

A Health and Safety Guideline for Your Workplace

Ventilation

Introduction

Ventilation is a primary engineering control available to reduce the concentration of gases, dusts, vapours, smoke, and fumes in the air.

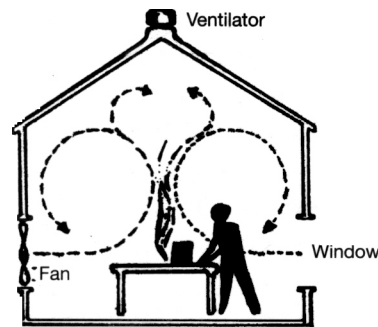
Dusts, fumes, vapours, and gases in the air are drawn into the ventilation system and carried to the collecting device by a pressure gradient created by the fan. The fan must have sufficient power to overcome the resistance to air flow created by the system.

There are two types of ventilation systems: general and local exhaust.

General Ventilation

General (dilution) ventilation systems supply clean air that mixes with the air in the workplace, diluting the concentration of the contaminant. General ventilation is not suitable to control exposure to toxic substances because these systems actually spread the contaminant throughout the workplace before exhausting it. Also, they require large amounts of air and may be costly to operate during the winter because of additional heating. General ventilation systems are used primarily to control temperature and humidity, to remove odours, and sometimes to remove traces of toxic substances and microorganisms emitted from carpeting, paneling, furniture, and people.

A General Ventilation System

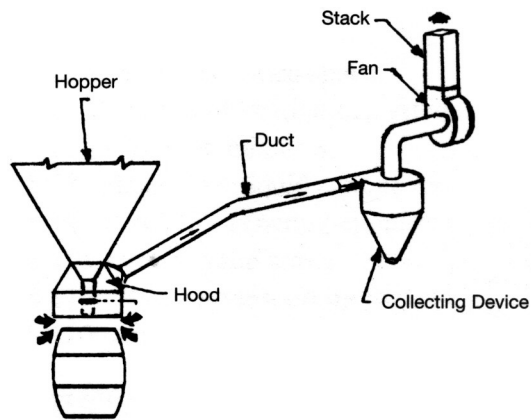


Local Exhaust

Local exhaust ventilation systems remove the contaminant before it spreads through the workplace. The systems are designed to take advantage of the motion of the contaminant in order to capture it without drawing in large amounts of air as well. They are most useful for controlling toxic materials when their airborne concentrations could exceed legislated standards.

There are four elements that make up a local exhaust ventilation system: the hood, the duct work, the air cleaning device, and the fan.

A Local Exhaust System



The hood captures the contaminant by overcoming its momentum and then drawing it into the system. Factors affecting the design and location of the hood include the form of the contaminant (dust, fume, vapours, or gas), and the speed at and direction in which the contaminant is released. For large, heavy dust particles released at high speeds (e.g., grinding), the hood must be positioned in the path of the particles. Typical capture velocities required are:

- 100 feet per minute (fpm) for vapours and gases
- 200 fpm or more for dusts

The duct work provides a pathway to carry the contaminant to the air cleaning device. The velocity of air in the duct must be high enough to prevent heavy particles from settling in the ducts. The heavier the particle, the greater the velocity needed. Typical velocities required are:

- 1000 fpm for vapours and gases
- 4000 fpm for heavy dusts

Also, there should be no obstructions or unnecessary bends and constrictions. These can cause excessive pressure drops.

The air cleaning device removes contaminants from the air stream before it is passed to the fan and expelled to the atmosphere or recycled to the work area. There are two types of air cleaning devices: air filters and dust collectors.

Air filters are designed to remove low dust concentrations of the magnitude found in atmospheric air. Dust collectors are designed for the heavier concentrations that are generated by industrial processes.

The fan is the device that draws the air through the entire system. It must be capable of generating enough of pressure drop to draw the required volume of air through the hood, ducts, and collecting devices at the correct velocity, and of overcoming the resistance to air flow from hoods, ducts, and collecting devices.

Each of these elements must be designed specifically for the type of contaminant to be removed. The dust collector must be capable of meeting the environmental standards set by the Ministry of the Environment.

The elements must be maintained in optimum condition through regular inspection and maintenance.

Renovations

It may become necessary, because of changes in plant layout or processes, to make additions or renovations to the ventilation system. Before doing so, seek expert advice. What may seem to be minor alterations or additions can seriously impair the functioning of the entire system.

Hazards of Poor or No Ventilation

Depending upon workplace conditions and activities, the hazards of poor or no ventilation could include:

- lack of oxygen (headache, fatigue, asphyxiation), particularly in confined spaces
- excessive heat, cold, and humidity
- toxic fumes (e.g., lead, cadmium, zinc)

- toxic vapours (e.g., benzene, toluene, trichloroethylene, MEK)
- toxic gases (e.g., hydrogen sulphide, ammonia)
- dusts (causing poisoning or gradually reduced lung capacity)
- fire/explosion

Controls

Ventilation Control Program

All ventilation systems require inspections and testing. Training on routine and emergency operating procedures should also be provided. Incorporate these into a ventilation control program. Some factors to be considered and incorporated into the program are:

- written standards and procedures for operation
- regular daily or weekly inspections, depending upon the toxicity of substances to be exhausted
- regular cleanout schedule for settling chambers, dropout boxes, dust collectors
- posting of emergency and operating procedures
- regular maintenance
- operator training
- use of personal protective equipment, when warranted
- regular medical examinations, where applicable
- an emergency plan in case of fan failure or blockages of ducts
- consultations with the Fire Marshal about vents in fire hazard areas – should they be designed to open or close automatically in the event of a fire? Vents that open/close automatically should not depend on springs. When exposed to high temperatures, springs may fail due to loss of tempering

Inspection

Never assume the system is operating properly just because the fan is running.

Some things to be considered during inspections are:

- determining the velocities at which the system is to operate
- doing visual checks of the system – physical condition of ducts, dampers, hoods, stack, motor, fan, blades, belts
- checking the electrical system regularly
- checking noise levels from fans (increase in noise levels is an indication of problems; any increase in noise could also raise noise exposure levels to above legal limits)

Difficulty in opening doors in buildings with local exhaust may indicate that not enough make-up air is being supplied, so that the efficiency of the system is reduced.

The frequency of inspections depends on the manufacturer's recommendations, how often the system is used, and the form and concentration of the contaminant(s) being removed.

Testing

The following are some important aspects of testing:

- static pressure in system – unless test locations have been provided, caution must be used in drilling holes in duct work. The inner surface of the duct must remain smooth or the instrument may give a false reading
- air current test (i.e., smoke tube tests) are not an absolute indicator of hood efficiency
- testing should be done under the worst conditions (i.e., at peak operating times)

Determine the correct direction of rotation of the fan blades. Once this is determined, indicate the direction on the fan case. This will help in future inspections/maintenance.

Training

Training requirements should include the following:

- familiarity with the *Occupational Health and Safety Act* and Regulations
- the role of ventilation in contaminant control
- breakdowns which cause hazardous or nuisance conditions
- how to handle fire in ducts
- knowledge of tests carried out (to reinforce why there is such a ventilation system)
- position required to be in while working near exhaust hood
- shutdown procedures of fans, etc.

Maintenance

Any ventilation system will have slight performance fluctuations. As with any piece of machinery, a ventilation system is subject to wear, misalignment and breakdowns. Only through regular and thorough maintenance can it remain in effective operating condition. The following are a few of the more common problems to be aware of:

Hood System

- adjustable slots have been altered
- resistance has been changed (i.e., the hood has been modified or more fume hoods have been inappropriately added, so the velocity and flow rate of air are less than what was specified)
- holes in the enclosure resulting in air entering the hood in other locations
- inspection doors left open or removed, allowing air to enter.

Duct Work

- duct partially plugged, increasing the resistance of air flow and decreasing the flow rate of air through the system

- damper settings changed which lessens the amount of air flowing through the system (some ducts have fused dampers, designed to close in case of fire, and occasionally, fuses will melt, causing damper to close inadvertently)
- corrosion, leaks, holes, bent, crushed
- inspection doors left open
- ducts joints have worked loose or become separated
- hangers missing and/or damaged
- blast gates/dampers
- dust or corrosion
- incorrect position (causing system to become unbalanced)

Collecting Devices

- bags missing, blocked, overloaded
- cleaning mechanism not working
- hopper full of dust
- filters clogged

Motors/Fans

- duct or corrosion on fan blades
- incorrect rotation of blades (with flow axial fans, air flow may be reversed; with centrifugal fans, rate of flow may be reduced, making detection more difficult)
- fan blade assembly incorrectly mounted (turned around)
- incorrect fan size for system
- incorrect speed
- field modification to fan wheel or casing
- broken fan belt
- belt slippage/pulley sizes changed
- motors not lubricated, drives belts and other parts worn out
- poor fan inlet connections causing uneven air flow into fan (this can reduce fan capacity by 20%)

Checklist

This checklist is a sample only. Modify it to suit your own particular needs and operations. Although intended primarily as a maintenance or department check, it may be useful as a pre-shift check as well.

Dates of Inspection

✓Acceptable ✕Unacceptable	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Duct Work/piping (undamaged, uncorroded, unblocked)												
Dampers (condition, setting)												
Hoods (condition, efficiency Smoke test)												
Inspection doors (damaged/left open/removed)												
Duct collectors, bag houses, filters, setting chambers												
Fan blades (rotation, direction, condition, noise)												
Fan motor (lubrication, condition)												
Electrical system												
Belts/pulleys (broken, slipped)												
Air test for contaminants												
Static pressure in ducts												
Exhaust ports/stacks												
System balanced (blast gates/dampers)												
Maintenance (every 3 months)												
Instructions posted/up to date												
Initials of the person doing inspection												

Legislation

The following sections of the **Regulations for Industrial Establishments** (R.R.O. 851/90) deal with ventilation:

- S. 69 & S. 70 – confined space
- As of September 30, 2006 new confined space legislation will be in affect.
S. 119.1 – 119.20
- S. 63 – explosive mixtures
- S. 22 – flammable liquid storage rooms
- S. 127 – general requirement
- S. 138 – low oxygen atmosphere
- S. 128 – replacement air
- S. 119 – vehicle transporting loggers
- S. 120 – washrooms

The **Ontario Fire Code** contains the following provisions:

- S. 4.1.7 – ventilation for rooms or enclosed spaces where flammable liquids are processed, handled, stored, dispensed or used.
- S. 4.8.3 – ventilation for below grade areas to prevent accumulation of flammable vapours
- S. 5.1.4 – ventilation for hazardous locations and processes

References

- *Industrial Ventilation*, 24th Edition, 2001, ACGIH, Cincinnati, Ohio, U.S.A.
- McDermott, Henery J., *Handbook of Ventilation for Contaminant Control*, 2nd Edition, 1985.

Ventilation is one in a series of guidelines designed to help you make your workplace healthier and safer. Other guidelines that you may find useful are:

- Lighting at Work
- Lockout
- Safety Signs and Colour at Work
- Work Permits

For more general information contact inquiries Service at 1-800-406-4272.

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Revised: March 2006

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