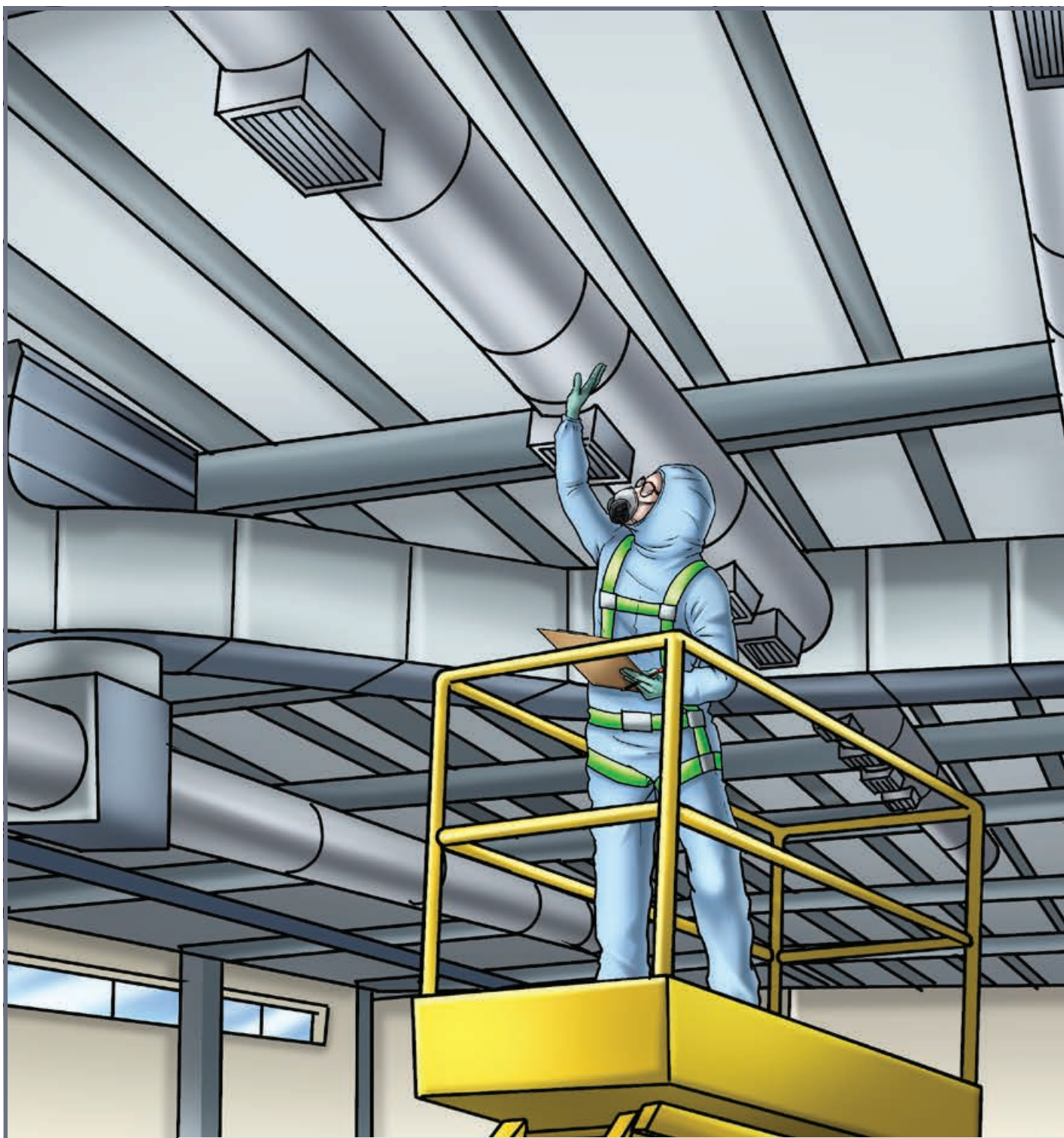




General Ventilation

Good Practice Guidance on controlling exposure to chemicals that cause platinum sensitisation

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Glossary

Air distribution registers

Openings in a building's heating and cooling system that control the flow and amount of air into rooms. These need to be adjusted according to the room's size, etc.

Airflow rate

How much air flows through a ventilation or air conditioning system during a specific unit of time (usually cubic metres per minute).

Envelope leakages

These are openings in a building that allow air, moisture or other substances to move between the inside and outside of the building. An airtight building has no envelope leakages.

Exfiltration

Air escaping out of, or leaving, a building through leaks or openings.

Humidity/humid

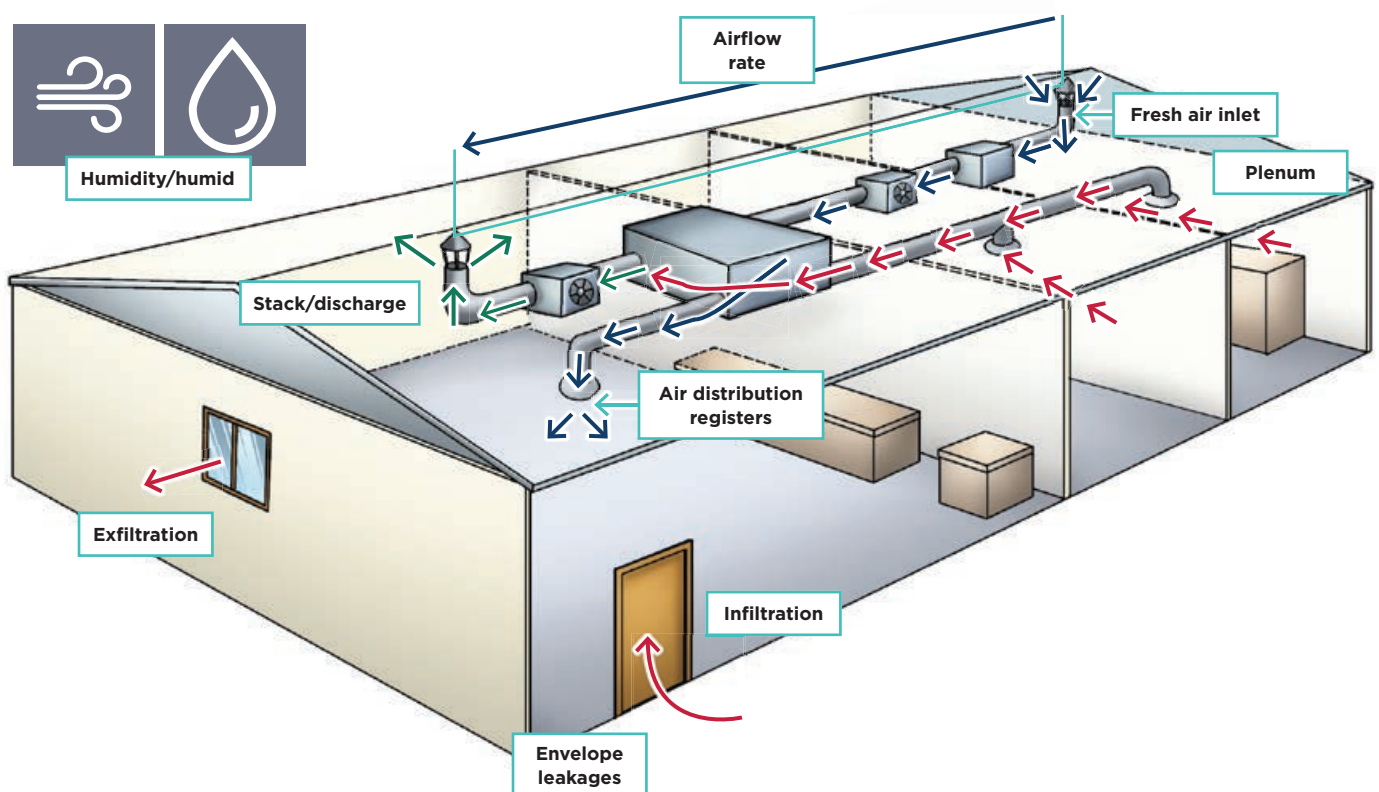
How much water vapour is present in the air (usually shown as a percentage). High humidity means lots of water vapour in the air, which can be uncomfortable and cause mould or other biological agents to grow. Low humidity means the air is drier, which can cause skin to become dry and other health issues, e.g. sore throats, asthma, coughing, etc. Good humidity levels are typically between 30-60%.

Infiltration

Outside air entering a building through leaks or openings.

Plenum

Plenums are air compartments or chambers that are connected to air-handling units, ducts or air distribution registers. Plenums help distribute conditioned air evenly through a building and are usually located in the gaps between ceilings and the floor slab above, or in gaps under raised floors and floor slabs.



Introduction

General ventilation is a crucial aspect of indoor air quality control that involves the introduction of fresh outdoor air into a building or work environment. It serves as a primary means of improving indoor air quality by maintaining air exchange and preventing the build-up of heat, humidity and carbon dioxide. It also reduces the concentration of indoor air contaminants from work activities, but this effect is not sufficient to control high-potency substances like chloroplatinates.

Other engineering controls, including Local Exhaust Ventilation (LEV), must be used to contain chloroplatinates and remove any chloroplatinate particles released into the air. Where LEV systems are present, general ventilation performs an additional critical role in replacing the air extracted by the LEV systems. LEV and general ventilation need to be properly managed and balanced for the LEV to be effective.

General ventilation is typically achieved through the use of mechanical systems, such as air ducts, fans, and filters, and is an essential component of modern building design, especially in spaces with high air pollution levels. General ventilation supports the maintenance of a healthy and safe indoor environment for workers and visitors.

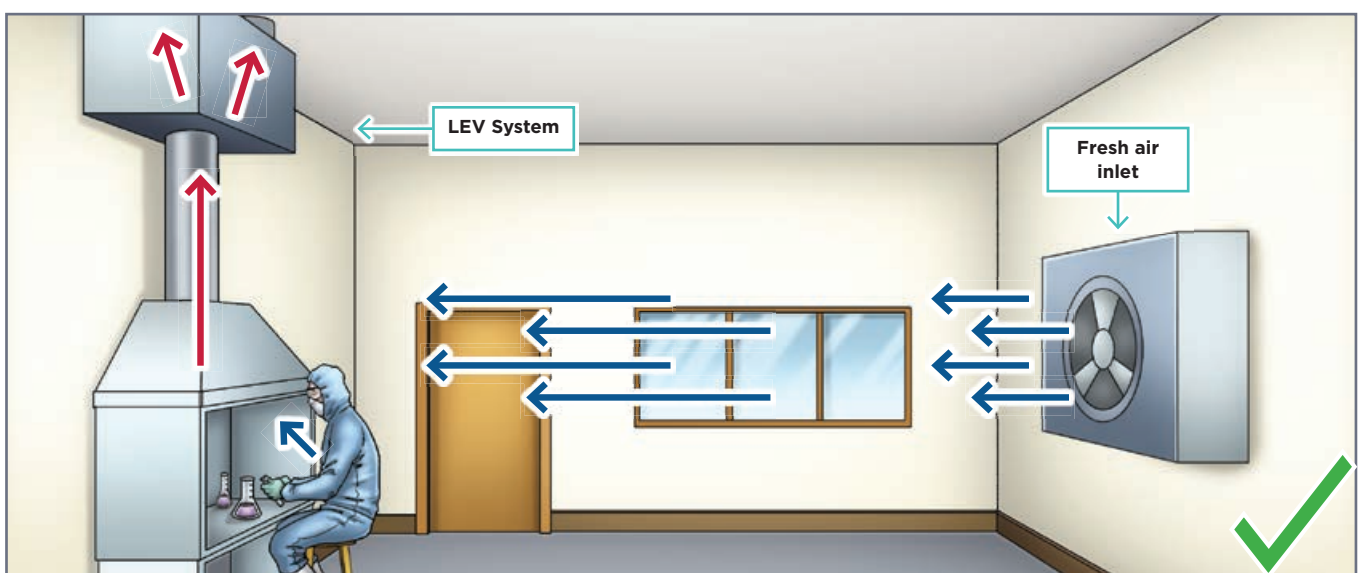
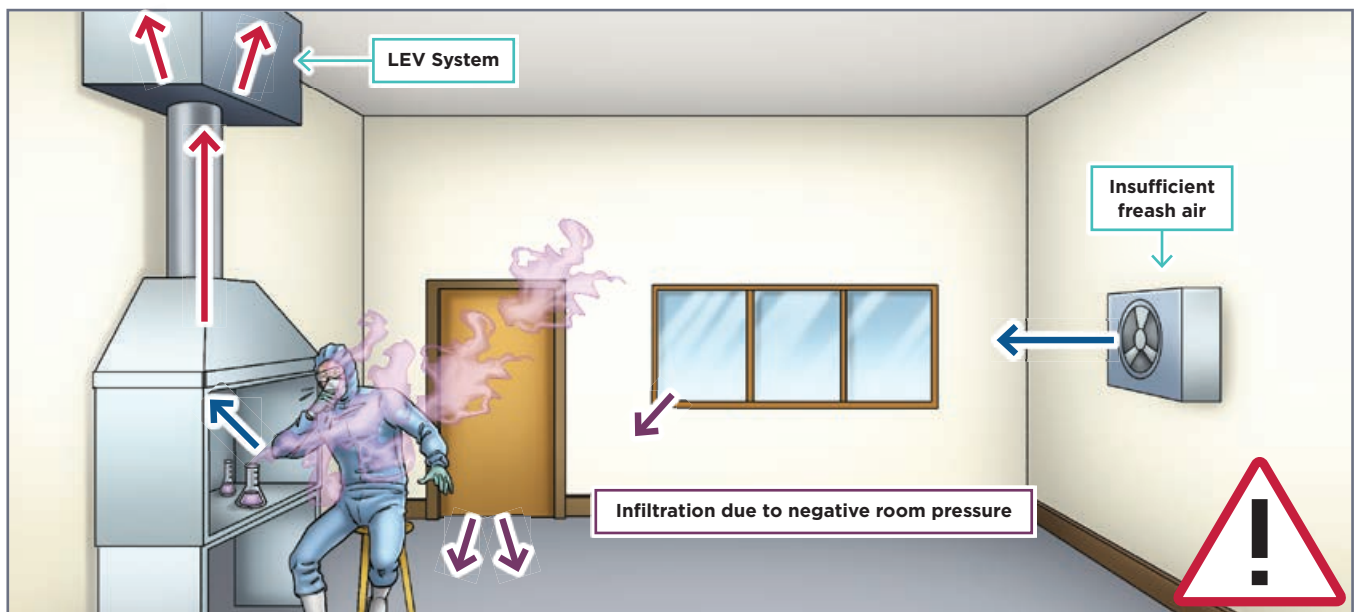
This guideline will assist in:

- Defining general ventilation
- Discussing principles of general ventilation
- Explaining fresh air ventilation requirements
- Measuring effectiveness of general ventilation systems
- Understanding the limitations of general ventilation

The need for fresh air in the workplace

We need fresh air in the workplace to:

- 1 Give us enough oxygen
- 2 Remove carbon dioxide
- 3 Control thermal conditions (temperature, humidity and airflow rate)
- 4 Remove or reduce odours/smells
- 5 Dilute contaminants produced by workplace activities
- 6 Create comfortable and healthier working conditions
- 7 Decrease stale air conditions
- 8 Help LEV systems function at their best (by replacing extracted air with fresh air)

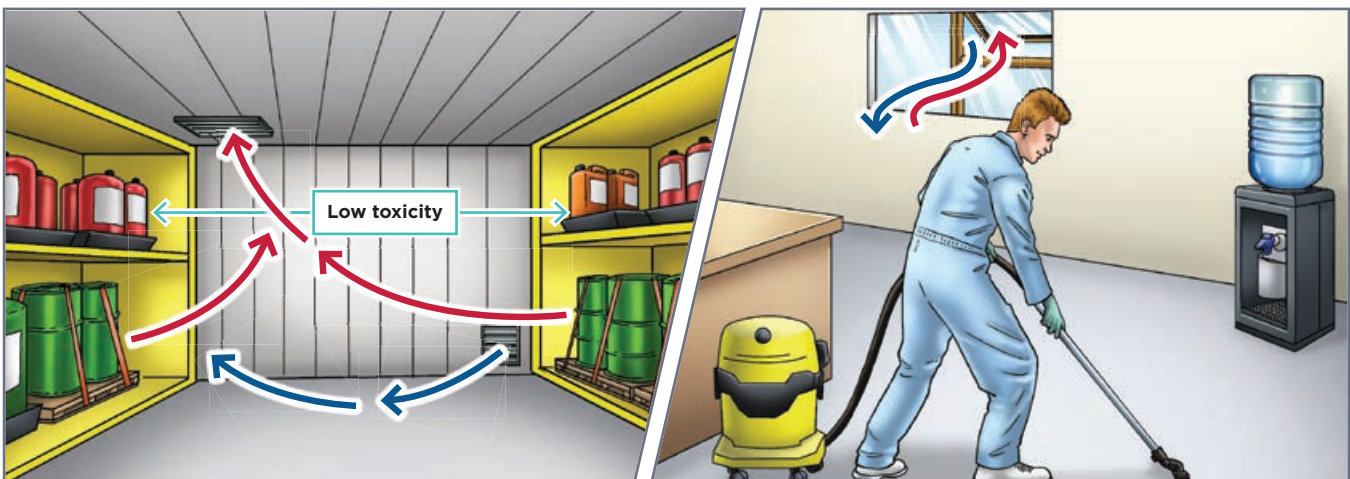
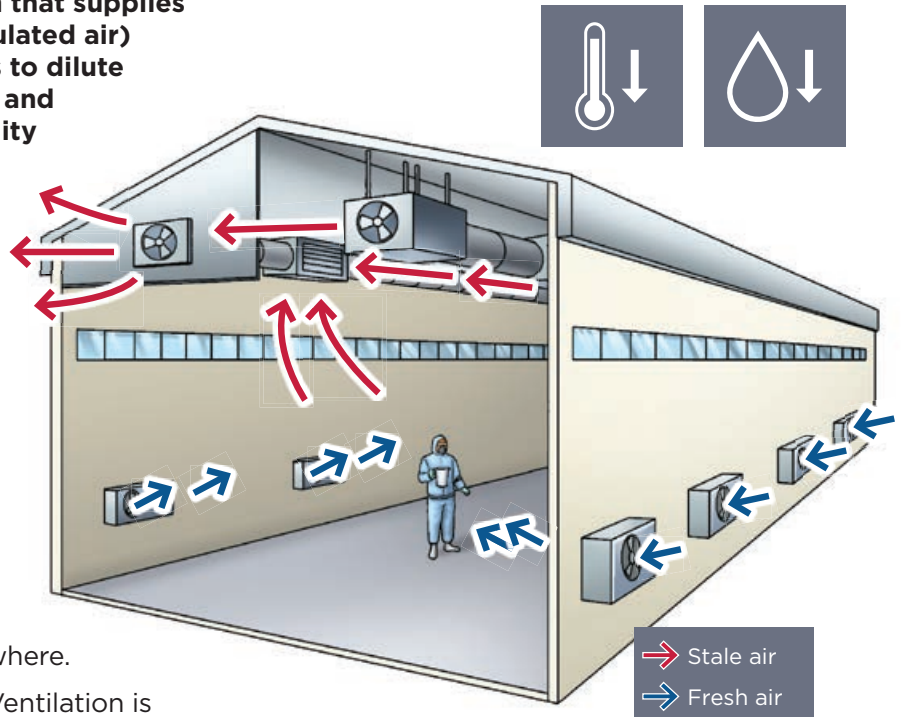


What is General Ventilation?

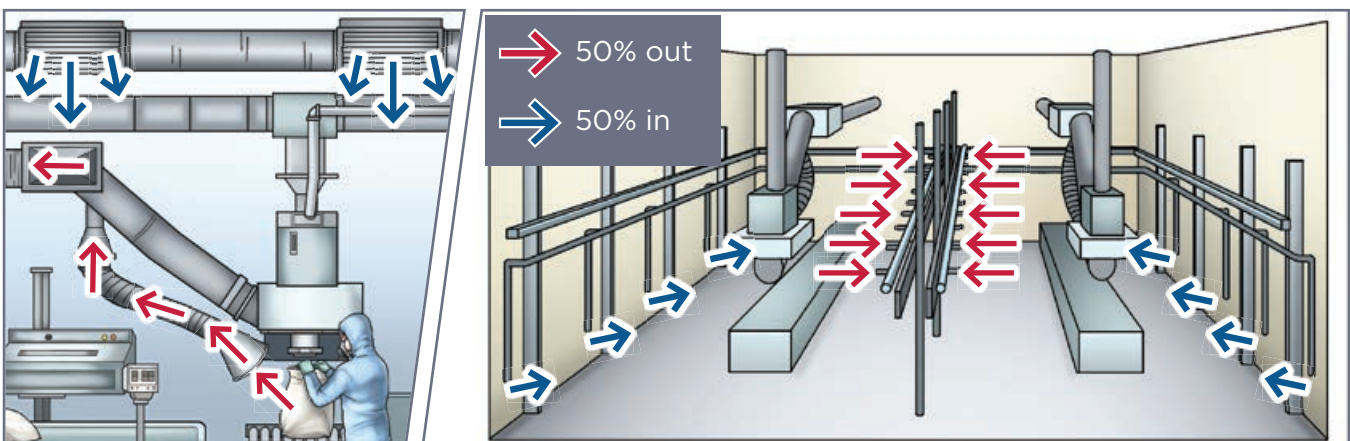
General ventilation refers to a system that supplies fresh air (or a mix of fresh and recirculated air) through a workspace. Its main goal is to dilute indoor air with fresh air from outside and control high temperatures and humidity to prevent discomfort or injury.

General Ventilation will also reduce concentrations of chemical contaminants within indoor air. However, general ventilation should not be used to control exposure to high-potency chemicals like chloroplatinates. General ventilation can only be used as a primary control when:

- The chemical contaminants in the air all have low toxicity, and are released into the air slowly so concentrations are never high anywhere.
- The fresh air provided by General Ventilation is sufficient to keep concentrations of the contaminants in the air breathed by workers well below acceptable levels at all times.



When the conditions can't be met through general ventilation alone, LEV must be used along with it. General Ventilation then serves a critical role in replacing the air extracted by LEV. The general ventilation and the LEV must be balanced (air in = air out) for the LEV to work properly.



Types of General Ventilation

General Ventilation can be divided into two main categories, which are natural and mechanical.

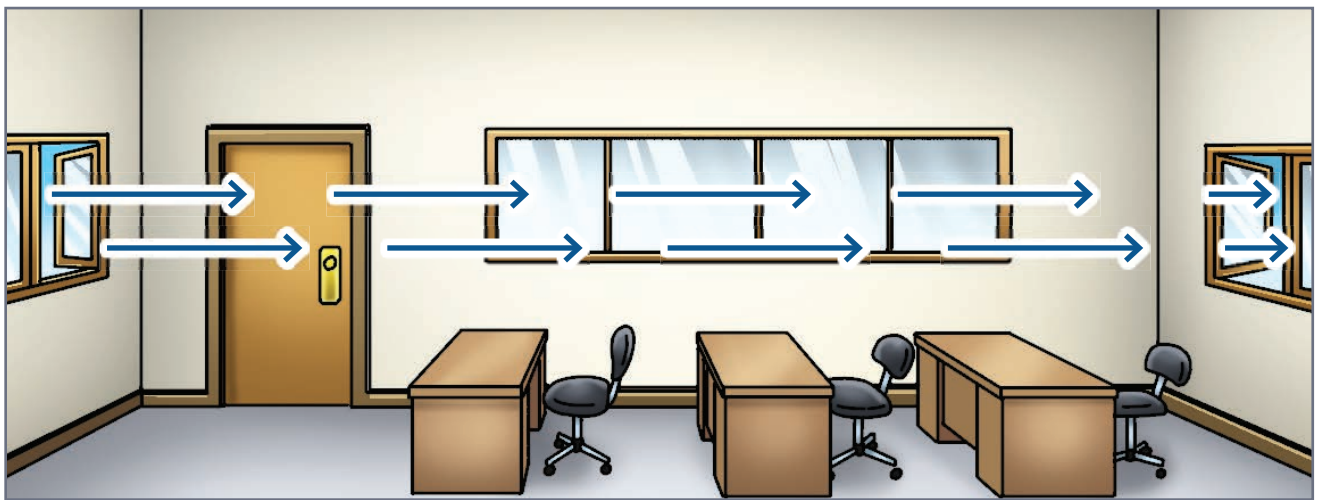
1. Natural ventilation

Natural ventilation uses differences in wind pressure and temperature to bring fresh air into a building - methods that cannot be completely controlled.

There are two types of natural ventilation:

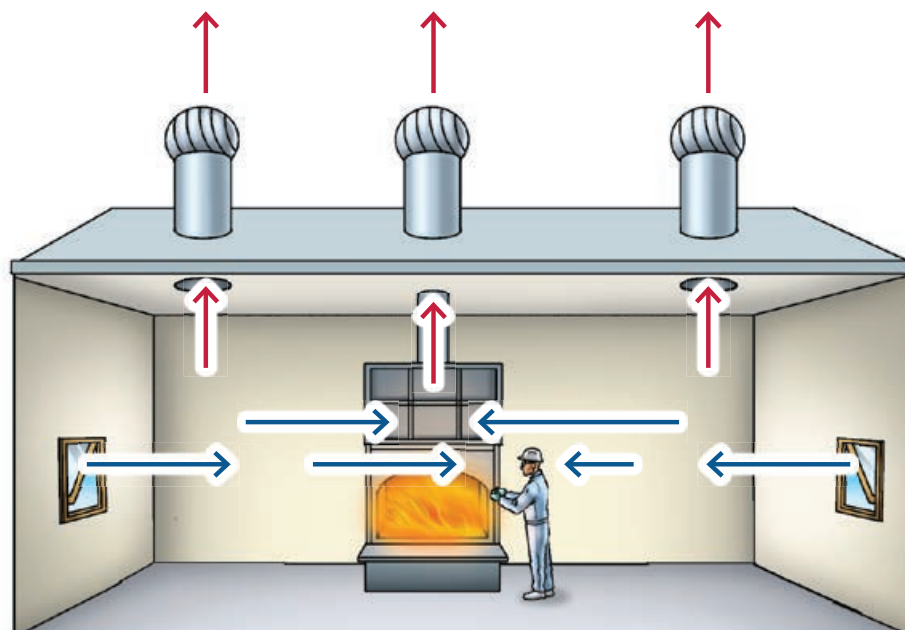
1.1 Wind-driven ventilation

Takes place because of different pressures created by wind around a building or structure that then flows through openings in the building.

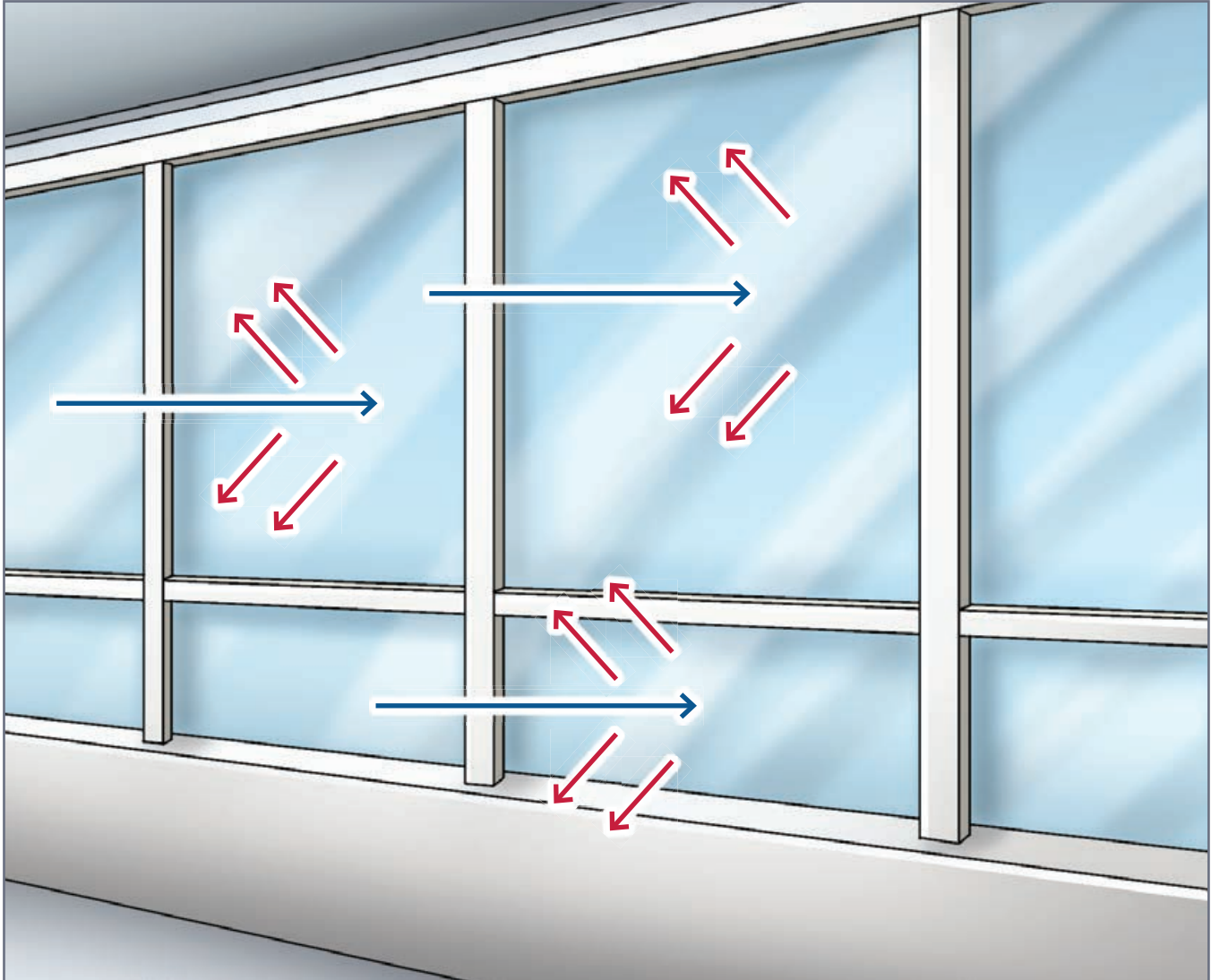


1.2 Buoyancy-driven ventilation

Occurs because heat inside (including heat from people and heat produced by processes, such as furnaces) create temperature differences between the inside and outside. The warmer air inside the building rises and escapes and cooler air from outside enters the building, which results in a flow of air.



Natural ventilation is not commonly used in the PGM processing industry because operations have strict security protocols that limit the use of open windows or doorways. Therefore, this guidance focuses mainly on mechanical ventilation.



2. Mechanical Ventilation

Mechanical Ventilation uses fans to move air into and out of a building, and consists of two main parts:.

a. Supply system

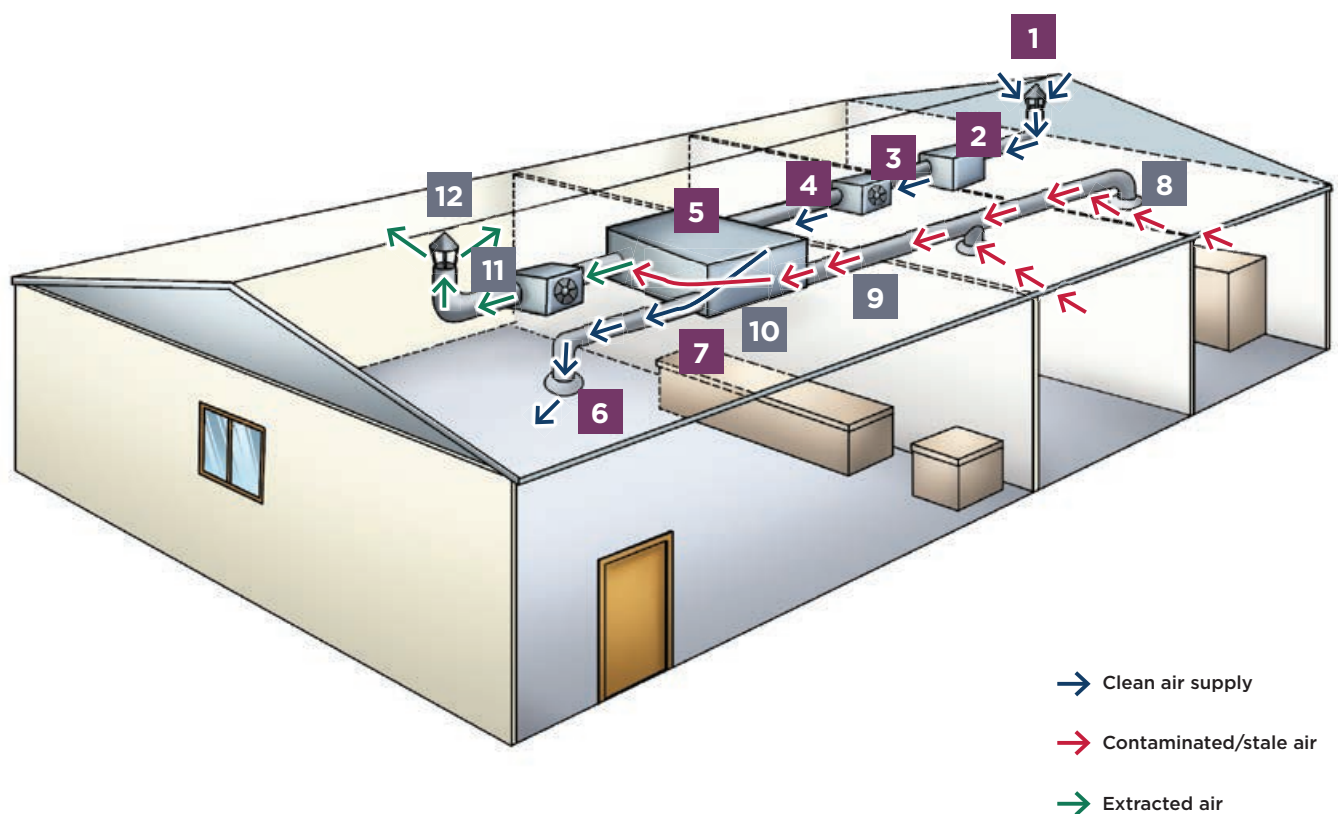
In general, the supply system is a heating, ventilation, and air-conditioning system (HVAC) and consists of:

- 1 Air inlet
- 2 Air filtering equipment
- 3 Fan
- 4 Ducts
- 5 Heating/cooling equipment
- 6 Air distribution registers
- 7 A fresh air supply system (sometimes topped up with clean, recirculated air)

b. Exhaust system

The exhaust system consists of:

- 8 An "air intake" area
- 9 Ducts to move air from one area to another
- 10 Air cleaning/filtering device(s)
- 11 Fan(s) to exhaust the indoor air
- 12 Discharge stacks

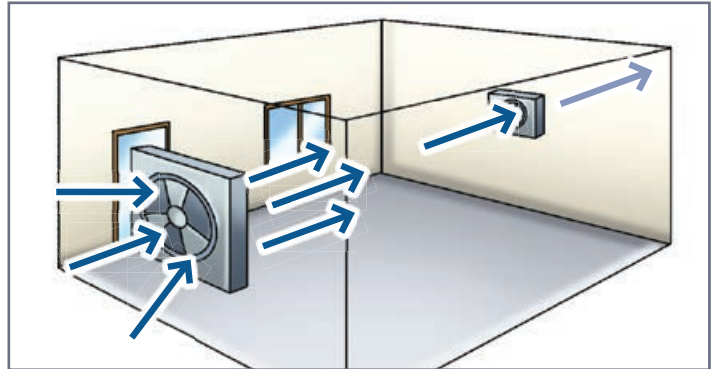


Typical Mechanical Ventilation systems used in general ventilation

Mechanical ventilation can be adjusted to form a positive or negative pressure system, as well as a balanced pressure system. The type of pressure system needed will depend on various factors, such as climate, the activities performed or hazardous substances handled, etc.

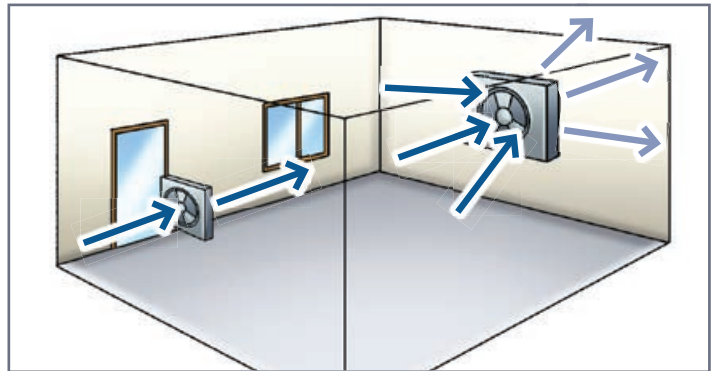
Positive pressure system

A positive pressure system blows more outside air into a building than it extracts, which creates a higher internal pressure than the outside air. This is typically used in warm/humid climates to reduce infiltration of unconditioned air getting into the building through envelope leakages, which also helps to stop hazardous airborne substances outside from entering a space/room.



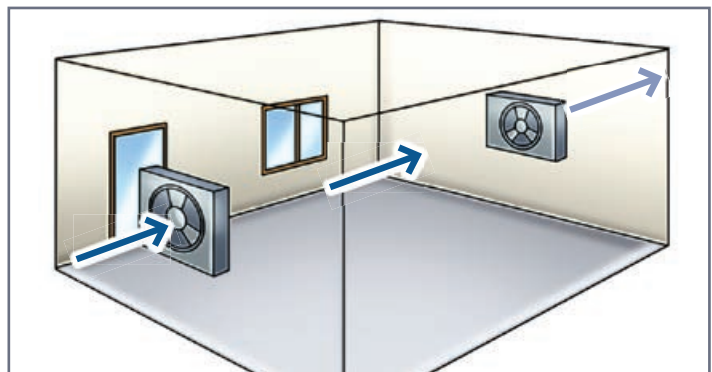
Negative (vacuum) pressure system

A negative (vacuum) pressure system extracts more internal air from the building than it blows in, which creates a lower air pressure inside the building than the outside air. This is typically used in colder climates to reduce exfiltration of unfiltered stale/contaminated air from getting out through envelope leakages.



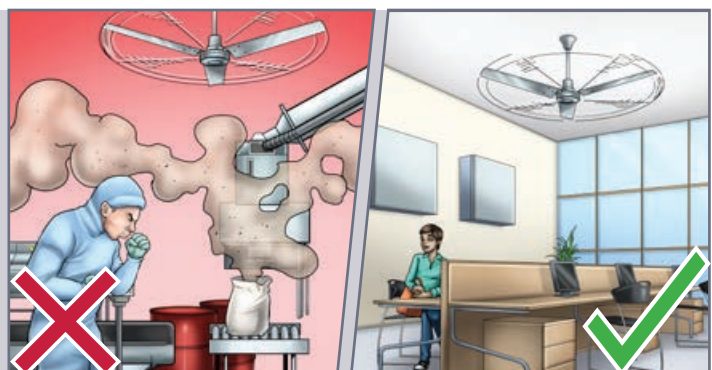
Balanced pressure system

A balanced pressure system is when the amount of air blown into a building or room is the same as the amount of air being extracted (air in = air out). The internal air will be at a similar pressure to the outside air, which reduces air infiltration and draughts. This system is ideal for use (with LEV) in areas where hazardous substances, such as chloroplatinates, are present.



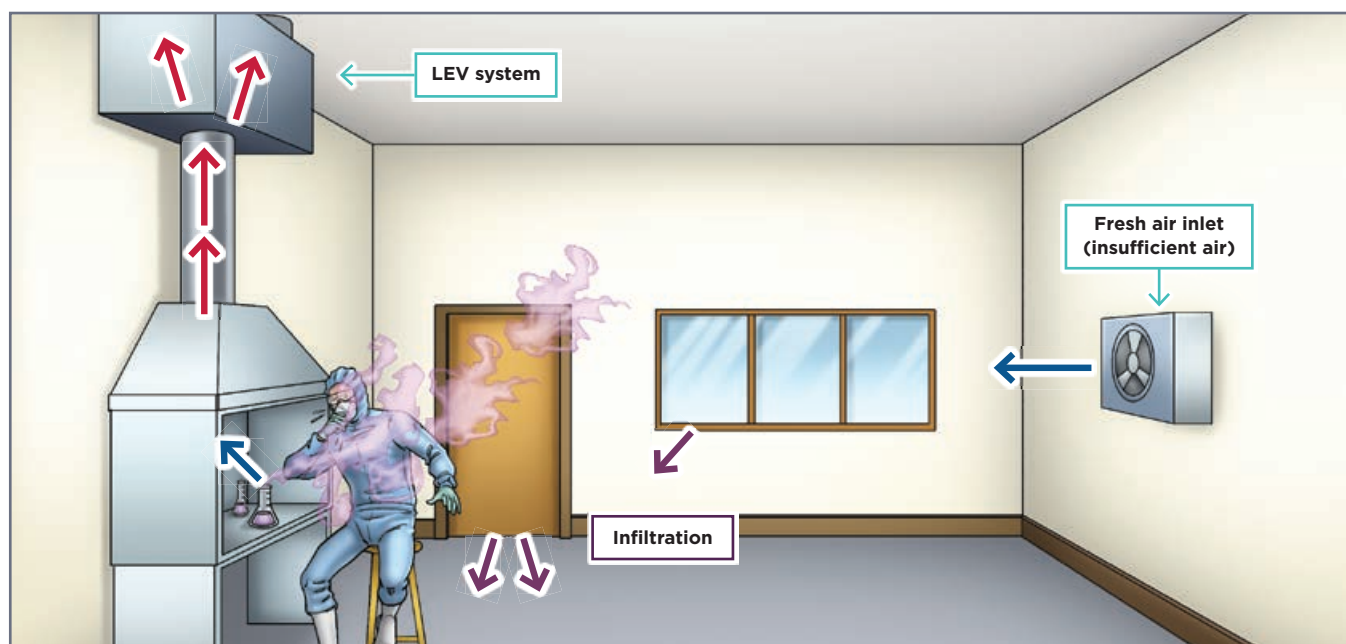
Distribution system

A distribution system uses a ceiling fan or wall-hung split unit air conditioner to create internal air movement, but does not introduce fresh air from outside. This type of system should not be used in areas where hazardous substances are handled or stored.

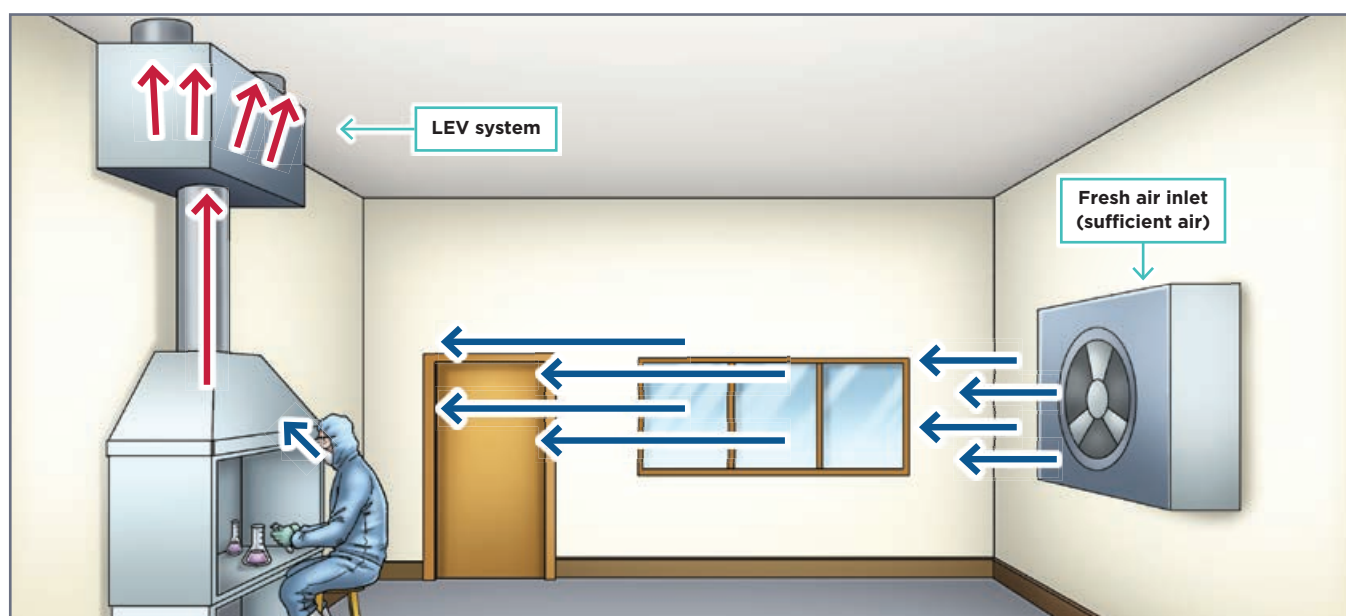


Fresh Air Ventilation Requirements

For a safe workplace, it's important to provide enough fresh air to replace the air that is being exhausted by a LEV system. If not enough fresh air is provided, the workplace may become "starved" of air, causing negative pressure, which will result in the LEV system removing less contaminated air, air entering the building through cracks around doors, windows, etc. and workers being exposed to uncontrolled contaminated air from adjacent operations.



To prevent negative pressure, the workplace should have enough fresh air from a separate intake fan located away from the exhaust fans.



The amount of fresh air needed will depend on the number of employees, the exhaust system, building layout, etc.

$$\text{Fresh Air Requirement} = \text{Number of Employees} + \text{Exhaust System} + \text{Building Layout}$$

The equation is represented by icons: a wind symbol for fresh air requirement, an equals sign, three human figures for the number of employees, a plus sign, a fan icon for the exhaust system, another plus sign, and a floor plan icon for building layout. Each of the three terms on the right side of the equation has a red question mark next to it, indicating that these factors are variables that need to be determined.

The movement of air within the workplace due to General Ventilation should not affect the comfort of workers. A minimum air velocity of 0.1 m/s is required, and the maximum should normally not exceed 0.5 m/s. The amount of outside air needed is measured in Air Changes per Hour (ACH), and the required ACH will depend on the size of the workplace, processes, and other factors.

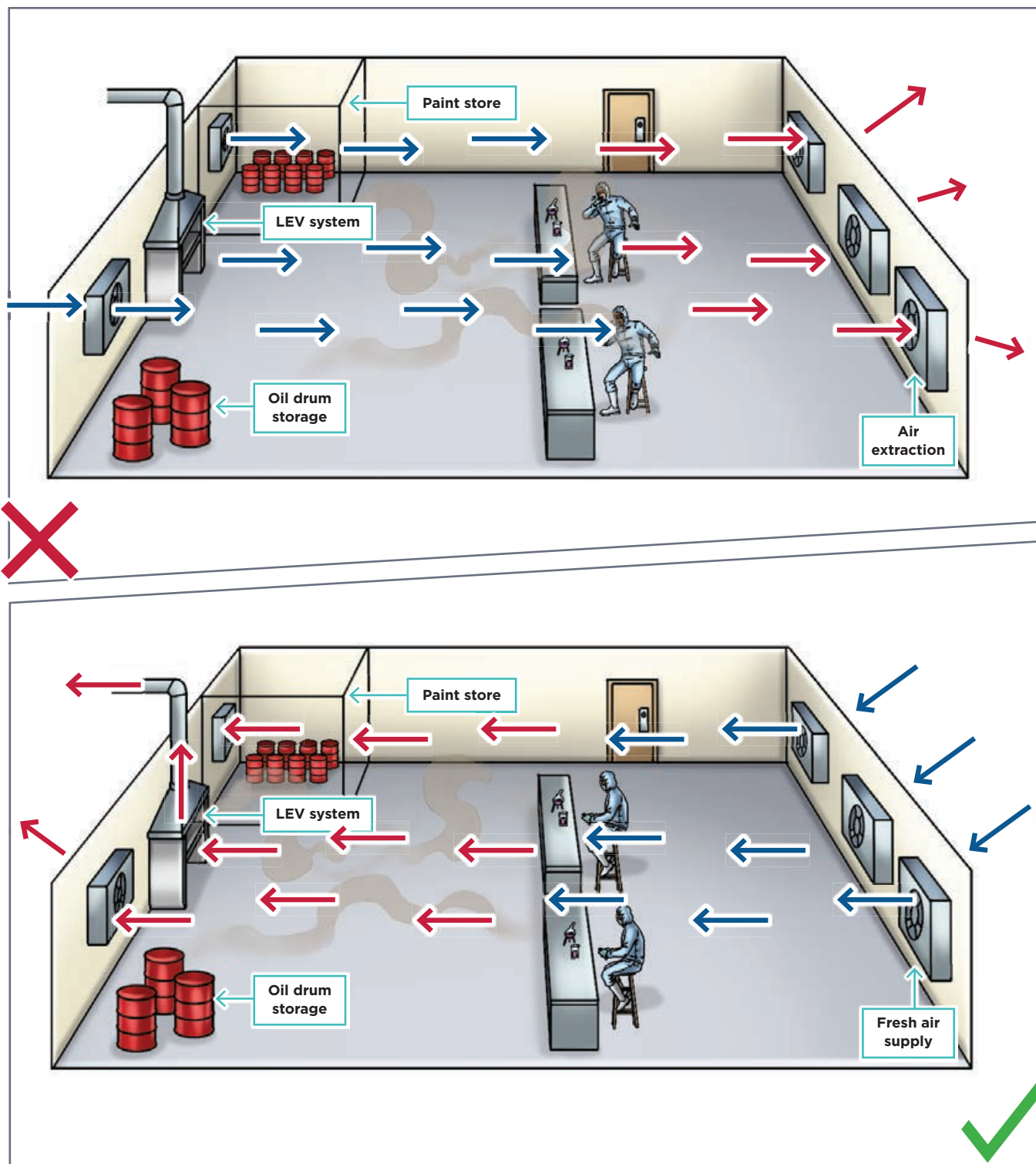
A designer may suggest lower or higher ventilation rates based on the owner's preference or specific ventilation needs associated with the space. However; it's important to determine the specific ACH requirements for the workplace.



Typical General Ventilation Layout

A good General Ventilation system uses inlet and extraction fans to provide fresh air to workers and carry contaminated air away from workers. It is therefore important to think about the location of sources of contamination, as well as the general ventilation system, when designing a building layout.

The air inlet and exhaust fans, including Local Exhaust Ventilation (LEV) systems, should be positioned so that the air flows from clean areas to dirty areas and is then removed.



Assessing General Ventilation Required in a Workplace

The ventilation requirements for a workplace should be determined by a qualified ventilation expert. Their assessment should consider the following elements:



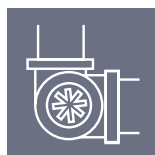
Workplace layout.



Thermal conditions.



Number of employees in the area.



Type and position of general ventilation system.



Sources of contamination in the area.



Any LEV systems in the workplace and their locations.

General Ventilation Requirements should be re-evaluated when alterations are made to the building. For example, if the building is expanded or an area is decommissioned, when additional LEV systems are planned to be installed, and when fan systems need to be replaced.

Ventilation surveys should be performed at least annually. You can use various techniques to assess the effectiveness of general ventilation, but here are some examples:

Use smoke tubes to visualise the pattern of air movement around the workplace in real time. You'll be able to see airflow patterns, "dead spots" or stagnant areas, areas with infiltration or exfiltration, etc.



No infiltration



Infiltration

Perform air pressure measurements to check if the air pressure is too high or too low, as well as help evaluate in-duct airflow and performance (how much air is being supplied and distributed throughout the area).



Negative pressure



Positive pressure

Measure air velocities (air movement) to compare minimum and maximum indoor air quality standards for comfort purposes, as well as to identify ventilation dead spots. Substandard LEV performance could mean substandard fresh air supply/general ventilation.



Low air movement

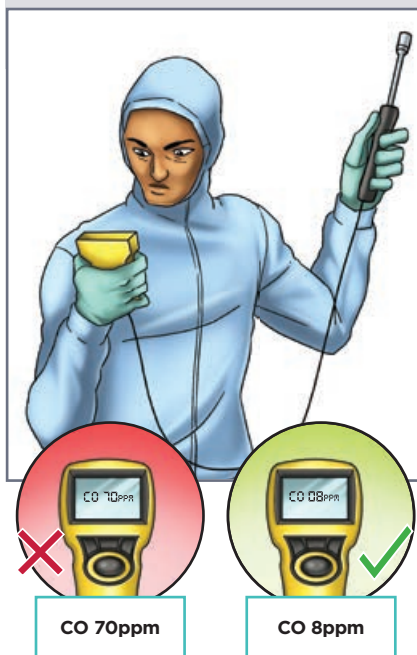


High air movement

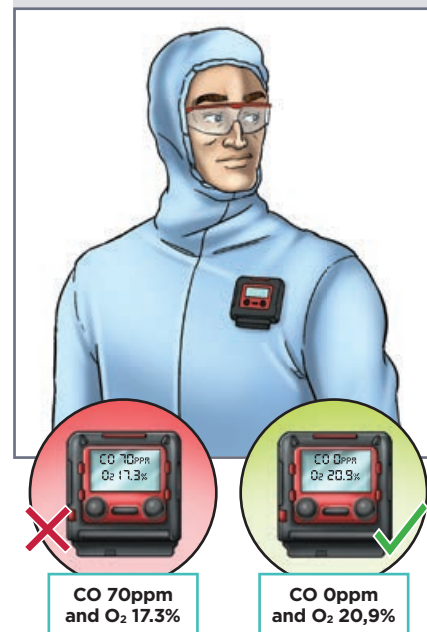
Use tracer gas to follow air movement through a building or to find out the air exchange rates by plotting the tracer gas's decay rate. This method can give valuable information, but specialised services and equipment are needed.



Perform indoor air quality surveys to determine carbon monoxide (CO), carbon dioxide (CO₂) and thermal conditions. This would assess the comfort level of an area and indicate areas with limited fresh airflow.



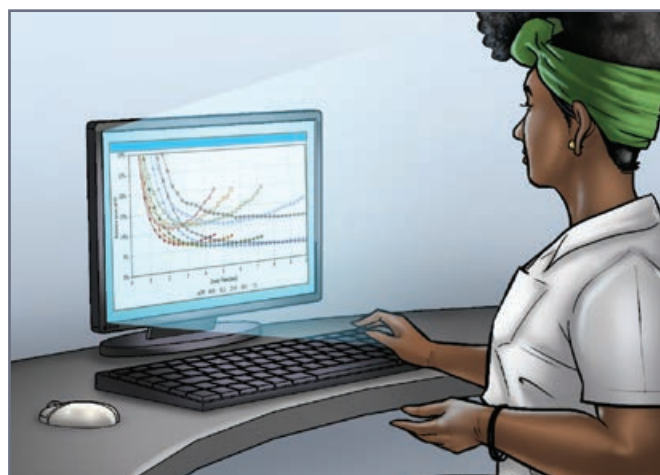
Monitor airborne contaminants using (static) and personal samplers. Some contaminants can be measured in real time (such as gas instruments or particle counters); others will need to be sent for analysis (such as platinum analysis).



You can also perform the following assessments for a more in-depth evaluation of the general ventilation system, but specialised services and software will be needed:



- Supply and exhaust fan inspection and performance measurements (using airflow monitoring equipment).
- Duct inspections and airflow/airflow distribution measurements (using velocity and pressure measurement equipment, as well as smoke tubes).



- CFD (Computational Fluid Dynamics) simulation of general ventilation airflow conditions (where the age of air can be determined).
- Conduct static airborne contaminant sampling and correlate the results with the 'age of air' to determine the ventilation required to prevent exceeding an Occupational Exposure Limit (OEL).

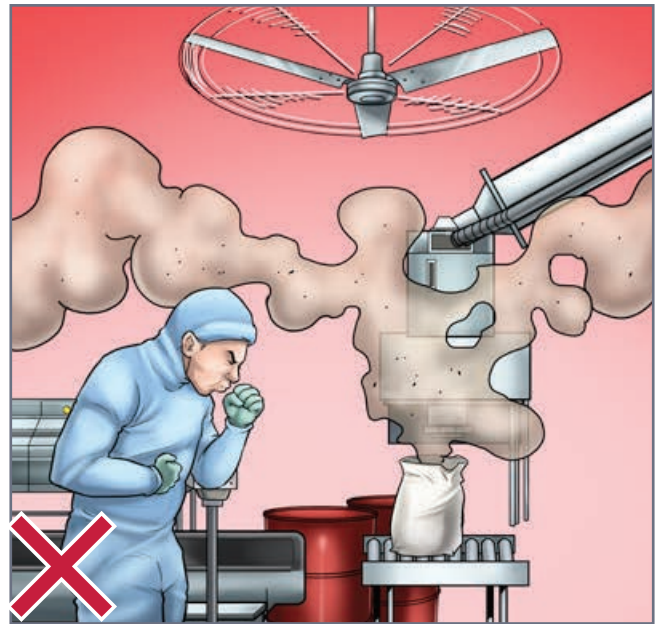
General Ventilation Limitations

In a controlled office environment, General Ventilation alone is normally sufficient to maintain air quality.

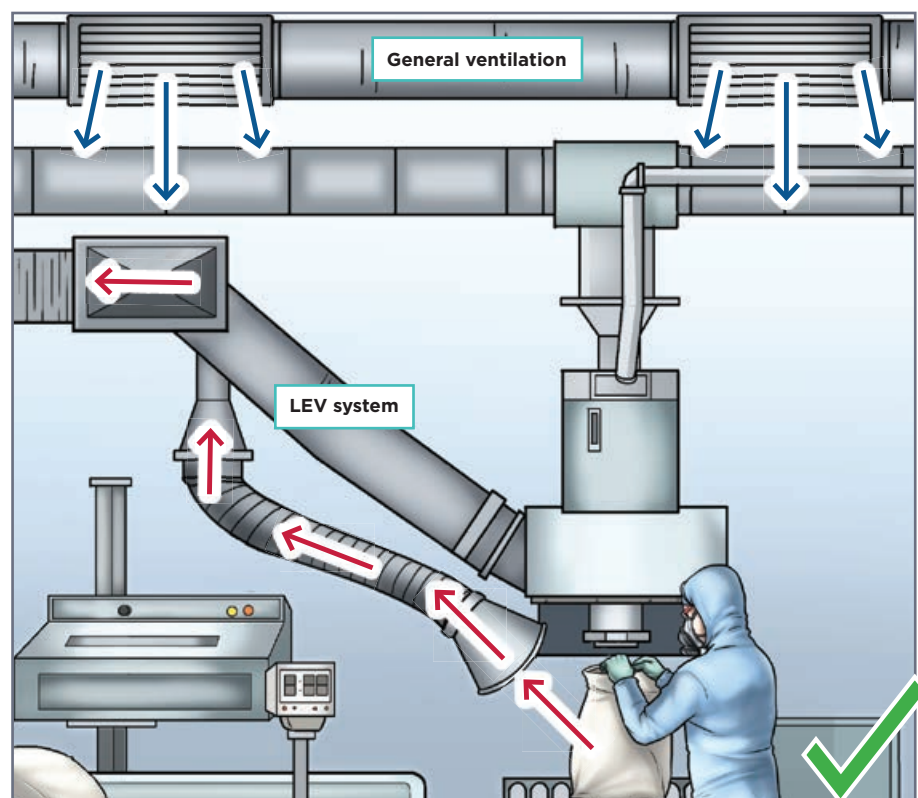


However, in a PGM processing environment, general ventilation should not be used as a primary control because it:

- Doesn't remove contaminants completely
- Can't be used for highly toxic or highly potent chemicals
- Is ineffective against dusts or metal fumes large amounts of gases or vapours
- Requires a lot of makeup air

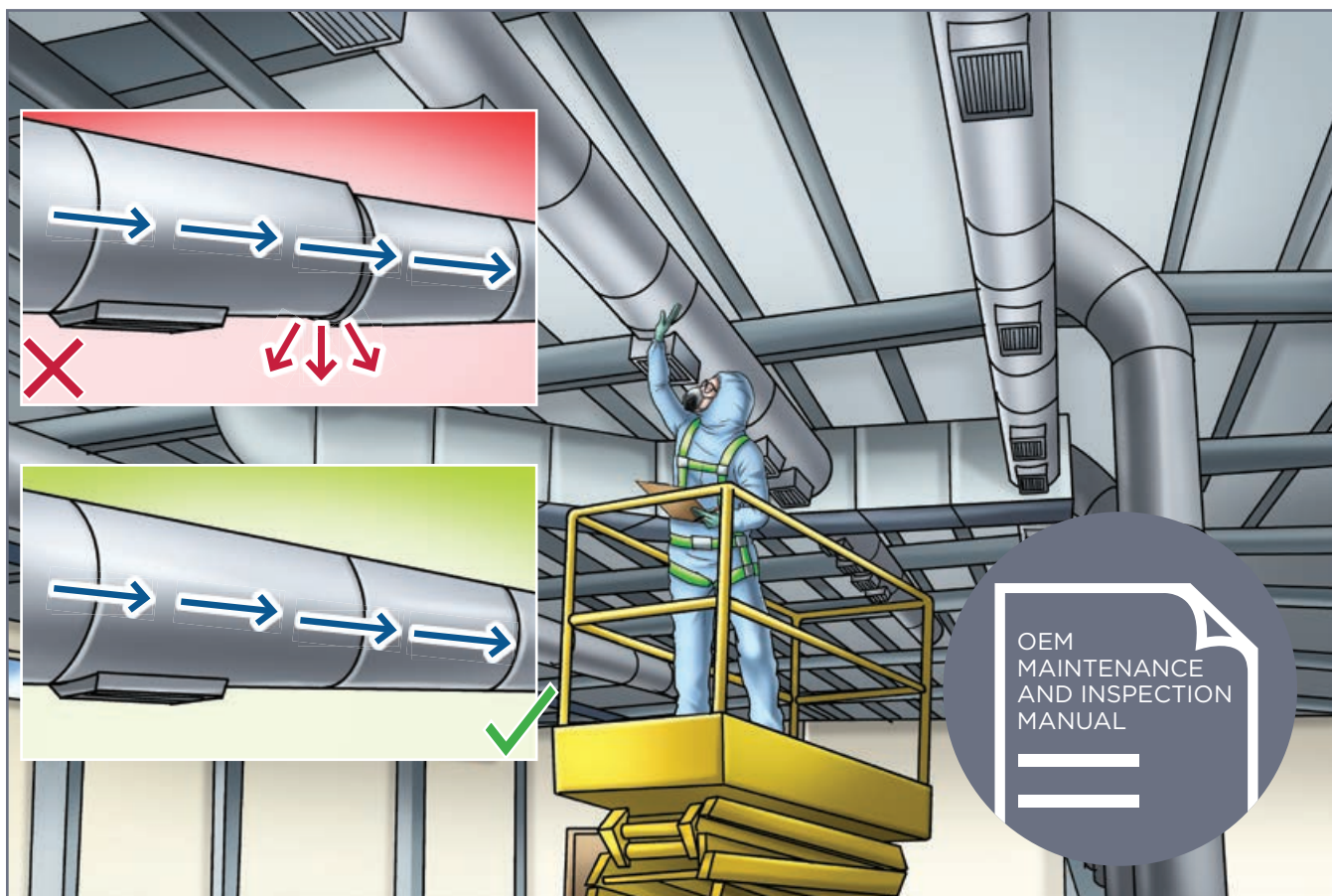


Instead, General Ventilation should be used with LEV systems to achieve a balanced system and protect workers. The amount of air extracted by the LEV systems will affect the general ventilation needed.



Maintaining Mechanical Ventilation Systems

It's important to regularly clean, maintain, and test mechanical ventilation systems, including air conditioning systems, to ensure they are functioning properly. The manufacturer or supplier should provide information on how to maintain the system, and regular inspections should be done to check all parts, including fans, vents, ductwork, air filters and sensors, are working and free of debris.

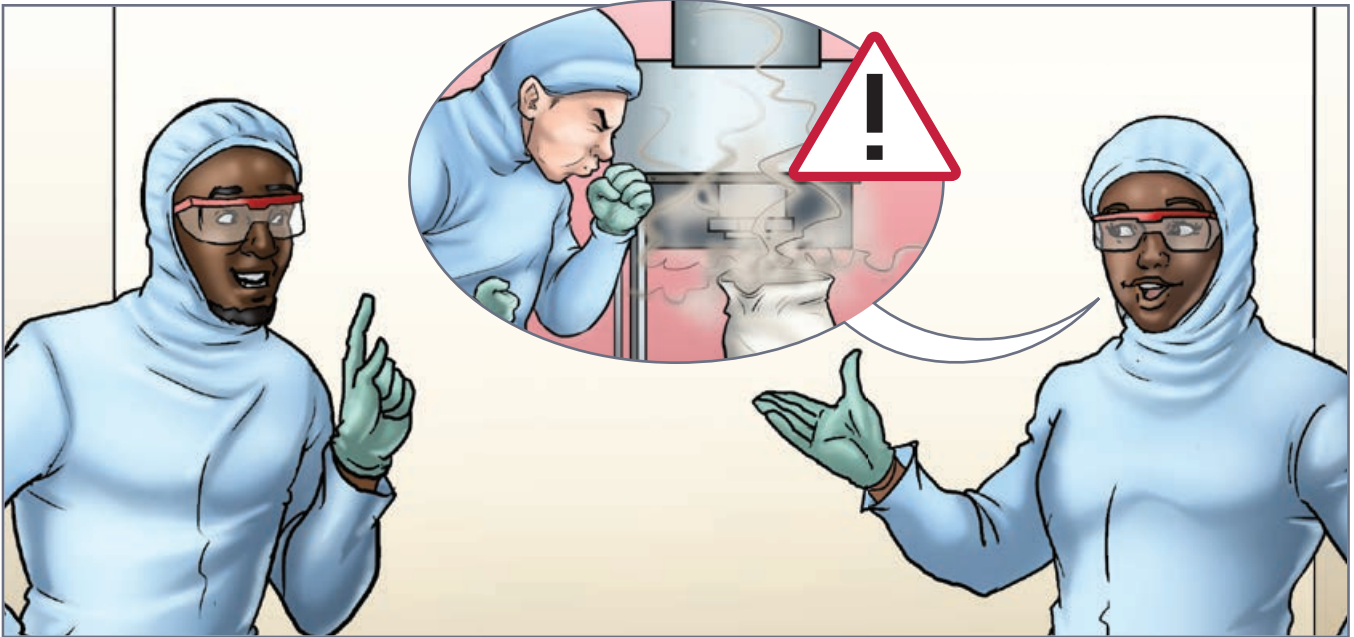


The frequency and method of maintenance will depend on the building's use (including a risk-based consideration of any chemicals used), the type of ventilation system, regulations, and guidance from the manufacturer or supplier. This should be considered in the design phase to make sure all parts can be easily accessed for inspection. In addition to planned maintenance, rectification of systems should be performed after a ventilation assessment. Real-time technology, such as pressure gauges, can also be used to indicate when maintenance is needed.

Although Ventilation Systems should not become contaminated when working properly, maintenance work should consider potential chemical exposure risks to both maintenance workers and others. The effect of turning off the ventilation system and the risk this may pose to those in the building must also be considered. Planned maintenance should be conducted when there are no other workers inside the affected area.

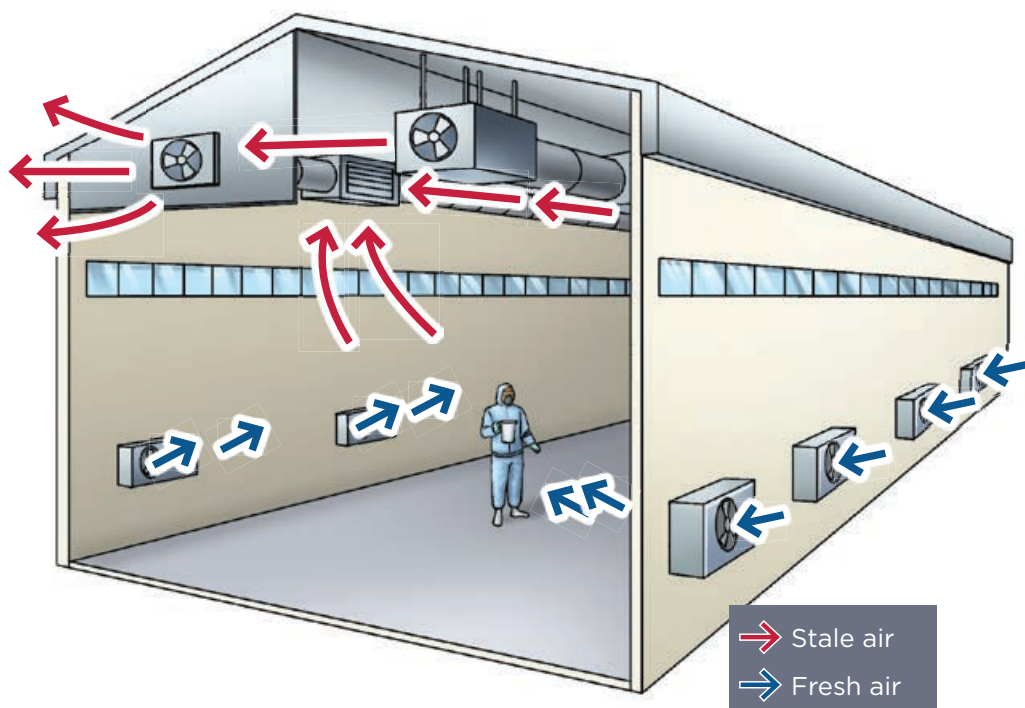
Ventilation System Failures

If a ventilation System Fails or is not working correctly, the potential risks to workers should be immediately assessed and action taken as necessary to protect worker health while an action plan is drawn up to fix the ventilation system.



General Ventilation Summary

General Ventilation is important for a healthy work environment, but it can only be used as the main control in limited areas, like offices. In the PGM processing industry, it will only play a supporting role in the larger ventilation system. The amount of fresh air needed will depend on the activities and processes in the area. To maintain the performance of the extraction systems, like LEV, a balanced ventilation system is necessary, where the extracted air is replaced by a fresh air supply.



Audit Questions

This section provides example lists of 'Go/No Go' questions that could be implemented as part of job risk assessments and operational documents to help manage General Ventilation as a critical control for controlling exposure to chemicals that cause platinum sensitisation. Example lists of 'Go/No Go' questions are provided for Superintendents, Managers, Maintenance/Engineering and Industrial/Occupational Hygienists responsible for installing new equipment and processes. Please refer to the list of questions for the role that most aligns with your role and responsibilities. The question lists are intended to verify that appropriate systems, processes and checks are in place to ensure General Ventilation as a critical control is effective. This includes empowering workers to stop work or not begin a task if a problem is identified.

These question lists are provided as examples. Implementation of such a scheme and the specific questions that would be most appropriate may differ between different companies and sites. Questions should be appropriate and understandable to their target audience and ideally be binary ('Go/No Go'). In implementing such a scheme, consideration should be given to when and how often it is appropriate to ask and answer individual questions. For some questions, such as those relating to checks performed by Operators, it may be appropriate to ask and answer the question each time before commencing a task that uses the critical control to help control exposure to chemicals that cause platinum sensitisation. For other questions, it may be more appropriate to schedule them for daily or weekly checks, while others, such as most of the questions intended for Managers, would be more suitable for attention perhaps quarterly or annually.



Superintendents

How to use this guide:

- Review each critical control's effectiveness, at their specified frequency, using the questions below.
- If you answer NO to any of the questions, immediate action must be taken to inform your line management to find a suitable temporary fix or permanent solution.
- Communicate this Good Practice Guidance and Audit Questions to Operators and other relevant staff and contractors.

Managing general ventilation systems or components as a Critical Control

1. Inspections and maintenance

Is the ventilation system being inspected according to a schedule to ensure that it is functioning as intended and that all components are free of debris and in good condition?

☐ YES☐ NO

Is the ventilation system being tested and maintained in accordance with manufacturer specifications and industry standards?

☐ YES☐ NO

2. Training

Are the workers being provided with adequate information about the ventilation system and its operation?

☐ YES☐ NO

Are the workers being encouraged to report any concerns or incidents related to the ventilation system or workplace environment?

☐ YES☐ NO

Are the workers aware of emergency procedures in the event of an exposure incident or malfunction of the ventilation system?

☐ YES☐ NO



Manager

How to use this guide:

- Review each critical control's effectiveness, at their specified frequency, using the questions below.
- If you answer NO to any of the questions, immediate action must be taken to find a suitable temporary fix or permanent solution.
- Communicate this Good Practice Guidance and Audit Questions to Superintendents, Operators, Maintenance/Engineering, and Industrial/Occupational Hygienists and/or EHS team members.

Managing general ventilation systems or components as a Critical Control

1. Design and installation

Is the ventilation system designed to meet the specific needs of the building and its occupants?

☐ YES☐ NO

Is the ventilation system installed according to manufacturer specifications and industry standards?

☐ YES☐ NO

Have the general ventilation requirements been assessed by a suitably-qualified expert within the last 12 months and since any changes to the chemical processes or LEV systems have been made that might affect general ventilation requirements?

☐ YES☐ NO

2. Inspections and maintenance

Has the general ventilation system been assessed by a suitably-qualified expert and confirmed to be performing to the latest ventilation requirements?

☐ YES☐ NO

Are inspections and maintenance being carried out according to a schedule to ensure the continued performance of the ventilation system?

☐ YES☐ NO

3. Training

Are superintendents and operators trained to ensure the ventilation system is being operated and controlled in a manner that ensures optimal indoor air quality for building occupants?

☐ YES☐ NO



Maintenance/Engineering

How to use this guide:

- Review each critical control's effectiveness, at their specified frequency, using the questions below.
- If you answer NO to any of the questions, immediate action must be taken to inform your line management to find a suitable temporary fix or permanent solution.

Managing general ventilation systems or components as a Critical Control

1. Design and installation

Have I ensured that the ventilation system is designed to meet the specific needs of the building and its occupants?

☐ YES☐ NO

Is the ventilation system installed according to manufacturer specifications and industry standards?

☐ YES☐ NO

Have the general ventilation requirements been assessed within the last 12 months and since any changes to the chemical processes or LEV systems have been made that might affect general ventilation requirements?

☐ YES☐ NO

When designing a new ventilation system or changing an existing system, are the maintenance requirements of the ventilation system being considered and planned for in the design phase to ensure that all components can be easily accessed for cleaning or inspection?

☐ YES☐ NO

2. Inspections and maintenance

Have I assessed the general ventilation system to confirm it's performing to the latest ventilation requirements?

☐ YES☐ NO

Are inspections and maintenance being carried out according to a schedule to ensure the continued performance of the ventilation system?

☐ YES☐ NO

Is the ventilation system being cleaned and tested according to a schedule to ensure that it is functioning as intended?

☐ YES☐ NO

2. Inspections and maintenance (continued)

Do I ensure that the inlet and outlet fans, vents, ductwork, air filters, and sensors are free of debris and functioning properly according to a schedule?

☐ YES☐ NO

Is the volume of fresh air being supplied to the building enough for the activities and processes taking place?

☐ YES☐ NO

Is the ventilation system balanced, with the volume of extracted air being readily replaced by a fresh air supply?

☐ YES☐ NO

3. Training

Are the engineering personnel tasked to perform the inspections, maintenance and cleaning of the general ventilation systems trained to do so in a safe manner?

☐ YES☐ NO



Industrial/Occupational Hygienists

How to use this guide:

- Review each critical control's effectiveness, at their specified frequency, using the questions below.
- If you answer NO to any of the questions, immediate action must be taken to find a suitable temporary fix or permanent solution.
- Communicate this Good Practice Guidance and Audit Questions to all relevant staff, including Managers, Superintendents, Operators, and Maintenance/Engineering.

Managing general ventilation systems or components as a Critical Control

1. Design and installation

Are the maintenance requirements of the ventilation system being considered and planned for in the design phase to ensure that all components can be easily accessed for cleaning or inspection?

☐ YES☐ NO

Have I assessed the general ventilation requirements within the last 12 months and since any changes to the chemical processes or LEV systems have been made that might affect general ventilation requirements?

☐ YES☐ NO

2. Inspections and maintenance

Have I assessed the general ventilation system to confirm it's performing to the latest ventilation requirements?

☐ YES☐ NO

Are regular inspections and maintenance being carried out according to a schedule to ensure the continued performance of the ventilation system?

☐ YES☐ NO

Is the ventilation system being cleaned and tested according to a schedule to ensure that it is functioning as intended?

☐ YES☐ NO

2. Inspections and maintenance (continued)

Is the volume of fresh air being supplied to the building enough for the activities and processes taking place?

YES

NO

Is the ventilation system balanced, with the volume of extracted air being readily replaced by a fresh air supply?

YES

NO

3. Training

Are the employees tasked with testing the ventilation system and/or taking ventilation measurements adequately trained to do so?

YES

NO

Additional Resources

- ACGIH (1998) Industrial Ventilation: A manual for recommended practice 23rd Edition.
- Nims, D.K. (1999) Basics of Industrial Hygiene: Preserving the legacy.
- HSG 202 (2000) General Ventilation in the Workplace: Guidance for employers.
- OHTA (2009) Control of Hazardous Substances (p 121 to 127)
- ASHRAE, ANSI/ASHRAE Standard-62.1-2019: Ventilation for acceptable indoor air quality, Atlanta, 2019.
- South African Bureau of Standards (SABS), SANS 10400 Part 0 – National Building Regulations and Building Standards, 2011.

Annexure I

Calculating Dilution Ventilation for Health Protection

Using dilution ventilation for controlling exposures to highly toxic materials is not recommended. Dilution ventilation is often used to control vapours from organic liquids with a TLV of 100 ppm or higher.

Example:

When a chemical is first released at a constant rate into a ventilated workroom there is a gradual concentration build-up until a steady-state equilibrium is reached. At this concentration, the emission rate and removal rate are in equilibrium, so the concentration remains more or less constant.

The amount of dilution airflow required depends on the:

- | | |
|--|--|
| • Physical properties of the contaminant | • The overall safety factor (K_f) |
| • Molecular weight | • K_f normally ranges from 3 to 10 depending on the overall effectiveness of the ventilation system and uniformity of contaminant evolution. A higher K_f value is associated with poor airflow conditions or circumstances that could increase worker exposures |
| • Specific gravity | |
| • Rate of contaminant release | |
| • Target airborne concentration (usually PEL or TLV) | |

An example equation for calculating the steady-state dilution airflow rate for less toxic or irritating contaminants is:

$$Q = \frac{403 \cdot \text{sp.gr.} \cdot W \cdot K_f \cdot 1,000,000}{M \cdot L}$$

Q	=	dilution airflow (ft. ³ /min.)
sp.gr.	=	specific gravity of liquid
W	=	amount of liquid used or released (evaporated) (pints/min.)
M	=	molecular weight of contaminant
L	=	target airborne concentration to be maintained (PEL, TLV, OEL) (ppm)
K_f	=	dimensionless safety factor

Various equations can be used to determine the required dilution airflow
- see *ACGIH Industrial Ventilation: A manual for recommended practice*

Notes

