RISK BULLETIN

ALLIANZ GLOBAL CORPORATE & SPECIALTY®

PRINCIPLES OF INDUSTRIAL VENTILATION

ALLIANZ RISK CONSULTING

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INTRODUCTION

Ventilation systems are an important, but often overlooked, element of a plant safety program. A properly designed ventilation system will provide good air quality, environmental comfort, removal of hazardous contaminants, and offer protection against fire and explosion. In fact, ventilation systems are the preferred method of controlling exposure to chemical contaminants and other environmental hazards in the workplace.

This Risk Bulletin will describe the two most common types of industrial ventilation systems in use today. The purpose, design, operation, maintenance, and inspection requirements of both are also discussed.

(Note that Heating, Ventilation, and Air Conditioning (HVAC) systems will not be covered here. See Allianz's "Proper Building Ventilation Systems" Risk Bulletin for information on HVAC systems.)

COMMON VENTILATION SYSTEMS

In industrial settings, the two basic types of ventilation systems are Dilution Ventilation and Local Exhaust Ventilation.

DILUTION VENTILATION SYSTEM

Dilution Ventilation is designed to reduce the concentration of pollutants in a work area by mixing outside air with the contaminated air. It also acts as a general ventilation system within the work area. Before deciding if a Dilution Ventilation system is right for your facility, consider these questions:

- Considering the amount of toxicity, dosage, and individual susceptibility, do the contaminants represent a relatively low health or safety hazard?

- Will chemicals be released over a wide area and throughout the day?
- Are the gases, vapors, or fumes used in your facility unlikely to settle to the ground?
- Is your plant located in a moderate climate? (Hot or cold outside air may affect the efficiency of a dilution ventilation system.)

Tip: Some ignore these limiting factors, and others consider a Dilution Ventilation system to be the answer for all situations. This may be a mistake. If the contaminant is toxic and present in significant volume, a Dilution Ventilation system will simply circulate the hazardous contaminants around the work area. Additionally, employees working nearby may be exposed to the hazardous material.

Tip: In work areas where chemicals are present in high concentrations, a Dilution Ventilation system is not always the control method of choice. Under these circumstances, consider "substitution" or "elimination" of the chemical hazard as alternatives.

The effectiveness of a Dilution Ventilation system is usually measured by the number of room air changes that take place in an hour. Four to six air changes per-hour (ACH) is typical for most ventilation systems. Depending on the industry and circumstance, an ACH factor of 20-25 may be appropriate. The number of ACH may need to be adjusted, depending on the nature of the contaminant and the existing environmental conditions.

Guidelines for an efficient Dilution Ventilation system:

- Place room exhausts (ceiling and wall fans) as close to the emission source as possible.
- Use auxiliary fans for effective mixing of room air.
- Place employees upwind of contaminant sources.
- Add tempered (depending on climate conditions) make-up air in situations where it will be the most effective.

Note: "Make-up air" is clean, fresh air, free of contaminants supplied to a work area in quantities equal to the volume of air exhausted through the ventilation system.

Tip: In areas of ambient temperature extremes, considerations should be made to temper (or blend) make-up air. This may involve significant energy costs, which is a good reason to consider an alternative ventilation system (see below).

LOCAL EXHAUST VENTILATION

The primary purpose of a Local Exhaust Ventilation system is to capture and remove chemical contaminants at or near the source. The components of a typical Local Exhaust Ventilation system usually includes a capture hood, booth or other capture system, ductwork, an air cleaning or scrubbing system, a fan, and an exhaust system that vents outside the building.

Criteria to consider when selecting and designing a Local Exhaust Ventilation system (one or more may apply):

- Do the chemical contaminants represent a significantly high hazard?
- Do the contaminants consist of larger particles that can settle over time?
- Do emission patterns vary over time?
- Do emissions emanate from a single source?
- Do employees work in the immediate vicinity of emission sources?

Examples of Local Exhaust Ventilation systems include spray paint booths, capture hoods for welding, and slot ventilation systems on plating tanks, among others. Local Exhaust Ventilation systems offer better control of contaminants, improved housekeeping, and lower energy costs over a Dilution Ventilation system.

All exhaust ventilation systems, whether large or small, are relatively complex, requiring five basic elements:

- Hoods
- Fans
- Ducts
- Air cleaners
- Stacks

Larger units usually require multiple branches and capture hoods with sophisticated designs and intricate engineering to achieve the desired control.

HOODS

Hoods capture contaminants from an emission source. The hoods are either "enclosure," "receiving," or "exterior."

- Enclosure hoods (such as a paint booth) completely enclose the point of contamination.
- Receiving hoods are located in the path of the discharged contaminant (such as particles that come off a grinding wheel).
- Exterior hoods capture contaminants from a point outside the hood (such as slot ventilation used on plating tanks or overhead canopy hoods).

Tip: Make sure all hoods fit properly. An ill-fitting hood may not capture all the contaminant, and can possibly exhaust clean air.

Tip: Take care not to place a worker between the contamination source and the hood. This is particularly important in instances where canopy hoods are used and when spraying is done inside the booth against the airflow. Both situations can increase the worker's exposure to hazardous chemicals.

FANS

Fans move the air through the exhaust system and pull contaminants through hoods, ductwork, and cleaners, ultimately exhausting to the outside. Fan design depends on the volume of air involved, desired velocity, type and concentration of contaminant, and the static pressure (or resistance) developed during the process.

Tip: Many types of fans are available (from centrifugal to axial). Carefully select the one that best suits your ventilation configuration and work environment.

Tip: Improper fan selection or faulty installation can reduce air flow and cause short circuits, which could result in the contaminant being returned to the workplace and cause cross-contamination.

DUCTS

Ducts are passageways for the contaminants as they move from a hood, through the air cleaner or contaminant collector, and to an exhaust outlet. Ducts are made with different types of material, usually sheet metal, but plastic, fiberglass, and even concrete are becoming more common. Design and arrange ductwork to minimize frictional loss (diminished airflow) and reduce the possibility of solid particles settling in the system.

Tip: Too many side branches, elbows, and flex ducts tend to increase static pressure, which reduces fan effectiveness.

Tip: "Blast gates" are often used with multiple branch ventilation systems. They close off branches not in use, thereby making the overall system more effective. Require that anyone adjusting blast gates receive proper training.

Tip: Ducts that exhaust dust can clog easily. For maximum efficiency, check and clean duct ports often.

Tip: Although the source of the contamination may have been shut down, keep the system operating to allow time for the contaminant to exit through the ventilation system completely.

Tip: Separate systems may be necessary to exhaust incompatible materials. A good example is printing operations where solvents and oxidizers are both used. (Ozone from the plate developer is the oxidizer that could mix with flammable vapors from the roller blanket wash).

AIR CLEANERS

Air cleaners range from bag houses, cyclones, scrubbing towers, or thermal oxidizers, and are selected based on the nature of the contaminant. Governing agencies may mandate a specific type of air cleaner, so check local codes and regulations.

Typical air cleaners protect the components of the exhaust system and collect or trap solid particulates, gases, and vapors. In some cases, this collected material can be taken to landfills or may be recycled. The regular maintenance of air cleaners is essential to ensure the overall efficiency of the ventilation system.

Tip: Take extreme caution when workers enter an air cleaner (especially a bag housing) to clean or make repairs. The worker is at risk of exposure to high levels of contaminants and may suffer from insufficient oxygen. Follow applicable "Confined Space" rules.

STACKS

The final component in a ventilation system is the exhaust stack. Stacks are usually mounted on the roof and direct exhaust into the outside air. Place stacks downwind from any air intake vents, and calibrate the stack exhaust velocity at 1.4 times the average wind velocity, or other recommended value.

Tip: Place carefully sized stacks downwind from, and higher than, air intake vents to avoid re-entrapment of "bad air."

FIRE PROTECTION

Fire in exhaust ducts, kitchen hoods, or bag housings can present many problems.

- Fire can be difficult to detect and extinguish
- Ductwork can spread a fire quickly to other parts of the building

Small particles such as wood or grain dust are highly combustible and can ignite from sparks generated from metal contaminants (nails and staples) that strike the inside of the ducts. Other potential fire hazards come from buildup inside exhaust ducts and hoods in commercial kitchens, exhaust ducts from paint booths, and dust collected inside bag house assemblies. Some control measures include:

- Spark detection systems inside exhaust ducts monitored by an alarm panel.
- Fire suppression systems inside ductwork and bag houses.
- Explosion venting built inside ducts.
- Regular inspections for accumulation of dust inside ductwork; examination of exterior surfaces.
- Sprinkler heads inside ducts and paint booths.
- Regular cleaning and treatment of kitchen exhaust systems.
- Regular servicing of kitchen fire suppression systems.

MAINTENANCE

All ventilation systems require regular inspection and maintenance to assure effective and continual operation. Local Exhaust Ventilation systems are especially prone to wear and tear, and any damage can greatly affect the performance of the system. Develop a regularly scheduled inspection and maintenance program to help the staff keep the system operating properly.

An effective maintenance and inspection program should include:

- Measuring static pressures in the system.
- Checking the airflow capture velocity at the hoods.
- Checking the fan performance against original design and specifications.
- Checking the operation of the air cleaner.
- Inspecting hoods, ducts, elbows, and connectors for damage or leaks.
- Re-balancing the system whenever additions or changes have been made.
- Tempering any recycled air (particularly relevant in colder climates).

Your maintenance program should examine the system with these questions in mind:

- Has the ventilation system been modified in any way since originally installed?
- Have additional branch lines been added?
- Has the nature of the contaminant changed since the original installation?
- Have OSHA or industry standards become more restrictive for the contaminants being removed?

A "Yes" answer may require a reevaluation of your system to make sure it performs according to specifications and current conditions.

Tip: Leave the task of ventilation measurement to engineers or technicians familiar with system requirements. However, a quick check of flow rates can be performed by maintenance staff using a variety of instruments and methods, including velometers, inclined manometers (as seen on the sides of spray paint booths), and smoke tube tests.

Tip: Never force inappropriate material (such as large wood chips or trash) through any ventilation system. Ventilation systems are NOT designed to be trash receptacles.

SUMMARY

The most effective way to protect workers from airborne contaminants is through a ventilation system. It can provide a comfortable environment, and reduce or eliminate the need for personal protective equipment such as respirators. Properly designed systems can also help reduce fire and explosion hazards by removing flammable solvents or combustible dust from the work environment.

It is important that management and employees know and understand the design and proper operation of a ventilation system, its limitations, and maintenance and inspection requirements. This will assure efficient and effective operation of the system.

FOR FURTHER ASSISTANCE:

Visit these Government Web sites:

- Occupational Safety and Health Administration: www.osha.gov
- National Institute for Occupational Safety and Health: www.cdc.gov/niosh/

Design: Graphic Design Centre