories that fall under the OSHA Laboratory Standard, and the ANSI Z9-5 Laboratory Ventilation Standard, are required to keep their exhaust system on at all times, even during a fire episode. Chemicals such as phenol, which are normally handled in chemical hoods, rarely produce significant vapor concentrations during an experiment. Therefore, the potential for employee or firefighter exposure to anything approaching a fraction of the LC50 in the exhaust system is just not possible. Therefore it is our opinion that a hazardous exhaust is unnecessary for laboratories using highly toxic materials.
6. Relatively small quantities of numerous chemicals are typically handled in a laboratory chemical hood. Also, significant dilution occurs because of the higher volume flow rates in manifolded systems. In our opinion, the potential for creating an environment in the ductwork capable of supporting a chemical reaction and related fire is extraordinarily small and therefore does not warrant a suppression system. This requirement is more appropriate for dedicated industrial exhaust systems that handle high concentrations of flammable vapors, corrosive chemicals, etc.
7. It is impractical to calculate the concentration that will be generated in the ductwork for all chemicals, which will be used in a chemical hood. In essence, this is what Section 510.2 (2) appears to require.

II. <u>Prohibition on Laboratory Hood Manifolding</u>

A. Relevant Excerpts from IMC-2000, ANSI/AIHA Z9.5 and NFPA 45-2000

IMC-2000

Section 510.4: Independent System states that, "Hazardous exhaust systems shall be independent of other types of exhaust systems. Incompatible materials, as defined in the International Fire Code shall not be exhausted through the same hazardous exhaust system. Hazardous exhaust systems shall not share common shafts with other duct systems, except where such systems are hazardous exhaust systems originating in the same fire area.

ANSI Z9.5 (Revision of 1992 Standard) - Sections Pertaining to Manifolding of Laboratory Chemical Hoods

Section 5.3.2 of ANSI/AIHA Standard Z9.5, pertaining to manifolding hoods, is reprinted in Table 1. The commentary of the standard (which is included on the right side of the page) indicates that manifolding hoods is encouraged and provides a long discussion of the pros and cons of manifolding hoods. The wording of the standard without the commentary is listed below.

5.3.2.2 Laboratory chemical hood ducts may be combined into a common manifold with the following exceptions and limitations:

Each control branch shall have a flow regulating device to buffer the fluctuations in pressure inherent in manifolds

Perchloric acid hoods shall not be manifolded with non-perchloric acid hoods unless a scrubber is installed between the hood and the manifold.

Where there is a potential contamination from hood operations as determined from the Hazard Evaluation and Analysis of Section 2.4, radioisotope hoods shall not be manifolded with nonradioisotope hoods unless in-line HEPA filtration and/or other necessary air-cleaning system is provided between the hood and the manifold.

5.3.2.3 Compatibility of sources

Exhaust streams that contain concentrations of flammable or explosive vapors at concentrations above the Lower Explosion Limit as well as those that might form explosive compounds (i.e., perchloric acid hood exhaust) shall not be connected to a centralized exhaust system. Exhaust streams comprised of radioactive materials shall be adequately filtered to ensure removal of radioactive material before being connected to a centralized exhaust system. Biological exhaust hoods shall be adequately filtered to remove all hazardous biological substances prior to connection to a centralized exhaust system.

NFPA 45-2000 - Sections Pertaining to Manifolding of Laboratory Chemical Hoods

6.5.10.2 Connection to a common laboratory hood exhaust duct system shall be permitted to occur within a building only in any of the following locations:

(1) Mechanical room protected in accordance with Tables 3.1.1(a) and 3.1.1(b)

(2) Shaft protected in accordance with the chapter for protection of vertical openings of NFPA 101, Life Safety Code

(3) A point outside of the building

B. AIHA Comments and Concerns Regarding Prohibition of Manifolding

IMC-2000 Section 510.4 appears to preclude the use of manifolded exhaust systems in laboratories because in these facilities small amounts of incompatible chemicals are likely to be vented through the same duct system. The wording in this section also appears to require that special care be taken to avoid the use of incompatible chemicals in a hood. In a research setting, this requirement would be difficult to comply with since the function of a typical general use chemical hood is in a constant state of flux.

The prohibition of manifolding in IMC-2000 is in direct conflict with other relevant guidelines (ANSI/AIHA Z9.5 and NFPA 45). Manifolded hood systems have been used in many facilities for the past decade without problems caused by different types of chemicals being vented into the same duct system. Use of the manifolded approach provides the following benefits:[1]

1. Enhanced dilution: If hood exhaust is mixed with general room exhaust we get immediate dilution. If we are dealing with a multi-story building we can combine the contaminated air from each floor on the roof of the building using a header duct thereby increasing the dilution factor even further. Finally, if the exhaust fan propels contaminated air off the building's roof at a rate of 3000-4000 feet per minute the resulting plume is diluted even further. In essence, once the building's exhaust reaches atmosphere, its chemical content is diluted to a point generally below measurable levels.
2. Minimize personnel exposure: By eliminating multiple dedicated fume hood exhaust fans we reduce the overall time that maintenance personnel must spend on the roof of the building. In addition, we would be eliminating employee exposure to hazardous chemicals typically associated with working on a fan problem while adjacent fans are actively spewing out contaminants.
3. Redundancy: Using a set of two or three exhaust fans to support the combined building exhaust system eliminates the problem of system failure since we always have backup capacity in service. In addition, it provides an opportunity to inspect and maintain the system components without shutting the system down.
4. Facility Flexibility: One of the hallmarks of a modern laboratory facility is its ability to respond to changes in direction of research, technology and personnel needs. As such the manifolded exhaust system would allow facility personnel to move or add fume hoods as needed in the future without major surgery to the ductwork, control systems or air

handlers. This level of flexibility would be difficult to attain unless the totally integrated manifold system were adopted.

5. Emergency Power: It is generally recognized in the health and safety community that, unlike other building types, a laboratory building exhaust system must be operational at all times- even during a fire. An integrated exhaust system lends itself to this requirement since it can easily be connected to an emergency power source while connecting individual fans would be problematic.
6. Heat recovery: As energy costs have increased many organizations have sought out opportunities to make their facilities more energy efficient. One approach applies heat recovery or in some locales, cooling recovery technology to pre-treat the incoming fresh air and thereby lowering the overall energy load. Adopting the integrated exhaust system is an important part of this approach since it concentrates all the exhaust air in one location and maximizes the efficiency of the system.
7. Minimize re-entrainment of contaminated air: Key to avoiding the problem of having exhausted contaminants re-enter the building is to physically separate the exhaust plume from the building's fresh air intakes. The manifolded approach is ideal for this application since it can isolate the source of the exhaust plume on the roof. On the other hand, having multiple fans on the roof limits our options since it may be difficult to localize the exhaust plum and direct it away from fresh air intakes.
8. Energy Conservation: A manifold system allows for designing for diversity. Since all hoods will not be fully operational at one time, this allows for the system to be designed smaller and to be operated with less total airflow.

1. 1-7 is from: Jerry Koenigsberg, *Should Your Laboratory Be Equipped With A Hazardous Exhaust System?* R&D Magazine, Laboratory Design Newsletter, Volume 7, #13 March 2002.

Conclusion

The AIHA has health and safety concerns regarding the IMC-2000 requirement for hazardous exhaust systems in laboratories and the prohibition of manifolding of laboratory chemical fume hood exhaust systems. We recommend that laboratories be exempt from these requirements as outlined in the executive summary.