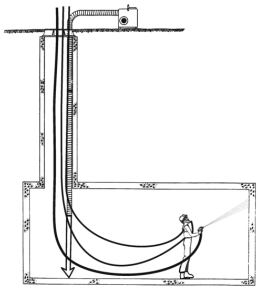
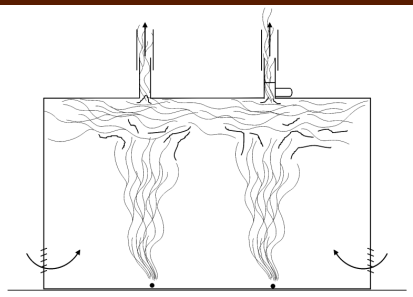
VENTILATION TECHNIQUES

1 Supply Ventilation: Dilution

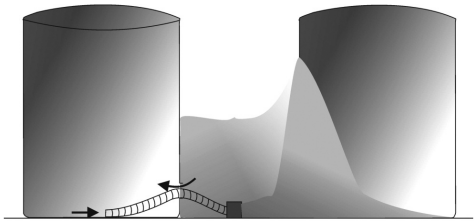


Adapted from WCB (BC)

2 General Exhaust Ventilation



3 Short-Circuiting



Clearing the air in construction

Simple ways to improve air quality and worker safety

By Neil McManus

A construction site is a rough and tumble, ever-changing environment. It embodies a culture of rugged individuals who pride themselves on their toughness in often hostile work environments which brings about hidden costs.

Jobsites expose workers to atmospheric health hazards such as solvent vapors from coatings, sealants and adhesives; mist from sprays; and dust from handling powdered materials, cutting, grinding, abrasive blasting and other sources. Gases and particulates in exhaust from engine-powered vehicles, mobile and portable equipment are ever-present hazards on jobsites.

Exhaust from internal-combustion engines contain a host of chemicals that are bad for humans. Gasoline engines produce more carbon monoxide than diesels, but diesels produce very odorous substances and particulates that are associated with respiratory diseases, including lung cancer.

Vehicle exhaust is less of a problem when catalytic converters and other pollution controls are used. However, small engines used in generator sets, pumps and other portable units that aren't fitted with catalytic converters are major sources of exhaust gases that can

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endanger workers.

Engine emissions are a big problem in structures where the building's geometry and lack of natural airflow prevent air exchange and dispersion. Small engines that are poorly maintained or operated until the engine or the driven component fails can expose workers to high levels of deadly exhaust gases.

Exposure and foolishness

Exhaust emissions from engines are complex mixtures of substances. Gases, such as carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO2) and sulfur dioxide (SO2), are easily measured but provide only a small picture of what is present in the exhaust plume.

In view of the known and suspected health concerns about exhaust gases, accepting exposure as part of the job or the culture of this industry is downright foolish. Exposure prevention is relatively easy to do and requires only a little knowledge, slight modification to the way things are done, and determination to make it happen.

Reducing needless exposure takes management and supervisory commitment. They are in the best position to learn early on about problems and have the resources that can affect the appropriate changes.

Managing exhaust

The location and direction of exhaust gas discharge from mobile and portable equipment can greatly affect anyone on the jobsite.

Because exhaust gas is hotter than the jobsite air, it tends to rise until it loses buoyancy as it cools to the ambient temperature. It can rapidly lose heat as it exits the engine's smokestack, especially in cooler weather. This can cause the exhaust plume to hang at fairly low levels.

Exhaust emits from an engine stack like a jet, projecting forward at a 22-degree angle. As the exhaust jet moves forward through space, it loses energy to the surrounding air. Velocity decreases to 10 percent of emission velocity at 30 diameters from the source in air of the same temperature. Idling engines create a greater likelihood of exposure at lower heights because the exhaust has little velocity compared with exhaust from engines operating under load.

Engine emissions are a big problem in structures where the building's geometry and lack of natural airflow prevent air exchange and dispersion.

Collecting gases at the source works with fixed sources, but isn't feasible for mobile and portable construction equipment. However, there are some simple strategies that can be applied in these situations.

Directing emissions away from workers can help control exposure. Most vertical stacks on trucks discharge horizontally. This prevents rain from getting into the exhaust system, but considerably reduces the energy of the exhaust discharge. The exhaust rapidly loses its velocity and its buoyancy, so the exhaust plume is lower in the air, likely in workers' breathing zone.

Vertical exhaust designs can minimize exhaust exposure, but this depends on the discharge height. It's best to position exhaust stacks at 8' or higher. That puts exhaust at a height greater than even the tallest basketball player, keeping exhaust emissions above the breathing zone.

Unfortunately, exhaust discharge of most portable and mobile equipment is well below the 8' level, so it must be actively addressed and managed on jobsites.

A stack extension can solve this safety hazard and can be built from readily available materials, such as flexible exhaust piping, a downspout and elbows, spiral-wound duct or spiral-wound sheathing (minus the black plastic cover) used in 480- and 600-volt armored cable.

Temporary stacks work best in open areas where the wind disperses the exhaust. Temporary stacks are only partially effective in below-grade locations or inside buildings or structures. Without a mechanism to force contaminated air to rise to the roof space or to the top of a structure, the gases will remain at the height at which they lose buoyancy.

Wind blowing through open doors or partially constructed walls can effectively purge the air space within the building envelope. However, wind can change in magnitude and direction as the day goes on, especially near large bodies of water or mountainous areas. If wind is used to move exhaust gases, its changing nature must be accommodated to assure worker safety.

Heated air can carry exhaust out of the building. As heated air rises, it creates a buoyant upward force. Be aware that cold air in the roof space can push exhaust downward. So ensure contaminated air rises and discharges at a height greater than the height of the people on the jobsite through known openings in the roof. Pay special attention to workers on ladders or in mobile personnel lifting equipment to assure they are not working where the air may be contaminated.

Take an active approach

Even with exhaust extensions or active air exchanges within a building, some situations require more aggressive intervention with

Photo: Neil McManus

portable ventilation equipment such as bare fans and fan-duct combinations. These can be powered by an engine, electricity, compressed air or hydraulics, but beware that exhaust gases from an engine-powered fan can be sucked into the air supply if it is set up improperly.

Fans create air displacement and dilution. Displacement is useful in ventilating excavations with portable and mobile equipment operations. Supplying air to the bottom of the excavation forces air in the space to rise to the top, effectively flushing the airspace.

Displacement can also be used to force exhaust gases to the top of the roof space, above the work environment.

Dilution can reduce the level of emission from coatings applied to surfaces and during spraying. Dilution is a random process, whereas displacement is directed and disciplined. Dilution does not prevent exposure; it merely reduces concentration. Unlike dilution, displacement can prevent exposure.

The primary modes of air removal are either general and local exhaust systems. General exhaust systems are used in asbestos, lead and mold abatement operations. They maintain the work area under negative pressure and entrain air from the surroundings into the temporary enclosure.

Local exhaust equipment collects emissions at its source and works best with fixed sources with well-defined characteristics of emission. These units are best suited to handle emissions from welding, but collecting welding emissions in the construction environment can be very difficult.

ANSI Z9.9 is coming

Creating a successful application of portable ventilation equipment for a specific problem requires knowledge, expertise, experience, and creativity. Presently, there is no single standard to which contractors can refer for best-practice information.

That's about to change with the ANSI Z9.9 standard on portable ventilation systems, which is expected to be available by Summer 2008. It will provide guidance to designers, manufacturers and end-users of portable ventilating equipment to help assure safer, healthier respiratory environments. ◙

Editor's note: Neil McManus is an industrial hygienist with almost 30 years of experience providing practical, cost-effective solutions to complex problems. He is the Chair of the ANSI Z9.9 Committee on Portable Ventilation Systems and the author of the draft standard.