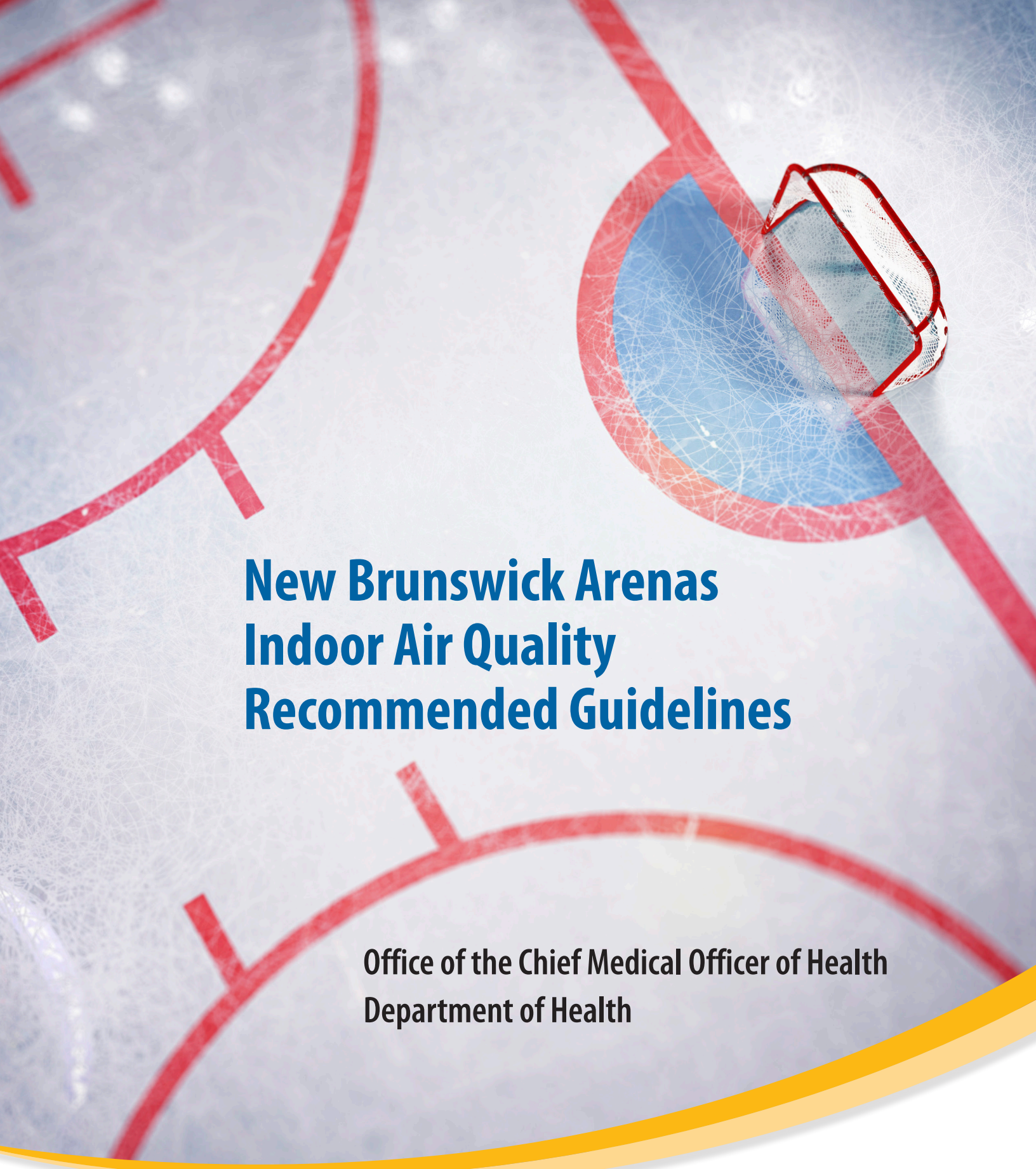

# New Brunswick Arenas Indoor Air Quality Recommended Guidelines

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# Foreword

Arenas are buildings in which an artificial ice environment is created for users to improve physical fitness, to compete, or for entertainment. Owners and operators are responsible to maintain a safe environment inside the facility for the general public and for their staff. Maintaining the best possible air quality and a safe environment will help prevent illnesses among arena users. The purpose of these guidelines is to provide Public Health recommendations for limiting public exposure to indoor carbon monoxide (CO) and nitrogen dioxide ($NO_2$). **These guidelines do not supersede or circumvent any legislation within the Province of New Brunswick.**

# Introduction

Incidents have been reported in arenas where people who participate in sport-related activities experience varying degrees of symptoms related to indoor air quality. The symptoms are often caused by air contaminants generated by gasoline, propane, diesel and natural gas engines. Past experience has shown that a large number of people could be affected by each exposure incident.

Incidents of poor air quality are more likely to happen during tournaments or weekends when the ice is used continuously and ice maintenance is more frequent. Special activities such as motorcycle races, big trucks events or tractor pulls can also expose participants and spectators to high levels of air contaminants.

The major air contaminants of concern are carbon monoxide (CO) and nitrogen dioxide ($NO_2$). The amount in the air of each of these contaminants depends upon the fuel used, how well the engine works, how much ventilation there is inside the arena and the frequency of use.

Two pieces of equipment are largely responsible for poor air quality in arenas during fall, winter and spring: the ice resurfacer and the edger. Air tests in Canadian arenas have shown that there could be high levels of CO and $NO_2$ in the air after the ice has been cleaned and flooded. In high concentrations, CO and $NO_2$ are dangerous. They can cause illness, coma and even death.

The use of the resurfacer and edger is generally confined to certain areas of the building (skating rink and equipment storage area). CO and $NO_2$ will therefore likely be in higher concentrations in those areas. It is still possible for other areas such as locker rooms to contain high levels of CO and/or $NO_2$.

Participants and spectators can spend from one hour to several hours in the facility depending on the activity.

**How fast and how sick someone will become with CO and $NO_2$ will be worse if the person:**

- is physically active (i.e. skating),
- is a child or elderly,
- or has illnesses such as asthma or heart disease.

# Carbon Monoxide (CO)

Carbon monoxide does not have any color, smell, nor taste. It can be produced in large quantities by the combustion of fuel such as gasoline, propane, diesel or natural gas. CO makes the blood less capable to carry oxygen.

At low levels, CO is reported to result in reduction in balance and vision. It may cause headache, fatigue, shortness of breath and impaired movements. These symptoms sometimes feel like the flu. An affected person may not notice these changes, but the exposure can still lead to falls. Individuals with pre-existing lung or heart disorders may be more sensitive to the effects of CO.

At higher levels, headaches are reported more frequently. Depending on the duration of exposure and the intensity of physical activity, symptoms can progress from headaches and drowsiness to rapid breathing, nausea, and vomiting. Coma and death can even occur at higher levels.

| **Carbon monoxide (CO) levels and relative effect on the body** | |
|---|---|
| 12.5 ppm | Recommended maximum level in arenas. |
| 20 ppm and above | Reduction in sense of balance and vision. Impaired movements and flu-like symptoms. |
| 50 ppm and above | Headaches, drowsiness, nausea and vomiting. |
| Above 500 ppm | Possible coma and death. |

## Sources of carbon monoxide are mostly:

- the ice resurfacer,
- ice edger,
- improperly vented gas fired infrared radiant heaters,
- special event equipment (motorcycles, monster trucks, tractor pulls, ATV races, etc.),
- vehicles idling in the parking facilities in close proximity to the building.

# Nitrogen Dioxide ($NO_2$)

When diesel engines are used in place of propane or gasoline, $NO_2$ rather than carbon monoxide tends to be the contaminant of most concern.

At low levels, people with asthma have increased reaction, with typical symptoms of cough, wheezing and shortness of breath.

At higher levels, it can be irritating to the eyes, nose and throat.

At even higher levels, more severe symptoms can develop such as inflammation of the lungs. Individuals with pre-existing lung disorders, such as asthma, may be more sensitive to the effects of $NO_2$.

| **Nitrogen Dioxide ($NO_2$) levels and relative effect on the body** | |
|---|---|
| 0.25 ppm | Maximum levels recommended in arenas. |
| 0.25 – 3ppm | Increased asthma, cough, wheezing, shortness of breath. |
| 5 ppm | Can be smelled. |
| 15-25 ppm | Eye, nose and throat irritation. |
| Above 25 ppm | Inflammation of the lungs. |

## Sources of nitrogen dioxide are mostly:

- the ice resurfacer (mostly diesel),
- special event equipment (motorcycles, monster trucks, tractor pulls, ATV races, etc.),
- vehicles (such as buses or trucks) idling in the parking facilities in close proximity to the building.

### Effects of CO and $NO_2$ are acute

This means that the effects of the exposure to elevated CO and $NO_2$ will appear immediately or shortly after the exposure occurs.

# Recommended Maximum Levels of Exposure

The following recommended maximum levels of exposure to CO and $NO_2$ have been established based on a review of similar criteria in other jurisdictions and research conducted in arenas.

1. The **CO** level should **not exceed 12.5 ppm at the ice level** while it is used by the public:
    - Levels above 12.5 ppm of carbon monoxide can affect vision and balance causing users and mostly children to have serious accidents while skating.
2. The **$NO_2$** level should **not exceed 0.25 ppm at ice level** while it is used by the public:
    - Levels above 0.25 ppm of $NO_2$ can result in increased breathing difficulty, especially for those with asthma.

If the CO and $NO_2$ levels are exceeded, the following actions should be carried out:

- ✓ All activities should be stopped.
- ✓ The building should be ventilated.
- ✓ A re-sample should be carried out before activities resume.
- ✓ The source of air contaminant should be identified and control measures should be undertaken without delay (see Control Measures section, page 8).

## Important Note:

All facility staff should become familiar with the symptoms associated with exposure to CO and $NO_2$. Early detection of an air quality problem may prevent a serious situation from getting worse.

Incidents among skaters or spectators that are similar to those caused by CO and $NO_2$ should lead to the following actions:

- ✓ All activities should be stopped.
- ✓ The building should be cleared of occupants if necessary.
- ✓ Affected individuals should be advised to seek medical attention.
- ✓ The building should be ventilated.
- ✓ Air sampling should be done.
- ✓ The incident should be reported to the Emergency Services (911) and to the Regional Public Health office. (The process to follow and phone numbers are available at the end of this document.)
- ✓ The source of air contaminant should be identified and control measures should be undertaken without delay (see Control Measures section, page 8) and completed prior to the public returning inside the building.

Increased vigilance, including monitoring is recommended during special events when equipment that could emit CO and/or $NO_2$ is in heavy use.

# Steps to Follow for Good Air Quality

To protect everyone in an arena, it is important that steps be taken to control air quality. The following are the best safety practices to provide a healthy arena environment:

- Control measures:
    a. Substitution of combustion source,
    b. Modifications to existing equipment,
    c. Maintenance,
    d. Ventilation.
- Air Quality Testing,
- Training.

A safety barrier (the boards with clear plexiglass) generally surrounds the ice in order to provide a measure of safety for spectators when hockey is played. The boards and plexiglass allow for a space where there is little air movement. Exhaust gases are trapped by the boards and plexiglass and remain undiluted near the ice due to the lack of air movement.

# Control Measures

The main sources of combustion gases in ice arenas are from gasoline, propane, natural gas or diesel operated ice resurfacing machines and ice edgers.

Reduction in exposure to combustion air contaminants can be achieved by several means, some of which are:

1. **Substitution of combustion engines:**
    a. Replacement of gasoline or diesel equipment with propane or natural gas is a good step to reduce CO and $NO_2$.
    b. Replacement of existing gas/propane equipment with electric powered equipment should eliminate most air quality problems. Electrical resurfacers are now available.
2. **Modifications to existing equipment:**
    a. **Extending the exhaust pipe** from the engines to a height of at least one foot (30 cm) above the arena's plexiglass barrier and discharging exhaust gas vertically upwards would enable the hot gases to rise and be diluted.
    b. The **addition of a catalytic converter** on the engine's exhaust is one of the most effective means of reducing CO. In order for the catalytic converter to be effective, an engine warm up time of at least five minutes is required, either outside or exhausted directly outside.
3. **A regular maintenance program** with final engine tuning through CO analysis of exhaust gases is essential to minimize CO levels from gasoline and propane fueled equipment. (Care must be taken when reducing CO levels by carburator adjustment to avoid a corresponding increase in relative amounts of $NO_2$). With diesel fueled vehicles, $NO_2$ and particulates are expected to be more of a concern than CO. Adjustments should be made to maintain the lowest possible emissions.
4. **Ventilation as a control measures:**

    Mechanical or natural ventilation can effectively reduce concentrations of air contaminants in an arena. There are advantages to both methods of ventilation, and therefore, each facility may incorporate measures best suited to their particular situation.

    **a. Natural Ventilation**

    Natural ventilation is provided by doors, and/or any opening within the structure which will allow for an exchange of air. It is also dependent on many environmental conditions (i.e. wind velocity, temperature, etc.). Caution should be used as to not allow outdoor contaminants such as exhaust from idling vehicles to enter the building.

There is little control with this type of ventilation, but there are steps which can increase the efficiency of combustion product removal during resurfacing operations:

i) Opening exterior doors and/or make-up air louvers provides an added source of fresh air during ice resurfacing.

ii) Opening resurfacer entrance doors (onto the ice surface and to the outside) during resurfacing will create air movement within the confines of the ice boards.

**b. Forced Mechanical Ventilation**

In new airtight arenas, there is a need for a more controlled method of exhausting and supplying air to supplement natural ventilation. Mechanical ventilation has the advantage of being an operator controlled system. In order for the ventilation to be effective:

i) The system switch must be turned on and operating effectively,

ii) The air flow distribution must be adequate to avoid dead spaces,

iii) The air flow volume must be capable of preventing the accumulation of toxic gases to an unsafe level,

iv) The air that is introduced in the building must be free of outside air contaminants.

The amount of mechanical ventilation required depends on:

- The frequency of the resurfacing operations,
- Air distribution inside the building,
- The combustion gases emitted from the equipment (usually CO is used as a benchmark),
- The internal size of the arena,
- Whether the arena will be used continuously or only during a few hours every day.

Adequate air volume replacement should be delivered at the opposite end of the arena from the exhaust to ensure an air flow along the entire length.

# Air Quality Testing

An effective air quality testing program should be carried out on a regular basis. Accurate testing equipment and records of results should be on-hand. Staff should be trained in air testing equipment use.

It is recommended that:

1. A **regular check** of **exhaust gases** from the equipment be performed,
2. A **regular check** of the **air inside the arena after the ice is flooded**, at least once a week and more frequently during periods of heavy use, such as tournaments.
    - Measurements should be taken in areas where people are likely to be exposed at their breathing zone level:
        - ✓ Various established areas on the ice surface at a height of about 1 meter,
        - ✓ Players' benches,
        - ✓ Dressing rooms,
        - ✓ Bleachers,
        - ✓ Concession area.
3. Periodic calibration of the air testing equipment should be performed as per the manufacturer's guidelines.
4. A review of the measurements should be done by staff to determine if the implemented control measures are effective, and to determine if further corrective actions are necessary.

After testing over a few weeks, the areas of greatest concern inside the arena will likely be identified.

It is recommended that once established, methods and locations for air quality monitoring should remain consistent. In addition, a written record of air quality testing should be maintained in a logbook.

# Measurement Devices

There are simple measurement devices on the market that can provide the concentration of CO and $NO_2$ with +/- 5% accuracy. Most measurement devices give instant digital readings. Some devices are capable of connecting to a computer for analyzing the data and printing. Some devices will monitor up to twenty-four hours per day.

Permanently installed CO detectors can be used but are the most expensive solution. They should be of an industrial quality. This type of testing equipment is available from local workplace safety equipment suppliers. Permanent CO detectors purchased at the local hardware store are not recommended as they do not provide a measurement but will only trigger an alarm at a level of CO set by the manufacturer. They are not designed to operate in a cold and damp environment such as arenas. They also lack accuracy.

Gas detector glass tubes are not recommended. They offer low precision. Levels can be difficult to read.

# Staff Training

Facility staff must be properly and regularly trained in the following areas:

- Use and maintenance of ice resurfacing equipment,
- Ice maintenance best practices,
- Awareness of hazards and the symptoms associated with excessive exposure to CO and $NO_2$,
- Use and maintenance of air quality testing equipment,
- Emergency procedures with respect to high levels of CO and $NO_2$,
- The measuring and recording of air quality data.

# Contact Information

### During regular hours:

In case of illness in your arena, please **dial 911 first**, then call your Regional Health Protection Branch Office (numbers are listed below) to report the incident or evacuation.

For routine questions or concerns during regular hours, call your Regional Health Protection Branch Office:

**Central Region**
Fredericton.....506-453-2830
Perth-Andover.....506-273-4715
Woodstock.....506-325-4408

**South Region**
Saint John..... 506-658-3022
St. Stephen..... 506-466-7615
Sussex.....506-432-2104

**North Region**
Bathurst..... 506-549-5550
Campbellton..... 506-789-2549
Caraquet..... 506-394-4728
Edmundston.....506-737-4400
Grand Falls.....506-737-4400
Shippagan.....506-394-4728
Tracadie-Sheila.....506-394-4728

**East Region**
Moncton..... 506-856-2814
Miramichi..... 506-778-6765

**After Hours:**
In case of illness in your arena, please **dial 911 first** and then report the incident or evacuation to **811** afterwards.

# Resources:

Ontario Recreation Facility Association:
http://www.recconnections.com/docs/AirQualityGuidelinesforArenasORFA.pdf

Air Quality Guidelines for Arena Operations in Manitoba, February 18, 2009
http://www.gov.mb.ca/health/publichealth/environmentalhealth/protection/aaq.html

Recreation Facility Association of Nova Scotia
http://www.recconnections.com/docs/AirQualityGuidelinesforArenasNovaScotia.pdf

Guide de sécurité et de prévention dans les arénas ; Québec
http://collections.banq.qc.ca/ark:/52327/bs51990